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GENETIC STUDIES ON YIELD AND ITS COMPONENTS IN FOUR BREAD WHEAT CROSSES

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ABSTRACT

Three experiments were carried out at Bahteem Agricultural Research Station during three successive seasons from 2005/2006 to 2007/2008. In 2005/2006 season using three wheat (*Triticum aestivum* L.) crosses namely; Gemmeiza 7 x Sids 1, Sakha 94 x Irena and Sids 1 x Sakha 94. Six populations (P1, P2, F1, F2, BC1 and BC2) for each cross were used in this investigation. The data were recorded on an individual guarded plants for number of spikes / plant, number of kernels / spike, 100-grain weight and grain yield / plant. Significant heterotic effects were obtained for number of spikes / plant, grain yield / plant and number of kernels / spike in the first cross while, heterotic increase in grain weight, grain yield / plant and number of kernels / spike seemed to be accounted for the heterotic response observed in the second cross. Also, significant heterotic effect was found for number of spikes / plant, grain weight and grain yield / plant in the third cross.

Inbreeding depression estimates were significant for all studied attributes except for number of spikes / plant in the first cross. Over dominance towards the higher parent for number of spikes / plant, grain weight, grain yield / plant and number of kernels / spike were observed in the first cross. Meanwhile, over or partial dominance towards the lower parent was obtained for all characters in the third cross. On the other hand, partial dominance was observed for all characters (number of spikes / plant, grain weight, grain yield /plant and number of kernels / spike) in the second cross. F2 deviations (E1) were significant for all studied characters in the three crosses, except for number of spikes / plant in the first and second crosses, and grain weight in the first cross only. Moreover, backcross deviations (E2) were significant for all characters studied in all crosses, except for number of spikes / plant and for grain weight in the first cross, grain yield / plant in the first and the second ones. The additive gene effects were significant for all studied characters in the second and the third crosses, except for number of spikes / plant, grain weight , grain yield / plant and number of kernels / spike in the cross (Gemmeiza 7 x Sids 1). These results suggest the potential for obtaining further improvement in most studied character. In addition, dominance epistasis was significant for some of the studied attributes (number of kernels / spike, grain yield/ plant in the first and second crosses; and grain weight in the first and third ones; and number of spikes / plant in the third one).

High to medium values of heritability were associated with high and moderate genetic advance as percentage of F2 mean in most characters. These results indicated that selection for the studied characters could be useful in the early generations.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in Egypt. Increasing wheat production to narrowing the gap between production and consumption is considered the main goal in Egypt as well as in most countries all over the world (Shehab El Din, 1993).

For the effectiveness of any breeding program especially with diverse germplasm, it is necessary to measure the behavior and relative magnitude of different gene actions for the various quantitative characters. These information will help wheat breeders to identify types of genetic. Variations in the characters by which the selection is intended and to carry out rapid evaluation of yielding ability of the breeding materials by identifying crosses of superior genotypes which have higher yielding ability. Crumpacker and Allard(1962)reported that the efficiency in breeding for self-pollinating crop plants depending, first on accurate identifications of hybrid combinations that have the potentiality of producing maximum improvements and the second, on identifying superior lines among the progeny of the most promising hybrids in early segregating generations. Therefore, the information on the genetic and gene effect of breeding materials may be ensuring long-term selection and better genetic improvements.

Estimates of genetic variance are very essential among the basic information required for plant breeders. If most of the genes controlling a character are mainly of additive nature in a cross, the improvement of these characters could be achieved and selection may be effective (Abul Naas *et al.,* 1993).

Mosaad *et al.* (1990) found that additive genetic variance was the prevalent type controlling umber of days to heading, plant height and spike length.

Moreover, Abul Naas *et al.* (1991) and Al Kaddaussi *et al.* (1994) reported that, dominance component played an important role in genetic control of number of spikes/plants, number of kernels/spike, kernel weight and grain yield/plant. On the other hand, El Hossary *et al.* (2000) found that grain yield and its components in eight durum wheat parent diallel cross were controlled by both additive and no additive gene effects. In addition, concerning the heritability estimates, Gouda *et al.* (1993) indicated that heritability values ranged from 14 to 71% for grain yield. Meanwhile Mostafa (2002) and Hendawy (2003) reported that, heritability estimates for plant height, heading date and yield components were medium to high (more than50%) and El_sayed (2004) and Abdel-Nour, *et al.* (2005) reported that, heritability estimates for yield and its components were medium to high.

Also Moshref (2006) reported that high to medium values of heritability estimates were found to be associated with high and moderate genetic advance as percentage of F2 mean in most characters (plant height, number of spikes / plant , number of kernels /spike, kernel weight, grain yield /plant and biological yield /plant)

The present work was conducted to study the genetic variance and its components, gene action, heritability and expected genetic advance under selection for number of spikes/plant, number of kernels/spike, 100 grain weight, as well as grain yield /plant.

MATERIALS AND METHODS

This investigation was carried out at Bahteem Research Agriculture Research Station Center during three successive seasons from 2005/2006 to 2007/2008. In 2005/2006 season, four bread wheat genotypes namely, Gemmeiza7, Sids 1, Sakha 94 and Irena representing a wide range of variability in most studied characters and four crosses were made, i.e., Gemmeiza 7 x Sids 1 , Sakha 94 x Irena and Sids 1 x Sakha94 were used in the study. The name, origin and pedigree of these genotypes are presented in Table (1).

Table 1: Name, pedigree and origin of the four parental bread wheat genotypes.

Genotype	Pedigree	Origin
Gemmeiza 7	CM74A.630/SX//SER182/3/AGENT GM.4611-2GM-3GM-1GM-0GM	Egypt
Sids 1	HD2172/Pavon"S"//1158.57/MAYA74"S". SD46-4SD-2SD-1SD-0SD	Egypt
Sakha 94	OPATA/RAYON//KAUZ.	Egypt
IRENA	BUC/FLK//MYNA/VUL	CIMMYT Mexico

In the first season, the parental genotypes were evaluated in a randomized complete block design with three replications. Simultaneously, pair crosses were made to obtain F1 seeds. In the second season, the hybrid seeds were sown and the F1 plants of each cross were backcrossed to their respective parents to produce the two backcrosses (BC1) and (BC2). At the same time, pair crosses were made to produce new F1 seeds and meanwhile, F1 plants were self pollinated to produce F2 seeds. In the third season, the obtained seeds of these populations i.e.P1, P2, F1, F2, Bc1 and Bc2 for the three crosses were evaluated using a randomized complete block design with three replications. Rows were 4m. Long and 20 cm. apart and the space between plants was 10cm. Each plot consisted of two rows for each of .P1, P2, F1, Bc1 and Bc2 as well as five rows of F2 genotypes. Data were recorded on 20 individual guarded plants in P1, P2, and F1, 40 plants in Bc1 and Bc2, and 100 plants in the F2 for number of spikes/plant , number of kernels/spike, 100_grain weight, as well as grain yield/plant.

Various biometrical parameters were calculated for all studied characters. Heterosis (%) was expressed as percentage increase in F1value over better Parent. Inbreeding depression (%) was also estimated as the average percentage decrease of the F2 from the F1. In addition, F2 deviation (E1) and backcross deviation (E2)were measured as suggested by Mather and Jinks (1971).likewise, potency ratio (P) was also calculated according to Peter and Frey (1966). Genetic analysis of generation means to give estimates of mean effect parameter(m),additive (a) dominance (d), additive x additive (aa), additive x dominance(ad) and dominance x dominance(dd)were obtained using the method illustrated by Gamble (1962). Heritability in both broad and narrow senses were calculated according to

Mather's procedure (1949). Furthermore, the predicted genetic advance (Δ g) was computed according to Johanson *et al.* (1955). Likewise, the genetic represented as percentage of the F2 mean performance (Δ g %) was estimated using the method of Miller *et al.* (1958).

RESULTS AND DISCUSSION

Varietal differences in response to their genetic backgrounds and origins were significant for most characters under investigation. Moreover, the genetic variances within F2 populations were also significant for all studied characters. Hence, the different biometrical parameters used in this investigation were estimated. Means and variances of the six populations P1, P2, F1, F2, BC1 and BC2 for the studied characters are shown in Table (2).The value of heterosis, inbreeding depression percentage, potency ratio and different gene action parameters in the three studied crosses are presented in Table(3).

Significant positive heterotic effects were obtained for number of spikes / plant and grain yield / plant in the first cross; grain weight, grain yield / plant and number of kernels / spike in the second one; and number of spikes / plant, 100 grain weight and grain yield/plant in the third cross. On the other hand significant negative heterotic effects were found for number of kernels / spike only in the third one. Similar results were reported by El-Hosary *et al.* (2000) Moustafa (2002), Hendawy (2003) and Moshref (2006).

The expression of heterosis for a complex character i.e., high yielding ability , could be explained on the basis of components interactions, as the numerical value recorded for this complex character show is always a function of its components. Heterosis may be occurring without individual components exhibiting heterosis. The possibility of heterosis for a complex character, however, is increased if the individual components passes heterosis (Williams 1959).

Number of spikes / plant , number of kernels / spike and grain weight ,being the main components for grain yield / plant , heterosis increases if it is found in one , two or three of these main yield components , thus it may lead to favorable yield increase in the hybrid. The lack of heterosis for number of kernels / spike which may be due to the lower magnitude of the non additive gene action, may indicat that, the increases in number of spikes / plant and grain weight of the third cross were the major contributing factors to heterosis in the yield. These results are in agreement with those obtained by Ketata *et.al.*(1976), El-Rassas and Mitkees (1985) , Moshref (2006) and Khaled (2007).

Pronounced heterotic effects were detected for number of spikes / plant and grain weight in the third cross indicating that the cross (Sids 1 x Sakha 94) may be considered in a breeding program for high yielding ability through selecting for higher number of spikes / plant and grain weight.

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Potence ratio indicated over dominance towards the higher parent for all characters except for number of kernels / spike and grain weight in the first cross and number of spikes / plant in the second one. Meanwhile, there was over dominance towards the lower parent for number of kernels / spike in the first cross. On the other hand, complete dominance was found for grain weight towards the higher parent in the first cross, while partial dominance towards the height was detected for number of kernels / spike in the third cross. On the other side partial dominance towards the lower parent for number of spikes/ plant in the first cross was detected. Over dominance was detected for both grain yield / plant and number of kernels / spikes. These results are in harmony with those obtained by Moustafa (2002), Hendawy, (2003) ,Moshref (2006) and Khaled (2007). Over dominance was also obtained by Ketata *et al* (1976) , Mosaad et al (1990), for number of spikes / plant by Abul-Naas et al (1991) , Moshref (2006) and Khaled (2007), for number of kernels / spikes by Al-Kaddoussi *et al*.(1994) ,Moshref(2006) and Khaled (2007) for grain yield / plant

Both significant positive and negative values of inbreeding depression estimates in were found for all characters except for, number of spikes / plants (Table 3). Both heterosis and inbreeding depression are coincided with the same phenomenon, therefore, it is convenient to expect that heterosis in the F1 may be followed by substantial reduction in the F2 performance, as found in this study.

Significant heterosis and insignificant inbreeding depression were obtained for number of spikes / plant in the first cross only. These results suggest that, the major portion of the genetic effect was additive one. The contradiction between heterosis and inbreeding depression estimates may be also due to the presence of linkage between genes in these materials (Van der Veen, 1959).

Significant negative F2 deviations (E1) were shown for number of spikes / plant in the second cross, and for number of kernels / spike and for grain yield in the three crosses (Table 3). These may refer to the contribution of epistatic gene effects in the performance of these characters. On the other hand, insignificant F2 deviations were detected for number of spikes / plant in the first and second crosses. These results may indicat that epistatic gene effects have a minor contribution in the inheritance of these characters.

Backcross deviation (E2) was significant for all studied characters in the three crosses - and insignificant for number of spikes / plant, grain weight, and grain yield in the first cross, as well as for grain yield in the second cross. These results indicate the presence of epitasis in such large magnitude and could be used in breeding programs.

The choice of the most effective breeding procedure depends to a large extent on the knowledge of the genetic system contributing the characters to be selected. Therefore, the nature of gene action was also computed according to Gamble (1962). The estimates of various types of gene effect contributing to the genetic variability are presented in Table (3).

The estimated mean effect parameter (m), which reflects the contribution due to over all mean plus the loci effects of interactions of the fixed loci were very highly significant for all studied characters in the three crosses.

Significant negative additive gene affect was reported for number of spikes / plant , grain weight and grain yield / plant in both second and third cross, reflecting that the additive gene effect was of less importance in the inheritance of these characters. Similar results were obtained by El-Hossary *et al.*(2000), Hendawy(2003), El-Sayed(2004), Abdel-Nour*, et al.(*2005) and Moshref(2006). Dominance gene effects were significant for most studied characters, except for number of spikes / plant in the two crosses and grain weight in the second one in addition to grain yield / plant and number of kernels / spike in the third one pointing out the importance of dominance gene effects in the inheritance of these characters. Significant (a) and (d) components indicate that both additive and dominance gene effects were important in the inheritance of these characters. Therefore, selecting desired characters could be practiced in early generations but would be more effective in late ones.

In autogamous crops, i.e. wheat and barley, the breeder is normally aiming at isolating parental combination that is likely to produce desirable homozygous sergeants. Attempts at identify such pure lines is facilitated by the preponderance of additive genetic effects in self pollinating crops (Joshi and Dhawon, 1966).

Additive x additive types of epistatic gene effects were significant for most studied characters except for number of spikes / plant in the second cross, grain yield / plant in the three crosses, and for number of kernels / spike in two crosses. Significant negative additive x dominance type of epitasis was found for number of spikes / plant in the second and third crosses, grain weight in the second cross, and grain yield / plant in both first and second cross as well as for number of kernels / spike in second one. Dominance x dominance gene action was significant for most character except for, number of spikes / plant, grain yield / plant and number of kernels / spike in the first cross and grain weight in the third one.

The presence of both additive and non additive gene actions for number of spikes / plant, grain weight, grain yield / plant and number of kernels / spike in the first cross may indicate that selection procedures based on accumulation of additive gene effects could be very successful in improving these characters. However, to maximize selection advance, both additive and non-additive genetic variations are important and would be preferred. Similar conclusion was reported by Mosaad *et al.* (1990), El-Hossary *et al.*(2000), Moustafa (2002), Hendawy (2003) El-Sayed(2004) , Abdel Nour,, *et al.(*2005) , Moshref(2006) and Khaled (2007).

Heritability in both broad and narrow senses and genetic advance under selection for the three studied crosses are presented in Table (4). High heritability values in broad sense were detected for all studied characters.

High narrow sense heritability values were also recorded for number of spikes / plant, grain weight and number of kernels / plant in the first and the third crosses. Moreover, high narrow sense heritability were detected for 100-grain weight in the first and second crosses ,and grain yield / plant and number of kernels/ spike in the third cross. The difference in magnitude of both broad and narrow sense heritability estimates for all studied characters proved the presence of both additive and non additive gene action in the inheritance of the characters under study. Similar results were previously obtained by Jatasra and Parada(1980), Mosaad *et al.* (1990), and Gouda *et al*.(1993), Moustafa (2002), Hendawy (2003), El-Sayed (2004) , Abdel Nour, *et al.* (2005) , Moshref (2006) and Khaled (2007).

Table 4: Heritability % in broad and narrow sense, genetic advance upon selection and genetic advance for the studied characters of the three crosses.

Cross	Parameters	No. of spikes /plant	No. of kernels /plant	100-grain weight (gm)	Grain Yield /plant (gm)
cross I Gemmeiza7 x Sids1	Heritability(b)	82.51	87.14	94.799	91.76
	Heritability(n)	38.99	80.63	72.997	76.89
	Δg	8.784	10.31	28.169	1.047
	Δg%	13.87	51.79	57.9	22.71
Cross II Sakha 94 x Irena	Heritability(b)	90.59	76.29	92.842	81.499
	Heritability(n)	55.89	61.61	76.947	58.618
	Δg	15.88	6.359	32.504	0.789
	Δg%	21.787	29.03	51.39	15.058
Cross III Sids 1 x Sakha 94	Heritability(b)	91.79	86.99	94.38	89.52
	Heritability(n)	81.7	71.76	81.36	70.79
	Δg	26.62	11.455	12.358	0.818
	Δg%	36.719	65.459	21.124	15.65

Genetic advance under selection (Δ g %) was moderate in magnitude for 100-grain weight and number of kernels / plant in the first cross, for grain weight in the second one as well as number of kernels / plant in the third cross.

Low genetic gain was detected for grain yield / plant in the first cross, number of spikes / plant and number of kernels / spike in the second cross and also number of spikes / plant and grain weight in the third cross. Relatively low values of genetic gain were estimated for grain yield / plant in the second and third cross. Dixit *et al.* (1970) pointed out that high heritability is not always associated with high genetic advance, but in order to make effective selection, high heritability should be associated with high genetic gain. In this study, high to moderate values of genetic advance (Δ g %) were associated with high to moderate narrow sense heritability estimates for grain yield / plant in the first cross as well as number of spikes / plant and number of kernels / spike in the second cross. Consequently, selection for these characters would be effective and satisfying. Relatively low genetic gain was associated with low heritability values for number of spikes / plant in the first cross and grain yield / plant in the last two crosses. Hence, selection for these characters may be less effective. These results were in accordance with those obtained by Moustafa (2002), Hendawy(2003) and Moshref (2006).

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دراسات وراثية للمحصول ومكوناته فى ثلاث هجن من قمح الخبز

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أجريتذا البحث فى ثلاث مواسم متتالية من ٢٠٠٤ – ٢٠٠٥ الى ٢٠٠٦ – ٢٠٠٧ فى محطة البحوث الزراعية ببهتيم على ثلاث هجن من قمح الخبز و بتحليل العشائر (كل من الآباء والجيلين الأول والثانى و الجيلين الرجعيين) لكل من الهجن الثلاث (جميزة ٧ x سدس ١ وسخا ٩٤ x ارينا و سدس ١ x سخا ٩٤) وقد تمت دراسة صفات عدد السنابل على النبات و عدد حبوب لسنبلة ووزن المئة حبة ووزن حبوب النبات الفردى

وكانت أهم النائج المتحصل عليها من هذه الدراسة :

١ – كانت قوة الهجين معنوية وموجبة لعدد السنابل / النبات و محصول الحبوب فى النبات وعدد الحبوب فى السنبلة فى الهجين الأول أما الهجين الثانى فكانت قوة الهجين معنوية وموجبة بالنسبة لوزن المائة حبة و محصول حبوب النبات و عدد الحبوب فى السنبلة و أيضا ظهرت قوة الهجين معنوية و أثرت فى عدد السنابل للنبات ووزن المائة حبة و محصول الحبوب للنبات فى الهجين الثالث .

٢- تأثير التربية الداخلية كان معنويا لكل العوامل التى تحت الدراسة عدا عدد السنابل / النبات فى الهجين الأول.

٣ – أوضحت دراسة طبيعة التوارث ان درجة السيادة كانت لعدد السنابل / النبات ووزن المائة حبة و محصول الحبوب / النبات و عدد الحبوب / السنبلة فى الهجين الأول. بينما كانت طبيعة التوارث الكلية أوالجزئية تتجه قليلا نحو صفات الأب و ذلك تم الحصول علية فى الهجين الثالث . على الجانب الآخر طبيعة التوارث لدرجة السيادة كانت جزئية لكل الصفات (عدد السنابل / النبات ووزن المئة حبة ومحصول الحبوب / النبات و عدد الحبوب فى السنبلة) بالنسبة للهجين الثانى.

٤- كانت انحرافات الجيل الثانى E١ معنوية لكل الصفات المدروسة فى الهجين الأول و الثانى و الثالث , ما عدا عدد السنابل / النبات للهجينين الأول و الثانى , أيضا وزن ال ١٠٠ حبة فى الهجين الأول فقط. و أكثر من ذلك كانت انحرافات الأجيال الرجعيةE٢ معنوية لكل الصفات المدروسة فى الهجين الأول و الثانى و الثالث , ما عدا عدد السنابل / النبات ووزن المائة حبة فى الهجين الأول فقط , و محصول الحبوب / النبات فى الهجينين الأول و الثانى.

٥- اظهرت التأثيرات الوراثية المضيفة و كذلك الفعل الجينى معنوية لكل الصفات المدروسة فى الهجين الثانى و الثالث , ما عدا عدد السنابل / النبات , ووزن المائة حبة , محصول الحبوب / النبات و عدد الحبوب / السنبلة فى الهجين الأول (جميزة ٧ x سدس ١). أظهرت التأثيرات الوراثية المضيفة و كذلك الفعل الجينى غير المضيف (السيادة و التفوق) معنوية فى وراثة بعض الصفات المدروسة(عدد حبوب السنبلة و محصول الحبوب للنبات فى الهجين الأول والثانى ووزن المائة حبة فى الهجين الأول و الثالث و عدد السنابل للنبات فى الهجين الثالث).

٦- أظهرت الكفاءة الوراثية بمعناها الواسع قيما عالية لمعظم الصفات , كما أظهرت الكفاءة الوراثية بمعناها الضيق قيما عالية الى متوسطة لمعظم الصفات كنسبة التحسين الوراثى فى الجيل الثانى – النتائج المتحصل عليها تدل على أن الإنتخاب فى الأجيال الانعزالية المبكرة قد يكون مفيدا.

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Table 2 : Means(X) and variances(S^2) of six populations for the studied characters of the three wheat crosses

	parameters	Cross I (Gemmeiza7x Sids1)						Cross II (Sakha 94 x Erina)						Cross III (Sids1 x Sakha94)					
		P1	P2	F1	F2	Bc1	BC2	P1	P2	F1	F2	BC1	BC2	P1	P2	F1	F2	BC1	BC2
No.of spikes / plant	X	17.8	20.1	21.4	19.9	21.1	21	22.4	25.11	24.6	21.9	19.25	23.2	18.4	22.4	24.5	22.1	17.5	20.1
	S^2	5	8	4.95	38.5	22.95	21.94	5.69	6.59	5.95	25.1	11.5	23.11	4.62	5.69	7.81	60.1	34.59	44.19
100-grain weight(gm)	X	5.12	3.92	5.21	4.61	4.79	4.75	4.46	4.61	4.93	5.24	4.91	5.32	4.1	4.46	4.77	5.23	4.66	4.92
	S^2	0.08	0.12	0.04	0.44	0.298	0.198	0.041	0.062	0.079	0.43	0.321	0.301	0.055	0.041	0.03	0.32	0.099	0.29
Grain Yield /plant(gm)	X	50.6	44.9	76.5	48.7	62.96	61.84	60.5	65.24	71.5	63.3	64.41	72.9	51.9	60.5	65.7	58.5	53.9	60.2
	S^2	16.9	20	18.3	351	225.6	220	11.98	23.1	30.1	421	260.7	265.1	7.03	11.98	13	231	140.5	135.5
No. of kernels / spike	X	70.5	81.2	71.6	63.4	69.22	72.85	72.95	81.2	92.9	72.9	74.9	70.95	80.95	72.95	79.7	72.5	75.62	62.5
	S^2	21.2	24.5	20.9	120	110.5	80.8	10.97	25.9	17.9	190	123.4	150.5	14.75	10.97	20.5	250	120.5	180.6

Table 3: Heterosis, inbreeding depression, gene action and potence ratio parameters for three wheat crosses

characters	cross No.	heterosis % Over B.P	Inbreeding Depression %	Gene action parameters m	a	d	aa	ad	dd	E1	E2	potance Ratio (P)
No. of spikes /plant	**1**	6.47 *	7.01	19.9 **	0.15	6.95	30.74*	1.72	-19.98	-0.275	1.7	2.13
	2	-1.99	10.976**	21.9**	-3.95**	-1.85	0.1	8.075**	48.15**	-2.275**	-5.9**	0.629
	3	9.15**	9.61**	22.1**	-2.6**	-9.15**	-13.76*	9.12**	50.82**	-0.325	-7.25**	2.025
No. of kernels / spike	**1**	-11.82*	11.52*	63.35**	-3.63	26.49*	-4.5	4.16	-7.9	-10.375**	-5.38*	-0.794
	2	14.409**	21.529**	72.9**	3.95*	-4.075*	-2.7	-2.6**	14.5**	-12.088**	-24.125**	3.836
	3	-1.54	9.03**	72.5**	13.12**	-11.01	-13.2**	-0.6	27.7**	-5.825**	-18.53**	0.68
100-grain weight(gm)	**1**	1.76	11.516 **	4.61**	0.04	1.33*	55 **	-1.73	-52.1 *	-0.255	-0.19	1.15
	2	6.94**	-6.288**	5.24**	-0.41*	-0.105	20.6*	-6.13*	-27.46/	0.5075**	0.765**	0.629
	3	6.95**	-9.64 **	5.23**	-0.26	-1.27**	-5.8*	-2	21.4	0.705**	0.53**	2.722
Grain Yield /plant(gm)	**1**	51.185 **	36.405 **	48.65**	1.12	83.75**	0.64	-0.56**	-0.26 **	-13.475**	0.55	10.088
	2	9.595**	11.538**	63.25**	-8.5**	30.23**	-0.5	-0.335*	-1.03*	-3.935*	2.93	3.641
	3	8.595**	10.959**	58.5**	-6.3**	3.7	-1.76**	-0.08	0.7*	-2.45*	-7.8**	2.209

- **And ** significant at 0.05 and 0.01 probability levels, respectively**