Assiut J. of Agric. Sci., 42 (Special Issue)(The 5th Conference of Young Scientists Fac. of Agric. Assiut Univ. May,8, 2011) (1-16)

Genetic Analysis of Yield Traits in Faba Bean (*Vicia faba* L.)

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Abstract:

The combining ability and heterosis have been analyzed in a 7-parents F1 diallel cross for yield and its components. The experiment was conducted at the Experimental Farm., Faculty of Agricultural, Assiut University. The analysis of variance indicated highly significant differences among the 28 entries for days to 50% flowering, plant height, first fruiting node on the main stem, number of branches/plant, number of seeds/pod, number of pods/plant, 100 seed weight and seed yield/plant. Variances due to general combing ability as well as specific combing ability were highly significant for the above-mentioned traits. However, the ratio of the genetic components; $\Sigma g_i^2 / \Sigma s_{ij}^2$ was less than unity of the non-additive genetic variance in the inheritance of all the above traits except days to 50% flowering. The analysis of variances and covariance of arrays indicated epistatic effect of complementary type in the inheritance of first fruiting node, and non-allelic interaction of duplicate type for number of branches/plant, number of seeds/pod, 100 seed weight and seed yield/plant. Hertotic effects over mid and better parents were shown in F_1 hybrids for all studied characters.

Introduction:

Faba bean (*Vicia faba* L.) is one of the most important crops which grown for seeds in Egypt. Due to its high nutritive value, it is a primary source of protein in the diet of masses. Many of developing countries depend on it in feeding a large sector of human populations. The protein content was estimated at 5.5 and 5.9% for green and dry straw, respectively (Nassib *et al.* 1991). Total cultivated area was approached 25 million hectares with 18.4 million tones of seed yield production in the world (FAO, 2004). Low and unstable yields have been historically reported as major problems for faba bean (Duc, 1997; Knott, 1997) and this is due to the nature and the inheritance of its yield. Seed yield is a complicated trait that is quantitatively inherited with low heritability value (Bond, 1966 and Kambal, 1969)). The relationship between seed yield and its components may be used as a distractive tool to breeders in order to screen the breeding materials and then

Received on:5/5/2011 **Accepted for publication on**: 6/5/2011
Referees: Prof.Dr.Kamal A.Abdel-Ghani Prof.Dr. Abdel-Azeem A. Ismail

selecting donor parents for breeding programs. The genetic improvement of various traits, which depends on the nature and magnitude of genetic variability, and hybridization, which plays a critical role for obtaining the new recombinations and releasing new materials, will help the breeders to identify the best combinations to be crossed and exploit heterosis or build up the favorable fixable genes. Heterosis is considered good criteria for synthetics and ultimately hybrids and could lead to improve the yield and its components in faba beans. Superiority of hybrids over the mid and better parents for seed yield was found to be associated with manifestations of heterotic effects in main yield components i.e., number of branches, number of pods, number of seeds/plant, seed yield/plant and 100 seed weight (Attia and Salem, 2006). The concept of combining ability is useful in connection with "testing" procedures, in which it is desired to study and compare the performances of lines in hybrid combination (Griffing, 1956). Combining ability analysis helps the breeders to identify the best combiners which may be hybridized either to exploit heterosis or to build up the favorable fixable genes. Therefore, GCA and SCA variance will be accurate calculations for evaluating yield and components. The objective of this study was to evaluate the nature of gene action and general and specific combining abilities of seven faba bean genotypes and their F_1 hybrids.

Materials and Method

Seven genotypes of faba bean (*Vicia faba* L.) namely, Misr1 "M1", Misr2 "M2", Giza40"G40" Giza843"G843", Giza429 "G429", Giza2 "G2" (provided from Legumes division, A.R.C., Giza) and Assiut 67 "As67" were quite variable in yield and its components were used as aparental varieties in this study. The seven genotypes and their F1-hybrids were sown during two winter growing seasons; 2009/2010 and 2010/2011 at the Experimental Farm., Faculty of Agricultural, Assiut University.

In 2009/20010 season, the seven parental genotypes were sown in the field in three planting dates with two weeks intervals to obtain enough flowers for crossing. The seven parents were crossed in all possible combinations except reciprocals using hand emasculation and pollination to produce 21 F_1's hybrids. The parents were protected to obtain selfed seeds.

In the 2010/2011 season, the seven parents and their 21 F_1 hybrids were sown in the field in free infected soil from broomrape in the Experimental Farm of the Faculty of Agriculture, Assuit University. The Experimental layout was a Randomized Complete Block Design (R.C.B.D.) with three replications. Planting was carried out on 17th October, 2010. Seeds were sown in rows, 2m long and 60 cm apart, with double seeded hills, spaced at 20 cm. Each entry was represented by one row/replication. The agricultural practices of irrigation and fertilization were followed as recommended for faba bean production. The whole experiment was covered by a net to protect plants from insects during flowering period. Days to 50% flowering were recorded when 50% of the plants of each row gave the first flower. At harvest, ten plants were randomly sampled from each row to take measurements for plant height (cm), first fruiting node on the main stem, number of branches/ plant, number of seeds/pod, number of pods/plant, 100-seed weight; g., and seed yield/plant; g.

Statistical analysis was made on plot mean basis. The variation among parents and F_1 crosses was partitioned into general and specific combining abilities as illustrated by Griffing, (1956) Method 2, Model 1. The analysis of variance and covariances were performed according to Hayman (1954) and Mather and Jinks (1971).

The heterotic effects of F_1 crosses were estimated as a percentage from mid and better parents using the following formula:

Mid parent heterosis (%) =

$$\frac{F_1 - midparetnt}{midparent} \times 100$$

Better parent heterosis (%)

$$= \frac{F_1 - betterpare\ nt}{betterpare\ nt} \times 100$$

The test of significant of heterosis was performed using LSD (Bhatt 1971).

Results and Discussion:

Evaluation of the parents and F_1 hybrids:

The analysis of variance (Table 1) was highly significant (P<0.01) among genotypes for all traits, indicating a wide genetic variability in these materials and the genetic analysis could be performed. Means of parents and their F1 hybrids are presented in Table 2. Means of the seven parents were wide extended with a range of 42-56.67; 120.75-153.07; 11.33-17.25; 3.20-4.48; 2.54-2.93; 16.40-34.31; 74.49-93.86 and 26.45-41.65 for days to 50% flowering, plant height, first fruiting node on the main stem, number of branches/plant, number of seeds/pod, number of pods/plant, 100 seed weight; g. and seed yield/plant, respectively. Meanwhile, means of F_1 hybrids were extended with a range of 45.67-57.33; 138.71-170.06; 9.17-17.15; 2.83-5.75; 2.75-3.32; 14.92-34.75; 75.09-110.44 and 29.08-53.53 for the above-mentioned traits, respectively. The F_1 mean increased over the parental mean for all studied traits. Apparently, the different means among the seven parents and their F_1 seemed to be valuable in improving the studied traits in faba bean breeding programs.

Analysis of Wr and Vr:

The analysis of variance of Wr+Vr and Wr-Vr (Table 3), and the joint regression analysis (Figs. 1 and 2) indicated the adequacy of the simple additive-dominance model in the inheritance of days to 50% flowering and plant height. However, the analysis of Wr and Vr (Table 3) and the regression line (Figs. 3a and b) of first fruiting node on the main stem form a curve being concave upwards indicating non-allelic gene interaction of complementary type. Furthermore, the Wr and Vr analysis (Table) and the regression line indicated inadequacy of the simple additive-dominance model and presence of epistatic effects of duplicated type for number of branches/plant, number of seeds/pod and seed yield/plant in which the regression line of quadratic type concave downwards (Figs. 4-8b).

Combining ability analysis:

The analysis of variance (Table 1) indicates significant ($P<0.01$) general combining ability (gca) and specific combining ability (sca) mean squares for all the studied characters, indicating additive and non-additive genetic effects were involved in the control of these characters. The ratio of genetic variance components $\Sigma g_i^2/\Sigma S_{ij}^2$ was less than unity for all the studied characters except days to 50% flowering, indicating that non-additive gene effects were predominant in the inheritance of all these characters and that additive gene effects were predominant in the inheritance of days to 50% flowering in these materials. Similar results were reported by (Attia and Salem, 2006), (El-Harty *et al.* 2008), (Alghamdi, 2009) and (Ibrahim 2010).

Estimates of gca and sca effects are shown in Tables 4 and 5, respectively. Regarding to GCA effects for each parent, no parent showed significant gca effects for all studied traits. Only two among seven parents M1 and G40 showed highly significant negative effects for days to 50%flowering, therefore, they could be a good source for earliness in faba bean breeding programs. For plant height, the two parents G2 and G40 revealed highly significant positive effects. Two parents (M2 and As67) showed highly significant negative gca for first fruiting node on the main stem. The two parents M2 and G2 showed significant positive effects for number of branches/plant. Moreover, only one parent As67 exhibited highly significant positive effects for number of seeds/pod. Two parents (G40 and G429) showed highly significant positive gca for number of pods/plant. For 100 seed weight, the parents G843 and As67 exhibited highly significant positive gca. The two parents M2 and G40 were highly significant positive for seed yield/plant. On the other hand, concerning sca effects, two out of twenty one hybrids showed highly significant effects for days to 50%flowering. Ten crosses exhibited highly significant positive sca for plant height. The sca effects for first fruiting node on main stem were highly significant negative in five hybrids. Only five hybrids exhibited positive significant sca effects for number of branches/plant. The specific combining ability (sca) effects for number of seeds/pod were significant positive in three crosses. 7 out of 21 hybrids showed positive significant sca for number of pods/plant. Among the twenty one hybrids, 10 crosses showed positive and significant sca for 100 seed weight. For seed yield/plant, 13 crosses showed positive significant (P<0.01) sca.

Heterotic Effects:

Percentages of hertosis relative to the mid and better parent are given in Table 6.

Only two crosses showed highly significant positive heterosis over better parents for number of branches and number of seeds/pods. Significant mid-parent heterosis for days to 50% flowering was recorded for M1/M2 hybrids. The same hybrid showed insignificant heterosis from the better parent (earlier parent) which accounted for 3.51%. These results indicate low level of heterosis in days to 50% flowering in these materials. Heterosis percentage relative to mid and better parent for first fruiting node on main stem extended from -32.42 to 38.61 and from –27.22 to 51.37, respectively. Only two crosses M1/M2 and G2/As67 exhibited significant negative heterotic effects over the better parent for first fruiting node on the main stem. These results were in line with those reported for first fruiting node on the main stem by (EL-Harty, 1999). Regarding to both estimates of heterosis percentage, eleven, one, two, two, twelve and fourteen crosses exhibited significant positive heterotic effects over mid and better parents for plant height, number of branches/plant, number of seeds/pod, number of pods/plant, 100 seed weight and seed yield/plant, respectively. These values of heterosis indicated to the genetic diversity among the seven parents with non allelic interaction which increase or decrease the expression of heterosis (Hayman, 1956). In addition, the different degrees of F_1 superiority, which presented in various cross combinations, were due to the genes in parental combinations that may contribute directly or indirectly to these characters (Alghamdi, 2009). Favorable ranges of heterosis have been obtained by previous researches for all studied traits by (Gasim and Link, 2007).

Our results indicated that some yield components via; number of seeds/pod, number of pods/plant and 100 seed weight are more important than other in improving the yield. GCA effects play an important role in revealing the validity of line in hybrid combination, meanwhile, SCA effects could be related to heterossis effects (Peng and Virman, 1999). Obviously, no relation was found between GCA and SCA effects in crosses. In across which has significant effects of SCA, it might include only one good combiner (Alghamdi, 2009). However, when parent with high GCA crossed with other with low GCA, the hybrids between them may show high SCA (Marinkovic and Marjanovic-Jeromela, 2004).

Table 1. Mean squares for genotypes and their general and specific combining abilities, and gca/sca ratio for the studied characters

Source of variance	d.f.	Mean squares							
		Dayes to 50% flowering	Plant height (cm)	First fruiting node	Number of branches/plant	Number of seeds/pod	Number of pods/plant	100-seed weight (g)	Seed yield/plant (g)
Blocks	2	23.59**	6.13	0.94	1.68**	0.03	5.94	10.13	4.05
Genotypes	27	42.52**	366.21**	13.31**	1.03**	0.10*	115.83**	280.91**	209.64**
G.C.A.	6	143.36*	754.83**	15.71**	1.78**	0.153**	234.90**	139.56**	86.84**
S.C.A.	21	13.71**	255.204**	12.63**	0.82**	0.078*	81.81**	321.29**	244.719**
Error	54	5.06	17.08	1.34	0.17	0.03	6.60	7.26	4.52
g_i^2/S_{ij}^2	--	1.78	0.34	0.14	0.28	0.28	0.34	0.05	0.04

*, ** Significant at 0.05 and 0.01 level of probability, respectively.

Table 2. Means of parents and their F_1-hybrids for the studied characters:

Genotypes	Dayes to 50% flowering	Plant height (cm)	First fruiting node	Number of branches/plant	Number of seeds/pod	Number of pods/plant	100-seed weight (g)	Seed yield/plant (g)
M1	47.33	141.07	17.25	4.21	2.90	16.40	79.35	40.60
M2	51.67	120.75	12.55	4.15	2.86	17.00	93.79	37.44
G2	56.67	153.07	14.54	4.18	2.54	17.92	74.49	26.45
G843	46.67	141.97	11.33	4.48	2.99	26.02	89.71	26.97
As67	55.33	150.10	12.60	3.50	2.93	17.19	84.26	30.31
G40	42	152.50	13.16	3.20	2.65	27.37	93.86	41.65
G429	49	131.92	13.2	3.84	2.91	34.31	76.60	32.54
M1/M2	45.67	138.96	10.32	3.64	3.01	18.96	107.50	52.78
M1/G2	54.67	165.60	12.83	3.88	3.13	22.00	97.88	47.63
M1/G843	52.67	148.76	11.4	3.74	2.96	15.97	93.03	46.48
M1/As67	50.67	167.73	10.83	3.60	3.10	17.07	95.18	29.08
M1/G40	46.33	158.94	13.05	3.95	2.89	17.83	98.21	42.03
M1/G429	49	150.71	15.87	3.83	2.85	31.69	87.71	33.04
M2/G2	56	156.50	10.75	5.75	2.90	21.75	98.74	49.39
M2/G843	53.67	150.60	11.5	4.82	3.05	18.88	78.80	50.25
M2/As67	55.67	138.71	13.67	4.71	3.21	15.25	96.92	49.90
M2/G40	48	152.40	13.17	3.83	2.97	25.35	86.71	51.12
M2/G429	50.67	149.33	14.32	4.43	2.81	18.95	75.09	30.12
G2/G843	51	161.81	17.15	3.43	2.86	20.07	95.94	39.58
G2/As67	57.33	147.00	9.17	4.44	2.92	25.89	102.30	48.42
G2/G40	49	161.30	16.02	4.30	2.75	23.00	92.51	42.69
G2/G429	52.33	156.98	14.3	3.48	2.84	15.02	89.92	41.26
G843/As67	49	152.80	12.12	4.62	3.25	14.92	107.12	53.53
G843/G40	49	170.06	14.09	3.65	2.95	24.50	88.62	41.58
G843/G429	51	155.38	17	3.83	3.00	26.50	110.44	41.78
As67/G40	48.33	166.92	11.65	3.48	2.92	32.13	98.75	42.59
As67/G429	51	146.79	13.58	4.33	3.31	34.75	101.18	53.24
G40/G429	46	154.74	14.9	2.83	3.32	28.29	87.77	48.22

Table 3. Mean squares of Wr+Vr and Wr-Vr analysis

Source of variance	d.f.	Mean squares							
		Dayes to 50% flowering		Plant height (cm)		First fruiting node		Number of branches/plant	
		Wr+Vr	Wr-Vr	Wr+Vr	Wr+Vr	Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr
Reps	2	269.26	15.94	918.12	5131.76	45.18	29.95	0.01	0.09
Bet. Arrays	6	187.38*	54.64	21364.59**	718.33	38.81*	25.04	0.11	0.18
Error	12	40.77	45.67	2834.35	615.61	11.42	12.71	0.05	0.07
Source of variance	**d.f.**	**Mean squares**							
		Number of pods/plant		**Numberof seeds/pod**		**100-seed weight (g)**		**Seed yield/plant (g)**	
		Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr	Wr+Vr	Wr-Vr
Reps	2	1381.098	57.9666	0.00019	0.00407	872.368	992.6036	63.38926	125.6924
Bet. Arrays	6	4504.6**	789.89**	0.00113	0.00088	8625.2**	12617.95**	2077.948**	4634.861**
Error	12	106.6673	45.15565	0.00090	0.00102	644.824	585.8392	354.0969	40.93742

*,** significant at 0.05 and 0.01 level of probability

Table 4. General combining ability (gca) effects for the seven parents for all the studied characters

Parents	Days to 50% flowering	Plant height (cm)	First fruiting node	Number of branches/plant	Number of seeds/pod	Number of pods/plant	100-seed weight (g)	Seed yield/plant (g)
M1	-1.201**	0.046	0.270	-0.109	0.010	-2.219**	0.043	-0.249
M2	0.947*	-9.376**	-0.840**	0.383**	0.002	-2.573**	-0.721	2.662**
G2	3.243**	4.770**	0.326	0.178*	-0.130**	-1.414**	-1.282**	-1.339**
G843	-0.534	1.214	-0.050	0.111	0.045	-0.929	1.727**	-0.816*
As67	2.021**	0.863	-1.129**	0.017	0.103**	-1.095*	3.572**	0.323
G40	-3.757**	6.330**	0.313	-3.999**	-0.062*	2.949**	0.274	1.894**
G429	-0.720	-3.846**	1.110**	-0.180*	0.032	5.282**	-3.612**	-2.416**

*, ** Significant at 0.05 and 0.01 level of probability, respectively.

Table 5. Specific combining ability effects (sca) for F_1 hybrids for all the studied characters

Crosses	Dayes to 50% flowering	Plant height (cm)	First fruiting node	Number of branches/ plant	Number of seeds/pod	Number of pods/plant	100-seed weight (g)	Seed yield/plant (g)
M1/M2	-4.639**	-3.259	-2.407**	-0.641**	0.042	1.716	15.946**	8.557**
M1/G2	2.065	9.235**	-1.059	-0.190	0.293**	3.597**	6.888**	7.468**
M1/G843	3.843**	-4.079	-2.114**	-0.266	-0.051	-2.918*	-0.965	5.735**
M1/As67	-0.713	15.276**	-1.605**	-0.312	0.031	-1.656	-0.660	-12.804**
M1/G40	0.731	1.018	-0.833	0.451*	-0.014	-4.936**	5.665**	-1.425
M1/G429	0.361	2.955	1.190*	0.111	-0.148	6.591**	-0.946	-6.102**
M2/G2	1.250	9.557**	-2.033**	1.184**	0.075	3.701**	8.515**	6.321**
M2/G843	2.694*	7.213**	-0.908	0.318	0.047	0.343	-14.434**	6.591**
M2/As67	2.139	-4.322*	2.338**	0.309	0.152	-3.119*	1.838	5.105**
M2/G40	0.250	3.897	0.397	-0.155	0.073	2.935*	-5.068**	4.758**
M2/G429	-0.120	11.007**	0.749	0.226	-0.181*	-5.795**	-12.805**	-11.939**
G2/G843	-2.269	4.277*	3.577**	-0.867**	-0.015	0.374	3.270*	-0.011
G2/As67	1.509	-10.182**	-3.324**	0.244	-0.003	6.363**	7.783**	7.686**
G2/G40	-1.046	-1.349	2.084**	0.517*	-0.021	-0.570	1.290	0.385
G2/G429	-0.750	4.504*	-0.433	-0.520*	-0.015	-10.884**	2.586	3.262**
G843/As67	-3.046**	-0.826	-0.002	0.484*	0.146	-10.039**	9.590**	12.210**
G843/G40	2.731*	10.967**	0.533	-0.066	0.007	0.444	-5.606**	-1.307
G843/G429	1.694	6.460**	2.643**	-0.103	-0.037	0.111	20.097**	3.202**
As67/G40	-0.491	8.175**	-0.831	-0.139	-0.080	5.237**	2.767*	-1.437
As67/G429	-0.861	-1.772	0.305	0.491*	0.216*	8.527**	8.989**	13.523**
G40/G429	-0.083	0.711	0.180	-0.596**	0.393**	-1.977	-1.120	6.929**

*, ** Significant at 0.05 and 0.01 level of probability, respectively.

Table 6. continue.

Entry	Number of pods/plant		Number of seeds/pod		100 seed weight'g		Seed yield/plant'g	
	M.P heterosis	B.P. heterosis	M.P heterosis	B.P. heterosis	M.P heterosis	B.P. heterosis	M.P heterosis	B.P. heterosis
M1/M2	13.53	11.53	4.58	3.79	24.18**	14.62**	35.27**	30.01**
M1/G2	28.21*	22.77	15.29**	7.93	27.25**	23.35**	42.08**	17.32**
M1/G843	-24.71**	-38.62**	0.55	-1.00	10.06**	3.71	37.58**	14.49**
M1/As67	1.64	-0.70	6.50	5.80	16.35**	12.96**	-17.98**	-28.37**
M1/G40	-18.53*	-34.86**	4.15	-0.34	13.40**	4.63	2.20	0.91
M1/G429	24.99**	-7.64	-1.75	-2.06	12.49**	10.54**	-9.65*	-18.62**
M2/G2	24.57*	21.37	7.62	1.40	17.35**	5.28*	54.61**	31.92**
M2/G843	-12.23	-27.44**	4.26	2.00	-14.11**	-15.98**	56.03**	34.21**
M2/As67	-10.79	-11.29	11.12*	9.56	8.86**	3.34	47.31**	33.28**
M2/G40	14.27	-7.38	7.96	3.85	-7.58**	-7.62**	29.27**	22.74**
M2/G429	-26.14**	-44.77**	-2.43	-3.44	-11.86**	-19.94**	-13.92**	-19.55**
G2/G843	-8.65	-22.87**	3.32	-4.35	16.86**	6.94**	48.18**	46.76**
G2/As67	47.48**	44.48**	6.97	-0.34	28.88**	21.41**	70.61**	59.75**
G2/G40	1.57	-15.97*	5.79	3.77	9.90**	-1.44	25.37**	2.50
G2/G429	-42.49**	-56.22**	4.47	-2.41	19.02**	17.39**	39.89**	26.80**
G843/As67	-30.94**	-42.66**	9.66*	8.70	23.15**	19.41**	86.91**	76.61**
G843/G40	-8.22	-10.49	4.31	-1.34	-3.44	-5.58*	21.19**	-0.17
G843/G429	-12.15*	-22.76**	1.59	0.33	32.81**	23.11**	40.41**	28.40**
As67/G40	44.21**	17.39*	4.49	0.34	10.88**	5.21*	18.37**	2.26
As67/G429	34.95**	1.28	13.31**	12.97**	25.79**	20.08**	69.42**	63.61**
G40/G429	-8.27	-17.55*	19.49**	14.09**	2.98	-6.49**	29.99**	15.77**

*, ** Significant at 0.05 and 0.01 level of probability, respectively.

Table 6. Percentage of heterosis relative to mid- and better parent fro the studied traits

Entry	days to 50% flowering		Plant height		First fruiting nodes on the main stem		Number of branches/plant	
	M.P heterosis	B.P. heterosis	M.P heterosis	B.P. heterosis	M.P heterosis	B.P. heterosis	M.P heterosis	B.P. heterosis
M1/M2	-7.74*	-3.51	6.15**	-1.50	-30.74**	-17.76*	-12.96	-13.54
M1/G2	5.13	15.51**	12.60**	8.19**	-19.28**	-11.76	-7.42	-7.84
M1/G843	12.06**	12.86**	5.12*	4.78*	-20.22**	0.61	-13.94*	-16.52
M1/As67	-1.29	7.06	15.21**	11.74**	-27.46**	-14.05	-6.63	-14.51
M1/G40	3.72	10.31*	8.29**	4.22	-14.17*	-0.84	6.55	-6.24
M1/G429	1.72	3.53	10.41**	6.83**	4.20	20.23**	-4.93	-9.11
M2/G2	3.38	8.38*	14.31**	2.24	-20.63**	-14.34	38.09**	37.57**
M2/G843	9.15**	15.00**	14.65**	6.07*	-3.69	1.50	11.68	7.60
M2/As67	4.06	7.74*	2.43	-7.59**	8.66	8.92	23.21**	13.56
M2/G40	2.48	14.29**	11.55**	-0.06	2.45	4.94	4.31	-7.63
M2/G429	0.66	3.41	18.20**	13.20**	11.22	14.10	10.97	6.83
G2/G843	-1.30	9.28*	9.69**	5.70*	33.15**	51.37**	-20.85**	-23.48*
G2/As67	2.375	3.61	-3.02	-3.97	-32.42**	-27.22**	15.77*	6.38
G2/G40	-0.69	16.67**	5.57**	5.37*	15.67*	21.73**	16.57*	2.93
G2/G429	-0.97	6.80	10.16**	2.55	3.10	8.33	-13.14	-16.65
G843/As67	-3.92	4.99	4.63*	1.80	1.30	6.97	15.79	3.16
G843/G40	10.51**	16.67**	15.50**	11.51**	15.07*	24.36**	-4.97	-18.52*
G843/G429	6.61	9.28*	13.46**	9.44**	38.61**	50.04**	-7.81	-14.36
As67/G40	-0.70	15.07**	10.32**	9.46**	-9.55	-7.54	3.98	-0.57
As67/G429	-2.23	4.08	4.10	-2.20	5.27	7.78	18.08*	12.85
G40/G429	1.10	9.52*	8.81**	1.47	13.05*	13.22	-19.54*	-26.24**

*, ** Significant at 0.05 and 0.01 level of probability, respectively.

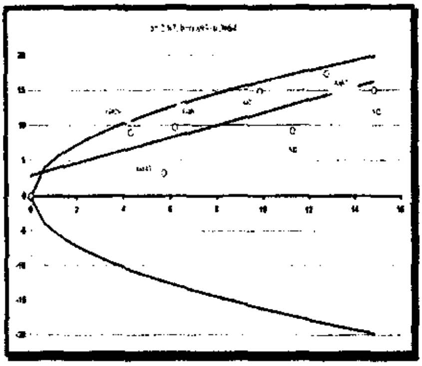

Fig.1. The graph of Wr and Vr for days to 50% flowering

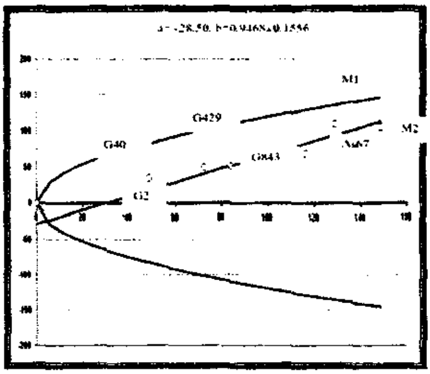

Fig. 2.The Wr/Vr graphs for plant height.

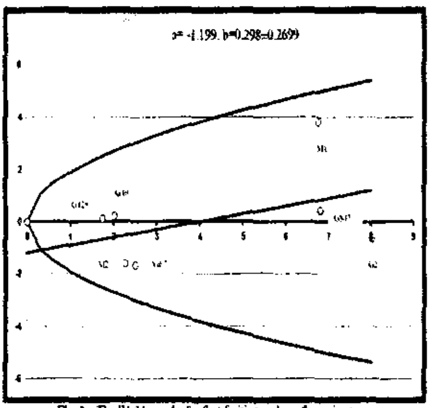

Fig. 3a. The Wr/Vr graphs for first fruiting node on the main stem.

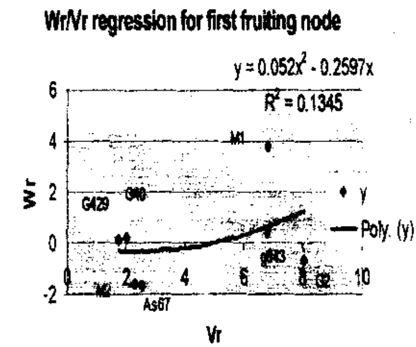

Fig. 3b.The Wr/Vr graphs for first fruiting node on the main stem

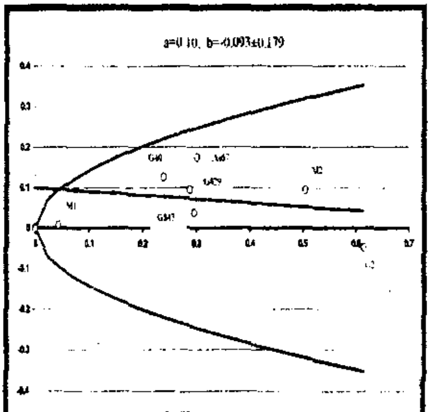

Fig. 4a. The Wr/Vr graphs for number of branches/plant

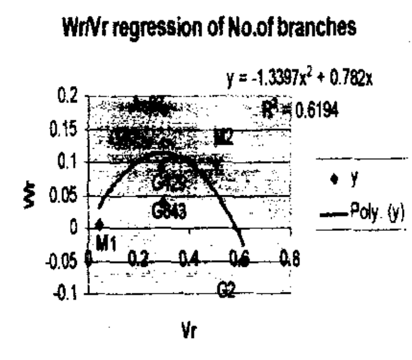

Fig. 4b. The Wr/Vr graphs for number of branches/plant

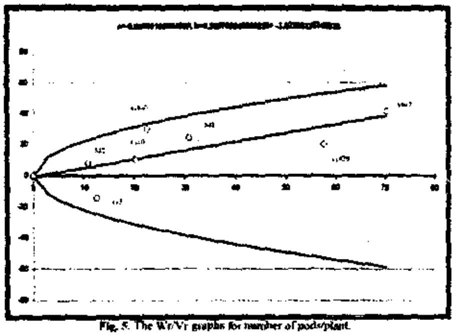

Fig. 5. The Wr/Vr graphs for number of pods/plant.

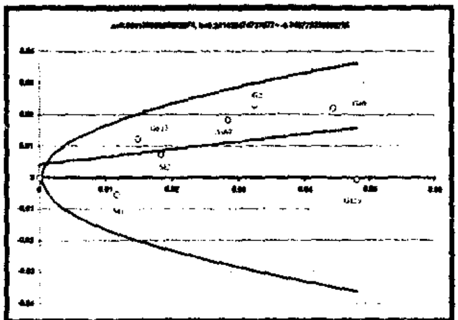

Fig. 6a. The Wr/Vr graphs for number of seeds/pod.

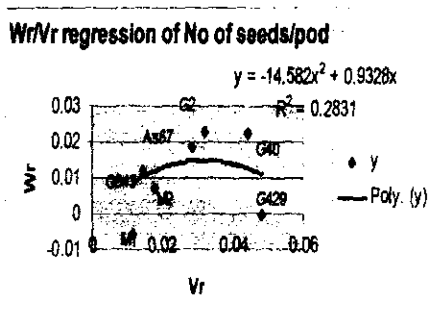

Fig. 6b. The Wr/Vr graphs for number of seeds/pod.

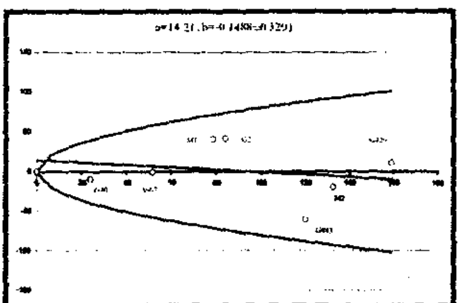

Fig. 7a. The Wr/Vr graphs for 100 seed weight/plant.

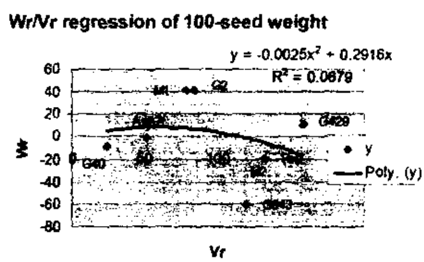

Fig. 7 b. The Wr/Vr graphs for 100 seed weight/plant.

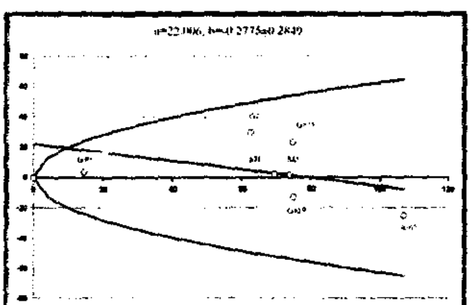

Fig 8a. The Wr/Vr graphs for plant yield

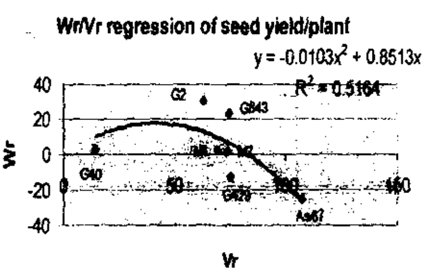

Fig 8b. The Wr/Vr graphs for plant yield.

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التحليل الوراثى لصفات المحصول فى الفول البلدى

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تم إجراء التهجين الدائرى لسبعه أباء منتخبة فى اتجاه واحد بمزرعة كليه الزراعة جامعة أسيوط خلال موسم 2009– 2010 لدراسة التحليل الوراثى وطبيعة فعل الجين المتحكم فى وراثه صفه التبكير فى الإزهار والمحصول ومكوناته في الفول البلدى . تم تقييم الآباء بالإضافة الى 21 هجين فى تصميم قطاعات عشوائية كاملة بثلاثة مكرارات في موسم 2010– 2011 . ثمانية صفات تم قياسها على الاباء و نباتات الجيل الأول و هى ميعاد الازهار و طول النبات و عدد الافرع فى النبات و ارتفاع اول قرن على الساق الرئيسية و عدد القرون فى النبات الواحد و عدد البذور فى القرن و وزن 100 بذرة و وزن محصول النبات. أوضحت النتائج المسجلة ، ان هناك اختلافات معنوية بين التراكيب الوراثيه ، مما يشير الى وجود مدى واسع من الاختلافات الوراثية في جميع الصفات المدروسة مما يتيح امكانية التحسين الوراثى فى برامج تربية الفول البلدى. كان متوسط الجيل الاول اعلى من متوسط الاباء فى الصفات المدرسة. سجلت بعض الهجن قوه هجين محسوبه من الأب الأعلى تراوحت من 5.37–13.20 لصفه طول النبات ومن –17.76– –27.22 لصفه إرتفاع أول قرن على الساق الرئيسيه ومن 18.52–37.57 لصفه عدد الأفرع على النبات ومن12.97–14.09 لصفه عدد البذور فى القرن ومن 17.39 – 44.48 لصفه عدد القرون على النبات ومن5.28–23.35 لصفه وزن ال100 بذره ومن 14.49–76.61% لصفه وزن محصول النبات. لوحظ بالنسبة لصفة الازهار وجود مستويات منخفضه لقوه الهجين. أظهرت كل من القدرة العامة و الخاصة على الائتلاف اختلافات معنوية في جميع الصفات المدرسة ، مما يشيرالى أهمية كل من فعل الجين المضيف والغير مضيف فى توارث هذه الصفات. حددت الآباء الأفضل قدره على الائتلاف فى جميع الصفات.