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COMBINING ABILITY FOR SOME CHARACTERS IN SUMMER SQUASH (*Cucurbita pepo* L.).

Abou El–Nasr, M. E.[1]; M. H. Tolba [2] and H. M. I. Ahmed [2]

1- Cucurbits and Cross Pollinated Vegetable Crops Dept., Horticulture Res. Inst., Agric. Res. Center, Giza, Egypt.

2- Vegetable Crops Seed Production and Technology Dept., Horticulture Res. Inst., Agric. Res. Center, Giza, Egypt.

***Corresponding Author e-mail: hamdino@yahoo.com**

ABSTRACT

These experiments were carried out at El-Baramon Horticulture Res. Station of Horti.Res. Institute , during the two successive summer seasons of 2008 and 2009. Five inbred line selected from Eskandrani cultivars differing in some economical traits, i.e., number of internodes to the first female flower ,early yield fruit weight and number),total yield fruit weight and number ,plant vigor and leaf area ,were chosen as original plant materials in this study . In summer season 2008 , the five parents were crossed in the field and their all possible crosses ,without reciprocal , to obtain the experimental materials .The F_1 crosses and their parental lines were planted in the field experiment in the second season 2009 .The objective of this study was to determine the different types of gene effect in terms of general and specific combining abilities (GCA and SCA)regarding some characters viz ,number of internodes to the first female flower ,early yield as fruit number and weight ,total yield as fruit number and weight per plant and leaf area .This knowledge about the sort of genetics would be helpful to the plant breeder for planning a successful breeding program.

The obtained results could be summarized as follows :

1- Highly significant differences for general and specific combining abilities for all studied characters were found .

2- The estimated ratio between GCA and SCA mean squares suggested that the additive gene effects have the main role in the inheritance of all studied characters expect the nods of first female flower appearance and sex ratio.

3- Obtained values of GCA for the studied traits in each of studied parental lines showed that the inbred lines P_1 and P_2 are the best of all since it showed significant GCA values for all studied traits, followed by inbred line P_3.

4- A critical examination of data obtained on SCA effects for F_1 hybrids showed that the best crosses were P_1 X P_3, P_2 X P_4, P_2 X P_3, since they showed significant SCA effect values for all evaluated characters. Accordingly, these superior and prospective materials can be used in summer squash improvement through breeding programs.

Keywords: General and specific combining abilities, parental lines, additive and non additive effect.

INTRODUCTION

Cucurbits play a significant role in human nutrition, especially in tropical and Mediterranean countries .In Egypt, the acreage of summer squash (*Cucurbita pepo* L.).in 2008 was 102715 feddan and total production of summer squash was 1181527 ton, with average of 11.500 ton / feddan. The nature of gene action of the quantative traits should be investigated with respect to the relative magnitudes of additive and non – additive gene action

represents the major components of the total genetic variation, a maximum progress would be expected in selection programs. Additive and non- additive genetic effects could be determined from estimates of GCA and SCA ,respectively. The improvement and producing of local summer squash hybrids may be achieved through a successful hybridization program.

Many investigators conducted research on GCA and SCA for nodes to first female flower appearance, among them, Sachan and Nath,(1976) who studied the combining abilities in a complete set of diallel crosses involving watermelon .The results showed that GCA and SCA effects were significant for number of days to the first female flower anthesis . Fredrick and Staub, (1989) found that the both GAC and SCA mean squares were significant for days to anthesis in cucumber. Gharib, (1991) and Hatem, (1992) showed that the mean square for GCA and SCA showed highly significant for days to anthesis of the first female flower in cucumber and melon, Kamooh, (2002) and Ahmed *et al.*,(2003) showed that the mean square for GCA and SCA showed highly significance for days to anthesis of the first female flower in squash .Moreover ,variance of SCA for F_1 crosses was greater than the GCA .El-Mahdy *et al*., (1992) reported that both GCA and SCA were significant for time needed to female flower ring in cucumber .Therefore, the additive and non- additive gene effects were important in the inheritance of this trait. Waddid,(1996), Hatem *et al*., (2009) found that GCA and SCA were highly significant for days to the first female flower in cucumber and melon.

Abd El-Mageed (1989), Arora *et al*., (1996) Lopez-Anido *et al*.,(1998) and Abd El-Hadi *et al*.,(2005) found significant effects for both GCA and SCA for early and total yield per plant in squash. Therefore, El-Mighawry,(1998) and Hatem *et al*.,(2009) showed that GCA was greater than SCA for early and total yield in melon ,suggesting that additive variance was more important than non –additive .

Several studies were conducted on GCA and SCA effects for sex ratio in cucurbits .Abd El-Hadi *et al*.,(2005) and Hatem *et al.,* (2009), reported that the dominance genetic variance was more important than the additive one for this traits in squash and melon.

Combining ability was studied for leaf area in watermelon by Salim,(1989) and Khalil *et al*., (1990) .The estimated F values for both GCA and SCA were found to be highly significant for this trait , indicating the importance of both additive and non-additive gene effects in the inheritance .However , the additive gene effects were much higher than those of the non-additive in the inheritance of leaf area .Hatem, (1992)reported that the variance associated with GCA and SCA were highly significant .These obtained results indicated that the total leaf area in melon is controlled by additive and non-additive genes. The mean squares for GCA were much higher than for SCA .Ratio between GCA / SCA mean squares showed that the additive components of genetic variance to be 2.66 times higher than the non-additive components.

Therefore, this study was conducted to determine information about the relative importance of the different types of gene actions (general and specific combining abilities) in the inheritance of some characters of summer squash.

MATERIALS AND METHODS

The present investigation was carried out at El-Baramon Horticulture station of Hort.Res. Institute, during two successive summer seasons of 2008/2009 .Five inbred lines of summer squash (*C. pepo* L.) were found among the local Eskandarany cultivar ,which have been designated as P_1, P_2, P_3, P_4 and P_5 .This group of the parental Eskandarany cultivar differed in some economical traits .

These parental lines were obtained from vegetable Research Department at Dokki, Giza, Egypt.These parental lines had a high degree of homozygosity since they were previously selfed for four generations.

In the summer season of 2008, the five parental lines were planted in the field on March first and their all possible crosses, in one direction without reciprocals, were made to generate the experimental materials (F_1 combinations).

The 15 genetic population viz.,5 parental lines and 10 F_1 hybrids ,were planted in 2009 summer season in the field on March 3rd for measuring the different types of gene effects in the terms of general and specific combining abilities (GCA and SCA) in summer squash .A randomized complete blocks design with three replicates was adopted .Each plot contained three rows each of 5.00 m long and 0.70 m wide ,ten plants were grown in each row. The standard culture practices were applied in the two experimental seasons.

The studied characters were:

1- Number of nod to first female flower appearance: as mean of all plants for each replicate.
2- Early yield as fruit number and weight (kg / plant) in the first 10 days of harvesting.
3- Total yield as fruit weight (kg): It was calculated as the mean of all plants per plot.
4- Sex ratio: It was determined for three at random plants from each plot for each genotype, (Total number of male flowers / Total number of female flowers appearance).
5- Leaf area per plant at stage flowering and fruit set: fresh and dry weight and surface area of leaves per plant were determined by cutting out twenty leaf discs from each plant using a cork borer and drying them in an oven at 70 C^0 for 4 days .Based on knowing dry weight of known surface area of leaves, viz, leaf discs, and the total dry weight of leaves; leaf surface area / plant was determined.

Statistical procedures:

1- Analysis of variance was made in order to test the significance of the differences among the means of tested populations as shown by Cochran and Cox (1957). Differences among all characters were tested for significant according to the least significance differences (L.S.D).
2- The analysis of general and specific combining abilities was done according to method (2) model (1) Griffing, (1956).

RESULTS AND DISCUSSION

General and specific combining abilities (GCA and SCA) were measured to determine the additive and non-additive gene effects for the studied traits .The analysis of variance of GCA and SCA for the studied traits is shown in Table (1) .

Table (1): Mean squares for general and specific combining abilities (GCA and SCA) for all studied traits.

Traits and source of variation	M.S	GCA / SCA
Number of node to first female flowers		
GCA	2.838**	**0.868**
SCA	3.271**	
Early yield (number of fruit /plant)		
GCA	7.130**	**5.317**
SCA	1.341**	
Early yield (fruit weight /plant)		
GCA	8.285**	**5.172**
SCA	1.602**	
Total fruit weight / plant		
GCA	13.030**	**10.593**
SCA	1.230**	
Sex ratio		
GCA	4.338**	**0.941**
SCA	4.612**	
Leaf area		
GCA	10.703**	**6.986**
SCA	1.532**	

***: Significant at 0.05 level of probability according to the "T" test.**
****: Significant at 0.01 level of probability according to the "T" test.**

The variances associated with both GCA and SCA were highly significant for all studied herein traits .This result suggested that both additive and non-additive genes effects are involved in the inheritance of these quantative traits .The ratio between the mean squares of GCA and SCA showed that the additive component of genetic variance played the main role in the inheritance of all studied characters , expect number of node of to first female flower appearance and sex ratio .The ratio between GCA and SCA for the two previous characters were 0.868 and 0.941 , respectively ,suggesting that they are controlled by dominant and epistatic gene effects .These results confirm those reported by Gharib (1991), Hatem (1992) ,Lopez-Anido *et al*., (1998) ,Kamooh ,(2002) , Ahmed Ibn Oaf and Jack (2003) ,Abd El-Hadi *et al* ., (2005) and Hatem *et al* ., (2009).

1-General Combining Ability (GCA) Effects :

The comparison among the effects of GCA of the compared genetic population are listed in Table (2). Highly significant negative GCA effect were shown by the parental lines P_1,P_2 and P_3 for number of node to first female flower appearance .Their GCA estimated values were -2.823 , -1.921 and -

0.935 ,respectively .Regarding the early yield as fruit number per plant ,the estimated GCA effects showed that the first three parental lines P_1,P_2 and P_3 gave significant positive GCA values (1.852 , 1.953 and 0.921 ,respectively),for fruit number, GCA values were 0.924 , 0.972 and 1.475 , respectively ,for early yield as fruit weight/plant .These results suggest that these three parental lines could be considered as the best combiners and may be possessing genes for early yield ,Table (2) . On the other hand the parental lines P_4 and P_5 showed positive effects with 3.562 and 2.117 ,respectively ,for number of node to first female flower appearance. The same two parents P_4 and P_5 reflected the values were -2.231 and -2.495 respectively ,for early yield as number of fruit / plant and -0.981 and -2.390 respectively ,for early yield as fruit weight .These parental lines may be possessing genes for late yield .

Examination of GCA effect values illustrated in Table (2) showed that also three parental lines P_1,P_2 and P_3 are the best combiner for breeding to total fruit weight / plant .

Table (2): Estimates of general combining ability (GCA) effects for the parental lines regarding some traits in summer squash.

Traits / Parental Lines	Number of node to first female flowers	Early yield (number of fruit /plant)	Early yield (fruit weight /plant)	Total fruit weight / plant	Sex ratio	Leaf area
P_1	-2.823**	1.852**	0.924*	2.531**	-1.346**	2.631**
P_2	-1.921**	1.953**	0.972**	1.546**	-1.724**	3.245**
P_3	-0.935**	0.921*	1.475**	0.784*	-0.474	1.621**
P_4	3.562**	-2.231**	-0.981**	-5.227**	4.029**	-5.331**
P_5	2.117**	-2.495**	-2.390**	0.366*	-0.485*	-2.166**

***: Significant at 0.05 level of probability according to the "T" test.**
****: Significant at 0.01 level of probability according to the "T" test.**

They showed the highest values (2.531, 1.546 and 0.784, respectively). On the other hand, the other two parents are the poorest combiner for breeding to high yield, since they exhibited negative values (-5.227 and -0.366, respectively). Three parental lines P_1, P2 and P_5 reflected the highest negative GCA values (-1.346, -1.724 and -0.485, respectively, for sex ratio. These results suggest that these three parental lines could be considered as the best combiner and may be possessing genes for highly female flower appearance.

Regarding the leaf area ,estimated GCA effects showed that the three parental lines P_1,P_2 and P_3 gave significant positive GCA effects with 2.631 , 3.245 and 1.621 ,respectively .These results suggest that these three parental lines could be considered as the best combiner and may be possessing genes for light leaf area .On the other hand ,the parents P_4 and P_5 showed negative effects with -5.331 and -2.166 ,respectively ,for leaf area These results suggest that these two parents may be possessing genes for heavy leaf area . In general, the parental lines P_1, P2 and P_3 were the best general combiner of the parents, since they showed significant GCA values for all of studied characters .The three parental lines exhibited high effects for all traits.

1-Spesific Combining Ability (SCA) Effects :

Regarding number of node to first female flower appearance ,the combination P_1 X P_2, P_1 X P_3 , P_1 X P_4 , P_1 X P_5 , P_2 X P_3 , P_2X P_4 , P_2 X P_5 and P_3 X P_4 , showed significant negative SCA values (-2.531 , -2.304 , -1.425 , -0.622 ,-3.104 , -1.520 , -1.241 and -2.45 , respectively) ,Table (3) .

Table (3) : Estimates of specific combining ability (SCA) effects for some traits in summer squash.

Parental lines	Characters	SCA				
		P1	P2	P3	P4	P5
P1	Number of node to first female flowers		-2.531	-2.304**	-1.425*	-0.622*
	Early yield(number of fruit /plant)		3.614**	2.564**	1.365*	0.412
	Early yield(fruit weight /plant)		2.641**	1.850**	1.362**	1.621**
	Total fruit weight / plant		1.215*	2.331**	3.215**	0.621*
	Sex ratio		-3.52**	-2.210**	-0.951*	-0.312
	Leaf area		3.420**	2.625**	0.925*	1.371*
P2	Number of node to first female flowers			-3.104**	-1.520**	-1.241*
	Early yield(number of fruit /plant)			2.410**	1.625**	0.321
	Early yield(fruit weight /plant)			3.504**	2.225**	1.325*
	Total fruit weight / plant			2.647**	1.892**	0.854*
	Sex ratio			-2.530**	-1.521*	-2.354**
	Leaf area			2.111**	0.921*	1.253*
P3	Number of node to first female flowers				-2.456**	-0.352
	Early yield(number of fruit /plant)				2.351**	1.337*
	Early yield(fruit weight /plant)				-1.621**	2.035**
	Total fruit weight / plant				0.921*	1.623**
	Sex ratio				1.352*	0.781*
	Leaf area				0.235	0.310
P4	Number of node to first female flowers					-0.352
	Early yield(number of fruit /plant)					-0.411
	Early yield(fruit weight /plant)					0.357
	Total fruit weight / plant					0.871*
	Sex ratio					-0.416
	Leaf area					1.321*

***: Significant at 0.05 level of probability according to the "T" test.**
****: Significant at 0.01 level of probability according to the "T" test**

These results suggest that these hybrids are good combination for nods to first female flower appearance .Concerning early yield (number of fruit / plant) , seven crosses viz ., P_1 X P_2 , P_1 X P_3 , P_1 X P_4, P_2 X P_3 , P_2X P_4 , P_3 X P_4 and P_3 X P_5 showed significant positive SCA values (3.614 , 2.564 ,1.365 , 2.410 , 1.625 , 2.351 and 1.337 , respectively .Regarding early as fruit weight , nine crosses viz., P_1 X P_2 , P_1 X P_3 , P_1 X P_4, P_1 X P_5 , P_2 X P_3 , P_2X P_4 , P_2 X P_5 , P_3 X P_4 and P_3 X P_5 , showed significant positive SCA values (2.641 , 1.850 , 1.362 , 1.621 , 3.504 , 2.225 , 1.325 , 1.621 and 2.035 , respectively).

These results suggested that these hybrids are good combinations for early yield .Concerning total yield, eight F_1 hybrid viz., P_1 X P_2 , P_1 X P_3 , P_1 X P_4 , P_1 X P_5 , P_2 X P_3 , P_2X P_4 , P_2 X P_5 and P_3 X P_5 , showed significant positive GCA values (1.215 , 2.331 , 3.215 , 0.621,2.647 , 1.892 , 0.845 , 0.921 and 1.623 , respectively, for the total yield as fruit weight . These results suggest that these hybrids are the best combination for high total yield (Table 3).

Concerning leaf area ,eight F_1 hybrids ,viz., P_1 X P_2 , P_1 X P_3 , P_1 X P_4 , P_1 X P_5 , P_2 X P_3 , P_2 X P_4 , P_2 X P_5 and P_4 X P_5 reflected significant positive SCA values (3.420 , 2.625 , 0.925, 1.371 , 2.111 , 0.921, 1.253 and 1.321 , respectively).These results indicated that these crosses are the best combination s concerning high leaf area (Table 3) .

In general ,examination of data concerning GCA effects for the studied parental lines in this investigation ,showed that certain parents gave high effects for certain characters ,but not for all of them .It could be stated that the parental lines P_1 and P_2 showed high significant effects for all studied characters ,followed by inbred line P_3 .These results,generally ,postulated that each of the studied parental lines can be considered as good combiner breeding to several characters .In this respect , the parental lines P_1, P_2 and P_3 are the best of all ,since its showed significant GCA values for most studied traits .

A critical examination of data obtained on SCA effects for F_1 hybrid showed that the best crosses were P_1 X P_2 , P_1 X P_3 , P_1 X P_4 , P_2 X P_3 and P_2 X P_4, since they showed significant SCA effects values for all evaluated characters .

Accordingly, these superior and prospective materials can be used in summer squash improvement through breeding programs.

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القدره على الائتلاف لبعض الصفات فى الكوسة.

محمد السعيد ابو النصر[١] , محمد حامد طلبه[٢] و حمدينو محمد ابراهيم احمد[٢]
١ قسم بحوث القرعيات والخضر خلطية التلقيح – معهد بحوث البساتين – مركز البحوث الزراعية بالجيزة
٢ قسم تكنولوجيا انتاج تقاوى الخضر - معهد بحوث البساتين – مركز البحوث الزراعية بالجيزة

أجريت هذه الدراسه فى الموسمين الصيفيين المتتاليين ٢٠٠٨ و ٢٠٠٩ بمزرعة محطة بحوث البرامون – التابعة لمعهد بحوث البساتين بهدف الحصول على المزيد من الايضاحات فى وراثة بعض الصفات الهامة فى الكوسة وذلك للمساعدة فى اعداد برنامج التربية والتحسين فى الكوسه .واستخدم فى هذه الدراسه خمس سلالات نقية من الكوسة الاسكندرانى (ب١, ب٢, ب٣, ب٤, ب٥) حيث أجرى التهجين بينهم بنظام الداى اليل فى العام الأول للحصول على بذور الجيل الأول اللازمة للدراسة – وفى العام الثانى زرعت الآباء الخمس والعشرة هجن الناتجة فى تجربة صممت بطريقة القطاعات كاملة العشوائية , فى ثلاث مكررات – وأخذت القياسات التالية وهى :-
رقم أول عقدة تحمل زهرة مؤنثة – المحصول المبكر (عدد ووزن الثمار) – المحصول الكلى – النسبة الجنسية – المساحة الورقية .

وبعد تحليل البيانات المتحصل عليها كانت أهم النتائج :-

١- كان التباين لكل من القدرة العامة والخاصة على الائتلاف معنويا لكل الصفات المدروسة مما يؤكد على اهمية كل من الفعل المضيف وغير المضيف للجينات فى وراثة الصفات المدروسة.
٢- أوضحت النسبة المقدرة من متوسط مربعات الانحرافات للقدرتين العامة والخاصة على الائتلاف أن الفعل المضيف أكثر أهمية فى وراثة جميع الصفات ماعدا صفتى رقم أول عقدة تظهر عليها أول زهرة مؤنثة والنسبة الجنسية مما يؤكد على أهمية الجينات غير المضيفة (السيادة) عن الجينات المضيفة فى هاتين الصفتين .
٣- اختلفت السلالات الأبوية فى تاثيرات القدرة العامة على الائتلاف وعموما فان السلالتين (ب١ , ب٢) اظهرتا انهما افضل السلالات حيث اعطت تاثيرات قدرة عامة على الائتلاف لجميع الصفات المدروسة , يليهما السلالة (ب٣) ولهذا يمكن الاستفادة بهم فى برامج التربية لتحسين الكوسة.
٤- أوضحت تأثيرات القدرة الخاصة على الائتلاف أن أفضل التراكيب الوراثية للصفات المدروسة كانت فى الهجن التالية والتى اشتركت فيها الآباء ب١ , ب٢ ب١ X ب٢ , ب١ X ب٣ , ب١ X ب٤ , ب٢ X ب٣ , ب٢ X ب٤ حيث أعطت تاثيرات معنوية فى جميع الصفات المدروسة.

قام بتحكيم البحث

أ.د / طه السيد عمر الجزار — **كلية الزراعة – جامعة المنصورة**
أ.د / حوريه محمد فتحى حسن — **المركز القومى للبحوث**