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EVALUATION OF NEW INBRED LINES AND THEIR HYBRIDS IN BALADY SQUASH VARIETY (*Cucurbita pepo* L.)

El-Gazzar, T. M. ; E. A. Tartoura and M. M. Nada
Vegetables and Floriculture Dept., Fac. Agric., Mansoura Univ., Egypt.

ABSTRACT

In this investigation three inbred lines which were desired from Balady squash population by selection and their 6 F_1 hybrids including reciprocal were used as genetic materials. The inbred lines and their F_1 hybrids included reciprocal hybrids were evaluated for some economic traits; vegetative growth, flowering and earliness as days to first female flower anthesis, fruit, as well as yield and its component traits in field trial during 2014 summer season. The result of mean values showed that no parental line was superior for all studied traits. Meanwhile, the parent P_3 exhibited the best values for most studied traits. As well as, the obtained results showed that the highest values recorded in the F_1 hybrids compare with their parents (inbred lines) were; i.e., P_3xP_2 for earliness and sex ratio, P_3xP_2 for fruit number per plant, P_1xP_3 for total yield per plant. As well as, P_1xP_2 for total soluble solid and dry weight of fruits, P_2xP_3 and P_3xP_1 for ascorbic acid content. These crosses could be used as commercial cultivars which may compete with imported hybrids. Moreover, their parents (stable inbred lines) which exhibited best combinations for previous traits could be used in breeding program according to their objectives.

INTRODUCTION

Summer squash (*Cucurbita pepo* L.) is considered one of the most favorable and common vegetable crops grown in Egypt, as well as, in other countries. Summer squash are the edible immature fruits of *Cucurbita pepo* L., a highly diverse species of the gourd family, *Cucurbitaceae*. Summer squash are an easy-to-grow, short season to crop best adapted to temperate and subtropical regions Prohens and Nuez (2008). It's cultivated under open field and in greenhouses conditions. Therefore, it's available in the market all over the year. In Egypt, Pumpkins, squash and gourds harvested area 29824 ha (71009.57 Fed), yielded 182180.12 hg/ha (7651.56 kg/Fed) and gross production 543334.00 tonnes, FAO (2013). All the area is cultivated with imported seeds with high cost. It is therefore necessary to improve local squash hybrids with good fruit quality and resistance to certain diseases Hussein *et al.* (2013).

Summer squash *Cucurbita pepo* (2n=20) has a wide range of variability. It is an interesting crop plant for genetically studies. Many of the genetic variations that have arisen were perpetuated for their horticulutural values and rich reservoir of genetic diversity. Cucurbits including squash have been cultivated over countries. Squash fruits are used for local consumption. Squash fruits contain some nutritional compounds for human feeding such as moderate quantity of mineral salts, little quantity of vitamins, i.e., A, B and C Prohens and Nuez (2008). The strategy for breeding F_1 hybrid squash is to develop parental lines through self-pollination. However, it increases plant mean homozygosis, which is not the natural genetic state of a cross-pollinated species, and can cause, somewhat, “inbreeding depression’’

Cardoso (2004)**.** The performances of most $F_{1,1r}$ hybrids of summer squash were variable and the results cleared that no hybrid was the best all for earliness traits El-Adl *et al.* (2014). Similar to the superior individual performance, parental selection for crosses can take into account high adaptability traits and yield stability. Considering these points, the selection of parents is also highly important for breeding programs aiming for a broader area of coverage, mainly for locations that show distinct soil and climate conditions Ivandro *et al*. (2014)**.** Major breeding goals for squash improvement are non-bitterness and larger fruit size, fruit shape and color variation, bush growth habit, less branching, femaleness, earliness, the zucchini fruit type, F_1 hybrids Prohens and Neuz (2008).

The main objective of this study was to improve heterozygous Balady squash variety by selection for individual plants to produce improved inbred lines and crossing them to obtained F_1 hybrid which evaluated for some economic traits to determine the best genotypes for commercial production. Also, to show the best genotypes could be used in the program of squash breeding.

MATERIALS AND METHODS

In this investigation three inbred lines which were derived from Balady squash population by selection and their 6 F_1 hybrids including reciprocals were used as genetic materials. The experiment was designed in a randomized complete block design with three replicates. Each replicate consisted of 9 plots which included: 3 inbred lines (parents) and their 3 F_1 hybrids, 3 F_{1r} hybrids. The plot was one ridge 5 m long and 1.6 m wide. The distance between hills was 0.5 m with each ridge contained 10 hills. Seeds were hand planted at the rate of 4 seeds per hill. After full germination, plants were thinned to one plant per hill. Each plot had 10 plants divided into two groups equally; five plants were used for measuring vegetative traits whereas the other five plants were used for flowering and fruit traits. Normal culture practices as; soil preparation, fertilizer application and other field practices for squash crop were followed according to the instruction laid down by Egyptian Ministry of Agriculture.

Data were recorded on five plants within plot on the following traits: Vegetative traits; Plant length (cm) (from the crown base to the top of the plant in the end of the season), Internode length (cm), Leaf number per plant, Leaf area (cm^2), Total Chlorophyll in leaves (mg/g), were calorimetrically determined as described by Mackinney (1941). For studying flowering behavior, five plants from each plot were chosen and labeled to determine the following data, such as node number of the first female flower, days to first female flowers anthesis, sex ratio. As well as, Fruit traits were determined by measuring the following traits on harvested fruits per plot during harvested season as; Fruit length (cm), Fruit diameter (cm), Fruit shape index, Average fruit weight (g). Also, yield and yield components traits were measured on five plants per plot on the following traits; Fruit number per plant, Fruit yield per plant (kg). Dry weight of fruits (%), samples of 100g from fresh fruits were oven dried at $70C^o$ for 72 hours till a constant dry weight.

Ascorbic acid contents in immature fruit stage as mg/100g fresh weight Rangana (1979). Total soluble solid content (%) determine by Abbe hand refractometer according to the method of A.O.A.C. (1990).

Differences among genotypic means for all traits were tested for significance using F-test according to Steel and Torrie (1960), The means of these observations for genotypes were separated using LSD at 0.05 level of probability (SAS program, V 9.1, 2005).

RESULTS AND DISCUSSION

In this investigation, the means of all studied traits for all genotypes; 3 parents (inbred lines), 3 F_1 hybrids and 3 F_{1r} reciprocal hybrids were calculated for comparison of the differences among them. The performance of these genotypes evaluated for vegetative and some economic traits as follow:

Vegetative traits

Data of vegetative traits represented in Table 1 show significant differences among squash genotypes for plant length, leaf number per plant, internode length, leaf area and total chlorophyll in leaves**.**

Table 1: Mean performance of parental lines and their F_1 hybrids for vegetative traits

Traits Genotypes	Plant Length (cm)	Leaf number /plant	Internode length (cm)	Leaf area (cm^2)	Total chl. In leaves (mg/g)
Parents (inbred lines)					
P_1	98.67f	30.27e	3.27de	931.87a	3.14ab
P_2	177.60a	34.47bc	5.16a	734.46b	2.93cd
P_3	112.07d	35.73bc	3.14ef	369.52f	3.31a
F_1 hybrids, F_{1r} reciprocal hybrids					
P_1xP_2	110.53de	31.93de	3.47cd	642.22bc	2.72e
P_1xP_3	102.20ef	33.60cd	3.04f	485.30de	2.98bc
P_2xP_3	151.47b	38.00a	3.99b	563.71cd	2.97bc
P_2xP_1	124.87c	32.00de	3.91b	535.96de	2.76de
P_3xP_1	104.13def	31.53de	3.30de	449.58ef	3.07bc
P_3xP_2	128.87c	35.93ab	3.59c	382.78f	2.97bc
LSD 5%	8.97	2.14	0.22	96.11	0.21

Means having the same letter in the same column are not significantly different (L.S.D, 0.05 level of probability).

The means of vegetative traits were obtained for all genotypes parents, F_1 hybrid and F_{1r} reciprocal hybrids. The means showed that no specific parent was exceeded all other parental lines for all studied vegetative traits. However, parental line P_2 exhibited the highest values for plant length (177.60 cm) and internode length (5.16 cm), while the inbred line P_3 was the highest parent for leaf number / plant (35.73) and total chlorophyll in leaves (3.31 mg/g), but the parent P_1 (931.87 cm^2) was the greatest one for leaf

area. On the other hand, the parent P_3 (3.14 cm) was the best parent for internode length (desirable). While, the parent P_1 had the lowest values for plant length (98.67 cm) and leaf number / plant (30.27). Also, the parent P_3 and P_2 gave the lowest values for leaf area (369.52 cm^2) and total chlorophyll in leaves (2.93 mg/g), respectively.

Concerning F_1 and F_{1r} reciprocal hybrids, data in Table 1 showed that most of the means were distributed around the mid of their parents but the cross P_2xP_3 was considered the best for all traits; 151.47 cm, 38.00 and 2.97 mg/g for plant length, leaf number / plant and total chlorophyll in leaves, respectively. Except for internode length it gave the highest value (3.99 cm, undesirable). On the other hand, the best cross for Internode length was P_1xP_3 (3.04 cm) which less than all parents and P_1xP_2 for leaf area (642.22 cm^2). These finding agree with those obtained by El-Gendy (1999), Gabr (2003), Sadek (2003), Abdein (2005), Refai and Mohamed (2009), Moualla *et al.* (2011), Omran *et al.* (2012), Mohan *et al.* (2012).

Flowering traits

Data presented in Table 2 indicated that there were significant differences among all studied genotypes for flowering and earliness traits.

The results listed in Table 2 clearly showed that parental inbred line P_3 was the better line for all traits which gave the lowest values (desirable) 5.20, 45.33 and 1.87 for node number of first female flower, days to first female flower anthesis and sex ratio, respectively. On the other hand the parent P_1 had the highest values for all traits which mean that it was late flowering parent.

Table 2: Mean performance of parental lines and their F_1 hybrids for earliness and flowering traits

Traits Genotypes	Node number of first female flower	Days to first female flower anthesis	Sex Ratio
Parents (inbred lines)			
P_1	7.27a	50.60a	2.17a
P_2	6.13bc	45.53bc	1.95cd
P_3	5.20d	45.33bc	1.87de
F_1 hybrids, F_{1r} reciprocal hybrids			
P_1xP_2	6.27bc	42.93de	2.02bc
P_1xP_3	7.13a	43.00de	2.10ab
P_2xP_3	6.73ab	41.47e	1.98cd
P_2xP_1	6.00c	46.87b	1.99bc
P_3xP_1	5.93c	44.53cd	1.95cd
P_3xP_2	4.87d	39.60f	1.82e
LSD 5%	0.71	1.62	0.11

Means having the same letter in the same column are not significantly different (L.S.D, 0.05 level of probability).

Regarding F_1 hybrids and their F_{1r} reciprocal hybrids, data represented in Table 2 indicated that the hybrid P_3xP_2 was earlier than all other hybrids and parents, as well as it had the lowest values for node number to first female flower (4.87) and days to first female flower anthesis

(39.60)., and less than its reciprocal. In addition it had the best value for sex ratio (1.82) which mean expected high number of fruits and yield per plant. Many workers found also significant differences among squash regarding flowering and earliness traits among them, El-Gendy (1999), Ercan and Kurum (2003), Gabr (2003), Sadek (2003), Abdein (2005), Refai and Mohamed (2009), Ghobary and Ibrahim (2010), Moualla *et al.* (2011), Shamloul and Askar (2011), Mohan *et al.* (2012), Jahan *et al.* (2012), El-Adl *et al.* (2014).

Fruit characteristics

Fruit traits were measured by several characteristics. Significant variation was detected among genotypes for fruit length, fruit diameter, fruit shape index, and average fruit weight.

Concerning squash parent, data presented in Table 3 show that the means had significant variation among parents for all traits. The result showed that no specific parent is superior or inferior for all traits which arranged from 10.37 (P_1) to 12.41 cm (P_3), 3.45 (P_2) to 4.29 cm (P_1), 2.42 (P_1) to 3.18 (P_3) and 94.733 (P_1) to 98.813 g (P_3) for fruit length, fruit diameter, fruit shape index and average fruit weight, respectively.

Table 3: Mean performance of parental lines and their F_1 hybrids for fruit traits

Traits Genotypes	Fruit length (cm)	Fruit diameter (cm)	Fruit shape Index	Average fruit weight (g)
Parents (inbred lines)				
P_1	10.37d	4.29abc	2.42c	94.733bc
P_2	10.84d	3.45e	3.14a	87.563c
P_3	12.41b	3.91cd	3.18a	98.813b
F_1 hybrids, F_{1r} reciprocal hybrids				
P_1xP_2	10.34d	4.63a	2.23d	98.117b
P_1xP_3	13.70a	4.31ab	3.18a	109.193a
P_2xP_3	10.95cd	4.00bcd	2.74b	94.080bc
P_2xP_1	11.25cd	4.19bcd	2.68b	97.320b
P_3xP_1	12.49b	3.85d	3.24a	98.350b
P_3xP_2	12.01bc	4.27abc	2.82b	101.430ab
LSD 5%	1.20	0.39	0.19	8.53

Means having the same letter in the same column are not significantly different (L.S.D, 0.05 level of probability).

Regarding the means of F_1 hybrids including reciprocal indicated that there were significant differences among crosses. The cross P_1xP_3 obtained the best values for most traits. The highest values were 13.70 cm P_1xP_3, 4.63 cm P_1xP_2, 3.24 P_3xP_1 and 109.19g P_1xP_3 for fruit length, fruit diameter, fruit shape index and average fruit weight, respectively. Similar results were reported by El-Gazzar (1981), El-Gendy (1999), Abd El-Hadi *et al.* (2001), El-Lithy (2002), Ercan and Kurum (2003), (2003), Gabr (2003), Sadek (2003), Abdein (2005), Refai *et al.* (2009), Ghobary and Ibrahim (2010), Shamloul and Askar (2011), Jahan *et al.* (2012), Omran (2012), Mohan *et al.* (2012)

who showed that there were significant differences among the genotypes of squash and cucurbits in fruit characteristics.

Yield and its component

In respect with yield and its component, the results of yield components are consisted of ascorbic acid content, total soluble solids, dry weight of fruit, fruit number per plant and fruit yield per plant, presented in Table 4. The means of genotypes showed that there were significance differences among genotypes for all traits.

Regarding parental inbred lines, the results showed that the inbred line P_3 gave the highest values for all traits. Therefore, The parent P_3 consider the superior line for all traits and scored 16.80 mg/100g, 5.83 %, 6.27 %, 12.47 and 1.23 kg for ascorbic acid content, total soluble solids, dry weight of fruit, fruit number per plant and fruit yield per plant, respectively.

Concerning F_1 hybrids and F_{1r} reciprocal hybrids (Table 4), data indicate that there were significant differences among the means of crosses for all traits except for fruit number per plant which was not significant. The results cleared that no specific cross exceed their parents for all traits, but most of them exceeded their parent in some others. As well as, the values of crosses ranged from 15.68 (P_1xP_3) to 20.16 mg/100g (P_2xP_3, P_3xP_1) for ascorbic acid content, 4.19 (P_2xP_3) to 5.95% (P_1xP_2) for total soluble solids, 5.79 (P_2xP_3) to 7.00 % (P_1xP_2) for dry weight of fruit, 11.40 (P_1xP_2) to 13.00 (P_3xP_2) for fruit number per plant and 1.12 (P_1xP_2) to 1.32 kg (P_3xP_2) for fruit yield per plant. Many investigators, El-Gazzar (1981), El-Gendy (1999), Abd El-Hadi *et al.* (2001), El-Lithy (2002), Gabr (2003), Sadek (2003), Abdein (2005), Refai and Mohamed (2009), Ghobary and Ibrahim (2010), Shamloul and Askar (2011), Moualla *et al.* (2011), Feyzian *et al.* (2009), Omran *et al.* (2012), Jahan *et al*. (2012) and Mohan *et al.* (2012) found highly significant differences among squash genotypes for these traits.

Table 4: Mean performance of parental lines and their F_1 hybrids for yield and its component traits

Traits / Genotypes	Ascorbic acid content (mg/100g)	Total soluble solid (%)	Dry weight of fruit (%)	Fruit number /plant	Fruit yield / plant (kg)
Parents (inbred lines)					
P_1	15.31d	4.63f	5.24c	9.00b	0.85e
P_2	16.43cd	4.23g	5.06c	11.33a	0.97de
P_3	16.80c	5.83ab	6.27ab	12.45a	1.23abc
F_1 hybrids, F_{1r} reciprocal hybrids					
P_1xP_2	18.29b	5.95a	7.00a	11.40a	1.12cd
P_1xP_3	15.68cd	5.15e	6.79ab	12.53a	1.36a
P_2xP_3	20.16a	4.19g	5.79bc	12.80a	1.20abc
P_2xP_1	18.67b	5.60bc	6.33ab	11.67a	1.13bcd
P_3xP_1	20.16a	5.24de	6.69ab	11.47a	1.13cd
P_3xP_2	19.60ab	5.40cd	6.92a	13.00a	1.32ab
LSD 5%	1.48	0.23	1.00	1.96	0.19

Means having the same letter in the same column are not significantly different (L.S.D, 0.05 level of probability).

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تقييم السلالات الجديدة والهجن الناتجه منها فى الكوسة البلدى

طه محمد الجزار ، السيد احمد طرطورة و محمد مسعد ندا.
قسم الخضر والزينه – كلية الزراعة – جامعة المنصورة.

قد أجريت تجربه حقليه لتقييم الأباء (السلالات الجديدة الناتجة من التربية الذاتية للكوسة البلدى) والهجن الناتجه منها بنظام التزاوج الدائرى فى موسم صيف ٢٠١٤ لبعض صفات النمو الخضرى، الزهرى، الثمرى، المحصول ومكوناته. وأظهرت النتائج وجود اختلافات معنويه بين التراكيب الوراثية محل الدراسة لجميع الصفات المدروسه، وكانت أهم النتائج المتحصل عليها تتمثل فى التالى:

بدراسة متوسطات الاباء (السلالات النقية المنتخبة) فى هذه الدراسة اثبتت النتائج أنه لا يوجد اب واحد يتفوق على كل الاباء لجميع الصفات المدروسة واظهرت النتائج ان الاب P_3 كان ذات متوسطات افضل لمعظم الصفات خاصة صفات المحصول وصفات التبكير فى الازهار.

بالنسبه لهجن الجيل الأول سجل الهجين P_1xP_3 أعلى القيم للمحصول الكلى للنبات، وسجل الهجين P_3xP_2 أعلى القيم لعدد الثمار الكلى للنبات. فى حين سجل الهجين P_3xP_2 افضل القيم بالنسبه للتبكير فى الازهار. اما بالنسبه لصفات الجودة سجلت الهجن P_2xP_3 ، P_3xP_1 أعلى القيم بالنسبه لمحتوى الثمار من حمض الأسكوربيك. بينما سجل الهجين P_1xP_2 اعلى القيم للمادة الجافة وللمواد الصلبه الذائبه الكليه فى الثمار.

ومن النتائج السابقة يتضح لنا انه من الممكن عزل سلالات متجانسه وراثيا يمكن استخدامها كأصناف تجارية جديدة، أو ادخالها فى برامج التربية كأباء وانتاج الهجن المتفوقة كما تم اجراءه فى هذه التجارب، وترجع اهمية هذه الدراسة الى محاولة استخدام الكوسة البلدى (صنف محلى) كأصل وراثى عالى الأقلمة للظروف البيئية و كمصدر لبعض جينات المقاومة والتحمل للظروف البيئية المختلفة على المستوى المحلى وبذلك يكون احد المصادر فى برامج التربية لزيادة الانتاجيه ولمقاومة الامراض و الاقلمة للظروف البيئية فى الكوسة.