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HERITABILITY, HETEROSIS AND CORRELATION COEFFICIENT FOR YIELD AND YIELD COMPONENTS OF F_1 HYBRIDS AMONG NEW SELECTED INBRED LINES OF GURMA MELON (*Citrullus colocynthoides*)

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ABSTRACT

For a long time, no attempts were made to improve gurma melon characteristics or to develop new hybrids. So, this investigation was conducted to identify desirable parents and cross combinations as well as to gather information on genetic behavior of gurma melon yield and yield component traits. In this respect, a diallel cross without reciprocals, was made among five parental inbred lines of gurma melon in S_6 generation, that were selected in an earlier study through self-pollination and selection program for the commercial cultivar. All 10 F_1 hybrids with their parents were evaluated. The results showed high value of coefficient of heritability for all the studied traits (fruit weight, number of fruits/plant, seeds weight/fruit, 100-seed weight and seed yield/plant). This finding indicates a scope for improvement these characters through selection and hybridization. The results also indicated that line 3 and line 4 were the best combiner parents when crossed with the other parents with regard to seed yield traits. Moreover, the hybrids 2×3, 2×4 and 3×4 were the best cross for seed yield per plant. In addition, heterosis that was strongly expressed in case of number of fruits/plant, seeds weight/fruit and seed yield/plant would justify the commercial utilization of hybrid vigor in gurma melon. On the other hand, seed yield per plant showed positive significant genotypic and phonotypic correlations with seeds weight/fruit and 100-seed weight, thus, selection for increasing any one of these traits would certainly increase seed yield. Generally, the results showed that the possibility of using these new lines to generate desirable new hybrids for gurma melon.

INTRODUCTION

The economic importance of gurma melon has recently increased, because its production exceeds the domestic consumption, hence, Egypt became able to export large quantities of its seeds. Moreover, its ability to tolerate drought and salinity conditions makes it suitable for the new reclaimed lands. However, its production has been confined to one variety. Because of cross-pollination the heterogeneity of plants and seeds of this locally cultivated variety were increased. Thus, there is a need to increase the productivity of gurma melon with best quality through genetic improvement. Indeed, successful breeding programs need continuous information on gene action and genetic system controlling the inheritance of gurma melon traits. Information on the association among the studied traits is a basic requirement. Also, the choice of parents for hybridization and selection of the best parents from hybrid progenies is required.

Nevertheless, very little genetic studies have been conducted to improve gurma melon traits. Abd El-Rahman *et al.* (1995 and 2005) started with 20 fruits collected from different gurma melon fields. They carried out six generations of inbreeding and selection to develop five inbred lines. These lines achieved the highest production of seeds in comparison with the commercial cultivar, and can be either used as new cultivars or they can be used for breeding programs to produce hybrids.

Firpo *et al*. (1998) concluded that inbreeding and crossing methods could be a useful tool in increasing the population means for summer squash yield traits through hybrid or synthetic variety production. Crosses between inbred lines derived from different populations (interpopulation crosses) were reported to increase heterosis (El-Adl *et al*., 1996; Miranda Fihlo,1997; Abd El-Hadi *et al*., 2001).

On the other hand, many genes controlling seed characters in watermelon have been identified and their segregation patterns studied (Zhen Qing and Jin Hua 1995; Zhang 1996). Moreover, several researches have been done on other cucurbits crops. El-Adl *et al.* (1996) on agoor, EL-Mighawry (1998) on summer squash, Abd El-Hadi *et a*l. (2001) on sweet melon and EL-Mighawry *et al.* (2001) on muskmelon found heterosis effect for some yield traits.

Moreover, El-Gazar and Zaghloul (1984) on cucumber, Gad El-Hak *et al*. (2000) on melon, EL-Mighawry *et al.* (2001) on muskmelon and Karuppaiah *et al.* (2002) on ridge gourd obtained relatively high estimates of heritability for yield and yield components.

In addition, EL-Mighawry (1998) on summer squash and Abd El-Hadi *et al.* (2001) on sweet melon studied genotypic and phonotypic correlation coefficients between yield and its component traits. They found high and significant values of genotypic correlation for most pairs of studied traits.

Therefore, this investigation was carried out to evaluate the performance of parental lines and their F_1 hybrids to produce and select good hybrids with high yield and better seeds quality. Also, to obtain more information on the genetic behavior, the heterosis performance of five inbreed lines of gurma melon for several important traits and the interrelationships among yield and yield contributes through genotypic and phonotypic correlations.

MATERIALS AND METHODS

The genetic materials used in this investigation were five families in the S_6 generation, which were obtained from a previous research work conducted by Abd El-Rahman *et al.* (1995 and 2005) by using a pedigree selection program on the commercial cultivar of gurma melon. This investigation was carried out at El-Baramoon Experimental Farm, Dakahlia Governorate during 2005 and 2006 seasons.

The selfed parental lines were sown on 20 March of 2005 season, and all possible crosses excluding reciprocals were made to generate 10 F_1 hybrids. In the summer seasons of 2006 the 15 entries, *i.e*., the five parental lines along with their 10 crosses were planted for evaluation. The seeds were on 20 March and the experimental materials were arranged in a randomized complete blocks design with three replicates. Each experimental unit area was consisted of two ridges each of 5 m length and 1.5 m in width, and one plants per hill with 50 cm apart. The culture practices were done according to the general program of gurma melon cultivation.

At the harvesting time, a random sample of 10 plants was taken from each experimental unit to study the number of fruits/plant and seed yield/plant characters, while fruit weight, seeds weight/fruit and 100-seed weight were recorded as the average data of 12 fruits/plot.

Analysis of variance was computed among 10 F_1's hybrids according to Snedecor and Cochran (1982). The coefficient of heritability (h^2) was estimated by analysis of variance as described by Dospekhov (1984) as follows:

S.V.	D.F.	Mean square	Expectation
Replications	r-1		
Hybrids	g-1	M_2	$\sigma^2 e + r\,\sigma^2 g$
Error	(r-1) (g-1)	M_1	$\sigma^2 e$

Where: r: is number of replications g: is number of hybrids

$\sigma^2 g = (M_2 - M_1)/r$ $\sigma^2 e = M_1/r$ $\sigma^2 ph = \sigma^2 g + \sigma^2 e$ $h^2 = \sigma^2 g / \sigma^2 ph$

Potence ratio and average degree of heterosis as percent increase or decrease of the F_1 performance above the mid-parents value and the high-parent value were computed according to Sinha and Khanna (1975).

In order to estimate the genotypic and phonotypic correlations between pairs of traits, a covariance analysis was made between all possible pairs of studied traits, and they were calculated from the following equations as outline by Singh and Choudhry (1979):

Genotypic correlation (r_g) = Cov g_1g_2/ $(\sigma^2 g_1 . \sigma^2 g_2)^{1/2}$

Phonotypic correlation (r_{ph}) = Cov ph_1ph_2/ $(\sigma^2 ph_1 . \sigma^2 ph_2)^{1/2}$

Where: Cov g_1g_2 = the genotypic correlation between any pairs of traits.

Cov ph_1ph_2 = the phonotypic correlation between any pairs of traits.

$\sigma^2 g_1$ and $\sigma^2 g_2$ are the genotypic variance of the first and second trait, respectively.

$\sigma^2 ph_1$ and $\sigma^2 ph_2$ are the phonotypic variance of the first and second trait, respectively.

The significant of the r_g and r_{ph} was tested with "t" test as described by Cochran and Cox (1957).

RESULTS AND DISCUSSION

Heritability coefficient (h^2):

The analysis of variance for the studied traits showed that the differences among hybrids were significant for all studied traits (Table 1). These results were expected due to the great variability among the parental lines. Therefore, it makes sense to determine the coefficient of heritability. Heritability provides information on relative practicability of selection and to determine the extent of the different traits respond to selection procedure.

The heritability coefficient characterizing the transfer of the studied traits from the paternal to the hybrids was 76, 67, 87, 85 and 98 for fruit weight, number of fruits/plant, seeds weight/fruit, 100-seed weight and seed yield/plant, respectively (Table 1). These high values indicate that greater effect of genetics on these traits, and major part of variability resulted from additive action of genes, and hence the phenotype could provide reliable measure of genotype. Consequently, the selection for these traits might be effective to choose the best available parents based on good combinations. These results are in line with those obtained by El-Gazar and Zaghloul (1984) on cucumber, Gad El-Hak *et al.* (2000) on melon, EL-Mighawry (2001) on muskmelon and Karuppaiah *et al*. (2002) on ridge gourd.

Table 1: Mean squares and coefficient of heritability for five studied traits of gurma melon

Source of variation	df	Fruit weight (g)	Number of fruits/ plant	Seeds weight/fruit (g)	100-seed weight (g)	Seed yield/ plant (g)
Mean squares						
Replicates	2	184.90	0.065	0.922	0.470	1.93
Hybrids	9	8449.37**	0.018*	6.000**	4.000**	41.55**
Error	18	2007.12	0.006	0.860	0.590	0.68
Heritability coefficient (%)						
		76	67	87	85	98

*** Significant at 5% level   ** Significant at 1% level**

Mean performances and manifestation of heterosis:

It is evident from the data in Table 2 that all F_1 crosses had higher number of fruits/plant, seeds weight/fruit, and seed yield/plant than the means of corresponding parents. Also, all F_1 crosses gave positive heterosis in relation to their respective mid- or better-parent for these traits (Table 3). So, it may refer to over dominance effect. The obtained potence ratio values for these crosses (Table 4) supported the existence of this gene reaction.

Regarding fruit weight, the hybrid means of 4 out of 10 crosses (1×5, 2×3, 2×4 and 4×5) were more than their higher parents (Table 2). Also, these crosses showed positive heterosis relative to mid- and better-parent with relatively high potence ratio for these traits (Tables 3 and 4). These findings suggest a case of over dominance. Moreover, data in Table 2 clear that the hybrids 1×3 and 1×4 gave lower average fruit weight than their mid-parents, and they exhibited negative heterosis values for fruit weight relative to mid- or better-parent (Table 3). Their potence ratio values pointed out to partial dominance towards the low parent (Table 4). On the other hand, the crosses 1×2, 2×5, 3×4 and 3×5 gave higher mean performance than the respective mid-parents and reached to the edge to the higher parents. Also, these crosses gave the positive heterosis values relative to mid-parent and the negative heterosis values relative to better-parent with low potence ratio; these supported the partial dominance towards the heavy fruit parent.

Concerning 100-seed weight trait, data in Table 2 show that seven hybrids (1×4, 2×3, 2×4, 2×5, 3×4, 3×5 and 4×5) gave higher means than the means of corresponding parents. The high positive heterosis relative to mid- and better-parent with relatively high potence ratio for this trait (Table 3 and 4), suggesting over dominance towards the heavy seed parent. On the other hand, the phenomena of the crosses 1×2, 1×3 and 1×5 may be referred to partial dominance to the heavy seed parents, because they gave higher mean performance than the respective mid-parents and reached to the edge to the higher parents (Table 2), and they gave the positive heterosis values relative to mid-parent and the negative heterosis values relative to better-parent (Table 3) with low potence ratio (Table 4).

Table 2: Mean performance of five parental lines of gurma melon and their F_1 crosses for studied traits

Parents and crosses	Fruit weight (g)	Number of fruits/ plant	Seeds weight/ fruit (g)	100-seed weight (g)	Seed yield/ plant (g)
P1	614	2.675	29.17	13.90	73.64
P2	543	2.884	29.72	11.71	80.43
P3	570	2.793	30.80	12.87	83.70
P4	655	2.617	32.95	11.13	85.56
P5	716	2.716	28.94	10.04	75.35
P1×P2	606	3.091	34.39	13.88	97.99
P1×P3	591	2.998	35.32	13.80	97.49
P1×P4	633	2.890	36.89	14.02	99.18
P1×P5	724	2.968	33.97	12.83	93.04
P2×P3	578	3.147	35.64	15.87	103.33
P2×P4	674	3.018	37.82	14.96	104.85
P2×P5	687	3.128	34.26	12.37	98.72
P3×P4	633	2.998	38.07	15.75	105.11
P3×P5	645	3.059	34.98	13.34	98.23
P4×P5	732	2.956	36.76	14.36	100.21
LSD at 5%	74.1	0.08	1.38	1.34	1.20
LSD at 1%	204.8	0.21	3.82	3.71	3.31

Table 3: Estimation of heterosis (percentage) based on mid-parents (MP) and high-parents (HP) for the studied yield traits in the 10 F_1 crosses of gurma melon

F_1	Fruit weight (g)		No. fruits/ Plant		Seeds weight /fruit (g)		100-seed weight (g)		Seed yield/plant (g)	
	MP	HP	MP	HP	MP	HP	MP	HP	MP	HP
P1×P2	4.75	-1.30	7.59	7.18	16.77	15.71	8.35	-0.14	27.19	21.83
P1×P3	-0.17	-3.75	9.66	7.34	17.77	14.68	3.06	-0.72	23.92	16.48
P1×P4	-0.32	-3.36	9.22	8.04	19.15	12.64	11.98	0.86	24.60	15.92
P1×P5	8.87	1.12	10.09	9.28	16.90	16.46	7.19	-7.70	24.89	23.48
P2×P3	3.86	1.40	10.85	9.12	17.78	15.71	29.13	23.31	25.91	24.65
P2×P4	12.52	2.90	8.33	4.65	21.06	15.48	31.00	27.75	26.33	22.55
P2×P5	9.13	-4.05	11.71	8.46	16.81	15.28	13.70	5.64	26.74	22.74
P3×P4	3.35	-3.36	10.64	7.34	19.79	16.24	31.25	22.38	24.20	22.85
P3×P5	0.31	-9.92	11.03	9.52	17.11	13.57	16.41	3.65	23.51	17.36
P4×P5	6.78	2.24	10.84	8.84	18.77	11.56	35.60	29.02	24.55	17.12

Table 4: Estimation of potence ratio (PR) for the studied yield traits in the 10 F_1 crosses of gurma melon

Crosses	Fruit weight (g)	No. fruits/ plant	Seeds weight/fruit (g)	100-seed weight (g)	Seed yield/ plant (g)
P1×P2	0.77	2.02	17.96	0.98	6.17
P1×P3	-0.05	4.47	6.54	0.80	2.74
P1×P4	-0.10	8.41	3.312	1.08	3.29
P1×P5	1.16	13.27	42.70	0.45	21.68
P2×P3	1.59	6.77	9.96	6.17	31.00
P2×P4	1.34	2.36	4.34	12.21	8.52
P2×P5	0.66	3.91	12.64	1.78	8.20
P3×P4	0.48	3.33	6.45	4.31	22.02
P3×P5	0.03	7.90	5.49	1.33	4.48
P4×P5	1.53	5.84	2.90	6.92	3.81

These results suggested that the heterotic effect and the dominant genes play an important role in the inheritance of these studied traits. These results were opined by El-Adl *et al.* (1996) on agoor, EL-Mighawry (1998) on summer squash, Abd El-Hadi *et al.* (2001) on sweet melon and EL-Mighawry *et al.* (2001) on muskmelon.

Association between studied traits:

The genotypic and phonotypic correlations among all studied wee calculated and the results are presented in Table 5.

Table 5: Estimates of genotypic and phonotypic correlations among yield and its component traits of gurm melon

Traits	No. fruits/ plant	Seeds weight/ fruit (g)	100-seed weight (g)	Seed yield/plant (g)
Fruit weight (g)	-0.312 -0.316	-0.127 -0.062	-0.564 -0.481	-0.349 -0.278
No. fruits/ plant		-0.386 -0.378	0.053 0.010	0.170 0.150
Seeds weight/ fruit (g)			0.797** 0.668*	0.805** 0.763**
100-seed weight (g)				0.915** 0.826**

Genotypic correlation is above values and phonotypic correlation is below values.
*** Significant at 5% level ** Significant at 1% level**

The results cleared that the magnitudes of the genotypic correlations were almost similar or very close to the corresponding phenotypic correlation. These results were expected, since the magnitude of the error covariance was relatively small compared with the respective values of genotypic covariance.

The results also indicated that seed yield per plant showed positive significant genotypic and phonotypic correlations with seeds weight/fruit and 100-seed weight. Thus, selection for increasing any one of these traits would certainly increase the seed yield. Similar results were obtained by EL-Mighawry (1998) on summer squash and Abd El-Hadi *et al.* (2001) on sweet melon.

In general, the results of the present study indicated that the possibility of using these new inbred lines to generate desirable new hybrids for gurma melon. Thus, the hybrids 2×3, 2×4 and 3×4 can be used as high yielding commercial F_1 hybrids.

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درجة التوريث و قوة الهجين و معامل الارتباط للمحصول ومكوناته في هجن الجيل الأول بين سلالات جديدة منتخبة من بطيخ اللب (الجورمة)

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لم تكن هناك محاولات لتحسين بطيخ اللب (الجورمة) أو لاستنباط هجن جيدة منه. لهذا تم في هذه الدراسة إجراء التهجين النصف دائري لخمسة سلالات نقية من بطيخ الجورمة تم إنتاجها من خلال برنامج انتخابي سابق مع التلقيح الذاتي حتى الجيل السادس للصنف التجاري المفتوح التلقيح، وذلك للحصول على ١٠ هجن فردية. ثم تمت مقارنتها مع آبائها بغرض تحديد أفضل الآباء و الاتحادات الوراثية، و كذلك التعرف على طبيعة العلاقة بين المحصول و الصفات المساهمة فيه.

أظهرت النتائج أن معامل التوريث كان عاليا لكل الصفات المدروسة (وزن الثمرة، وعدد الثمار للنبات, ووزن البذور في الثمرة, ووزن ١٠٠ بذرة, ومحصول البذور/نبات)، و هذا يشير إلى الإمكانية الكبيرة لتحسين هذه الصفات خلال التهجين والانتخاب.

أظهرت النتائج أن السلالتين الأبويتين رقمي ٣، ٤ هما أفضل الآباء بالنسبة لصفة ومحصول البذور للنبات، وأن الهجن ٢×٣، ٢×٤, ٣×٤ هم أفضل الهجن لنفس الصفة. علاوة علي ذلك، يمكن استخدام قوة الهجين التي ظهرت واضحة بالنسبة لعدد الثمار للنبات, ووزن البذور في الثمرة, ومحصول البذور/نبات على نطاق تجاري في تحسين الصنف المحلي مفتوح التلقيح.

كذلك أظهرت النتائج أيضا أن صفة محصول البذور للنبات كانت مرتبطة موجبا مع كل من صفة وزن البذور في الثمرة, و صفة وزن ١٠٠ بذرة, لذلك يكون من المتوقع أن الانتخاب لزيادة أي من هاتين الصفتين سوف يؤدي بالفعل لزيادة محصول النبات من البذور.

بصفة عامة, أظهرت النتائج إمكانية استخدام هذه السلالات الجديدة لإنتاج هجن مرغوبة و متفوقة من بطيخ اللب (الجورمة).