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INHERITANCE OF SOME *IN VITRO* TRAITS FOR ANTHER CULTURE OF SQUASH *(Cucurbita pepo L.)*

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ABSTRACT

Knowledge about the mode of gene action of in vitro traits, which directly contributes towards higher response to anther culture in any crop like summer like summer squash helps to formulate the genetic basis for improvements. Therefore, this investigation aimed to evaluation of a set of diallel crosses from four Squash varieties for their response to anther culture. Subsequently, nature of gene action of these traits could be estimate to determine the proper breeding program for improvement anther culture response. The data were recorded on the following traits: Responding anthers, Callus weight and Shoot ratio. The statistical analysis was made for the obtained data and the results could be summarized in the following: Significant testes on the mean squares of genotypes were highly significant for callus weight / responded anther and shoot ratio, while it was insignificant for responding anther. This result revealed that the comparisons between these genotypes as well as the partition of genetic variance to it's components are valid. No crosses exhibited positive significant heterosis for responding anthers. On the other hand, two out of six crosses exhibited significant positive heterosis for callus weight which were 23.17 % (White Bush × Eskandrani) and 42.56 % (Eskandrani × White Bush Scallop). While, in the case of shoot ratio, three out of six crosses exhibited positive and significant heteroic values which were 45.87 % (White Bush × Eskandrani), 73.02 % (Eskandrani × White Bush Scallop) and 92.73% (Baladi × White Bush Scallop). In addition, the results revealed White Bush × Eskandrani and Eskandrani × White Bush Scallop were the best combinations for calli weight / responding anthers. Furthermore, the combination between Baladi × White Bush Scallop (P_3 × P_4) was the best regenerable, which had positive and significant SCA effect value for shoot ratio. This finding indicates these combinations are the best from this set of genotypes for anther culture purpose in Squash. In addition, the results revealed that the magnitude values of dominance genetic variance were positive and larger than the corresponding values of additive genetic variance were positive and larger than the corresponding values of additive genetic variance for the studied *in vitro* traits. These traits were mainly controlled by dominance genetic variance. This result could be emphasized by dominance degree ratio, which were more than unity, revealing the importance of over dominance in the genetic expression of these traits.

In conclusion, from the previous results, which revealed the predominance of non-additive gene action in the gene action in the genetic expression of the studied *in vitro* traits. These traits were mainly controlled by over dominance genes. It could be recommended the hybrid production as breeding programme for improvement these traits.

INTRODUCTION

In Egypt, summer squash *(Cucurbita pepo L.)* is popular vegetable crop. The initiation of pure lines is often considered a first step in genetic improvement of vegetable crops. This pure line are genetically pure or homozygous plants resulting from continuous self-fertilization for several

generations, this takes more than seven years to produce such pure lines. The utilization of biotechnology and new *in vitro* culture techniques is necessary to reduce the required time needed to obtain pure lines. One of the most successful methods to obtain such pure lines is anther culture techniques which considerably speed up the production of haploid plants which followed by duplication in order to produce the doubled haploids (DHs) plants for breeding programs. These DHs could be used for hybrid production to save time and the cost of hybrid's seed production.

Knowledge about the mode of gene action of *in vitro* traits, which directly contributes towards higher response to anther culture in any crop like summer squash helps to formulate the genetic basis for improvements. Additive and non-additive genetic variance could be derived from the combining ability analysis. In this respect, a few publications were dealing with the nature of gene action involved in this process. However, most of publications take attention on the effect media composition and culture conditions on the embryiod induction and regenerations percentage through anther and / or ovule culture among them Kurtal *et al.,* (1999) studied the effect of different sucrose and 2.4-D combinations on plant propagation in 4 Squash cultivates by means of anther culture. The results showed that the best variety was Sakiz and three plants were obtained on the medium with 120 g / litre sucrose and 5 mg / litre 2.4-D combination. However. Mohamed and Refaei (2004) studied the best callus induction and proliferation and plant regeneration responses in anther cultures of Zucchini type of summer squash cv. They found that cultures of anthers prepared from donor plants grown during the winter season greatly enhanced callus induction and plant regeneration when compared with those of the summer season. In addition, approximately 60 % of the regenerated plants were haploid. Mustafa and Mallaiah (2005) studied the regeneration of plantlets from long term callus culture of *Cucurbita pepo L.* The results cleared that high frequency regeneration was achieved on MS + L - glutamic acid (2.5 mg / litre) in combination with kinetin (2 mg / litre). Shalaby (2007) studied the influence of genotype, position of female flower on plant stem, temperature and sucrose concentration on the *in vitro* gynogenesis induction of Squash. The results cleared that differences among sucrose concentrations were statistically significant and ovules cultured on the MS medium containing 30 g 1^{-1} sucrose produced the best result. Badawi *et al.,* (2008) studied production of haploid plants by unpolinated ovules culture in Squash *(Cucurbita Pepo. L.)*. They found significant effect for cold pre-treatment at 4°c for 0, 8, 16day.

Therefore, this investigation aimed to evaluation of a set of diallel crosses from Squash varieties for their response to anther culture. Subsequently, nature of gene action of these traits could be estimate to determine the proper breeding program for improvement anther culture response.

MATERIALS AND METHODS

In this investigation four Squash varieties belong to species *(Cucurbita Pepo L.)* were used. This varieties included two American varieties

(White Bush and White Bush Scallop), as well as two local varieties (New Eskandrani and Baladi).

During summer season of 2005, seeds of these varieties were cultivated at the Experimental station, Faculty of Agriculture, Mansoura University. At the flowering time, all single crosses excluding reciprocals among these varieties were made according to half diallel crosses. The crossing process yielded 6 F_1 hybrids.

All genotypes were cultivated during two successive summer seasons of 2006 and 2007 at the Experimental station, Faculty of Agriculture, Mansoura University. At suitable stage, the buds were selected for anther culture purpose. Male buds having a length of 9 - 10 mm and containing anthers with mid to late uninucleate microspores stage were collected in the morning. These buds were kept at 4 ° c for 4-7 days pretreatment. Buds were then sterilized with 1% $Hgcl_2$ solution with the addition for two drops of Tween-20 as a wetting agent for 10 minutes and rinsed three times with sterile distilled water. Then, the anthers without filament were excide and divided to three parts and plated on 10 cm Petri dish in diameter with induction medium. Each Petri dish included 4 buds was considered as experimental unit. All the previous steps were made under sterile conditions. The experimental design was a completely blocks with three replications. Each replicate contained 10 genotypes, which included 4 parents and 6 F_1 hybrids. Each replicate was represented by three Petri dish from each genotype. The dishes were sealed with parafilm and incubated in the dark at 25 ^{O} C ± 2 ^{O} C for 4 week. The total responding anthers (which gave calli and/or embryoids) were counted. Then samples of calli from each Petri dish were weighted. The produced calli and/or embryoids were transferred to regeneration medium for shoot development. The culture were kept under 16 hours illumination at 22 ^{O} C ± 2 ^{O} C for 6 weeks. Then, the green point were calculated and transferred to regeneration medium without kinetine and addition 1 mg/l benzyl amino purine (BAP) for further investigation. The induction medium used in this study was M.S according to (Murashige and Skoog 1962) containing 9 % sucrose and 1 mg/l 2.4 dichlorophenoxy acid (2,4-D). The PH was adjusted to 5.8 before autoclaving at 121° C for 20 minutes. However, the regeneration medium was the same MS medium containing 3% sucrose, 0.5 mg/l naphthylacetic acid (NAA) and 0.5 mg/l kinetin.

The data were recorded on each replicate for the following traits: Responding anthers as the ratio of the number of responded anthers to total number of anthers plated. Callus weight, as the ratio of the weight of embryiod and / or calli originated from responding anthers divided by the number of responded anthers. Shoot ratio, as the ratio of the number of green points to the total number of calli transferred to regeneration medium.

Statistical analysis :

In order to normalize the distribution of the percentage data which fall between 0.00 to 1.00 were transformed by using arcsine $X^{1/2}$ function prior to statistical analysis for anther responded and weight callus traits. In this study, different forms or analysis of variance were employed in order to test the significance of differences among the four parental varieties their 6 F_1 hybrids

through two years. In addition, a combined analysis of variance for genotypes over the two years was made according to Steel and Torrie (1960). The amounts of heterosis were determined as the percentage increase of F_1 hybrid means over their mid parents and / or their high parents. The significance of heterosis was determined using the least significance difference, which was suggested by Steel and Torrie (1960). The combining ability analysis of variance for each year as well as the combined analysis over the two years was carried out to determine the general combining ability (GCA), specific combining ability (SCA) and their interactions with years. The statistical analysis were performed according to Griffing's method II (1956) as described by Singh and Chaudhary (1985).

On the basis of the expected mean squares, estimates of GCA variance (σ^2g), SCA variance (σ^2s) were obtained for all studied traits on the two years. These estimates could be expressed in terms of the covariance among the two types for relatives in a diallel cross. However, general combining ability variance (σ^2g) is equivalent to the covariance among half-sibs and the specific combining ability variance (σ^2s) is equivalent to the covariance among full-sibs minus twice of covariance among half-sibs (Hallauer and Mirand, 1988). The covariance of relatives was translated into appropriate genetic components of variance as outlined by Matzinger and kempthorne, (1956) and Cockerham (1963). Therefore, additive genetic variance (σ^2A), additive by years variance (σ^2AY), dominance genetic variance (σ^2D) and dominance by years (σ^2DY) were estimated. In addition, the dominance degree ratio as well as the heritabilities in broad and narrow senses were determined.

RESULTS AND DISCUSSION

This investigation was undertaken to study the nature of gene action for some *in vitro* traits. The analysis of variances of the studied genotypes for *in vitro* traits at each year was made and the obtained results are presented in Table 1. Mean squares of genotypes indicated the presence of significant differences between these genotypes for callus weight / responding anthers (C.W / R.A) and shoot ratio (Sh.R) with respect to each year. In addition, the data which were obtained from the two years for parental varieties and their 6 F_1 hybrids were set up in a combined analysis and the obtained results are presented in Table 2. significant testes on the mean squares of genotypes were highly significant for callus weight / responded anther (C. W / R.A) and shoot ratio (Sh.R), while it was insignificant for responding anther (R.A). This result revealed that the comparisons between these genotypes as well as the partition of genetic variance to it's components are valid. On the other hand, the mean square of genotype by years interaction was highly significant for callus weight / anther responded.

Table 1 : Analysis of variance and mean squares of parents and their F_1 hybrids at each year for *in vitro* traits

S.O.V		d.f	R.A	C.W/R.A	Sh.R
Rep	Y_1	2	4.68	23.40	0.75
	Y_2		133.49	0.68	0.04
Genotypes	Y_1	9	116.13	344.06**	2.72**
	Y_2		63.79	299.74**	2.90**
Error	Y_1	18	62.21	14.72	0.29
	Y_2		183.15	7.09	0.34

** significant at 0.01 level of probability.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

Table 2 : Combined analysis of variance and mean squares of genotypes over two years for *in vitro* traits

S.O.V	d.f	R.A	C.W/R.A	Sh.R
Years (y)	1	432.18	11.18	2.35
Rep / y	4	69.08	12.03	0.39
Genotypes (G)	9	90.12	547.73**	5.37**
GxY	9	89.79	96.07**	0.24
Error	36	122.68	10.90	0.31

** significant at 0.01 level of probability.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

Means of four varieties and their 6 F_1 hybrids for *in vitro* traits at each year are presented in Table 3.

Table 3 : Mean performances of parents and their F_1 hybrids for *in vitro* traits at each year

Genotypes	R.A		C.W/R.A		Sh.R	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
White Bush (p_1)	90.00	83.53	46.90	47.10	1.05	1.08
Eskandrani (p_2)	83.87	80.67	47.03	52.33	2.48	2.40
Baladi (p_3)	71.13	80.67	40.20	51.37	1.31	1.51
White Bush Scallop (p_4)	77.40	83.53	41.77	38.57	1.26	1.43
$P_1 \times P_2$	71.80	83.53	63.90	55.17	2.75	2.36
$P_1 \times P_3$	80.87	74.67	36.43	36.80	1.13	1.26
$P_1 \times P_4$	79.07	75.33	28.00	32.07	0.83	1.23
$P_2 \times P_3$	90.00	83.87	40.57	41.70	2.25	2.89
$P_2 \times P_4$	83.87	81.87	60.53	67.63	3.02	3.53
$P_3 \times P_4$	77.40	71.00	41.63	42.87	2.49	2.80
LDS 5 %	17.69	23.55	6.60	4.57	0.92	0.99
1 %	24.26	32.3	9.02	6.26	1.27	1.37

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

The means of the four parents showed that no specific parent and / or cross was superior or inferior for all studied traits at two years. However, of the parental varieties, the greatest mean of callus weight and shoot ratio were observed in Eskandrani (P_2) with means of 47.03 and 2.48 at 1st year, as well

as 52.33 and 2.4, at 2nd year, respectively. The greatest mean of responding anther were observed in White Bush (P_1) with mean of transformed value equal to 90 in the 1st year and 83.53 in the 2nd year. Although, the greatest overall value for callus weight and shoot ratio was recorded in the cross Eskandrani × White Bush Scallop ($P_2 \times P_4$), the lowest values were observed in the combination of White Bush × White Bush Scallop ($P_2 \times P_4$).

The means of four parents and their F_1 hybrids were combined from the data over the two years and the obtained results are shown in Table 4. The magnitude of means for parental varieties showed that responding anthers, callus weight and shoot ratio ranged from 85.57 (P_3) to 86.93 (P_1), 40.17 (P_4) to 49.68 (P_2) and 1.07 (P_1) to 2.44 (P_2), respectively. Regarding F_1 hybrids, the means showed that responding anthers, callus weight and shoot ratio ranged from 76.98 ($P_1 \times P_2$) to 84.20 ($P_2 \times P_3$) 30.04 ($P_1 \times P_4$) to 64.08 ($P_2 \times P_4$) and 1.03 ($P_1 \times P_4$) to 3.27 ($P_2 \times P_4$), respectively.

The estimated amounts of heterosis relative to mid-parent were determined for all *in vitro* traits at each year and the obtained results are shown in Table 5.

Table 4 : Mean performances of parents and their F_1 hybrids for all *in vitro* traits from combined data over the two years

Genotypes	*R.A*	*C.W/R.A*	*Sh.R*
White Bush (p_1)	86.93	47.00	1.07
Eskandrani (p_2)	85.57	49.68	2.44
Baladi (p_3)	85.57	45.79	1.41
White Bush Scallop (p_4)	86.76	40.17	1.34
$P_1 \times P_2$	76.98	59.54	5.26
$P_1 \times P_3$	77.90	36.62	1.20
$P_1 \times P_4$	82.67	30.04	1.03
$P_2 \times P_3$	84.20	41.14	2.57
$P_2 \times P_4$	82.72	64.08	3.27
$P_3 \times P_4$	77.45	42.25	2.65
LDS 5 %	18.36	5.47	0.93
1 %	24.60	7.34	1.25

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

The results showed that two out of six crosses exhibited positive and significant heterosis relative to their mid-parents for callus weight at two years. These heterotic values were 36.06% ($P_1 \times P_2$), 36.33% ($P_2 \times P_4$) at 1st year and 10.97% ($P_1 \times P_2$), 48.8% ($P_2 \times P_4$) at 2nd year. While, in the cases of shoot ratio, three and two out of six crosses exhibited positive and significant heteroic values at 1st year and 2nd year, respectively, which were 55.8% ($P_1 \times P_2$), 61.5% ($P_2 \times P_4$), 93.77% ($P_3 \times P_4$) at 1st year and 84.33% ($P_2 \times P_4$), 90.48% ($P_3 \times P_4$) at 2nd year. On the other hand, all studied crosses dos not exceeded their mid-parents in case of responding anther ratio.

Table 5 : Estimates heterosis based on the mid parents (M.P) for all *in vitro* from the combined data over two years

Heterosis	*R.A*	*C.W/R.A*	*Sh.R*
$P_1 \times P_2$	-10.75	23.17**	45.87*
$P_1 \times P_3$	-9.68	-21.07**	-3.23
$P_1 \times P_4$	-4.81	-31.08**	-14.88
$P_2 \times P_3$	-1.6	-13.82**	33.51
$P_2 \times P_4$	-3.99	42.56**	73.02**
$P_3 \times P_4$	-10.11	-1.7	92.73**
LDS 5 %	15.89	4.72	0.8
1 %	21.3	6.35	1.08

*,** significant at 0.05 and 0.01 levels of probability, respectively.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

P_1 , P_2 , P_3 and P_4 are Whit Bush, Eskandrani, Baladi and Whit Bush Scallop, respectively

Furthermore, the amount of heterosis relative to high parent for all *in vitro* traits at two years were determined and the obtained results are presented in Table 6.

Table 6 : Estimates heterosis based on the higher parents (H.P) for *in vitro* traits at each year

Herteosis	*R.A*		*C.W/R.A*		*Sh.R*	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
$P_1 \times P_2$	-21.51**	-0.37	35.87**	5.43	10.89	-1.67
$P_1 \times P_3$	-9.84	-10.92	-22.32**	-28.37**	-13.47	-16.56
$P_1 \times P_4$	0.00	-10.14	-40.3**	-31.91**	-34.13	-13.99
$P_2 \times P_3$	-6.09	3.34	-13.47	-20.31**	-9.27	20.48
$P_2 \times P_4$	-7.18	-1.97	28.71**	29.24**	21.77	47.08*
$P_3 \times P_4$	-6.83	-14.98	-0.34	-16.55**	90.08*	85.43*
LDS 5 %	13.52	23.20	6.60	4.57	0.92	0.99
1 %	18.55	31.82	9.02	6.26	1.27	1.37

** significant at 0.05 and 0.01 levels of probability, respectively.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

P_1 , P_2 , P_3 and P_4 are Whit Bush, Eskandrani, Baladi and Whit Bush Scallop, respectively

The results revealed that no crosses exhibited positive significant heterosis for responding anthers. While, two out of six crosses exhibited significant positive heterosis for weight which were 19.82% ($P_1 \times P_2$) and 28.96% (P_2 P_4). While, in the case of shoot ratio, one of six crosses exhibited positive and significant heteroic value which was 87.94% ($P_3 \times P_4$).

The mean squares of the combining ability analysis for each year are presented in Table 7.

Table 7 : Analysis of combining ability variance and mean squares for *in vitro* traits at each year

S.O.V		d.f	R.A	C.W/R.A	Sh.R
GCA	Y_1	3	35.07	326.92**	3.20**
	Y_2		37.25	241.01**	1.69**
SCA	Y_1	6	156.65**	352.64**	2.48**
	Y_2		77.06	329.11**	3.51**
Error	Y_1	18	20.74	4.90	0.10
	Y_2		61.05	2.36	0.11
GCA / SCA	Y_1	--	0.22	0.92	1.29
	Y_2	--	0.48	0.73	0.48

** significant at 0.01 level of probability.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

Tests of significance on the mean squares of general combining ability (GCA) and specific combining ability (SCA) showed that GCA were significant in all cases except for responding anthers. While, SCA was significant for all cases except for responding anthers at 2nd year. In addition, mean squares for combining ability from the combined data over two years for all *in vitro* traits which presented in Table 8, revealed that both GCA and SCA mean squares were significant for all *in vitro* traits expect for GCA in the case of responding anther. On the other hand, the magnitudes of GCA mean squares were less than the corresponding values of SCA with respect to all studied *in vitro* traits. This results could be emphasized by GCA / SCA ratio which were less than unity. These indicate the contribution of non-additive gene action in the genetic expression and the dominance genes effects play the major role in these traits.

Table 8 : Analysis of combining ability and mean squares for all *in vitro* traits from the combined data over two years

S.O.V	d.f	R.A	C.W/R.A	Sh.R
GCA	3	7.59	502.67**	4.54**
SCA	6	132.63**	570.26**	5.77**
GCA x Y	3	64.73	65.25**	0.37*
SCA x Y	6	101.08**	111.48**	0.22
Error	36	40.89	3.63	0.11
GCA / SCA	--	0.05	0.88	0.78
GCAXY / SCAXY	--	0.64	0.58	1.68

*,** significant at 0.05 and 0.01 levels of probability, respectively.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

Furthermore, the interaction between the GCA by year (GCA × Y) and SCA by years (SCA × Y) were significant in all cases except for (GCA × Y) for responding anthers and (SCA × Y) for shoot ratio. This finding may indicate these parameters were unstable with different environmental conditions.

The estimated amounts of general combining ability effect (g_i) for each parental variety for all *in vitro* traits within each year are shown in Table 9. In addition, the estimated values of GCA effects (g_i) for each parental variety were determined, from the combined data over the two years and the obtained results for *in vitro* traits are shown in Table 10.

Table 9 : General combining ability effects (g_i) of each parent al variety for *in vitro* traits at each year.

Parents	R.A		C.W/R.A		Sh.R	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
White Bush (P_1)	-0.85	0.21	-0.225	-3.261**	-0.495*	-0.425*
Eskandrani (P_3)	-1.36	1.93	-5.931**	5.228**	0.534*	0.303
Baladi (P_3)	0.45	-1.36	-4.075**	-0.617	-0.051	0.09
White Bush Scallop (P_4)	1.76	-0.78	-1.631	-1.35	0.012	0.033
S.E (gi)	1.61	2.76	0.78	0.54	0.11	0.12

*,** significant at 0.05 and 0.01 levels of probability, respectively.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

Table 10 : General combining ability (g_i) effects of parent al variety from the combined data over the two years for *in vitro* traits.

Parents	R.A	C.W/R.A	Sh.R
White Bush (P_1)	- 0.33	-1.74	-0.45*
Eskandrani (P_3)	0.27	5.57**	0.41*
Baladi (P_3)	- 0.44	-2.34*	0.02
White Bush Scallop (P_4)	0.49	-1.49	0.02
S.E (gi)	2.26	0.67	0.12

*,** significant at 0.05 and 0.01 levels of probability, respectively.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

The results revealed that the best combiner for responding anthers was White Bush Scallop, which had the highest positive GCA effect value. However, Eskandrani was the best combiner for calli weight / responding anthers and Shoot ratio, which exhibited the highest and positive significant GCA effect values.

The estimates of specific combining ability effects (S_{ij}) for each cross with respect to the studied *in vitro* traits within each year are presented in Table 11. The results revealed that no crosses exhibited positive significant SCA effects except for $P_1 \times P_4$ at 1st year for responding anthers. While, two and one out of six crosses had a significant positive SCA effects for callus weight at 1st and 2nd year, respectively, which were ($P_1 \times P_2$) at 1st year and ($P_2 \times P_4$) at 2nd year. While, in the case of shoot ratio two and two out of six crosses had a significant positive SCA effects at 1st and 2nd year, respectively. These crosses were ($P_1 \times P_2$) and ($P_3 \times P_4$) at 1st year as well as ($P_2 \times P_4$) and ($P_3 \times P_4$) at 2nd year. Therefore, estimates of SCA effects from the combined data over two years determined and the obtained results are presented in Table 12. The results revealed, in spite of no crosses showed

superiority for responding anther, White Bush × Eskandrani and Eskandrani × White Bush Scallop were the best combinations for calli weight / responding anthers. Furthermore, the combination between Baladi × White Bush Scallop ($P_3 \times P_4$) was the best regenerable, which had positive and significant SCA effect value for shoot ratio.

Table 11 : Specific combining ability effects (S_{ij}) of each cross for *in vitro* traits at each year

Crosses	R.A		C.W/R.A		Sh.R	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
$P_1 \times P_2$	-12.53**	1.40	13.49**	- 2.36	0.75*	0.12
$P_1 \times P_3$	-3.81*	- 4.17*	- 3.96*	- 4.88*	- 0.28	- 0.36
$P_1 \times P_4$	3.72*	- 4.08*	- 14.84**	- 8.88**	- 0.64	- 0.72**
$P_2 \times P_3$	0.07	3.29	- 5.98**	- 8.47**	- 0.19	0.14
$P_2 \times P_4$	-2.23	0.73	11.53**	18.19**	0.51	0.84*
$P_3 \times P_4$	-3.72*	- 6.84**	2.64	- 0.72	1.57**	1.85*
S.E	1.07	1.42	1.9	1.32	0.27	0.28

*** significant at 0.05 and 0.01 levels of probability, respectively.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical anaiysis.

P_1 , P_2 , P_3 and P_4 are Whit Bush, Eskandrani, Baladi and Whit Bush Scallop, respectively

Table 12 : Specific combining ability effects (S_{ij}) of each cross from the combined data over the two years for *in vitro* traits

Crosses	R.A	C.W/R.A	Sh.R
$P_1 \times P_2$	- 5.64**	5.569**	0.451
$P_1 \times P_3$	- 4.00*	-4.423*	-0.325
$P_1 \times P_4$	- 0.18	-11.862**	-0.686
$P_2 \times P_3$	1.69	-7.229**	-0.12
$P_2 \times P_4$	- 0.73	14.866**	0.688
$P_3 \times P_4$	- 5.28**	0.958	1.709**
S.E	1.29	1.63	0.28

*** significant at 0.05 and 0.01 levels of probability, respectively.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

P_1 , P_2 , P_3 and P_4 are Whit Bush, Eskandrani, Baladi and Whit Bush Scallop, respectively

The additive ($\sigma^2 A$) and non-additive ($\sigma^2 D$) variances in addition to heritability in broad (H_b) and narrow (H_n) senses as well as, dominance degree ratio (D.d) were estimated from each year for *in vitro* traits and the obtained results are presented in Table 13.

Table 13 : Estimates of relative magnitudes of different genetic parameters for *in vitro* traits at each years

Genetic Parameters	R.A		C.W/R.A		Sh.R	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
$\sigma^2 A$	- 40.52	- 13.18	-8.57	-29.37	0.24	-0.61
$\sigma^2 D$	135.91	16.01	347.74	326.75	2.38	2.37
$\sigma^2 e$	20.74	61.05	4.9	2.36	0.1	0.11
H_b %	88.76	20.78	98.61	99.28	96.32	95.56
H_n %	0	0	0	0	8.82	0
D.d	> 1.0	> 1.0	> 1.0	> 1.0	3.15	> 1.0

The negative values were considered equal to zero during the calculation of heritabilities and dominance degree.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

The results revealed that magnitude of non-additive genetic variance were positive for the studied *in vitro* traits at two years, indicating the contribution of dominance genes in the inheritance of these traits. However, negative values of additive variance were observed for these in vitro traits except for shoot ratio (Sh.R) in the 1st year, suggesting the predominance of dominance gene effects in the genetic expression of these traits. These results could be emphasized by dominance degree ratio as well as the higher values of heritability in broad sense compared to heritability in narrow sense for all *in vitro* traits with respect to both years, revealing the importance of over dominance in the expression of these traits.

Furthermore, the relative magnitudes of the previous genetic parameters were estimated for all studied *in vitro* traits from the combined data over two years and the obtained results are shown in Table 14.

Table 14 : Estimates of relative magnitudes of different genetic parameters for *in vitro* traits obtained from the two years

Genetic Parameters	R.A	C.W/R.A	Sh.R
$\sigma^2 A$	- 14.78	-3.56	-1.38
$\sigma^2 D$	15.78	229.39	2.78
$\sigma^2 AY$	-12.12	-15.41	0.05
$\sigma^2 DY$	60.19	108.14	0.15
$\sigma^2 e$	40.89	3.63	0.11
H_b %	65.01	67.3	89.97
H_n %	0	0	0
D.d	> 1.0	> 1.0	> 1.0

The negative values were considered equal to zero during the calculation of heritabilities and dominance degree.

Note :

Data were transformed using arcsin $\sqrt{x}$ for responding anther and callus weight / responding anther percentage prior to statistical analysis.

The results revealed that the magnitude values of dominance genetic variance were positive larger than the corresponding values of additive genetic variance for the studied *in vitro* traits. These traits were mainly controlled by dominance genetic variance. This result could be emphasized

by dominance degree ratio, which were more than unity, revealing the importance of over dominance in the genetic expression of these traits. Also, the results showed that heritability in broad sense was higher than the corresponding values in narrow sense with respect to all studied *in vitro* sense.

In addition, the results also showed that variance due to additive by years interaction were negative for responding anthers and callus weight. However, the variance due to dominance by years interaction were positive and larger in magnitudes than the additive by years interaction. This finding indicates that dominance gene action is highly influenced by environment conditions.

In conclusion, from the previous results, which revealed the predominance of non-additive gene action in the gene action in the genetic expression of the studied *in vitro* traits. These traits were mainly controlled by over dominance genes. It could be recommended the hybrid production as breeding programme for improvement these traits.

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توريث بعض الصفات المعملية لزراعة متوك قرع الكوسة

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توافر المعلومات عن طبيعة فعل الجين للصفات المعملية للاستجابة لزراعة المتوك في أي محصول مثل محصول قرع الكوسة تساعد على فهم الأساس الوراثي لتحسين مثل هذه الصفات. ولذلك هذه الدراسة تهدف إلى تقييم مجموعة من الهجن وآبائها من أصناف قرع الكوسة في نظام التزاوج النصف الدائري للأربعة أصناف للاستجابة لزراعة المتوك.

وبالتالي طبيعة الفعل الجيني لهذه الصفات يمكن تقديرها لتحديد برنامج التربية المناسب للتحسين الوراثي للاستجابة لزراعة المتوك. وبالتالي تم تقييم العشر تراكيب الوراثية (6 هجن + 4 آباء) لاستجابتها لزراعة المتوك خلال عامين متتاليين. وسجلت البيانات على الصفات التالية : استجابة المتوك ــ وزن الكالس ــ نسبة النباتات الخضراء.

ويمكن إيجاز نتائج التحليل الإحصائي لهذه البيانات في الآتي : اختبارات معنوية متوسط مربعات التراكيب الوراثية كانت عالية المعنوية بالنسبة لوزن الكالس ونسبة النباتات الخضراء ، بينما كانت غير معنوية بالنسبة لاستجابة المتوك مما يشير إلى إمكانية إجراء المقارنة بين هذه التراكيب الوراثية وتقسيم التباين الوراثي إلى مكوناته.

بالرغم من عدم وجود هجن تظهر قوة هجين موجبة ومعنوية لصفة معدل استجابة المتوك فيوجد اثنان من بين ستة هجن أظهرت قوة هجين موجبة ومعنوية بالنسبة لوزن الكالس وكانت (وايت بوش × اسكندراني) و (اسكندراني × وايت بوش اسكالوب) بينما في حالة نسبة النباتات الخضراء يوجد ثلاثة من بين ستة هجن كانت موجبة ومعنوية كانت قيمتها 45.87 % (وايت بوش × اسكندراني) و 73.02% (اسكندراني × وايت بوش اسكالوب) و 92.37% (بلدي × وايت بوش اسكالوب) بالإضافة إلى ذلك الهجن (وايت بوش × اسكندراني) و (اسكندراني × وايت بوش اسكالوب) أفضل الهجن بالنسبة لوزن الكالس ونسبة النباتات الخضراء ، حيث أنها أظهرت قيم موجبة ومعنوية لتأثير القدرة الخاصة على التآلف لهذه الصفات مما يشير إلى أن هذه الهجن أفضل التراكيب الوراثية تحت الدراسة لغرض زراعة المتوك في قرع الكوسة.

أظهرت النتائج أيضا أن قيم التباين الوراثي السيادي كانت موجبة وأعلى من قيم التباين للعوامل ذات الأثر المضيف لكل الصفات المعملية تحت الدراسة ولذلك تكون هذه الصفات يتحكم بها العوامل ذات الفعل السائد بصفة رئيسية وأمكن تأكيد هذه النتائج بقيم معامل السيادة التي تزيد قيمتها عن الواحد الصحيح.

ويمكن أن نستخلص من النتائج السابقة التي أشارت إلى أن هذه الصفات يساهم في تعييرها الوراثي كل من الفعل الجيني المضيف والسيادي ، ولكن الجينات ذات الأثر السيادي لها الدور الرئيسي ، ولذلك يمكن أن نزكي طريقة إنتاج الهجن أو الانتخاب المتكرر كطريقة لتحسين هذه الصفات.