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ESTIMATION OF GENETIC VARIANCE FOR YIELD AND YIELD COMPONENTS IN TWO BREAD WHEAT (*Triticum aestivum* L.) CROSSES

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ABSTRACT

These experiments were carried out at Sakha Agricultural Research Station during four successive seasons from 2002 / 2003 to 2005 / 2006. Two crosses i.e. Giza 168 X Gemmeiza 7 and Gemmeiza 9 X Sakha 93 were evaluated . Five populations , (P_1 , P_2 , F_1 , F_2 and F_3) were used in this concern . Significant F_2 mean values were obtained for all studied traits in the two crosses, then various biometrical parameters were estimated . Significant positive , heterotic effects towards better parent were detected for number of kernels / spike and grain yield / plant in the two crosses and for number of spikes / plant , 100-Kernel weight in the first cross (Giza 168 X Gemmeiza 7) .

The obtaind results indicated that , heterosis compared with better parent was significant for all studied characters in the two studied crosses except ; number of spikes / plant and 100-kernel weight in the second cross (Gemmeiza 9 X Sakha 93)

Inbreeding depression estimates were found to be significantly positive in the first cross for ; number of spikes / plant and100-Kernel weight .The same direction was obtained in the second cross for ; number of spikes / plant , number of Kernels/ spike ,100-Kernel weight and grain yield / plant . F_2 deviation (E_1) were significant for number kernels / spike and 100-kernel weight for two crosses . Moreover , F_3 deviation (E_2) was significant for all studied characters in the two studied crosses except , for number of spikes / plant in the second cross and grain yield / plant in the two crosses . Additive type of gene effect , was significantly positive in the first cross for ; number of spikes / plant , number of Kernels / spike and grain yield / plant . The same effect was obtained in the second cross for ,100-Kernel weight . Meantime , dominance gene effect showed that , most of the studied traits in both crosses were significantly positive . Heritability as a broad sense gave high estimate value for all studied traits in both crosses while , heritability as a narrow sense showed the same direction for all the studied traits in both crosses except for ; number of spikes / plant and number of kernels / spike in the second cross .

Additive X additive (i) type of gene action was positive and significant for all the studied characters except ;100-kernel weight in the first cross . On the other hand , in the second cross only 100-kernel weight was positive and significant . Meanwhile , dominance X dominance was positive and significant for , number of kernels / spike in the second cross and 100-kernel weight in the first cross only .

The obtained results indicated that ,selection for the studied traits may be effective in the early generations but it may be more effective if postponed to late generations. Also, these study concluded that, it can be take in consideration the first cross (Giza 168 X Gemmeiza 7) to improve the breeding program in the National Wheat Research Program

INTRODUCTION

It is well known that, the development of wheat varietals improvement strategy should be based on the genetic information i.e. heritability and types of gene action that controlling yield and other agronomic traits. It is also known that , the diallel analysis is an attempt to partition phenotypic variation into genotypic and environmental components and to subdivide genotypic variation into additive and non-additive components. These estimates can be used to draw inferences about the genetic system involving yield and its components and the best breeding strategy to be used in improvement wheat characters .

Furthermore, maximum progress in improving a character would be expected with a carefully designed pedigree selection program when the additive gene action is the main component . whereas , the presence of high non-additive gene action would be suggest the use of a crossing program. In addition, the effectiveness of selection will be determined by calculating heritability value as a narrow sense. In this respect, the majority of reports on genetic behavior of yield and its components in wheat indicated that , the additive components of genetic variance are more important than those attributed to non-additive components. (Abul-Naas *et al.* (1991) and Al Kaddoussi *et al.* (1994) reported that , dominance component of gene action played an important role in the genetic control for ; number of spikes / plant . number of kernels / spike , 100-kernel weight and grain yield / plant . On the other hand Crumpacker and Allard (1962) reported that , the efficiency in breeding of self-pollinated crop plants depended firstly. on, accurate identification of hybrid combinations that had the potentiality of producing maximum improvement and secondly on identifying the superior lines among the progeny of the most promising hybrids in early segregating generations .

Therefore , information on the gene effect and variances of breeding materials could ensure long - term selection of gains and better genetic improvement . On the other hand , El-Hossary *et al.* (2000) found that , grain yield and its components in a diallel cross among eight parents, were controlled by both additive and non-additive gene effects. In addition , concerning the heritability as a narrow sense , Gouda *et al.* (1993) showed that , heritability in a narrow sense ranged from 14 to 71% for grain yield , Moustafa (2002) , Hendawy (2003) , El-Sayed (2004) , Nadya Abdel - Nour *et al.* (2005) , Nadya Abd el-Nour and Moshref (2006) and Nagwa (2006) reported that , heritability estimates for yield and its components were medium to high .

This study was conducted to study the genetic variance , gene action , heritability and comparison between actual and expected genetic gain of two bread wheat crosses derived from four parental wheat genotypes using five populations of each cross .

MATERIALS AND MATHODS

Two bread wheat crosses were used in the present study derived from four wide diverse parental bread wheat cultivars. The names, pedigree and origin of the parental genotypes are given in Table (1) These genotypes were used to obtain the following two crosses , the first one was Giza 168 X Gemmeiza 7 and the second cross was Gemmeiza 9 X Sakha 93 to study the yield and its main components i.e , number of spikes / plant , number of kernels / spike , 100 - kernel weight (g) and grain yield / plant (g) .

Table (1): Names, pedigree and origin of the parental wheat cultivars

Cultivar	Pedigree	Origin
Giza 168	MRL/ BUC/SERI CM933046-8M-OY-OM2Y-OB-OGZ	Egypt
Gemmeiza 7	CMH74A . 630/ SX//SERI 82 /AGENT . CGM4611- 2GM-3GM-IGM-OGM	Egypt
Gemmeiza 9	ALD(S) / HUACCMH 74 A .630/SX CGM 4583-5GM-IGM-OGM .	Egypt
Sakha 93	Sakha 92 / TR8 103228 S8871-1S-2S-1S-0S	Egypt

The experimental work of the present investigation was carried out at Sakha Agricultural Research station during four succesive seasons i.e. , 2002 /2003 to 2005 /2006 . In the first seasons (2002 / 2003) . the parental genotypes were crossed to obtain F_1 hybrid seeds .

In the second season (2003 /2004) , the hybrid seeds of the two crosses were sown to give the F_1 plants. These plants were selfed to produce F_2 seeds . Morever , the same parents were crossed again to have enough F_1 hybrid seeds . The new hybrid seeds and a part of seeds that obtaind from F_1 selfed plants (F_2 seeds) were kept to be evaluated in the final experiment . In the third season (2004/ 2005), two F_1 and F_2 plants were selfed to produce F_2 and F_3 seeds , respectively . In the fourth season , (2005 / 2006) . the obtained seeds of the five populations i.e. , P_1 ,P_2 , F_1 ,F_2 and F_3 for the two studied crosses were evaluated in a randomized complete block design with three replicates .

The experimental unit was two rows for each of parents and F_1 totaling 20 plants from each of them , 20 rows for F_2 generation totaling 200 plants and five rows for F_3 families totaling 50 plants for each cross . Each row was 2m long and 20 cm. apart. The plants within the same row were 10 cm spaced. The data were recorded on an individual guarded plants for number of spikes / plant , number of kernels / spike, 100 – kernel/ weight (g) and grain yield / plant (g) .

Various biometrical parameters were calculated only if the F_2 genetic variance was found to be significant. In this concern, F_2 genetic variance was found to significant . Heterosis % was expressed as percentage increase in F_1 performance above the better parent value. Potence ratio (p) was also calculated according to Peter and Frey (1966). In addition , F_2 deviation (E_1) and F_3 deviation (E_2) were measured as suggested by Mather and Jinks (1971) .

The estimates of mean effect parameter (m) , additive (d*) , dominance (h) , dominance X dominance (e) and additive X additive (i) were obtained by five parameters model illustrated by Hayman (1958) . Heritability was calculated as both broad and narrow senses according to Mather (1949) procedure and parent offspring regression according to Sakai (1960). Furthermore, the expected and actual genetic advance (Δg) was computed according to Johansen *et al.*. (1955). Likewise, the genetic gain represented as percentage of the F_2 and F_3 mean performance (Δg %) was estimated using the method of Miller *et al.* (1958). Inbreeding depression was calculated as the difference between the F_1 and F_2 means expresed as a percentage of the F_1 mean . The T-test was used to determine the significance of these deviations wherease the standerd error (S.E.) was calculated as followe : S.E. for better parent heterosis and S.E. for inbreeding depression

$$\overline{F1} - \overline{F2} = (V\overline{F1} + V\overline{F2})^{1/2}$$

RESULTS AND DISCUSSION

The choice of the parents to be used in the crossing programs is the most important problem facing wheat breeders. If the parents are precisely selected , the desired recombination's will be found in the segregated generations (Mahrous , 1998) . Parental differences in response to their genetic background were found to be significant in most characters under investigation. The results revealed significant differences among the parental genotypes ivolved in the present investigation , suggesting presence of considerable amount of genetic variation . Thus , parental genotypes were genetically different for loci controlling the studied characters . The presence of fair amount of gentic variation offer breeder broad genetic base for futher improvement and valid to be used for further genetic assessment . Data in Table (2) showed that , the F_1 means were larger than the high performing parent for ; number of spikes / plant , and 100-kernel weight in first cross and grain yield / plant in both of two studied crosses indicating that , increasing alleles were more frequent than decreasing one . The other studied traits were less than the high performing parent indicating that decreasing genes were more frequent than the decreasing ones . On the other hand , F2 mean values were less than the corresponding F1 mean values for all studied traits in two studied crosses indicating the role of dominance gene action in the inheritance of these characters and exhabitied desirable recombinations in segregating generations as well as the occurrence of transgressive segregation .

The F_2 population were also significant for all studied characters in the two studied crosses. Thus, different biometrical parameters used in this study were estimated. Means and variances of five population I .e. , (P_1, P_2 , F_1, F_2 and F_3) of the studied characters in the two studied crosses are presented in Table (2) . Heterosis , potence ratio (P) , inbreeding depression percentage and different gene actions for the four studied characters are given in Table (3)

In self pollinated crops such as wheat , plant breeders have investigated the possibility of developing hybrid cultivars . The feasibility of growing hybrid cultivars depends on the economic production of large quantity of hybrid seeds and significant superiority in yield as well as best performance of hybrids compared to the current commercial cultivars (Mahrous , 1998) .

Thus., heterosis over better parent may be useful in these , identifying the best hybrid combinations but these hybrids can be immense practical value if they involve the best cultivar of area (Prasad *et al.* 1998) .

Significant positive heterotic effects were found for all studied characters in the first cross and for grain yield / plant in both two crosses .On the other hand , number of kernels / spike and 100-Kernel weight in the second cross recored significantly negative heterotic effect

These results are similar of those reported by Moshref (1996) Hendawy (1998) , EL-Hossary *et al.* (2000) , Moustafa (2002) , Hendawy (2003) , El Sayed (2004) Nadya Abdel-Nour *et al.* (2005) ,Nadya Abdel-Nour and Moshref (2006) and Abdel-Nour , (2006) .

Number of spikes / plant, number of Kernels /spike and 100 - Kernel weight are the main components of grain yield. So, increasing heterosis percentage in one or more of these attributes may lead to favorable yield increasing in a hybrid .

The absence of significance heterosis for number of spikes / plant in the second cross may be due to the lower magnitude of the non additive gene action . These results are in agreement with those of Keteta *et al.* (1976) and El-Rassas and Mitkess (1985).The pronounced heterotic effect for number of Kernels / spike in the first cross (Giza 168 x Gemmiza7) may be taken in consideration in a breeding program for high yielding ability when selecting for this character .

Potence ratio (p) values as indicated that the over dominance was resulted for all studied characters in the first and second cross except for ; number spikes / plant , 100-kernel weight and number of spikes / plant in the second cross which showed complete dominance towards the higher parent . On the other hand , number of kernels / spike showed partial dominance in second cross . These results are in agreement with those obtained by Rady *et al.*. (1981) Moustafa (2002) , Hendawy (2003) , Al-Kaddoussi *et al.*. (1994) , Mosaad *et al.* (1990) , Nadya Abdel-Nour and Mosherf (2006) , and Nagwa Salem (2006) .

Inbreeding depression measured the reduction in performance of F_2 generation due to inbreeding . Inbreeding depression values that obtained in the two crosses illustrated that all studied characters showed significant values except for number of kernels per spike and grain yield / plant in the first cross .These results , since the expression of heterosis in the F_1 may be followed by reducing in F_2 performance .The obtained results for most crosses were in harmony with those obtained by Khalifa *et al.* (1997) . Significant positive heterosis and significant inbreeding depression were obtained for number of spikes / plant ,100-Kernel weight in the first cross and for grain yield / plant in the second one .The contradiction between heterosis and inbreeding depression estimates values may be due to the presence of linkage between genes in these materials , Van der Veen (1959) .

The choice of the most effect of breeding procedures depends on a large extent on the knowledge of the genetic system contributing to the selected characters. Therefore, the nature of the gene action was also computed by using five parameters analysis accordig to Hayman modle (1958) and presented in Table (3) .

The estimated mean effects of F_2 (m) ,which reflects the contribution due to overall means plus the locus effects and interactions of the fixed loci , was found to be highly significant for all the studied characters .

Additive gene effect (d*) was positive and significant for ; number of spikes / plant , number of kernels / spike and grain yield / plant in the first cross . On the other hand , (d*) was negatively significant for , number of spikes / plant , number of kernels / spike and grain yield / plant in the second cross and for 100 kernel weight in the first cross These results suggested that, the potential for obtaining further improvement for the former characters could be realized by applying pedigree selection program. These results were greatly in agreement with those obtained by Amaya *et al.* (1972) , Hendawy (1998), El Hosary *et al.* (2000) , Moustafa (2002) Hendawy (2003) , El Sayed (2004) , Nadya Abdel-Nour and Moshref (2006) and Nagwa Salem (2006) .

Dominance gene effect (h)was significantly positive for ; number of spikes / plant , and grain yield / plant in the two studied crosses . On the other hand ,100-kernel weight showed significantly negative (h) in the first cross , and for number of kernels / spike in the second ones . Significance of these components indicated that both additive and dominance gene effects had an important role in the inheritance of these characters . Hence the selection of the desired characters may be practiced in the early generations but may be more effective in latest one , Shehab El-Din (1993) .

Dominance X dominance (e) type of gene action was significantly positive for 100 – kernel weight in the first cross and number of kernels / spike in the second one . At the same time, number of spikes / plant and number of kernels / spike per plant showed significant negative (e) component in the first cross and 100-kernel weight in the second one . On the other hand , significant positive additive X additive type of epistasis (i) was detected for ; number of spikes / plant , number of kernels / spike and grain yield / plant in the first cross . On the other hand ; number of spikes / plant , number of kernels /spike and grain yield / plant in the second cross showed significant negative (i) values . The same direction was detected for 100-kernel weight in first cross .

The important role of both additive and non-additive gene action in certain studied characters indicated that the selection procedure based on the accumulation of additive effects may be very successful in improving these characters . Similar approaches were reported by Gouda *et al.* (1993). Al-Kaddoussi *et al.* (1994) , El Hossary *et al.* (2000) , Moustafa (2002) , Hendawy (2003) and Nagwa Salem (2006).

Significant positive F_2 deviation was detected for 100-kernel weight in both two studied crosses . Meanwhile , significant negative values for F_2 deviation were also obtained for 100-kernel weight in the two studied crosses . These results may be refer to the contribution of epistatic gene effects in the perform of these characters . F_3 deviation (E_2) was detected and significant negative for , number of spikes / plant and number of kernels / spike in first cross . Also , 100-kernel weight behave so in the two studied crosses . These results may be ascertain the presence of epistasis in such large magnitude as to warrant great deal of attentiation of breeding programs .

Heritability value indicates whether progress from selection for plant character is relatively easy or difficult to make in a breeding program . A plant breeder , through experiences , can perhaps rate a series of characters on their response to selection . Heritability gives a numberical description of this concept .

Heritability in both abroad and anarrow senses between generations (parent offspring regression) are presented in Table (4). High heritability values as abroad sense were detected for all the studied characters. High to moderate estimates of narrow sense heritability and parent offspring regression were found for all the studied characters in the two studied crosses. The difference in magnitude of both narrow sense and parent offspring regression heritability estimates for all the studied characters may be assure the existence of both, additive and non-additive gene effects in the inheritance of these characters. Similary , Jatasre and Paroda (1980) , Mosaad *et al.* (1990) , Moshref (1996) , El Syaed (2004) ,Nadya Abdel-Nour *et al.* (2005) reported these conclusions the expected genetic gain and actual gain for studied characters are also shown in Table (4) . The expected genetic advance (Δ g % of F_2) and actual genetic advance (Δ g % of F_3) ranged from moderate to high values for all the studied characters except for 100-kernel weight in the two studied crosses . These results indicated the possibility of practicing selection in early generations to be assure that these characters and hence, selecting high yielding genotypes. Dixit *et al.* (1970) recorded that, high heritability was not always associated with high genetic advance , but in order to make effective selection , high heritability should be associated with high genetic gain .

Table (4): Heritability and expected versus actual gain for all studied characters in two crosses of bread wheat

Character	Cross	Heritability		Parent off spring regression	Expected gain		Actual gain	
		Broad sense	Narrow sense		Δ g	%of F_2	Δ g	%of F_2
Number of spikes /plant	1	83.66	58.67	71.95	7.019	30.92	7.276	38.60
	2	83.98	68.91	77.06	7.89	34.165	7.00	31.86
Number of Kernels / spike	1	92.67	63.19	77.90	20.639	30.38	30.38	33.185
	2	89.23	77.09	83.97	22.149	32.15	32.15	26.29
100-Kernel weight (g)	1	85.59	76.86	81.22	0.758	14.12	0.628	11.00
	2	88.84	69.30	79.07	0.662	13.186	0.612	14.49
Grain yield / plant (g)	1	94.22	65.59	84.76	26.826	45.678	23.697	42.43
	2	91.44	89.45	90.14	34.888	55.63	26.22	43.88

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تقدير التباين الوراثي للمحصول ومكوناته فى هجينين من قمح الخبز

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أجرى هذا البحث في محطة البحوث الزراعية بسخا في أربعة مواسم زراعية من (2002 / 2003) إلي (2005 / 2006)علي هجينين من قمح الخبز وهما (جيزة 168 X جميزة 7) , (جميزة 9 X سخا 93) , وقد اشتملت الدراسة علي كل من الأبوين والأجيال الأول والثاني والثالث . وقد تمت دراسة صفات عدد السنابل علي النبات وعدد حبوب سنبلة الساق الرئيسية ووزن المائة حبة , ووزن حبوب النبات الفردي.

ويمكن تلخيص نتائج الدراسة كالتالي :

- أظهرت الدراسات أن متوسطات قيم الجيل الثاني كان معنوياً في جميع الصفات تحت الدراسة في كلا الهجينين .
- كانت قوة الهجين موجبة وعالية المعنوية في وزن المائة الحبة وعدد حبوب السنبلة وعدد سنابل النبات في الهجين الأول , وكذلك في محصول الحبوب للنبات الفردي في كلا الهجينين .
- أوضحت الدراسة وجود سيادة فائقة تجاه الأب الأعلى في جميع الصفات تحت الدراسة في الهجين الأول , وكذلك كانت السيادة تامة تجاه الأب الأعلى أيضاً في صفتي عدد السنابل علي النبات , وعدد حبوب السنبلة للنبات في الهجين الثاني .
- كان تأثير التربية الداخلية موجباً ومعنوياً في كلا الهجينين الأول والثاني في صفات عدد السنابل علي النبات الفردي , وعدد حبوب السنبلة ووزن مائة حبة ومحصول حبوب النبات الفردي .
- أوضحت الدراسة أن الفعل الجيني المضيف , كان موجباً ومعنوياً في صفات عدد السنابل على النبات الفردي , وعدد حبوب السنبلة , ومحصول النبات الفردي في الهجين الأول , كما أظهرت صفة وزن المائة حبة نفس الاتجاه في الهجين الثاني حيث أظهرت قيماً سالبة ومعنوية .
- كان تأثير الفعل السيادي للجين موجباً ومعنوياً في جميع الصفات تحت الدراسة فيما عدا وزن الحبة التي أظهرت معنوية سالبة في الهجين الأول , وكذلك عدد حبوب السنبلة في الهجين الثاني حيث أظهرت معنوية سالبة .
- كانت انحرافات الجيل الثاني (E_1) وانحرافات الجيل الثالث (E_2) معنوية لمعظم الصفات في الهجين تحت الدراسة مما يوضح أهمية الفعل الجيني التفوقي في وراثة هذه الصفات .
- أظهرت الكفاءة الوراثية بمعناها الواسع قيماً عالية لمعظم الصفات تحت الدراسة في كل من الهجينين , وكذلك أعطت الكفاءة الوراثية بمعناها الضيق نفس القيم العالية في جميع الصفات تحت الدراسة في كل من الهجينين . وكذلك الكفاءة الوراثية بين الأجيال قيماً عالية إلي متوسطة في معظم الصفات الموروثة .
- كانت قيم التحسن الوراثي الفعلي المتحصل عليه متطابقة مع تلك القيم المتنبأ بها لتحسين المحصول ومكوناته من خلال الانتخاب , ومن ثم يمكن للمربي الاعتماد علي القيم المتنبأ بها في الانتخاب لتحسين الصفات المحصولية .
- أظهرت الدراسة أن التأثيرات الوراثية للجين المضيف وغير المضيف دوراً هاماً في وراثة جميع الصفات تحت الدراسة .
- توصي الدراسة بأخذ الهجين الأول (جيزة 168 X جميزة 7) في الاعتبار عند عمل برنامج تربية لتحسين محصول القمح في مصر , ويؤيد هذا الاتجاه وجود دراسات سابقة تؤكد وجود تباعد وراثي كبير بين الاصناف الداخلة في هذا الهجين .

Table (2): Means ($\bar{\bar{X}}$) and Variance (S^2)for some studied characters using the five populations of the two bread wheat crosses :

Characters	Parameter	Giza 168 X Gemmeiza 7					Gemmeiza 9 X sakha 93				
		P_1	P_2	F_1	F_2	F_3 bulk	P_1	P_2	F_1	F_2	F_3 bulk
Number of spikes/plant	$\bar{X}$ S^2	21.4 5.8	20.0 3.65	22.7 5.51	21.14 33.7	18.8 24.1	20.5 2.95	25.1 4.21	24.9 4.35	23.1 29.9	21.9 19.5
Number of Kernels/spike	$\bar{X}$ S^2	80.5 20.3	68.1 16.9	68.0 18.4	67.9 251	63.4 171.9	68.9 15.8	77.9 16.6	74.2 20.9	68.9 194.5	72.4 121.1
100 kernel weight (g)	$\bar{X}$ S^2	4.46 0.04	5.01 0.02	5.38 0.03	5.27 0.22	5.71 0.14	5.01 0.02	4.51 0.02	5.01 0.02	5.02 0.22	4.22 0.14
Grain yield /plant (g)	$\bar{X}$ S^2	55.8 18.9	52.1 18.0	61.2 17.1	58.7 296.8	55.9 184	50.9 16.2	61.9 27.8	67.9 30.9	62.7 360	59.76 199.4

Table (3): Heterosis, Potence ratio ,inbreeding depression and gene action parameters for two bread wheat crosses

Characters	cross no.,	Heterosis % over B.P	Potence ratio (P)	Inbreeding depression %	Gene action parameters						
					m	d*	h	i	e	E_1	E_2
Number of spikes/plant	1 2	6.1** -.06	2.91** 0.93	6.87** 7.41**	21.14** 23.10**	0.675* -2.3*	7.15** 4.25**	6.30** -2.16*	-8.05* -1.09	-0.57 -0.78	-5.72** -1.55

Number of Kernels/spike	1 2	15.52** - 4.75**	-1.01 0.20	0.16 7.14**	67.90** 68.90**	6.20** -4.5**	12.10** -5.8**	30.77** -14.4**	-23.71** 28**	-3.26** -4.9*	-15.47** -2.8*
100 kernel weight (g)	1 2	7.4** 0.00	2.37** 1.00	2.05* 0.20*	5.27** 5.02**	-0.28** 0.25**	-1.1** 2.18**	-2.29** 2.42**	2.64** -4.29**	0.21** 0.25**	1.31** -1.33**
Grain yield /plant (g)	1 2	9.75** 9.83**	3.92** 2.11*	4.16 7.70*	58.7** 62.72**	1.86* -5.49**	9.3** 11.38**	5.71* -10.23**	-8.40 -5.52	1.10 0.55	-3.5 -4.82

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