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GENETIC VARIANCE COMPONENTS OF SOME YIELD TRAITS IN PEA

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ABSTRACT

Half diallel crosses involving divergent genetically and morphologically genotype was used to estimate genetic components of some yield traits in pea. The analysis of the F_1 crosses and parents revealed that the additive dominance model of gene action was operating for days to flowering, plant height, and green pod length, number of seeds/pod and green pod yield/plant. Both additive and dominance gene effects were important in controlling the variation of all studied traits. Additive variance (D) was larger than the dominance (H_1) for days to flowering, plant height, pod length, number of seeds\ pod and green pod yield/plant, confirming the presence of partial dominance, while the additive was smaller a dominance for total green pod yield tonfed. Indicating the presence of over dominance. Narrow sense heritability was high for green pods/ plants (0.85), pod length (0.81), plant height (0.80), Days to flowering (0.78), total green pod yield ton/ fed (0.76), and number of seeds/ pod (0.73). High estimates of heritability for these traits suggested that the genetic improvement could be achieved through individual and recurrent methods selection.

Key words: ***Garden pea, Yield and its components, Diallel, wr/vr relationship, Gene action, Heritability.***

INTRODUCTION

Garden pea (*Pisum sativum* L.) is one of the most important leguminous crops in several parts of the world. In Egypt, pea is a popular vegetable crop. it is well adapted to stress and has excellent nutritional qualities. The partitioning of the genetic variance is of great importance to the breeder to choose the appropriate breeding programme for improving pea. For effective and rapid improvement of yield and its components in pea, through conventional breeding methods, availability of genetic variation among parents in the initial crosses is essential. Much work has been done towards understanding the inheritance of yield and yield components in pea, (Shalaby 1974, Waly and Abd El-Aal 1986, Singh *et al.* 1987, Singh and Singh 1989, Sarawat *et al.* 1994, Singh, A.K. 1995, Zayed 1998, Abdou 1999, Zayed 1999, Jangpo *et al.* 2001, Tyagi and Srivastava 2002, Singh and Sharma 2001, Abdou 2005. Sardana *et al.* 2007 and Nausher wan *et al* 2008). The present investigation was planned to:

1- Estimation of the type of gene action and heritability controlling the inheritance of yield and its components traits of pea.
2- Identification of the parents which carry the dominate and recessive alleles for the studied traits.

MATERIALS AND METHODS

The present study was conducted in the winter seasons of 2007/2008 and 2008/2009 at the Experimental Farm of the Faculty of Agriculture, South Valley University, Qena Governorate. The soil structure was clay loam. The name and source of six pea cultivars used in this experiment are given in Table (1).

Table 1. Originated Characteristics for the six pea varieties used in this study

Genotype	Source	Plant height	Dry-seed color	Dry- seed texture	Flower color
Master B (P_1)	Egypt	Short	Green	Wrinkled	White
Little Marvel(P_2)	USA*	Short	Green	Wrinkled	White
Alaska(P_3)	USA*	Medium	Green	mooth	White
Dwarf Gray Sugar(P_4)	USA*	Medium	Mottled	Wrinkled	Purple
Early Perfection (P_5)	USA*	Medium	Green	Wrinkled	White
Victory Fruther (P_6)	USA*	Medium	Green	Wrinkled	White

The Egyptian Agricultural organization

All possible F_1 single crosses among the six cultivars of pea were made in winter 2007/2008 season. In the following season, the seed of 21 entries, i.e., the six parents and 15 individual crosses hybrids were planted in the field on October 20, 2008 on the northern side of the row 3m long and 0.6m wide, with space of 20 cm between plants. The genetic materials were arranged in a randomized complete block design, with three replicates. The experimental plot for each parental genotype of F_1 hybrid consisted of three rows ($5.2m^2$). The recommended practices of cultivation, irrigation, fertilization, weed and pest control of pea were followed.

Traits Measured

1- Days to 50% flowering, based on all grown plants per plot.
2- Plant height (cm), as an average of measurements taken from cotyledonary node to the tip of the main stem of the 10 randomly sampled plants per plot.
3- Pod length (cm), average of records on 10 sampled pods per plot in each harvest at the marketable green-maturity stage.
4- Number of seeds per pod, determined as an average of records on the 10 sampled pods per plot.
5- Green-pod yield / plant (g), as the weight of green pods in all harvests in each plot divided by no. of plants.

6- Total green pod yield (ton) /fed. as the total weight of green pods in all harvests per fedden.

Statistical Analysis

The analysis of data was done according to the methods of Hyman (1954) and Jinks (1954).

RESULTS AND DISCUSSION

Analysis of variance showed that, there are significant differences among all the studied traits (Table 2). The results in (Table 3) showed that the mean days to flowering appearance for the parents ranged from 47.03 days for P_3 (Alaska) to 76.17 days for P6 (Victory Fruther). The mean of F1 hybrids ranged from 46.14 days for the cross P1x P3 (Little Marvel x Alaska) to 75.04 days for the cross P1xP6 (Master B x Victory Further).Meanwhile, mean plant height cm of the parents ranged from 61.30 cm for P_3 (Alaska) to 90.67 cm P_4 (Dwarf Gray Sugar) and from 65.52 cm for (P_3 xP_6) to 100.50 for (P_4 xP_5). As for pod length cm, the mean of the parents ranged from 6.632 cm for P_3 (Alaska) to 9.277 cm for P_1 (Master B) and her too from 6.900 cm for P3xP4 (Alaska x Dwarf Gray Sugar) to 9.077 cm for P_1 x P_5 (Master B x Early Perfection).The mean number of seeds/pod ranged from 5.617 seeds/pod for P_4 (Dwarf Gray Sugar) to 7.823 seeds/pod for P_1 (Master B). The results in (Table 3) showed that the mean weight of pods/plant of the parents ranged from 44.22 (g) foı P_3 (Alaska) to 174.94 (g) for P_5 (Early Perfection). And from 69.33 (g) for P_2xP_3 (Little Marvel x Alaska). To 198.70 (g) for P_5xP_6 (Early Perfection x Victory Fruther). Regard of total green pod yield ton/fedden. The mean ranged from 1.104 ton/fed. To 6.705 ton/fed. For parents and ranged from 2.030 ton/fed. to 8.005 ton/fed. For hybrids. Similar results were obtained by Shalaby (1995), Abdou (1999), Mahmoud, (2004) and Abdou (2005).

Table 2. Mean squares of studied traits among the different genotypes in the growing season of 2009.

Source of Variance	d.f	Days of flowering	Plant height	Pod length	Number of seeds/pod	Weight of pods/plant	Total green pod yield ton/fed
Reps.	2	0.038	0.367	0.003	0.004	0.199	0.0001
Genotypes	20	262.724**	430.329**	1.692**	1.603**	6845.125**	15.503*
Error	40	0.018	0.202	0.008	0.003	0.142	0.0001

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

Table 3. Means of the parents and F_1 diallel crosses for all studied traits in the growing season of 2009.

Genotypes	Days of flowering	Plant height	Pod length	Number of seeds/pod	Weight of pods/plant	Total green pod yield ton/fed
P_1	74.05	83.52	9.277	7.823	98.72	3.202
P_2	71.11	67.20	8.297	7.217	80.77	2.398
P_3	47.03	61.30	6.633	5.550	44.72	1.104
P_4	55.26	90.67	7.193	5.617	87.75	2.605
P_5	61.07	85.69	8.337	7.200	174.97	5.200
P_6	76.17	62.66	8.117	6.500	160.10	6.705
Mean (Ps)	**61.13**	**75.17**	**7.97**	**6.65**	**107.83**	**3.55**
$P_1 \times P_2$	72.13	75.80	8.723	7.420	100.00	3.902
$P_1 \times P_3$	55.17	70.75	7.460	5.820	80.75	2.805
$P_1 \times P_4$	60.19	95.68	8.317	5.993	110.67	3.105
$P_1 \times P_5$	63.06	90.75	9.077	7.507	190.27	7.205
$P_1 \times P_6$	75.04	77.35	8.650	6.820	165.25	7.905
$P_2 \times P_3$	46.14	69.08	7.217	6.133	69.33	2.030
$P_2 \times P_4$	53.06	96.17	7.733	5.857	97.88	3.500
$P_2 \times P_5$	60.24	80.66	8.850	7.377	180.64	7.515
$P_2 \times P_6$	73.13	69.67	8.450	7.003	165.17	7.005
$P_3 \times P_4$	50.10	75.38	6.900	5.750	90.84	2.900
$P_3 \times P_5$	55.05	73.68	7.550	6.200	110.61	5.802
$P_3 \times P_6$	70.12	65.52	8.267	6.150	100.55	6.013
$P_4 \times P_5$	58.37	100.50	8.750	7.500	194.17	6.905
$P_4 \times P_6$	62.20	85.98	8.500	6.800	171.22	7.643
$P_5 \times P_6$	63.06	94.57	9.017	7.247	198.70	8.005
Mean(F1's)	64.11	81.43	8.23	6.64	135.06	5.48
L.S.D 0.05	0.22	0.74	0.15	0.09	0.72	0.01

The diallel analysis

Highly significant additive and non-additive gene effects were indicated by the significance of "a" and "b" items parameters, respectively (Table 4) for all studied traits. The results illustrated that additive gene effects were greater in magnitude than those of dominance gene effects for all studied traits in accordance with results of (Shalaby 1974, Waly and Abdel-Aal 1986, Zayed *et al* 1999, Tyagi and Srivastava 2002, Singh and Mishra 2003, Singh and Mishra. 2003 and Abdou 2005). The significance of "b_1" parameters showed that the F_1 hybrids exhibited directional dominance for all studied traits except seeds/pod. The average of F_1 hybrids (Table 3) exceeded that of the parents by 7.69% for plant height, 3.15% for pod length, 20.16% for weight of pods/plant and 7.69% for total green pod yield ton/fed. On the contrary, the mean of F_1 was lower than the mean of parents

for seeds/pod, indicating that the direction of dominance for lower seeds/pod. Similar results were obtained by Nashwa (2006) and El-Ameen (2008). High significance of "b_2" parameters for all studied traits (Table 4) indicated that a symmetrical gene distribution of genes effecting at loci showing dominance, while the significance of "b_3" parameters indicated further dominance effects due to specific combination. These results were in agreement with those obtained by Tahany *et al* (1991), Gad *et al* (2005), Nashwa (2006) and El-Ameen (2008).

The Wr/Vr relationship

The analysis of variance of Wr/Vr and Wr/Vr is shown in (Table 5). The results revealed highly significant differences Wr + Vr and Wr-Vr for all studied traits indicated the presence of non- additive genetic effect and that non-allelic gene interaction was operating. The slope of the Wr/Vr regression line significantly deviated from zero, but not from unity for days to flowering, plant height(cm), pod length(cm),number of seeds / pod and green pod/plant(g), confirming the adequacy of the additive dominance gene model as cleared in (Fig.1) a, b and c and (Fig.2) a and b , while the graph shows the array points along the line cutting the Wr axis well below the origin for total green pod yield ton/ fed., indicating over dominance for this trait (Fig.2c). Parent No. 2(little Marvel) represented the extreme recessive genotype which was located at the end of the regression line for plant height, pod/length, number of seeds/pod and days to flowering and total green pod yield. Meanwhile, parent No. 6 represented the extreme recessive genotype for plant height, parent No. 3 for pod length, parent No. 4 for total

Table 4. The results of the analysis of variance of diallel analysis for all studied traits in season of 2009.

Source of Variance	d.f	Days of flowering	Plant height	Pod length	Number of seeds/pod	Weight of pods/plant	Total green pod yield
a	5	1313.80**	2317.22**	8.8427**	7.5457**	38962.60**	79.6813**
b	15	121.28**	180.54**	0.64479**	0.89960**	2248.10**	7.9554**
b_1	1	132.97**	588.79**	0.97622**	0.00240**	1124.18**	55.8927**
b_2	5	45.592**	131.35**	0.85107**	0.93208**	1509.68**	4.6556**
b_3	9	162.979**	162.50**	0.49336**	0.98125**	1672.09**	4.4623**
B × a	10	0.0250	0.42812	0.01206	0.00473	0.175	0.00023
B ×b	30	0.03854	0.36250	0.01385fed	0.00511	0.39166	0.00007
B ×b_1	2	0.02113	0.01284	0.01600	0.00084	0.21142	0.00007
B ×b_2	10	0.08906	0.17890	0.0484	0.00221	0.16875	0.00004
B ×b_3	18	0.04582	0.50335	0.01734	0.00720	0.53559	0.00009
Block interaction	70	0.02008	0.21651	0.00733	0.00287	0.19285	0.00006

All items tested against block interaction

green pod yield and number of seeds/pod. In contrast, parent No. 4 (Dwarf Gray Sugar) represented dominant genotype which was located near the point of origin for days to flowering, parent No. 3 for weight of green pods/plant and plant height, parent No. 5 for days to flowering and total green pod yield and parent No. 6 for weight of green pods/plant and total green pod yield ton/fed.

Genetic parameters

The estimates of the components of the genetic variation are presented in Table (6.) The "D" parameter estimating the additive variance was larger than dominance (H_1) confirming that partial dominance was operating, which was also indicated by the average degree of dominance being less than one for most characters, i.e. days to flowering, plant height, pod length, seeds/pod, weight of green pod/plant, while the over dominance was manifested with total green pod yield ton/fed. These results were in agreement with those obtained by Singh *et al* (1987). They reported that partial dominance was found for all studied traits. In this study, the "F" value was positive for pod length and seeds/pod, indicating an excess of dominant than recessive alleles. Moreover, the "F" value. Was negative for days to flowering, plant height, weight of green pods/plant and total green pod yield ton/fed, indicating an excess of recessive than dominance alleles. These results is in agreement with theses obtained by El-Ameen (2008), who found that "F" value was negative for days to flowering, weight of green pods/plant and total green pod yield ton/fed.

The (uv) values were less than 0.25 indicating unequal distribution of the dominant and recessive alleles among the six parents analyzed which has been indicated before from the significant "b_2" parameters. Similar results were obtained by Tahany *et al.* (1991) and Nashwa (2006). Narrow sense heritability estimates were high for weight of green pods/plant (0.85), pod length (0.81), plant height (0.80), days to flowering (0.178), total green pod yield ton/fed.(0.76) and number of seeds/pod (0.73). High estimates of heritability for these traits suggested that genetic improvement could be achieved through individual and recurrent selection methods. High heritability estimates of broad sense were also shown for days to flowering, plant height, number of seeds/pod, weight of green pods/plant, pod length and total green pod yield ton/fed. These results are in harmony with those obtained by Singh and Singh (1989), Abdou (1999), Tyagi and Srivastava (2003), Mahmoud (2004) and Abdou (2005).

Table 5. Analysis of variance of (Wr+Vr) and (Wr – Vr) for all studied traits.

S.V.	d.F	Mean squares											
		Days of flowering		Plant height (cm)		Pod length (cm)		Number of seeds/pod		Weight of pods/plant		Total green pod yield	
		Wr+Vr	Wr-Vr	Wr+Vr	Wr–Vr	Wr-Vr	Wr+Vr	Wr – Vr	Wr+Vr	Wr – Vr	Wr+Vr	Wr – Vr	Wr+Vr
Reps.	2	0.90625	0.55737	66.6875	51.40514	0.011357	0.90625	0.55737	66.6875	51.40514	0.011357	0.00064	0.00002
Genotypes	5	19464.55**	807.9966**	15836.24**	1426.353**	0.302079**	19464.55**	807.9966**	15836.24**	1426.353**	0.302079**	49.509**	0.38267*
Error	10	2.1875**	0.13505	32.53125	6.987632	0.005777	2.1875**	0.13505	32.53125	6.987632	0.005777	0.00074	0.00001

Table 6. Components of the genetic variation and heritability for six traits studied at 2009 season

Character	Days of flowering		Plant height (cm)		Pod length (cm)		Number of seeds/pod		Weight of pods/plant (g)		Total green pod yield ton\fed	
parameters	X	±S.E	X	±S.E	X	±S.E	X	±S.E	X	±S.E	X	± S.E
D	134.45	0.229	166.34	1.648	0.8646	1.792	0.857	0.26	2488.099	3.487	4.146	0.006
F	-1.402	0.559	-62.001	4.27	6.883	7.378	0.224	5.537	-1505.664	8.520	-3.654	0.15
H_1	91.310	0.581	148.980	4.148	0.599	5.549	0.799	0.057	1833.702	8.854	6.338	0.0162
H_2	81.197	0.519	119.942	3.738	0.412	6.883	0.594	0.051	1498.358	7.909	5.303	0.014
E	2.008	8.662	0.21517	0.6230	7.331	0.006	0.0028	0.0085	0.192	1.318	5.929	0.002
$(H_1/D)^{\frac{1}{2}}$	0.82		0.94		0.83		0.96		0.85		1.23	
UV	0.22		0.20		0.17		0.18		0.20		0.20	
Heritability bs	0.999		0.998		0.98		0.994		0.99		0.99	
Heritability ns	0.782		0.80		0.81		0.73		0.85		0.76	

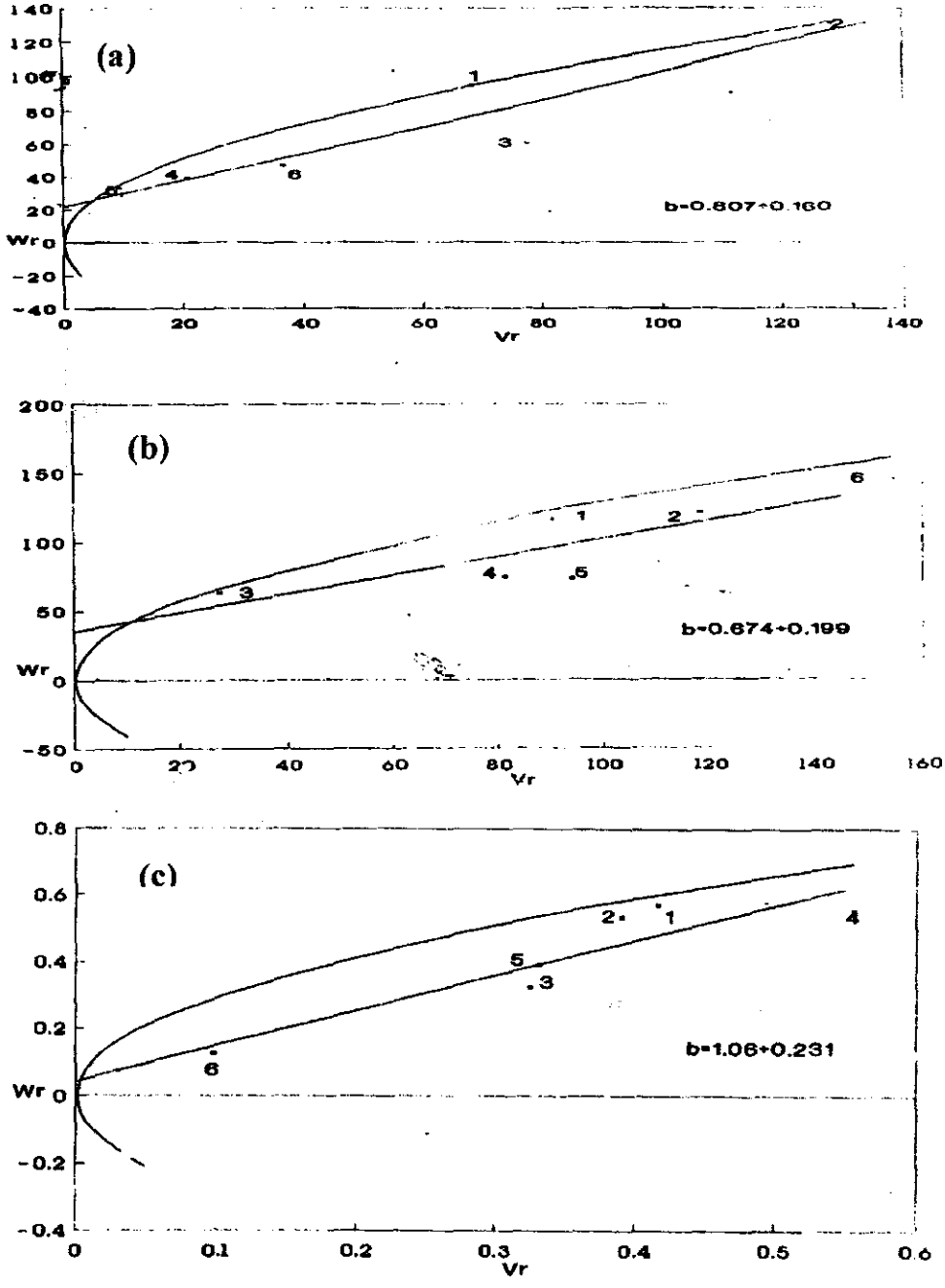

Fig.1. The Wr/Vr graph of F_1 diallel crosses for days to flowering (a), plant height (b) and pod length (c).

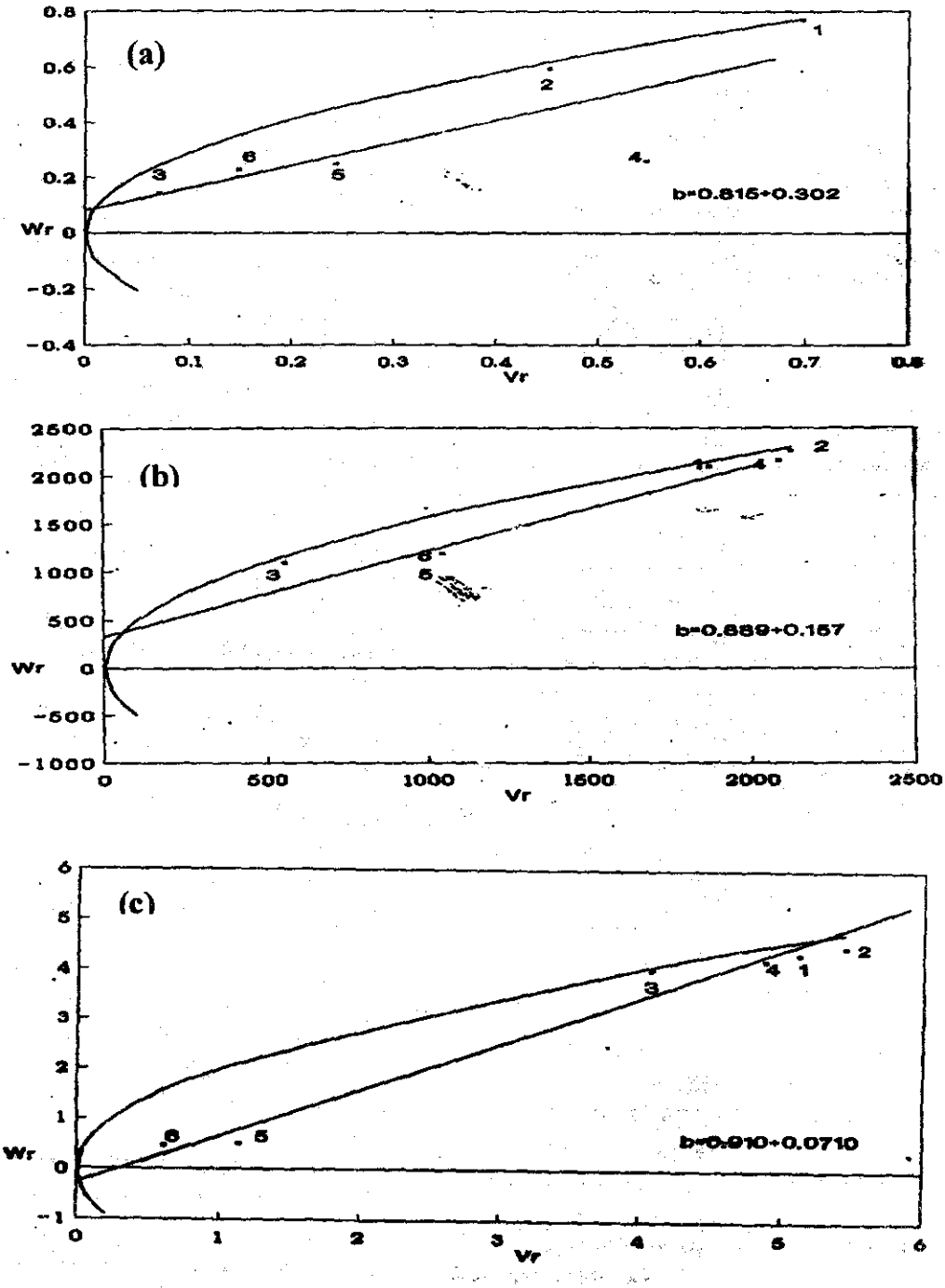

Fig.2. The Wr/Vr graph of F_1diallel crosses for number of seeds / pod (a), green pod/plant (b) and total green pod yield (c)

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مكونات التباين الوراثي لبعض صفات المحصول في البسلة

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قسم البساتين (خضر) – كلية الزراعة – جامعة جنوب الوادى – قنا

أجريت هذه الدراسة بمزرعة التجارب بكلية الزراعة بقنا – جامعة جنوب الوادي خلال موسمي ٢٠٠٧/٢٠٠٨، ٢٠٠٨/٢٠٠٩ بهدف دراسة فعل الجين ودرجة التوريث لبعض صفات المحصول فى البسلة. وقد استخدمت في هذه الدراسة ٦ تراكيب وراثية من البسلة هي: ماستر، لتل مارفل، الاسكا، دوارف جراى شوجر، ابرلى بيرفكشن، فيكتورى فريزر. فى الموسم الأول (٢٠٠٧/٢٠٠٨) تم التهجين بين الآباء الستة بنظام التهجين الدائري في اتجاه واحد وذلك للحصول بذور الجيل الأول F_1 (١٥ هجيناً). وفى الموسم الثاني (٢٠٠٨/٢٠٠٩) تم تقييم الآباء والجيل الأول. تم تحليل البيانات: لصفات الازهار، ارتفاع النبات، وطول القرن، وعدد البذور/القرن، وزن قرون/ النبات (جم) و كمية المحصول الكلي (طن/فدان). وذلك باستخدام موديل هايمن ١٩٥٤ جينكز ١٩٥٤.

وأظهرت الدراسة النتائج التالية:

١- النموذج الوراثى البسيط هو الملائم لدراسة السلوك الوراثى لجميع الصفات قيد الدراسة.

٢- جميع الصفات قيد الدراسة كانت محكومة وراثياً بالطراز السيادى والمضيف.

٣- الفعل الجينى المضيف كان أكثر أهمية من طراز الفعل الجينى السيادى لجميع الصفات قيد الدراسة.

٤- لعبت السيادة الجزئية دوراً هاماً فى توارث صفات التزهير، طول النبات، طول القرن، عدد البذور/القرن، وزن القرن الخضراء / للنبات. بينما كانت للسيادة الفائقة دور هام فى وراثة صفة كمية المحصول للفدان.

٥- درجة التوريث بمعناها الواسع و الضيق والواسع كانت عالية لجميع الصفات قيد الدراسة.