BREEDING STUDIES ON SOME AGRONOMIC AND QUALITY TRAITS IN RICE(*Oryza sativa* L.)

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ABSTRACT

This study was aimed to study the heterosis, degree of dominance and minimum number of effective factors for yield components (Panicle length, Panicle weight and Grain yield/plant) and some grain quality traits in rice (Hulling percentage, Milling percentage and Head rice percentage) under normal conditions. The materials for this study consisted of six rice genotypes namely; Sakha101, Sakha102, Egyptian Yasmin, GZ1368s-5-4, IET1444 and IR78875-176-B2-B, These genotypes have a wide range of variation due to their different genetic background. The six rice parents were crossed to produce F_1 hybrid seeds of three crosses, namely, Sakha101 x GZ1368s-5-4(I), Sakha102 x IET1444(II) and Egyptian Yasmin x IR78875-176-B2B(III). The six populations, P_1, P_2, F_1, F_2, BC_1 and BC_2 for each cross were utilized to determine the genetic parameters of the studied characters.

The results revealed that heterosis better parent values were highly significant in positive direction for all traits in all crosses in agronomy characters except for the cross III in panicle length character were negative direction. The mid parent values were highly significant in positive direction for all traits in all crosses in agronomy characters except for the cross I for panicle weight and cross III for panicle length character. Degree of dominance values were less than unity in the positive direction for the crosses I, II and III, for all agronomic traits except for cross II in traits panicle weight and grain yield\ plant and the cross III in Grain yield\ plan trait were negative direction, indicating the importance of partial dominance in the inheritance of this trait in these crosses, Moreover, the Castle-Wright formula revealed that the estimated values of minimum number of gene in Panicle length trait in the crosses I and II is simple trait governed by one or two pairs of genes while the cross III governed by large number of genes (-12.63). Panicle weight trait was controlled by less than two pairs of genes suggested that trait is qualitative character in the crosses I and III while the crosses II governed by large number of pair of genes more than 9 pair of genes. Meanwhile,

the Grain yield\ plant trait governed by large number of genes in the three crosses suggested that trait is quantitative character.

On the other hand, the heterosis of quality traits revealed the hulling trait in mid parents and better parent were no significant except the cross II in mid parent while milling and head rice traits were highly significant in negative direction except the cross III in better parent to two traits. Obviously. degree of dominance values were less than unity in the negative direction for all crosses of hulling and milling traits for each crosses except the cross III were positive direction to two traits while the head rice trait was less than unity in all crosses in the positive direction except the cross I was negative.

These results indicating the importance of partial dominance in the inheritance of this trait in these crosses. The Castle-Wright formula revealed that the estimated values of minimum number of gene in hulling% trait in the crosses I and III is simple trait governed by one or two pairs of genes while cross II governed by large number of genes (7.180),milling% trait was controlled by (2.160, 4.100 and0.890) pairs of genes in the three studied crosses respectively. The head rice% was governed by(2.470, -21.26 and 2.30) suggested that trait governed by large number of genes in crosses II.

Key words: Rice, breeding, heterosis, Yield components and Grain quality traits.

INTRODUCTION

Rice has always been one of the most important food crops in the world. It is estimated that 40 per cent of the world's population take rice as their major source of food. The advent of higher yielding semi dwarf varieties has been instrumental in achieving consistent progress in rice production in the past three decades and attaining self-sufficiency.

Rice is a highly self-fertilized plant, which means that pollen from the same flower or from another flower on the same plant will pollinate itself. Pollen is shed from the stamens and lands on the pistil of either the same flower or another flower of the same plant over 95% of the time.

In Egypt, rice is considered as one of the most important field crops, since it contributes about 20% of the total cereal consumption. Annually, more than one and half million feddans is cultivated with rice (one feddan = 4200 m2) producing about 6.5 million tons of rice, with an average of 4.6 ton/fed. (10.9 ton/ha) (RRTC, 2013).

Success in crop improvement generally depends on the magnitude of genetic variability and the extent to which the desirable characters are heritable.

Development of high-yielding varieties requires a thorough knowledge of the existing genetic variation for yield and its components and grain quality traits. The observed variability is a combined estimate of genetic and environmental causes, of which only the former one is heritable. However, estimates of heritability alone do not provide an idea about the expected gain in the next generation, but have to be considered in conjunction with estimates of genetic advance. Grain yield character in rice is quantitative trait in nature and is polygenically controlled. Selection on the basis of grain yield character alone is usually not very effective and efficient. However, selection based on its component characters could be more efficient and reliable. Quality is defined as a major factor which decides market values of agricultural products and foods in each phase from production through consumption. Rice grain quality has always been an important consideration in rice variety selection and development, it is second only to yield as a major breeding and thus relates to a number of factors, while the cooking and eating quality is a part of the factors in assessing the grain quality of rice.

In the future, grain quality will be even more important once, the very poor-many of whom depend largely on rice for their staple food become better off and begin to demand higher quality rice**.**

MATERIALS AND METHODS

The present study was laid out at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha, Kafer EL-Shiekh, Egypt, during three successive rice growing seasons, 2010, 2011 and 2012 to study the heterosis, degree of dominance and minimum number of effective factor of som grain yield, its components and some grain quality traits in rice under normal conditions. The materials for this study consisted of six rice genotypes namely; Sakha101, Sakha102, Egyptian Yasmin, GZ1368s-5-4, IET1444 and IR78875-176-2B, it was chosen as parents based on previous studies. These genotypes have a wide range of variation due to their different genetic background.

The six rice parents were crossed to produce F_1 hybrid seeds of three crosses. These three crosses were: Sakha101 x GZ1368s-5-4, Sakha102 x IET1444 and Egyptian Yasmin x IR78875-176-2B. The six populations, P_1, P_2, F_1, F_2, BC_1 and BC_2 for each cross were utilized to determine the genetic parameter of the studied characters.

1-Experimental field procedures:

In 2010 season, the parental genotypes were grown at RRTC farm in three planting dates with ten days interval in order to overcome the differences in flowering time between parents. Thirty days old seedling of each parent was

individually transplanted in the field in 10 rows. Each row was 5m long and included 25 hills. At flowering time, hybridization between parents was carried out following the technique proposed by Jodon (1938) and modified by Botany(1961) and the aforementioned three crosses were produced.

In 2011 season, parents and F_1 hybrid seeds of the three crosses together with their parental lines were planted under normal conditions.

At heading, parents were crossed again to produce the F_1 hybrid seeds of three crosses following the same technique. Moreover, some of F_1 plants were left to be self pollinated in order to produce F_2 seeds, while some other plants were crossed with their own parents as a male to produce BC_1 and BC_2 seeds. At harvest, seeds of different generations were individually harvested to be grown in the next season.

Subsequently, in 2012, summer season, seeds of the P_1, P_2, F_1, BC_1, BC_2 and F_2 of each cross were sown in normal conditions to estimate the genetic parameters of the three rice agronomic characters (Panicle length, Panicle weight and Grain yield/plant) and three rice quality characters (Hulling percentage, Milling percentage and Head rice percentage). Eighteen entries belongs to different generations (6 parents, 3F1's, 3F2's, 3BC1, 3BC2) were cultivated in a randomized complete block design experiment with four replication. Each replicate contained 10 rows of each P_1, P_2, 5 rows of each of F_1, BC_1 and BC_2 and 15 rows of F_2 generations.

2-Studied characters
a-Agronomic and yield traits
   1-Panicle length (cm): The main panicle of each plant was measured from the base of panicle to its tip, excluding awns, at complete maturity stage.
   2-Panicle weight (g): The weight in grams of main panicle was estimated at complete maturity stage.
   3-Grain yield/plant (g): It was recorded as the weight in grams of the individual plant grain yield and adjusted to *14% moisture content.*
b-Grain quality traits:
   1-Hulling percentage: duplicate ten grams of rough rice from each individual plant were used for hulling percentage determination. Hulling percentage was calculated according to Khush *et al.* (1979) as follows:

$$\text{Hulling \%} = \frac{\text{Brown rice weight (g)}}{\text{Total rough rice weight (g)}} \times 100$$

   2-Milling percentage: the objective of rice milling is the removal of bran and germ with the minimum breakage of the endosperm. Milling percentage was determined according to Ghosh *et al.* (1971) as follows:

$$\text{Milling \%} = \frac{\text{Total milled rice weight (g)}}{\text{Total rough rice weight (g)}} \times 100.$$

3-Head rice percentage: the whole grains (head rice grains)/panicle were separated according to the broken size (less than ¼th of grain length) with rice-sizing device and then weighted. Head rice percentage was determined as follows:

$$\text{Head rice \%} = \frac{\text{Weight of head rice (g)}}{\text{Milled rice weight (g)}} \times 100.$$

In all growing seasons of the study, all cultural practices such as field preparation, sowing method, transplanting and fertilizers, weed control were applied as recommended.

3-Statistical and genetic analysis:

I- Estimation of heterosis:

Heterosis relative to mid parent or better parent average values were estimated according to Mather (1949) and Mather and Jinks (1971):

$$\text{Heterosis over the mid parent (\%)} = \frac{F_1 - M.P.}{M.P.} \times 100$$

$$\text{Heterosis over the better parent (\%)} = \frac{F_1 - B.P.}{B.P.} \times 100$$

Where: F_1 = Mean value of the first generation, **M.P** = Mean value of mid parent calculated by using average mean of the tow parents and **B.P** = Mean value of the better parent.

II-Estimation of the nature of dominance and its directions:

The relative of potency ratio (P) was used to determined the degree of dominance and its directions according to the formula given by Mather and Jinks (1971) as follows:

$$\text{Potency ratio (P)} = \frac{F_1 - M.P}{\frac{1}{2}(P_2 - P_1)}$$

Where: F_1 = the mean of the first generation, P_1 = the mean of the low Parent, P_2 = the mean of the high Parent and .**P**. = the value of mid parent.

- Absence of dominance, is indicated when dominance ratio is equal to zero,
- Partial dominance is considered when ratio is between 1.0, and -1.0,
- Complete dominance is assumed when the ratio equals either ±1.0, and
- Over dominance is indicated when the ratio exceeds either ±1.0.

III-Estimation of the minimum number of effective factors controlling characters:

The number of gene pairs responsible for the parental difference for each character is determined by the following methods according to Castle-Wright-formula (1921)

$$N = \frac{(P_1 - P_2)^2}{8 (VF_2 - 3\sqrt{(VP_1 . VP_2 . VF_1)})}$$

Where: **N** = Minimum number of genes controlling trait, **P₁- P₂** = Difference between the parental means, **VF₂** = Variance of F_2 generation and VP_1, VP_2 and VF_1= Variance of the first parent, Second parent and F_1 generation, responsively.

The formula assumes the following :

a) Equal effect of genes involved, b) Additive gene action, c) Absence of dominance, d) Maximum range exists between parents, e) One parent contributes only genes with plus effects and the other parent contributes only genes with minus effects.

RESULTS AND DISCUSSION

The percentage of heterosis as deviation from mid parent (MP) and better parent (BP), degree of dominance and the minimum number of effective factors controlling panicles and yield characters (Panicle length, Panicle weight and Grain yield/plant) are presented in Table (1) and quality characters (Hulling percentage, Milling percentage and Head rice percentage) are presented in Table 2.

a- Agronomic and yield traits:

The percentage of heterosis as deviation from mid parent (MP) and better parent (BP), degree of dominance and the minimum number of effective factors controlling agronomic characters are presented in Table 1.

1-Panicle length

Table (1) reveals that highly significant and positive estimates of heterosis were recorded for panicle length (13.96 and 5.58) in crosses I and II, respectively, when it was measured as a deviation from better parent as well as in cross II, (5.58), when it was measured as a deviation from mid-parent. On the contrary, highly significant and negative estimates of heterosis were obtained in cross III, when it was measured as a deviation from mid an d better parent, (-10.18 and -10.89), respectively. The results suggested that heterosis played important role in the inheritance of panicle length in cross II. These results were in harmony with

Table 1: Estimates of heterosis as a deviation from mid-parent (MP) and better parent (BP), degree of dominance and minimum number of genes for agronomic characters, panicle length (cm), panicle weight (gm) and Grain yield\ plant (gm) in the three studies crosses.

Character	Cross	Heterosis		Degree of dominance	No. of minimum genes
		BP	**MP**		
Panicle length (cm)	I	8.44**	2.26	0.01	1.40
	II	13.96**	5.58**	0.03	1.76
	III	-10.18**	-10.89**	0.06	-12.63
Panicle weight (g)	I	1.15**	-2.98**	0.02	0.27
	II	20.22**	17.79**	-0.53	-9.81
	III	9.93**	2.34**	0.03	-1.43
Grain yield/ plant (gm)	I	34.54 **	18.93 **	0.017	-2.63
	II	62.48**	68.19**	-0.19	-18.4
	III	52.21**	35.6**	-0.05	-4.26

Where: Crosses I, II and III were Sakha 101 x GZ1368s-5-4, Sakha 102 x IET1444 and Egyptian Yasmin x IR78875-176-B2-B, respectively.

*and **: Significant at 0.05, 0.01 probability levels, respectively.

finding reported by Kole and Hasib (2005), Rosamma and Vijayakumar (2005), Chitra *et al.* (2006) and Senguttuvel *et al.* (2006).

Degree of dominance values were less than unity (0.01, 0.03 and 0.06) for crosses I, II and III, respectively, indicating the importance of partial dominance in the inheritance of this trait in these crosses. The tallest panicle was partially dominant over the shortest panicle in all crosses. The same results were obtained by Chitra *et al*. (2006), Senguttuvel *et al.* (2006), El-Naem (2010). Rahimi *et al.* (2010). Varpe *et al.* (2011). Abd El-Lattef *et al*. (2012). Nevame *et al.* (2012), Parimala and Cheralu (2012) and Anil Kumar and Mani (2013).

Results in Table (1) show that the minimum number of genes controlled this trait were (1.4, 1.76 and -12.63) in all studied crosses, respectively. These findings indicating that almost two to thirteen pairs of genes were governed such traits. Similar results were reported by El-Abd (1999), Abd El-Aty *et al.* (2002), Abd El-Lattef *et al*. (2008) and Abd El-Lattef *et al*. (2012).

2- Panicle weight

Results in Table (1) show that highly significant and positive estimates of heterosis were detected in all crosses, when it was measured as a deviation from mid and better parent, except that of recorded for mid parent in cross I, which found to be in negative direction (-2.98). The highest positive estimated values were recorded in cross II, (20.22 and 17.79), when it was measured as a

deviation from better and mid parent, respectively. These findings were supported by those reported by Agrawal (2003), Kole and Hasib (2005) and Sonika *et al.* (2009).

Results in Table (1) Show that the degree of dominance was lower than unity (0.02, -0.53 and 0.03) in the crosses I, II and III, respectively, suggesting the importance of partial dominance in the inheritance of this trait in these crosses. The heaviest panicle was partially dominant over the lightest panicle in the crosses I and III. On the other hand, the lightest panicle was partially dominant over heaviest panicle in the cross II. Similar results were reported by Lakshmana *et al.* (2007) and Sonika *et al.* (2009).

Meanwhile, the minimum number of effective factors controlling panicle weight trait were (0.27, -9.81 and -1.43) in the three studied crosses, Sakha 101 x GZ1368s-5-4, Sakha 102 x IET1444 and Egyptian Yasmin x IR78875-176-B2-B, respectively, indicated that this trait was controlled by one to two genes in the crosses I and III, respectively, while it was governed by large numbers of pairs of genes in cross II. Same results were reported by Abd El-Aty *et al.* (2002), Agrawal (2003) and Kole and Hasib (2005).

3- Grain yield/plant

It is evident in Table (1) that heterosis percentage as a deviation from better parent and mid parent was highly significant and positive. The highest estimated values were reported in cross II, followed by the cross III and cross I, when it was measured as a deviation from better parent, respectively. However, the highest estimates values of mid parent heterosis were recorded for grain yield /plant in the same crosses with the same ranking, their estimated values were (68.19, 35.6 and 18.93), respectively. These results were similarly with these reported by El-Rewainy *et al.* (2011), Chougule *et al.* (2012), Hussain and Sanghera (2012), Nevame *et al.* (2012), Reddy *et al.* (2012), and El-Naem (2014).

Data of degree of dominance values shown in Table (1) indicate that there were fewer than unity in all the studied crosses, suggesting that partial dominance was involved the controlling of such character in all the studied crosses. Their estimated values were (0.017, -0.19 and -0.05) in crosses, I, II and III, respectively, indicating that high yielding ability was partially dominant over low yielding ability in the first cross, while, low yielding ability was partially dominant over high yielding ability in the other two crosses. These results were agree with Hammoud (2005), Abd El- Lattef *et al.* (2008)and Abd El- Lattef *et al.* (2012).

The Castle-Wright formula revealed that the estimated values of minimum number of gene were (-2.63, -18.4 and -4.26) in the three studied crosses, Sakha 101 x GZ1368s-5-4, Sakha 102 x IET1444 and Egyptian Yasmin x IR78875-176-B2-B, respectively. suggesting the cross I, was

controlled by almost three pairs of gene, cross II was controlled by large numbers of pairs of genes more than eighteen pairs of gene and the cross III was controlled by almost five pairs of gene, Similar results were recorded previously by El-Abd (1999), Abd El-Aty *et al.* (2002) and Parimala and Cheralu (2012).

b- Grain quality characters
1-Hulling percentage

It clear from Table (2) that hulling percentage exhibited undesirable highly significant and negative estimates (-2.52) of heterosis as a deviation from mid-parent in the cross II, while, heterosis estimates were not significant in the other two crosses, I and III, when it was measured as a deviation from mid and better parent. Moreover, no significant and negative estimates of heterosis were found as a deviation from better parent in the cross II. The present conclusion was confirmed with the results obtained by Raju *et al.* (2003), El-Abd and Abd-Allah (2004) and El-Mouhamady *et al.* (2013).

In the present investigation, as shown in Table (2), the degree of dominance (-0.006, -0.02) in the crosses I and II, respectively were lower than unity in negative direction, suggesting that low hulling % was controlled by partial dominance or incomplete dominance, in addition, low hulling % was dominant over high hulling % in these two crosses. On the other hand,, the degree of dominance (0.103) was also lower than unity in the cross III, but it was in positive direction, indicating partial or incomplete dominance was involved in controlling hulling percentage, and high hulling % was dominant over low hulling % in this cross. Thus it could be concluded that the estimates of dominance genetic variances were differ according to the cross itself. These results were agreement with those obtained by Khedikar *et al.* (2003), El-Abd *et al.* (2009) and El-Refaee and Abdulmajid (2011).

Castle -Wright formula gave an estimates of (-0.057) pairs of genes in the first cross, (7.180) pairs of genes in the second cross and (-1.470) pairs of genes in the last cross, Table (2). These estimations suggested that the minimum number of genes were differed depended on the cross itself, the mean difference for hulling percentage in the three studied crosses may have been governed by one, eight and two pairs of genes in the cross I, II and III, respectively, indicating that hulling % was found to be simple trait, it was controlled by few number of genes. The present conclusion were confirmed the results obtained by El-Hissewy *et al*. (1988), Hsieh and Wang (1988) and El-Abd (1999).

2-Milling percentage

Obviously, Table (2) shows that undesirable highly significant in negative direction heterosis estimates were found in the two crosses namely, Sakha 101

Table (2): Estimates of heterosis as a deviation from mid-parent (MP) and better parent (BP), degree of dominance and minimum number of genes for quality characters, Hulling% Milling% and Head rice% in the three studies crosses.

Character	Cross	Heterosis		Degree of dominance	Minimum genes
		BP	MP		
Hulling%	I	-0.030	-0.490	-0.006	-0.057
	II	-0.660	-2.52**	-0.020	7.180
	III	1.610	0.510	0.103	-1.470
Milling%	I	-4.85**	-6.93**	-0.060	2.160
	II	-8.82 **	-10.74**	-0.009	4.100
	III	-1.620	-3.39 **	0.011	0.890
Head rice%	I	-6.43 **	-8.85 **	-0.055	2.470
	II	-22.07 **	-23.9 **	0.011	-21.26
	III	-4.450	-6.27 **	0.051	2.300

Where: Crosses I, II and III were Sakha 101 x GZ1368s-5-4, Sakha 102 x IET1444 and Egyptian Yasmin x IR78875-176-B2-B, respectively.

*and **: Significant at 0.05, 0.01 probability levels, respectively.

x GZ1368s-5-4 and Sakha 102 x IET1444, when it was measured as a deviation from better parent and mid parent, their estimated values were (-4.85 and -8.82) and (-6.93 and -10.74), respectively. Either insignificant negative or highly significant negative estimates of heterosis (-1.62 and -3.39) were measured as a deviation from better parent and mid parent in Egyptian Yasmin x IR78875-176-B2-B rice cross, this in turn suggested that heterotic effect played an important role in the inheritance of milling % in undesirable negative direction. Significant and positive heterosis over mid parent values and significant or insignificant negative heterosis estimates were found and differed from cross to cross by El-Naem (2010).

It is clear from Table (2) that the values of degree of dominance were (-0.060, -0.009 and 0.011) for all the studied crosses, I, II and III, respectively, it were lower than unity (-1 < P > +1) suggested that partial dominance was involved in the control such character in all the studied crosses. High milling return was partially dominant over low milling return in cross, III. On the contrary, low milling return was partially dominant over high milling return in crosses, I and II. Similar findings were obtained previously by Sultan *et al.* (2010), Hassan *et al.* (2011) and El-Naem (2014).

Table (2) show that the Castle and Wright formula exhibited the minimum number of effective factors controlling milling % in the three studied crosses. Their estimates were (2.16, 4.10 and 0.89) in the three studied crosses

I, II and III, respectively, suggested some difference between the genes for such trait in parental used. Milling trait was governed by three, five and one pair of major genes in these studied crosses, respectively. These findings were agreed with those obtained by Hsieh and Wang (1988) and El-Abd (1999).

3-Head rice percentage:

It is evident in Table (2) that heterosis percentage as a deviation from mid-parent were highly significant and negative in the three studied crosses, their estimated values were (-8.85, -23.9 and -6.27), respectively. On the other hand, highly significant and negative estimates of heterosis were recorded in the crosses, I and II, when it was measured from better parent, while, such estimates were no significant in negative direction in the cross, III. This in turn suggested that undesirable heterotic effect played an important role in the inheritance of head rice percentage, which is upon the cross itself. Similar results were obtained by El-Naem (2010), Sultan *et al.* (2010) and Hassan *et al*. (2011).

Furthermore, the degree of dominance were (-0.055,-0.011 and -0.051) in the crosses, I, II and III respectively. As shown in Table (2) the potence ratio was lower than unity, suggested the importance of partial dominance in these three crosses, unbroken rice grains were partial dominant over broken rice grains in crosses, II and III. On the contrary, broken rice grains were partial dominant over unbroken rice grains in cross, I. The same results were obtained by El-Abd *et al.* (2008), Sultan *et al.* (2010) and Hassan *et al*. (2011).

The Castle-Wright formula gave an estimate of (2.47, -21.26 and 2.3) pairs of genes in the three studied crosses, respectively. this formula indicated that almost three pairs of genes were controlled head rice percentage in the crosses I and III, while, large number of pairs of genes (more than twenty) were played a remarkable role in the controlling of head rice percentage in cross II. These results were agreed with the results obtained by Hsieh and Wang (1988), El-Abd (1999), Kheduikar *et al. (*2003) and Raju *et al.* (2003).

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دراسـات علـى تربيـة بعض الصفـات المحصوليـة وصفـات جودة الحبوب فى الأرز

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** قسـم بحـوث الأرز ـ معهـد بحـوث المحـاصيل الحقليـة ـ مـركـز البحـوث الزراعيـة ـ الجيـزة مصـر.

أجريت هذه الدراسـة بهدف دراسـة قوة الهجين ودرجـة السيادة وأقل عـدد من الجينـات المتحكمـة فى بعض صفات مكونات المحصول (طـول السنبلـة ووزن السنبلة ومحصول النبـات الفردى) وجودة الحبوب فى الأرز(نسبة التقشـير و نسبـة التبييض ونسبـة التدريج) تحت الظروف الطبيعيـة وكانت مـادة هذه الـدراسـة عبارة عن ست تراكيب وراثيـة مـن الأرز هى سخا ١٠١ وسخا ١٠٢ والياسمين المصرى و IET1444 وGZ1368s-5-4 و B-IR78875-176-B2 وهذه السـت تراكيب لهـا خلفيـة وراثيـة ذات مـدى واسـع من التبـاين واستخـدمت هذه كـآبـاء لإنتـاج ثلاث هجن هى سخـا ١٠١ X GZ1368s-5-4 (١) وسخـا ١٠٢X IET1444 (٢) والياسمين المصـرى IR78875-176-B2-B X (٣) وكـانت السـت عشـائر هى الأب الأول (P1) والأب الثانى (P2) والجيل الأول (F1) والجيل الثانى (F2) والهجين الرجعى الأول (BC1) والهجين الرجعى الثانى (BC2) لكل هجين لتحديد القيـاسـات الوراثيـة للصفـات المدروسـة وأظهرت النتـائـج أن قـوة الهجين بالنسبـة لأفضـل الآبـاء كانت معنويـة جداً فى الإتجـاه المـوجب لكل الصفـات الحقليـة فى كل الهجن ماعدا صفة طول السنبلة فى الهجـين رقم٣ فكـانت سالبـة، وقيمـة قوة الهجين بالنسبة لمتوسط الآبـاء كانت معنوية جداً فى الإتجـاه المـوجب لكل الصفـات الحقليـة فى كل الهجن ماعدا صفة وزن السنبلـة فى الهجـين رقم ١ و صفـة طـول السنبلـة فى الهجـين رقم ٣، قيمـة ودرجـة السيادة كانت أقل من الواحد فى الإتجـاه المـوجب لكل الصفـات الحقليـة فى الهجـن أرقـام ١و٢و٣ ماعدا صفـة وزن السنبلـة فى الهجين رقم ٢ فى حين أن صفـة محصول الحبوب للنبـات كانت سالبـة فى الهجين رقم ٢ و٣ وهذه النتـائـج تشـير إلى أهميـة السيادة الجزئيـة فى وراثة هذه الصفـات لهذه الهجن. زد علي ذلك كانت معـادلة كاسل ورايت تبين أن عـدد الجينات المتحكمـة فى صفة طـول السنبلـة فى هجين رقم ١و٢ واحد أو اثنـين من أزواج العـوامل الوراثيـة وأنها صفـة بسيطة بينما فى الهجين رقـم ٣ فهى صفـة كميـة محكومة بعدد كبير من أزواج العـوامل الوراثيـة (١٢٫٦٣) ووزن السنبلـة محكومـة بعدد أقل من٢ ويوحى بأنها

صفة بسيطة فى الهجين رقم ١و٣ بينما هى فى هجين رقم ٢ محكومة بعدد كبير أكثر من ٩ أزواج من العوامل الوراثية ، وفى الوقت نفسه صفة محصول النبات من الحبوب محكومة بعدد كبيرمن أزواج من العوامل الوراثية فى الهجن الثلاث وأنها صفة كمية.

وعلى الجانب الآخر بالنسبة لصفات جودة الحبوب فإن قوة الهجين لصفة نسبة التقشير منسوبة لمتوسط الآباء وأفضل الآباء كانت غير معنوية ما عدا الهجين رقم ٢ بالنسبة لمتوسط الآباء فى حين أن نسبة التبييض ونسبة التدريج أظهرتا معنوية عالية فى الإتجاه السالب لكل الهجن بالنسبة لأفضل الآباء ومتوسط الآباء ما عدا الهجين رقم ٣ بالنسبة لأفضل الآباء للصفتين، قيمة درجة السيادة يتضح أنها أقل من الواحد الصحيح فى الإتجاه السالب فى صفتى نسبة التقشير نسبة التبييض فى كل الهجن ما عدا الهجين رقم ٣ فكانت موجبة فى الصفتين بينما نسبة التدريج كانت أقل من الواحد الصحيح فى الإتجاه الموجب ما عدا الهجين رقم ١ كان سالباً، وذلك يشير إلى أهمية السيادة الجزئية فى وراثة هذه الصفات، وبالنسبة لمعادلة كاسل ورايت لعدد أزواج العوامل الوراثية توحى بأن صفة نسبة التقشير فى الهجينين أرقام ١و٣ صفة بسيطة محكومة بواحد أو اثنين من أزواج العوامل الوراثية أما فى الهجين رقم ٢ محكومة بعدد (٧,١٨) زوج من الجينات ، صفة نسبة التبييض محكومة بعدد (٢,١٦ و٤,١٠ و٠,٨٩) زوج من الجينات فى الثلاث هجين المدروسة بالترتيب، ونسبة التدريج محكومة بعدد (٢,٤٧ و٢١,٢٦ و٢,٣).

ومن هذا يتبين أن هذه الصفة فى الهجين رقم ٢ محكومة بعدد كبير مـن أزواج العـوامل الـوراثيـة.