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Genetic Studies of Pod Characters in Pea

Hassan S. Abbas and Ashraf G. Haridy
Hort. Dept., Faculty of Agriculture, Assiut Univ., Assiut, Egypt

Abstract:

A complete set of six-parent diallel crosses was evaluated in peas for five pod characters i.e. pod length, pod width, pod weight, no. of seeds per pod and 100-seed weight.

From the study, there were highly significant differences among the genotypes and existence of additive and absence of non-additive effects for all the studied characters.

Partial or over dominance effects controlled the studied characters and the Vr/Wr graphs confirm the analysis.

Broad and narrow sense heritability were ranged from moderate to low for all the studied characters.

Key words: Pea, Diallel crosses, Pod characters.

Introduction:

Garden peas (*Pisum sativum* L.) is considered one of most popular vegetable crops grown in Egypt. To decide selection or hybrid programe, information about the gene actions involved in the inheritance of the characters has to be acquired. The application of the diallel cross analysis provides the breeder with detailed genetic informations after one generation.

Shalaby (1974) using a diallel analysis in 5 cvs. of garden pea, reported that additive gene action appears to be much more important than non-additive gene action in the inheritance of number of seeds per pod.

Arndt (1980) studied heterosis in pea in 147 crosses, of which 75 were reciprocal crosses. Weak heterosis was observed in certain hybrids for length of pod, seeds per pod and 1000-seed weight.

Dhillon and Chahal (1981) reported that non-additive genetic variance was predominant for seeds per pod and additive genetic variance was predominant for pod length in a diallel cross in six pea cultivars.

Kumar and Agrawal (1981) found that pod length, the number of seeds per pod and 25-seed weight in a 10x10 diallel analysis were predominantly controlled by additive gene action.

Gupta (1982) presented data on the genetic variation in twelve pea cultivars by using the diallel cross system. Non-additive gene effects predominated for 100-seed weight and both non-additive and additive effects were equally important for number of seeds per pod.

Waly (1982) performed a half-diallel cross among nine varieties of peas to study the characters: pod length, pod width, and number of seeds per pod. He reported that the additive genetic effects were considerably larger than the non-additive effects.

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Pacucci and Troccoli (1985) showed that additive effects generally predominated, dominance and epistasis effects were of little or no important in a six pea cvs diallel.

Gupta and Dahiya (1986) found that additive effects were predominant for pod length and width in pea. Dominant alleles were predominant for both characters.

Singh *et al.* (1987) studied the combining ability of a diallel cross involving ten parents of pea. It showed significant additive and non-additive genetic effects for seeds per pod and pod length in both F_1 and F_2 generations.

Tewatia *et al.* (1988) reported that twelve varieties of pea were crossed in a partial diallel. They found that the differences among genotypes were high significant for pod length and total soluble sugar content.

The objective of this work was to study the genetic systems controlling the pod characters of garden peas.

Materials and Methods:

The present study was conducted at the Experimental Farm of the Faculty of Agriculture, Assiut University, Assiut during the seasons of 2009/2010 and 2010/2011. The soil types was clay.

Six cultivars of pea i.e. Alaska (P_1), Dwarf Gray Sugar (P_2), Manuela (P_3), Mani (P_4), Citrina (P_5) and Bördi (P_6) were used in this study. These cultivars were crossed according to diallel pattern with reciprocals to obtain all the possible hybrids. The 30 F_1 hybrids seeds were produced by hand pollination during the 2009/2010 season.

In season 2010/2011, seeds of 6 parents and 30 hybrids were planted in the field for genetical evaluation on 1st October. The genetical materials were arranged in a randomized complete block design with three replicates. The normal practices of cultivation, irrigation, fertilization and pest control of peas were followed.

Data were obtained for: pod length, pod width, pod weight, No. of seeds per pod and 100-seed weight.

A diallel analysis as developed by Hayman (1954 and 1968) and Mother and Jinks (1971) was performed on the collecting data.

Results and Discussion:

a- Pod length

analysis of variance for the pod length of parents and their F_1 hybrids are presented in Table 1. The results showed that there

were highly significant differences among the genotypes. The analysis of variance of the diallel cross (Table 1) showed the existence of additive (vi) and absence of the non-additive (hii) effects.

The ratio $(H_1/D)^{½}$ was 0.617, which less than one indicating partial dominance (Table 2).

Broad-sense and narrow-sense heritability values are presented in Table 2. h^2_{bs} value was 54.97%and h^2_{ns} value was 43.85%.

The Vr/Wr graph for pod length is shown in Figure 1. The regression line cuts the Wr axis in a positive position, showing the presence of partial dominance. The distribution of the parental arrays along the regression line in the F_1 hybrids showed that parents 1 and 3 possess on excess of dominated alleles, while parent 6 possess on excess of recessive alleles.

b- Pod width:

analysis of variance for the pod width of parents and their F_1 hybrids are presented in Table 1. The results showed that there were highly significant differences among the genotypes. The analysis showed that item vi was highly significant and item hii was not significant indicating the presence of additive and absence of non-additive effects on this character.

The average degree of dominance are presented in Table 2. The ratio $(H_1/D)^{½}$ was 1.58 which more than one indicating over dominance in this trait.

Broad sense and narrow-sense heritability for pod width was 20.48% and 9.01% respectively (Table 2).

The Vr/Wr graph for pod width is shown in Figure 1. The regression line cuts the Wr axis in a negative position, showing the presence of over dominance. The distribution of the parental arrays along the regression line in the F_1 hybrids showed that parent 1 possess on excess of dominant alleles, while parent 6 possess on excess of recessive alleles.

c- Pod weight:

analysis of variance for the pod weight of parents and their F_1 hybrids showed that there were highly significant differences among the genotypes. The analysis showed also the existence of additive effects (vi) and the absence of non-additive effects (hii) on this character (Table 1).

The ratio $(H_1/D)^{½}$ was 0.672 which less than one indicating partial dominance (Table 2).

Broad-sense heritability for pod weight 48.32% and narrow-

sense heritability was 36.04% for the same character (Table 2).

The Vr/Wr graph for pod weight is shown in Figure 1. The regression line cuts the Wr axis above the origin showing the presence of partial dominance. Parent 3 possess on excess of dominant alleles, while parents 4 and 6 possess on excess of recessive alleles for pod weight.

d- No. of seeds per pod:

Analysis of variance for No. of seeds per pod of parents and their F_1 hybrids are presented in Table 1. The results showed that there were highly significant differences among the genotypes. Also, the analysis showed the existence of additive (vi) and the absence of non-additive (hii) effects on this character.

The average degree of dominance was 1.18, indicating over dominance (Table 2).

Broad-sense heritability was 27.35% and narrow-sense heritability was 17.45% for No. of seeds per pod (Table 2).

The Vr/Wr graph for No. of seeds per pod is shown in Figure 1. The regression line cuts the Wr axis in a positive position, showing the presence of partial dominance. Parent 6 possess on excess of dominant alleles, while parent 4 possess on excess of recessive alleles.

e- 100-seed weight:

Analysis of variance for 100-seed weight of parents and their F_1 hybrids are presented in Table 1. The results showed that there were highly significant differences among the genotypes. The existence of additive effects is clearly demonstrated by the high significance of item vi, while item (hii) was not significant indicating the absence of non-additive effects.

Table1:Analysis of variance for the studied characters of 6x6 diallel crosses.

Source of variation	d.f	N.S.	Variance ratio
a- Pod length			
Blocks	2	0.041	0.208
Genotypes	35	0.871	4.421**
Cultivars (vi)	5	4.166	21.12**
Heterosis (hii)	15	0.340	1.728
Error	70	0.197	
b- Pod width			
Blocks	2	0.203	50.75
Genotypes	35	0.025	6.25**
Cultivars (vi)	5	0.021	4.85**
Heterosis (hii)	15	0.006	1.446
Error	70	0.004	
c- Pod weight			
Blocks	2	0.437	1.22
Genotypes	35	1.589	4.45**
Cultivars (vi)	5	6.108	12.101**
Heterosis (hii)	15	0.630	1.764
Error	70	0.357	
d- No. of seeds per pod			
Blocks	2	1.277	3.225
Genotypes	35	0.952	2.404**
Cultivars (vi)	5	3.496	8.822**
Heterosis (hii)	15	0.644	1.626
Error	70	0.396	
e- 100-seed weight			
Blocks	2	250.02	12.316
Genotypes	35	114.56	5.643**
Cultivars (vi)	5	560.58	27.60**
Heterosis (hii)	15	32.575	27.60**
Error	70	20.30	

** Significance at P = 0.01 * Significance at P = 0.05

Table 2: Average degree of dominance (H1/D)½, broad sense-heritability (h^2_{bs}) and narrow sense-heritability (h^2_{ns}) for the studied characters of 6x6 full diallel cross.

Item	Pod length	Pod width	Pod weight	No. of seeds per pod	100-seed weight
$(H1/D)^{½}$	0.617	1.58	0.672	1.18	0.61
h^2_{bs}	54.97%	20.48%	48.32%	27.35%	63.15%
h^2_{ns}	43.85%	9.01%	36.04%	17.45%	52.84%

The ratio $(H_1/D)^{½}$ was 0.61 which less than one, indicating partial dominance (Table 2).

Broad-sense and narrow-sense heritability for 100-seed weight was 63.15% and 52.84% respectively (Table 2).

The Vr/Wr graph for 100-seed weight is shown in Figure 1. The regression line cuts the Wr axis in a positive position, showing the presence of partial dominance. The distribution of parental arrays along the regression line in the F_1 hybrids showed that parent 2 possess on excess of dominant alleles, while parent 6 possess on excess of recessive alleles.

From the study, the analysis of variance showed that there were highly significant differences among the genotypes. The results showed also existence of additive effects and the absence of non-additive effects for all the studied characters.

Partial dominance effects controlling pod length, pod weight and 100-seed weight while, over dominance effects controlling pod width and No. of seeds per pod. The Vr/Wr graphs confirm the previous analysis in all characters except No. of seeds per pod.

Broad and narrow-sense heritability were ranged from moderate to low for all the studied characters.

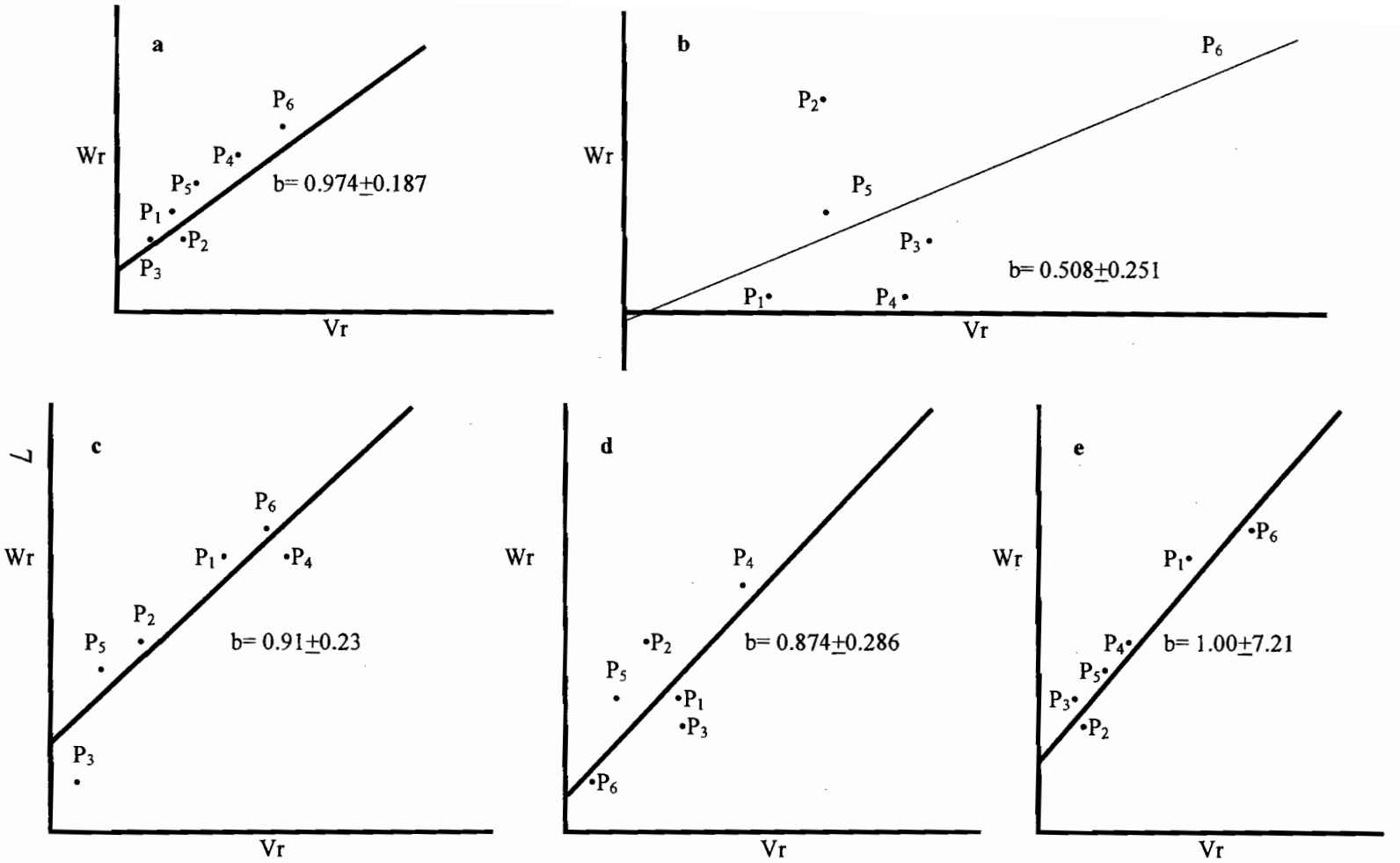

Fig. 1. Vr/Wr graphs for the studied characters.

Present results are in general agreement with the finding of Arndt (1980), Waly (1982), Pacucci and Troccoli (1985), Gupta and Dahiya (1986), Tewatia *et al.* (1988), Arumingtyas and Murfet (1992) and Sarawat *et al.* (1994).

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دراسات وراثية لصفات القرن في البسلة

حسن سيد عباس ، أشرف جلال هريدي
قسم البساتين – كلية الزراعة – جامعة أسيوط

أجري هذا البحث في قسم البساتين بكلية الزراعة جامعة أسيوط خلال موسمي 2010/2009، 2011/2010 علي ستة أصناف من البسلة والهجن الناتجة منها باستخدام طريقة الدايلل الكامل (في اتجاهين) وذلك لدراسة السلوك الوراثي لصفات القرن وهي: طول القرن – عرض القرن – وزن القرن – عدد البذور بالقرن – وزن 100 بذرة . واستخدمت في هذه الدراسة الأصناف الآتية: ألاسكا – دورف جراي شجر – مانويلا – ماني – سترينا – بوردي.

وأوضحت النتائج ما يلي:

1- كانت هناك اختلافات معنوية بين التراكيب الوراثية التي درست (ستة آباء ، ثلاثون هجيناً).

2- كان للفعل الإضافي للجين وجود ظاهر بينما غاب تأثير الفعل الغير إضافي لجميع الصفات التي درست.

3- كان هناك تأثير للسيادة الجزئية علي صفات طول القرن ووزن القرن ووزن 100 بذرة بينما كان هناك تأثير للسيادة الفائقة علي صفات عرض القرن وعدد البذور بالقرن.

4- تراوحت قيم درجة التوريث العامة ودرجة التوريث الخاصة لجميع الصفات بين القيم المتوسطة والمنخفضة.