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INHERITANCE OF TOTAL PROTEINS AND SUGARS IN GREEN SEEDS OF PEA

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ABSTRACT

Some parental genotypes which belong to green pea (*Pisum sativum* var *humile*), i.e. Snow pea, Early Perfection and Little Marvel, and some others which belong to sugar pea (*P. sativum* var. *macrocarpon*), i.e. Sugar Snap, Sugar Dady and Sugar Ann, were used in making a 6x6 diallel cross. Significant differences among each of parental genotypes and related F_1 hybrids concerning total proteins and sugars contents of green seeds were found. The highest value of green seed proteins content was associated with cultivar Sugar Dady, i.e. 7.43% f.w, followed by Early Perfection 6.63% f.w.. The highest value of green seed sugars content was associated with cultivar Sugar Ann, i.e. 7.82% f.w.. Significant reciprocal effects on the expression of green seed proteins and sugars content characters were recorded. The additive gene action was found to be predominant in the inheritance of the studied characters. The results indicated the presence of over-dominance for total sugars content in green seeds. The over-dominance acted in the direction of the parents with high total sugars in green seeds. Unequal distribution of alleles which decrease the expression of the total sugars content of green seeds character and those which increase it over the related loci in the parents was recorded. The six parents used in this study were found to carry more dominant than recessive alleles controlling total sugars content of green seeds. Concerning total sugars content of green seeds, the lowest values of Vr-Wr were associated with the parental cultivars Sugar Dady (0.765 and 1.638) Little Marvel (0.777 and 1.651), and Sugar Ann (0.794 and 1.670), which indicated that these parents carried most dominant genes controlling this character. The narrow

sense heritability values were 40.0% and 47.4% for total proteins and sugars contents of green seeds, respectively.

Key words: Green pea (*Pisum sativum* var *humile*) i.e. Snow pea, Early Perfection and Little Marvel - Sugar pea (*P. sativum* var. *macrocarpon*) Sugar Snap, Sugar Dady and Sugar Ann.

INTRODUCTION

Pea is a very popular vegetable crop grown in Egypt and many other countries all over the world. Improving the nutritional value of pea is one of the most important objectives of many pea breeding programs.

Variations among pea germplasm concerning dry seed proteins content were reported by Debelyi *et al.* (1978). In addition, Gueguen and Barbot (1988) reported differences between smooth and wrinkled pea cultivars concerning this character. Kelly and Bliss (1975) reported the predominance of the additive effect in the inheritance of proteins in dry seeds of common bean. Moreover, Limongelli *et al.* (1997) working on beans reported genetic differences between germplasm concerning dry seed proteins content. Gupta *et al.* (1998), working on pea, reported the presence of both additive and dominance types of gene effects in the inheritance of total proteins and sugars content in pea seeds. Gupta *et al.* (1998) recorded over-dominance for reducing sugars content in green seeds of pea. Pandey and Gritton (1975) working on pea reported a narrow sense heritability for percentage of proteins in dry seeds which ranged from 45 to 67%. On the other hand, Kelly and Bliss (1975) working on beans calculated moderately high broad and narrow sense heritability for dry seed proteins content. The role of environmental effects on the expression of seed proteins content character has been reported in beans (Kelly and Bliss, 1975; Hosifield and Vebersax, 1980; Forney *et al.*, 1990; Santalla *et al.*, 2001) and in pea (Tar'an *et al.*, 2004). In addition, some other factors may affect the data recorded by the different pea breeders concerning proteins' seed content in pea, such as genotype and its geographical origin (Debelyi *et al.*, 1978) as well as method of protein extraction (Colonna *et al.*, 1980). The effects of green seed maturity stage in pea on its sugars content have been reported (Basterrechea and Hicks, 1991).

The objective of the present research was estimating the genetic parameters which are necessary to design successful pea breeding programs to enhance the nutritional value of green seeds, through improving total proteins and sugars content.

MATERIALS AND METHODS

This research was conducted during winter seasons of 1997 to 1999, at the Experimental Farm and Germplasm Preservation Laboratory of Horticulture Department, Faculty of Agriculture, Benha University.

Parental genotypes:

Seeds of some parental genotypes which belong to green pea (*Pisum sativum* var *humile*), i.e. Snow pea, Early Perfection and Little Marvel, and some others which belong to sugar pea (*P. sativum* var. *macrocarpon*), i.e. Sugar Snap, Sugar Dady and Sugar Ann, were obtained from Germplasm Preservation Laboratory, Faculty of Agriculture, Benha University. Seeds of the previous mentioned parental genotypes were planted in the season of 1997/1998 and the plants of all parental genotypes were selfed to obtain more seeds for the crosses.

Crosses:

Seeds of the different parents were planted three times, at two weeks intervals starting on 24/10/1998 to assure interference of flowering periods of the different parental genotypes. This procedure was followed to find enough flowering buds in the right time to make crosses in all possible directions among different parental genotypes and to obtain enough F_1s' seeds.

Crosses were made in all possible directions among parental/genotypes to obtain seeds of F_1 hybrids and their reciprocals. In addition, some of the plants of the different parents were selfed to obtain more seeds for the next season.

Evaluation:

On 23/10/1999, seeds of the different parental genotypes, F_1 hybrids, and reciprocal F_1 hybrids were planted in the field of the Experimental Farm according to randomized complete block design with three replicates. Common agricultural practices were followed based on the recommendations of Egyptian Ministry of Agriculture.

The individual plants of the parental genotypes, and F_1 hybrids and their reciprocals were evaluated to estimate:

1. Total sugars of green seeds:

Total sugars content of green seeds of different genotypes was assayed directly after harvest according to the method described by Flood and Priestly (1973).

2. Total proteins of green seeds:

Total proteins content in green seeds of the different genotypes was estimated and calculated as percentage using the methods described by (A.O.A.C., 1990) and reported by Hafez and Mikkelsen (1981).

Genetic Statistical Analysis:

Griffing diallel analysis

General and specific combining ability were investigated by performing the Griffing's diallel cross analysis (Method 4, Model II) according to the method described by Griffing (1956).

Jinks-Hayman diallel analysis:

Data from parents and the related F_1 generations were analyzed using the diallel cross methods of Jinks (1954) and Hayman (1954).

Heritability:

Narrow sense heritability esimate for the genotypes used in the present study was calculated from the genetic components according to the formulas proposed by Mather and Jinks (1971). However, in cases where the assumptions required for Jinks-Hayman analysis were not valid, the broad and narrow sense heritability value was calculated according to the method described by Pandy and Gritton (1975) using the general and specific combining ability components.

RESULTS AND DISCUSSION

Total protein content of green seeds:

The results presented in Tables (1 and 2) indicate significant differences among each of parental genotypes and related F_1 hybrids concerning total protein content of green seeds. Variation among pea germplasm concerning dry seed protein content was reported by Debelyi *et al.* (1978). In addition, the same authors reported that out of the variation observed in protein content 32.4% was attributed to the genotypic effect. In addition, Gueguen and Barbot (1988) reported differences between smooth and wrinkled pea cultivars concerning this character. Moreover, Limongelli *et al.* (1997) working on beans reported genetic differences between germplasm concerning this character. The highest value of green seed protein content was

associated with cultivar Sugar Dady, i.e. 7.43%, on fresh weight (f.w.) basis, followed by Early Perfection 6.63% f.w. (Table 1). On the other hand, the lowest value was associated with cultivar Snow Pea (5.46% f.w.). In addition, the cultivars Sugar Ann, Sugar Snap and Little Marvel recorded values of 6.41, 6.05 and 6.01% f.w., respectively. Such information are of great value for pea breeders in breeding programs to improve this character.

Concerning performance of F_1 hybrids, the results in Table (1) indicate significant reciprocal effects on the expression of green seed protein content character. Such information is important in breeding programs to improve this character. The highest value of green seed protein content was associated with F_1 hybrid Little Marvel x Sugar Ann (7.31% f.w.), while the reciprocal F_1 hybrid Sugar Ann x Little Marvel had close value, i.e. 6.55% f.w., Table (1). In addition, the F_1 hybrid Snow Pea x Little Marvel recorded 6.42% f.w., while its reciprocal F_1 hybrid Little Marvel x Snow Pea had a value of 5.33% f.w. Moreover, the F_1 hybrid Sugar Snap x Little Marvel had 6.41% f.w., while its reciprocal F_1 hybrid Little Marvel x Sugar Snap recorded 6.05% f.w., and the F_1 hybrid Sugar Dady x Little Marvel had green seed protein content 6.14% f.w., while its reciprocal F_1 hybrid Little Marvel x Sugar Dady gave 5.24% f.w. (Table 1). Furthermore, the hybrid Sugar Snap x Sugar Dady had a value of green seed protein content equal to 5.86% f.w., while its reciprocal hybrid Sugar Dady x Sugar Snap had higher value, i.e. 7.10% f.w. These results indicated the influence of maternal effects on the expression of this character and the importance of choosing the suitable direction of hybrid to continue certain pea breeding program to improve this character.

The general (GCA) combining ability and specific (SCA) combining ability effects were significant (Table 2), which indicate the involvement of both additive and non-additive gene actions in the inheritance of green seed protein content. However, the ratio GCA/SCA was 2.33 which indicated that the additive gene action was predominant in the inheritance of this character. This result agreed with that of Kelly and Bliss (1975) who worked on common bean and reported the predominance of the additive effect. In addition, Gupta *et al.* (1998), working on pea, reported the presence of both additive and dominance types of gene effects in the inheritance of seed protein content.

Table (1): Means of total proteins and total sugars content (% f.w.) of green seeds of different parental genotypes and their F_1 hybrids.

Parents		Means of parents			
		Total protein content of green seeds (% f.w.)		Total sugars content of green seeds (% f.w.)	
Sugar Snap		6.05		4.05	
Sugar Dady		7.43		3.93	
Snow Pea		5.46		3.06	
Early Perfection		6.63		2.46	
Little Marvel		6.01		4.05	
Sugar Ann		6.41		7.82	
Involved parents		**Means of crosses**			
P_1	P_2	F_1 P_1xP_2	F_1 reciprocal P_2xP_1	F_1 P_1xP_2	F_1 reciprocal P_2xP_1
Sugar Snap	Sugar Dady	5.86	7.10	2.07	6.31
Sugar Snap	Snow Pea	5.55	5.50	4.53	2.98
Sugar Snap	Early Perfection	5.73	6.38	6.75	3.53
Sugar Snap	Little Marvel	6.41	6.05	3.22	9.17
Sugar Snap	Sugar Ann	5.73	6.69	6.99	6.75
Sugar Dady	Snow Pea	5.79	6.23	4.92	4.68
Sugar Dady	Early Perfection	5.67	5.72	5.24	5.24
Sugar Dady	Little Marvel	6.14	5.24	6.31	6.19
Sugar Dady	Sugar Ann	5.67	6.28	6.03	5.16
Snow Pea	Early Perfection	5.55	5.56	4.29	5.32
Snow Pea	Little Marvel	6.42	5.33	6.44	3.73
Snow Pea	Sugar Ann	5.58	5.93	3.85	6.27
Early Perfection	Little Marvel	5.62	5.53	6.11	6.35
Early Perfection	Sugar Ann	5.88	4.34	8.26	4.88
Little Marvel	Sugar Ann	7.31	6.55	3.97	7.62
L.S.D. at 5%		0.9441		1.3329	
L.S.D. at 1%		1.2493		1.7637	

Table (2): Mean square values of total proteins and sugars content (% f.w.) of green seeds.

Sources of variance	d.f.	Total proteins content of green seeds	Total sugars content of green seeds
Genotypes	35	1.14	8.56**
Parents	5	1.41	11.38**
Hybrids	29	1.02	8.07**
Parents vs hybrids	1	3.22	8.80**
Error	70	0.32	0.68
General combining ability (GCA)	5	0.49	4.83**
Specific combining ability (SCA)	15	0.21	0.75
Reciprocal	15	0.29	3.54**
Error	70	0.11	0.23
GCA/SCA		2.33	6.44

The results presented in Table (3) indicate that the highest value of general combining ability effects were associated with cultivar, Sugar Dady (0.23), Sugar Snap (0.11), Little Marvel (0.10) and Sugar Ann (0.10). These results indicate that the previously parental genotypes can be good combiners in forming F_1 hybrids with relatively high level of green seed protein content.

Table (3): General combining ability effects of total protein and sugars contents (% f.w.) of green seeds.

Parental	Total protein content of green seeds	Total sugars content of green seeds
Sugar Snap	0.11	-0.21
Sugar Dady	0.23	-0.24
Snow Pea	-0.29	-0.81
Early Perfection	-0.21	-0.16
Little Marvel	0.10	0.36
Sugar Ann	0.10	1.05

The results presented in Table (4) indicate that the highest desirable values of specific combining ability effects were associated with F_1 hybrids Little Marvel x Sugar Ann (6.85), Snow Pea x Little Marvel (6.12), Snow Pea x Sugar Ann (5.89), Early Perfection x Little Marvel (5.67) and Early Perfection x Sugar Ann (5.03).

Table (4): Specific combining ability effects (S_{ij}) of the different F_1 hybrids and their reciprocals for total protein and sugars contents (% f.w.) of greca seeds.

Involved parents		Total protein content of green seeds		Total sugars content of green seeds	
P_1	P_2	F_1 P_1xP_2	F_1 reciprocal P_2xP_1	F_1 P_1xP_2	F_1 reciprocal P_2xP_1
Sugar Snap	Sugar Dady	0.55	-0.52	-0.00	-2.12
Sugar Snap	Snow Pea	6.04	0.02	-0.51	0.77
Sugar Snap	Early Perfection	0.52	-0.22	0.54	0.12
Sugar Snap	Little Marvel	0.21	-0.33	-0.30	1.61
Sugar Snap	Sugar Ann	-0.14	-0.02	-0.20	0.00
Sugar Dady	Snow Pea	-0.29	-0.91	-0.64	-0.52
Sugar Dady	Early Perfection	0.09	0.18	-0.46	-2.98
Sugar Dady	Little Marvel	-0.45	0.45	-0.40	0.06
Sugar Dady	Sugar Ann	-0.26	0.55	-1.56	1.35
Snow Pea	Early Perfection	-0.56	0.05	-0.42	-0.12
Snow Pea	Little Marvel	6.12	-0.48	5.82	0.12
Snow Pea	Sugar Ann	5.39	-0.30	4.55	0.44
Early Perfection	Little Marvel	5.67	-0.17	4.01	-1.21
Early Perfection	Sugar Ann	5.03	0.77	5.52	1.69
Little Marvel	Sugar Ann	6.85	0.38	4.75	-1.83
Comparison item		S.E.	S.E.	S.E.	S.E.
S_{ii}		0.2810	0.5363	0.3967	0.7854
S_{ij}		0.2026	0.4013	0.2860	0.5664
r_{ij}		0.2384	0.4721	0.3366	0.6664
$S_{ii} - S_{jj}$		0.3893	0.7709	0.5496	1.0883
$S_{ij} - S_{ij}$		0.3893	0.7709	0.5496	1.0883
$S_{ii} - S_{ik}$		0.3372	5.6803	0.4760	5.6003
$S_{ij} - S_{ik}$		0.3078	5.9400	0.4345	5.9400
$S_{ij} - S_{kj}$		0.2753	6.2613	0.3886	6.2613
$r_{ij} - S_{id}$		0.3372	6.5669	0.4760	6.5669

S.E. = Standard error

These results indicate that selection for this character in the segregating generations of the previously mentioned F_1 hybrids may lead to new lines with high level of green seed protein content. Since the assumptions required for Jinks- Hayman analysis were not valid, the narrow sense heritability estimate was calculated using genetic components obtained from Griffing analysis. The narrow sense heritability value was 40.0% (Table 5). Pandey and Gritton (1975), has been reported in beans (Kelly and Bliss, 1975; Hosifield and Vebersax, 1980; Forney *et al.*, 1990; Santalla *et al.*, 2001) and in pea (Tar'an *et al.*, 2004). This role should be considered by the pea breeder to reach accurate conclusion about the inheritance of dry seed protein content. In addition, some other factors may affect the data recorded by the different pea breeders, such as genotype and its geographical origin (Debelyi *et al.*, 1978) as well as method of protein extraction (Colonna *et al.*, 1980). These factors may partially explain the differences in the results reported by different researchers concerning this character.

Table (5): Narrow sense heritability estimates calculated by using general and specific combining ability components (Grifing analysis) for total protein content (% f.w.) of green seeds.

Character	Narrow sense heritability %
Total protein content for green seeds	40.0

Total sugars content in green seeds:

The results presented in Tables (1 and 2) indicate significant differences among each of parental genotypes and related F_1 hybrids concerning the total sugars content in green seeds. The highest value of green seed sugars content was associated with cultivar Sugar Ann, i.e. 7.82% f.w. (Table 1). On the other hand, the lowest value was associated with cultivar Early Perfection (2.46% f.w.). In addition, both the parental genotypes Sugar Snap and Little Marvel were equal

in their sugars content of green seeds, i.e. 4.05% f.w. The parental cultivars Sugar Dady and Snow Pea expressed intermediate values, i.e. 3.93 and 3.06% f.w., respectively. Such information is of great value for pea breeders in selecting parental genotypes for breeding programs to improve this character.

Concerning performance of F_1 hybrids, the results in Table (1) indicate significant reciprocal effects on the inheritance of green seed total sugars content. Such information is important in studying the genetics of this character. The highest value of green seed-total sugars content was associated with F_1 hybrid Early Perfection x Sugar Ann (8.26% f.w.), While the reciprocal F_1 hybrid Sugar Ann x Early Perfection had a value of 4.88% f.w. (Table 1). In addition, the F_1 hybrid Sugar Snap x Sugar Ann had a value of 6.99% f.w., while its reciprocal hybrid Sugar Ann x Sugar Snap had a value of 6.75% f.w. On the other hand, the F_1 hybrid Sugar Snap x Little Marvel had the lowest value of 3.22 g/100 g f.w., while its reciprocal hybrid Little Marvel x Sugar Snap had the highest value of total sugars content of green seeds, i.e. 9.17 g/100 g f.w. These results indicate that the suitable direction of forming the pea hybrid is important to continue a certain pea breeding program to improve this character.

The general (GCA) combining ability effect was significant while the specific (SCA) combining ability effect was not significant (Table 2). These results indicated the predominance of additive gene action in the inheritance of total sugar in green seed. This conclusion was supported by the ratio GCA/SCA which was 6.44. On the other hand, Gupta *et al.*, (1998) recorded the presence of both the additive and dominance type of gene effects on the inheritance of this character. Using of different parental genotypes with different genetic control systems may had resulted in such differences.

The results presented in Table (3) indicate that the highest values of general combining ability effects were associated with cultivar Sugar Ann (1.05) and Little Marvel (0.36). This result indicate that those parental genotypes can be considered as good combiners in forming F_1 hybrids with relatively high level of total sugars content in green seeds.

The results presented in Table (4) indicate that the highest desirable values of specific combining ability effects were associated with F_1 hybrids Snow Pea x Little Marvel (5.82), Early perfection x Sugar Ann (5.52), Little Marvel x Sugar Ann (4.75) and Snow Pea x

Sugar Ann (4.55). These results indicated that selection for this character in the segregating generations of the previously mentioned F_1 hybrids may lead to new lines with high level of green seed sugars content.

The results presented in Table (6) show the homogeneity of Vr-Wr over arrays which indicated the validity of the major assumptions required to perform Jinks-Hayman analysis on data of total sugar in fresh green seed. The results presented in Table (6) show the high magnitude of the genetic part for each of the variance of parental means (V_0L_0), variance of the mean of arrays (V_0L_1), mean of array variance (V_1L_1) and mean of array covariance (V_0L_1), comparing to the magnitude of the non-genetic part which was relatively very small. These results can be considered as indicators for the potentiality of this character to be genetically improved.

The intercept (a) of the regression line of Vr-Wr was -0.20 meaning that the regression line intersected the Wr axis slightly below the origin (Figure 1 & Table 6). This result indicates the presence of over-dominance for total sugar in fresh green seeds. This result can be confirmed by the finding of Gupta *et al.*, (1998) who found over-dominance for reducing sugar content in green seeds of pea. The degree of dominance, averaged over all loci measured by $(H_1/D)^{1/2}$ was > 1.0, i.e. 1.01 (Table 6). This result can be considered as a further proof for the presence of over-dominance for this character.

The sign of h value, which measures the direction of dominance, was positive, i.e. +4.1676, (Table 6). This result indicates that the over-dominance acted in the direction of the parents with high total sugars content in green seeds.

The ratio, $H_2/4\ H_1$ which is used to estimate the average frequency of negative alleles versus positive alleles in the parents was 0.188 (Table 6). Since this value was less than 0.250, it indicates the unequal distribution of alleles which decreased the expression of the studied character and those which increase it over the related loci in the parents.

Table (6): Estimate of genetic and non-genetic components and heritability values in diallel pea crosses for total sugars content (% f.w.) of green seeds.

Components		Total sugars content in green seeds	
V_0L_0	Non-genetic	0.2586	
	Genetic	3.2500	
V_0L_1	Non-genetic	0.0251	
	Genetic	0.3871	
V_1L_1	Non-genetic	0.1508	
	Genetic	1.0006	
V_0L_{01}	Non-genetic	0.0431	
	Genetic	1.0059	
Regression coefficient (b)		1.0852	
Intercept (a)		-0.2000	
D		3.0000	
H_1		3.2375	
H_2		2.4461	
F		2.4807	
h		4.1676	
h/H_2		1.7038	
E		0.2553	
$(H_1/D)^{1/2}$		1.0100	
$H_2/4\ H_1$		0.1889	
$\|(4\ DH_1)^{1/2} + F\|/\ \|(4\ DH_1)^{1/2} - F\|$		1.5663	
h_{ns}		47.4300	
Tested hypothesis		Calculated $t_{0.05}$	Significance
Ho: Wr-Vr is homogenious		0.5850	ns

The ratio $[(4\ DH_1)^{1/2} + F] / [(4\ DH_1)^{1/2} - F]$ which measures the total numbers of dominate to recessive alleles in all parents was > 1.0, i.e. 1.566 (Table 6). This result indicates that the six parents used in this study, carry more dominant than recessive alleles. The previously mentioned conclusion is supported also by the positive value of F, i.e. +2.480 (Table 1), which indicates that there are more dominant than recessive alleles in the parents used in the present study.

The results presented in (Figure 1 & Table 7) show that the lowest values of Vr-Wr were associated with the parental cultivars Sugar Dady (0.765 and 1.638) Little Marvel (0.777 and 1.651), and Sugar Ann (0.794 and 1.670). The low value of Vr-Wr indicates that the related parents carry most dominant genes controlling the studied character. In addition, the close values of Vr-Wr values associated with the above mentioned parental cultivars indicate that these parental cultivars, i.e. Sugar Dady, Little Marvel and Sugar Ann can be classified to have similar genetic type concerning total sugars content of green seed directly after harvest. On the other hand, the parental cultivar Early Perfection had the highest values of Vr-Wr, i.e. 2.103 and 2.716, which indicated that this parental cultivar had unique genotype and contained most recessive genes controlling total sugars content of fresh green seeds (Fig. 1 & Table 7).

Table (7): Manual plotting for parabola limits and regression line according to Jinks-Hayman analysis for total sugars content (% f.w.) in green seeds.

Parents	Total sugars content in green seeds		
	Vr.	Wr-parabola	Wr-regression
Sugar Snap	1.610	1.625	2.377
Sugar Dady	0.765	0.439	1.638
Snow Pea	0.860	0.982	1.737
Early Perfection	2.103	2.008	2.716
Little Marvel	0.777	0.033	1.651
Sugar Ann	0.794	1.209	1.670

The results presented in Table (7) show intermediate narrow sense heritability, i.e. 47.4% which indicate possibility of improving total sugars in green seeds of pea. However, the influence of environmental factors on the expression of the studied character should be considered by the pea breeder during the selection process to improve this character. In addition, the effects of green seed

maturity stage on its sugars content (Basterrechea and Hicks (1991) should also be considered during selection in pea breeding programs.

Fig. (1): Variance (Vr) and covariance (Wr) graph of total sugars content in green seeds after harvest in F_1 generation of pea genotypes

P1: Sugar Snap
P2: Sugar Dady
P3: Snow Pea
P4: Early Prefection
P5: Little Marvel
P6: Sugar Ann

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تـــوريث البروتينات والسكريات الكلية فى البذور الخضراء للبسلة

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تم أستخدام بعض التراكيب الوراثية للبسلة الخضراء (*Pisum sativum* var *humile*) وهى Snow pea, Early Perfection , Little Marvel، و البسلة السكرية (*P. sativum* var. *macrocarpon*) وهى Sugar Snap, Sugar Dady Sugar Ann ، فى عمل تهجين تبادلى 6 X 6
ويمكن تلخيص أهم النتائج كالتالى:

- وجدت أختلافات معنوية بين كل من الاباء و الهجن الناتجة بالنسبة لصفتى المحتوى من البروتينات و السكريات الكلية فى البذور الخضراء
- أظهرت البذور الخضراء لصنفى Early Perfection و Sugar Dady أعلى محتوى من البروتينات الكلية (6.63% f.w و 7.43% f.w على التوالى).
- أظهر الصنف Sugar Ann أعلى محتوى من السكريات الكلية فى البذور الخضراء (7.82% f.w.).
- وجدت فروق معنوية بين الهجن و الهجن العكسية لها مما يؤكد تأثير الوراثة الأمية على توريث الصفات المدروسة.
- أظهرت النتائج أن التأثير الوراثى الإضافى أكثر أهمية فى توريث الصفات المدروسة.
- أظهرت صفة محتوى البذور الخضراء من السكريات الكلية سيادة فائقة فى أتجاه الأب ذو المحتوى العالى من السكريات الكلية فى البذور الخضراء.
- يوجد عدم توزيع متساوى للأليلات التى تزيد من تعبير صفة السكريات الكلية فى البذور الخضراء و تلك التى تقلل من تعبير هذه الصفة فى الأباء المستخدمة.
- أحتوت الأباء المستخدمة على أليلات سائدة أكثر من المتنحية بالنسبة لصفة محتوى البذور الخضراء من السكريات الكلية.
- وجد أن التراكيب الوراثية الأبوية Sugar Ann- Little Marvel-Sugar Dady
- تنتمى الى طراز وراثى واحد بالنسبة لصفة محتوى البذور الخضراء من السكريات الكلية.
- كانت درجة التوريث بالمعنى الضيق لصفتى المحتوى من البروتينات و السكريات الكلية فى البذور الخضراء 40.0% و 47.4% .