GENERATION MEAN ANALYSIS USING GENERATION VARIANCE IN DURUM WHEAT TRAITS (*Triticum durum* L.)

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ABSTRACT

The present investigation was conducted to estimate the gene action effects in some traits of durum wheat by using crosses two generation of wheat (Albit-9 X omgenil-3) through generation mean analysis during growing season 2016-2017, at Field Crops Department, Collage of Agricultural Engineering Sciences, University of Duhok. The analysis of variance showed significant differences between generations mean for studied traits except spike length which did not significant. The mean value of F_1 generation was higher than the respect parents (P_1 and P_2) F_2, Bc_1 and Bc_2 for most of studied traits in wheat crosses. The results of gene effect shown that the dominance gene effects were significant and positive with all studied traits, whereas additive gene effect did not significant for all traits except plant height and number of grain per spike, also The results exhibited that the dominance and additive X additive variance was positive for all traits this mean complementary gene effect controlling these traits, regarding of broad and narrow sense heritability. The results indicate that broad sense value was more than the narrow sense heritability. Heterosis in F_1 cross over mid parents was recorded a positive value (9.672, 8.112) for plant height and grain yield per plant, while inbreeding depression was measured as reduction in performance of F_2 generation a positive results were obtained for all traits.

Keyword, generation means, gene action, heritability, wheat crosses

تحليل متوسطات الأجيال بأستعمال تباينات الأجيال في الحنطة الخشنة
(*Triticum durum* L.)

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المستخلص

نفذت الدراسة لتقدير تأثير الفعل الجيني المسيطر على بعض صفات االحنطة الخشنة بأستخدام تركيبين وراثيين من الحنطة (Albit-9 X omgenil-3), ذلك بأستخدام: طريقة تحليل المتوسطات بأستعمال الأجيال في حقل قسم المحاصيل الحقلية, كلية علوم الهندسة الزراعية, جامعة دهوك, خلال الموسم النمو 2016-2017. أظهرت نتائج تحليل التباين وجود فروقات معنوية بين الأجيال عدا طول السنبلة. قيم الجيل الأول F_1 لمتوسطات الصفات المدروسة كانت أعلى من كلا الأبوين (P_1 و P_2) والجيل الثاني F_2 و التهجين الرجعي الأول Bc_1 والتهجين الرجعي الثاني Bc_2. أوضحت نتائج تأثير الفعل الجيني السيادي فروقات معنوية و بالأتجاه الموجب لجميع الصفات بينما الأضافي لم يكن معنويا في الصفات عدا أرتفاع النبات وعدد الحبوب/سنبلة. أظهرت نتائج التباينات السيادية و الأضافية x الأضافية بأنها كانت موجبة ومعنوية لكل الصفات مما يدل على وجود سيادة متممة لهذه الصفات. قيم التوريث بالمعنى الواسع كانت أعلى من قيم التوريث بالمعنى الضيق, أما قوة الهجين قياسيا مع متوسط الأبوين كانت موجبة وتراوحت بين (0.9672 - 0.8112) لصفتي أرتفاع النبات و حاصل الحبوب لكل نبات. رافقتها أنحدارا موجبا نتيجة التربية الداخلية.

الكلمات المفتاحية: متوسطات الأجيال, الفعل الجيني, التوريث, الحنطة

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INTRODUCTION

Grain yield is a complex character in wheat which focused by wheat breeder to improve it by developing a new genotype with a high yield potential with desirable genetic make up to overcome the consumption pressure of increasing population (14). Grain yield could be improved through indirect selection by improving the yield components (3). To choice breeding procedures for genetic improvement of wheat dependent on the knowledge of genetic component and presence of non-allelic interaction for different character of wheat (8 and 10). The results of different studies investigate the genetic basis of yield and its component as quantitative characters, showed that the dominance effects and epistasis were more important than additive effects (15). Inheritance of wheat characters needed the information about type of gene action which helpful in deciding the breeding procedure to be followed for wheat improvement (6). To induced new population with highest genetic variation for quantitative characters hybridization must be done between genetically divers parent (5 and 7). Generation mean analysis is a useful technique used by plant breeders to estimate main gene effects (Additive and dominance), (Additive X additive), (Additive X dominance) and (Dominance X dominance) interaction, which responsible for inheritance of quantitative characters (13). The present study was aimed to estimate the nature and magnitude of gene action effect for grain yield and its component characters in durum wheat through generation mean analysis.

MATERIAL AND METHODS

This study was carried out at Field Crops Department, Collage of Agricultural Engineering Science, Duhok University. In the first growing season (2016-2017) two genotypes of durum wheat (Albit-9 and Omgenil-3) were crossed to obtain F_1 cross. In the second season (2017-2018), F_1 crosses plant was selfed and back crossed for two parents to produce F_2, Bc_1 and Bc_2. In the next season (2018-2019) the six generation (P_1, P_2, F_1, F_2, Bc_1 and Bc_2) were sown in Randomized Complete Block Design (RCBD) with three replications in row 3.5 m long, 30 cm between row and 15 cm within the row. While the number of rows per plot and the number of analyzed plants per plot varied with generation, recommended cultured practices and management for experiments were followed to keep a good plants. The data collected for each replication 20 plant for (P_1 and P_2), 60 plants for F_1, 160 plants for Bc_1 and Bc_2, were selected randomly for recording data of the following traits:- plant height, number of spike per plant, spike length, number of grain per spike, grain yield, and 1000 grain weight.

Statistical and genetic procedures

The analysis were proceeded to estimate heritability, heterosis and inbreeding depression according to Miller *et al.,* (16), and estimate the various gene effect by using six genetic parameters model of Hayman (11), Jinks, and Jones (12) as follows:

m = Mean effect
d = Additive gene effect
h = Dominance gene effect
i = Additive X additive gene effect
j = Additive X dominance gene effect
l = Dominance X dominance gene effect

RESULTS AND DISCUSSION

Mean performances

The result of generation mean square for six studied traits are presented in Table 1, the results reveals that highest significant differences among all traits expect spike length which did non-significant, indicating the presence of genetic variability which necessary for success and development of any plant breeding program, this finding indicates that further portion of genetic variance to its components and the comparisons between mean are valid with respect to the studied traits (1,2 and 15).

Table 1. Analysis of variance for studied traits of six generation for durum wheat crosses.

S.O.V	D.F	Plant Height (cm)	Number of Spike / Plant	Spike Length (cm)	Number of Grain / Spike	Grain Yield / Plant (gm)	1000 Grain Weight (gm)
Replication	2	6515.44	966.04	1292.82	596.23	1477.50	2412.21
Generation	5	3505.70 **	435.30 *	311.13	5721.69 **	4558.75 **	15504.2 **
Experiment Error	10	804.84	107.50	116.32	33.76	115.75	171.55
Sampling Error	1482	55.34	2.090	2.27	8.58	19.82	33.55
Total	1499						

**** Significant differences at the level of probability (0.01)**
*** Significant differences at the level of probability (0.05)**

Generation mean value of six populations (P_1, P_2, F_1, F_2, Bc_1 and Bc_2) for analyzed traits with their standard error as compared with L.S.D test at 0.05 probability, shows in Table 2. Mean value of filial generation F_1 gave higher mean value reached (84.03, 8.75, 9.99, 50.63, 25.76 and 51.78) for plant height (cm), number of spike per plant, spike length (cm), number of grain per spike, grain yield per plant (gm), and thousand grain weight (gm) respective, while the mid parents scoring (74.35, 6.45, 7.19, 44.80, 17.65, and 49.00). The mean value of F_2 population comparing with their mid parents Bc_1 and Bc_2 was lower for all traits indicating the appreciable amount of genetic variability for these traits in the corresponding cross. The differences between F_2 and Bc generation mean values arise from different parental allelic contributions (4,9 ,17and 20).

Table 2. Generation mean and standard error (SE) of six traits in durum wheat crosses

Generation	Plant Height (cm)	Number of Spike / Plant	Spike Length (cm)	Number of Grain / Spike	Grain Yield / Plant (gm)	1000 Grain Weight (gm)
P1	79.923 ± 0.91	5.967 ± 0.42	6.623 ± 0.3	43.533 ± 0.96	18.767 ± 0.65	48.754 ± 1.30
P2	68.793 ± 0.64	6.933 ± 0.63	7.770 ± 0.31	46.067 ± 0.75	16.540 ± 0.64	49.366 ± 1.32
F1	84.030 ± 0.45	8.756 ± 0.23	9.991 ± 0.21	50.639 ± 0.47	25.766 ± 0.66	51.781 ± 0.88
F2	74.124 ± 0.71	5.477 ± 0.16	6.486 ± 0.16	36.533 ± 0.4	11.248 ± 0.38	32.463 ± 0.66
Bc1	53.251 ± 0.64	7.575 ± 0.14	7.918 ± 0.39	41.103 ± 0.48	14.762 ± 0.29	45.192 ± 0.68
Bc2	75.927 ± 0.37	7.889 ± 0.2	7.730 ±0 .14	43.722 ± 0.58	16.239 ± 0.40	47.499 ± 0.69
L.S.D at 0.05	18.9	3.7	3.8	7.4	11.3	14.7

Gene action

Estimation of gene action are derived from the six parameters model mean (m), additive (d), dominance (h), additive X additive (i), additive X dominance (j) and dominance X dominance (l), are shows in Table 3. Gene mean effect (m) was significant for all traits indicating that these traits were quantitatively inherited, additive (d) gene effect were non-significant for all traits except plant height and number of grain per spike at (0.01and 0.05) probability level respectively, while dominance (h) gene effect were significant for all studied traits and relatively highest compares to additive (d) gene effect, indicating the low importance of additive gene effects in the genetic control fir these studied traits revealing the role of dominance of gene action to inheritance these traits therefor the hybridization would be more effective then selection (2 and 18).

Table 3. Variance of six generation parameters for Durum wheat crosses.

Genetic Parameter	Plant Height (cm)	Number of Spike / Plant	Spike Length (cm)	Number of Grain / Spike	Grain Yield / Plant (gm)	1000 Grain Weight (gm)
m	0.5 ** ± 0.71	0.01 ** ± 0.16	0.01 ± 0.16	0.2 ** ± 0.40	0.1 ** ± 0.35	0.4 ** ± 0.66
d	0.5 ** ± 0.74	0.1 ± 0.24	0.2 ± 0.42	0.6 ** ± 0.75	0.2 ± 0.49	0.9 ± 0.97
h	10.2 ** ± 3.20	0.6 ** ± 0.74	1.1 ± 1.05	4.0 ** ± 2.0	3.3 ** ± 1.82	10.4 ** ± 3.22
i	10.28 ** ± 3.21	0.647 ** ± 0.80	1.089 ± 1.02	4.75 ** ± 2.18	3.3 ** ± 1.82	10.652 ** ± 3.26
j	1.059 ** ± 1.03	0.181 ± 0.43	0.244 ± 0.49	1.16 ** ± 1.08	0.55 ** ± 0.75	2.23 ± 1.49
l	18.87 ** ± 4.34	1.873 ** ± 1.37	3.547 ± 1.88	13.87 ** ± 3.72	8.75 ± 2.96	28.567 ** ± 5.34

** Significant differences at the level of probability (0.01)
* Significant differences at the level of probability (0.05)

The same Table shows the additive X additive (i) interaction value were significant for studied traits confirming the value of additive gene action was important to inheritance of these traits, while the additive X dominance (j) interaction was significant for plant height and grain yield per plant, indicting the importance of dominance to increasing these traits, while the dominance X dominance (l4) interaction was significant for three traits (plant height, number of spike per plant and 1000 grain weight). According to Kearsey and Pooni (13) mentioned that the epistasis is determined when dominance (h) and dominance X dominance (l) effects were significant with some signs epistasis is of complementary type, the result of present study plant height, number of spike per plant and 1000 grain weight, was under the complementary type, the result are in agreement with Esmail *et al.,* (6); Fellahi *et al.,* (8); and Hannachi *et al.,* (10).

Variance of component variation

Table 4, shows a significant differences between the variance of component variation indicating that the dominance variance (H) was more than the additive (D) variance for the most traits to ensure that the hybridization would be more important that the selection and three traits (spike length, number of grain per spike and 1000 grain weight) gave the positive value of dominance followed by the positive value for number of spike per plant, number of grain per spike and grain yield per plant. The results are in agreement with Fellahi *et al.,* (8) and Ninghot *et al.,* (18).

Table 4. Variance of the component variation, dominance ratio, F/(D*H)1/2 ratio and degree of dominance for Durum wheat crosses.

Traits	D	H	F	EW
Plant Height (cm)	0.9344 **	-55.297 **	-21.87	10.153
Number of Spike / Plant	-0.0142	-1.669 *	0.955	2.671
Spike Length (cm)	-0.2493	39.430 **	-11.233	1.90
Number of Grain / Spike	-0.499 **	50.499 **	4.858	12.024
Grain Yield / Plant (gm)	0.104 **	-30.565 **	3.133	12.948
1000 Grain Weight (gm)	-0.1756 **	8.465 **	-7.886	32.944

** Significant differences at the level of probability (0.01)
* Significant differences at the level of probability (0.05)

Heritability, Heterosis, and Inbreeding Depression

The proportion of variation which is non-heritable from that which is heritable, the result of heritability in Table 5, shows highest value of broad sense heritability for plant height, number of spike per plant, spike length, number of grain per spike, grain yield, and 1000 grain weight with value (0.86, 0.80, 0.72, 0.98, 0.97, and 0.98) respectively. While, narrow sense heritability value was lower as compared with the broad sense for all traits and in negative direction indicating the negative value of additive variance owing to the high value of sampling error, the same table displayed the heterosis value which was positive for plant height, number of spike per plant, spike length, number of grain per spike, grain yield, and 1000 grain weight with value (9.67, 2.30, 2.79, 5.83, 8.11, and 2.72) respectively, the highest positive heterosis recorded in plant height and grain yield per plant which was a good indication for breeding methods based on hybridization to improving these important traits, the expression of heterosis in F_1 will be followed by a considerable reduction in F_2 due to homozygosis. Concerning inbreeding depression, measured as reduction in performance of F_2 generation due to inbreeding, positive result were obtained for most studied traits. Similar results were recorded by Sharma *et al.,* (19) and *Yao et al.,* (21).

Table 5. Estimation of heritability broad sense (h.b.s), heritability narrow sense (h.n.s), heterosis and inbreeding depression for studied traits of Durum wheat

Genetic Parameter	Plant Height (cm)	Number of Spike / Plant	Spike Length (cm)	Number of Grain / Spike	Grain Yield / Plant (gm)	1000 Grain Weight (gm)
h.b.s	0.86	0.80	0.72	0.98	0.97	0.98
h.n.s	-0.145	-0.031	-0.0107	-0.012	0.009	0.250
Heterosis	9.672	2.305	2.794	5.838	8.112	2.721
Inbreeding Depression	9.91	3.28	3.50	14.838	14.52	19.32

In the present study the six trait of durum wheat were examined, the results shown a complex genetic behavior this main the selection in early segregated generation did not effective to improve these traits, additive and dominance component could be exploited in later generation according of that it suggested that selection should be delayed to later generation of segregation population after achieve of homozygous from heterozygous.

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