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Evaluation of the Variations of Some Traits Among Entries Genotypes of Bread Wheat (*Triticum aestivum* L.) and Their Relationship with Grain Yield

Salih Hadi Farhood Al-salim[1], Reem Al-edelbi[2], Hassin kassar[3], Hayder Najm Abed[4]

[1]Ministry of Agriculture, Directorate of Agriculture, Dhi-Qar, AL-Nassiriya, Iraq
[2]Faculty of Agriculture, University of Damascus, Damascus, Syria
[3]Ministry of Agriculture, Al-Moradia Research Station, AL-Hilla, Iraq
[4]Ministry of Agriculture, National Program of Wheat Development in Iraq, Baghdad, Iraq

Email address:

salihalsalim@gmail.com (S. H. F. Al-salim), agro_reem@hotmail.com (R. Al-edelbi)

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Abstract: A field experiment was carried out in Iraq, during the season 2013-2014, in order to evaluate the performance of different ten genotypes of bread wheat in irrigated field conditions, according to the design of randomized complete block in three replications. The results indicated the existence of genetic variability, in a significant manner (at the level 5%), in the response of the studied genotypes to the conditions of the field for all of the traits such as plant height (cm), number of tillers per plant, number of spikes per unit area, spike length (cm), weight of spikes per stem and thousand grains weight (g). Both Egyptian and American genotypes gave the highest grain yield which reached to 4.84, 4.66 tons hectare $^{-1}$ respectively. While both genotypes Apa-99 and Synthetic-10 gave less grain yield 2.62, 2.60 tons hectare $^{-1}$ respectively. The study showed the importance of the number of grains per spike and the thousand grains weight due to their positive and high significant correlation with the grain yield, so it can be used as indicators of suitable selection for the development of high- yielding genotypes.

Keywords: Bread Wheat, Genotypes, Correlation, Grain Yield

1. Introduction

Bread Wheat (*Triticum aestivum* L.) is the most important staple crop in the world in terms of the harvested area, production, and nutrition; as it supplies about 19% of the calories and 21% of the protein to the world's population (Harlan, 1998, FAO, 2011). The International Food Policy Research Institute (IFPRI) projections indicate that the world demand for wheat will rise to 775 million tons by 2020 and 60% by 2050 (Rosegrant & Agcaoili, 2010).

The most important criteria in any crop improvement program is the selection of genotypes with all possible desirable yield contributing traits. Therefore, It is important to investigate the genetic variation of the wheat genotypes in breeding programs (Hawkes, 1977) .Genetic diversity of plants can be identified by several methods such as morphological screening and morphological traits which eventually may result in enhanced food production (Akcura, 2011). According to Mollasadeghi *et al*., 2012) number of spike per unit area, plant height and grain number showed more genetic variation.

Grain yield is a complex trait which is result of yield components (number of plant per area, number of grain per spike, grain weight) as well as other related traits such as plant height, number of spikelets per spike and other traits and also it is influenced by genotype and agro ecological conditions (Atkinson *et al*. 2008). The grain yield of wheat is determined by three yield components: productive spikes per unit area, number of grains spike $^{-1}$ and 1000 grain weight (Tian et al., 2012). Correlation analysis provides information about association of plant characters and therefore, leads to a directional model for yield prediction (Ashfaq et al., 2003). The grain yield was significantly and positively correlated with number of spike per square meter (Korkut et al., 2001), plant height (Mohammadi et al., 2012), grains per spike (Babak and Ahmad, 2015) and 1000 grains weight (Khayatnezhad et al., 2010). Shamsi *et al*. (2011) showed that the most important yield component on grain yield is number of grains per spike followed by number of spikes per unit area and 1000 grains weight.

The aims of this research concentrated on evaluating genetic diversity in Bread wheat genotypes in normal irrigation conditions, to define the difference in the morphological and quantity traits between the studied genotypes, to study the correlation between studied traits and to determine the best genotypes to be exploited in breeding programs.

2. Materials and Methods

The present investigation was carried out in Iraq during the winter season of 2013-2014 under field irrigated conditions.

2.1. Plant Material

This study evaluated 10 diverse bread wheat (*Triticum aestivum* L.) genotypes which were planted under well-watered conditions. They are: Egypt, Sakha-93, Giza-11, Giza-168, Synthetic10, Synthetic13, Synthetic 38, Bohouth-22, Apa -99 and American. Seeds were obtained from the Gene-Bank of the Office of Agricultural Research-Ministry of Agriculture in Iraq, International Center for Agricultural Research in Dry Area (ICARDA) and from International Maize and Wheat Improvement Center (CIMMYT). The tested genotypes used in this study are presented in Table 1.

The data were recorded at appropriate time at maturity of ten randomly selected plants of two middle rows in each plot for eight traits as follows: plant height (PH) in (cm) ; was measured from soil surface to the highest plant tip excluding awns; Number of tillers per plant (NT); Number of Spikes Per Square meter (NS); Spike Length (SL) in (cm); Number of Grains per Spike (NGS); Spikes Weight per stem (SW) in (g); 1000-grains weight (TGW) in (g) measured after final harvest of the plots and grain yield (GY) in (t.ha^{-1}). It was recorded of each experimental plot after harvest on an electronic scale and then converted in to hectare.

Table 1. *List of studied wheat genotypes with their origin.*

No of Geno	Name	Row type	Origin
G1	Egypt	W1	ICARDA
G2	Sakha-93	W2	ICARDA
G3	Giza -11	W3	ICARDA
G4	Giza -168	W4	ICARDA
G5	Synthetic- 10	W5	CIMMYT
G6	Synthetic -13	W6	CIMMYT
G7	Synthetic -38	W7	CIMMYT
G8	Bohouth- 22	W8	Iraq
G9	Ipa -99	W9	Iraq
G10	American	W10	CIMMYT

2.2. Experimental Design

The seeds of ten genotypes were sown in the field area of AL-Graf, which belongs to proviance of Dhi-Qar and far away about 26 km from north of AL-Nasiriyah city in a Randomized Complete Block Design (RCBD) with three replications. In each replication each genotype was grown in a plot of 6 rows with a distance of 20 cm between two rows and the area of each experimental unit was 6 m^2. Crop care was uniformly carried out for the experiment throughout the growing season. The soil was fertilized by the composite fertile (100 kg .ha $^{-1}$) which was added at once through the tillage and Urea was used (46% N) at a rate of 200 kg N ha^{-1} in three equal doses; the first dose was applied through sowing, the second dose was applied after tillering and the third at booting stage.

soil sample was taken from depth 0-20 cm, contained 24% sand, 44% silt, 32% clay, alkaline pH of (7.72), total nitrogen (N) 0.62 %, available (Olsen) phosphorus (P) 0.51%, available potassium cation(K)1.24 % and electrical conductivity 3.81 dS m^{-1}.The physico-chemical properties of the soil is presented in Table 2

Table 2. *The physico-chemical properties of the site soil.*

Ions %			Components %			EC des/m	PH	The type of Soil	traits	The site
P	K	N	clay	silt	sand					
0.51	1.24	0.62	32	44	24	3.81	7.72	Loamy-Clay	Dhi-Qar *	

*these results were taken in Labor of water and soil in Agriculture Directorate of Dhi-Qar

2.3. Statistical Analysis

The analysis of variance (ANOVA) for the data collected for growth, yield and yield components was conducted by Genstat (Ver. 7.0) and correlation coefficients between each pairs of the traits computed by SPSS (Ver. 15.0). Means were separated using Fisher LSD.

3. Results

Results of the analysis variance of the studied traits showed (Tables 3and 4) that there were significant differences ($P<0.05$) between 10 wheat genotypes in almost traits which indicates that there was variation among the genotypes but there was no significant difference in some terms traits such the number of grains per spike and grain yield. This indicates that the studied genotypes are close to each other in terms of these traits.

The tallest wheat genotype was Synthetic 10 (66.7 cm), while the shortest one was Bohouth-22 (51.0 cm) and the mean plant height was (59.2 cm) Mahmood *et al*. [2006] obtained different results for wheat plant height from 62 to 110 cm, while Aliu and Fetahu (2010) realized range 71 to 79 cm for plant height in different bread wheat genotypes.

The highest tillers number was American (8.33), while Sakha-93 and Synthetic 10 gave the lowest tiller number (3.67) without any significant difference between them and the mean tiller number was (4.80). The range of variations for number of spikes per square meter was between 212 and 365, related to cultivars Giza -11 and Egypt, respectively. The increased number of spikes per square meter is a reason for higher total dry matter production. Genotype Giza -11 displayed the highest spike length (10.67 cm) while genotype American showed lower spike length (7.50 cm) and the mean spike length was 8.60 cm under irrigated condition (Table. 3).

The results exhibited that the highest amount of relative number of grains per spike (NGS) was attributed to genotypes American (42.3), Giza -168 (40.3) and Giza -11 (38.3). The minimum amount of NGS was presented in Synthetic 10 and Synthetic 13 (31.0) without any significant difference between them .The mean grain number was 35.1(Table 4).

Genotypes Synthetic 10 and Sakha-93 showed the highest Spikes Weight per stem 1090, 1083 respectively, while Genotypes Giza-168 and Synthetic 38 gave the lowest Spikes Weight per stem 793, 747. The mean Spikes Weight per stem was 926 (Table 4).

The genotype Giza-11 gave the highest 1000-grains weight (46.6 g) while genotype Synthetic 10 exhibited the lower value for this trait (27.0 g). The mean thousand grains weight was 33.8 g (Table 4).

Grain yield ranged among the genotypes from 2.60 to 4.84 $t.ha^{-1}$. The highest grain yield was obtained from Egypt, American and Sakha-93 4.84, 4.66, 4.43 $t.ha^{-1}$ respectively, while genotypes Apa -99 and Synthetic-10 gave the lowest grain yield reached to 2.62, 2.60 $t.ha^{-1}$ respectively. The mean performance of grain yield was 3.58 $t.ha^{-1}$.

Table 3. *Analysis of variance of studied traits in irrigated condition.*

Geno.	PH	NT	NS	SL
Egypt	62.0 ab	4.67 ab	a 365	7.83 b
Sakha-93	57.0 ab	3.67 b	a 345	8.50 b
Giza -11	65.2 a	4.33 b	c 212	a 10.67
Giza -168	51.0 b	4.00 b	abc 293	b 8.17
Synthetic 10	66.7 a	3.67 b	ab 309	ab 9.00
Synthetic 13	55.0 ab	4.00 b	a 338	b 7.83
Synthetic 38	a 64.3	4.33 b	bc 222	b 8.67
Bohouth -22	51.0 b	4.67 ab	abc 287	ab 9.33
Apa -99	57.5 ab	6.33 ab	abc 282	b 8.50
American	ab 62.3	a 8.33	a 352	b 7.50
Mean	59.2	4.80	300	8.60
L.S.D at 0.05	11.90^{*}	3.817^{*}	94.6^{*}	1.916^{*}
C.V%	11.7	46.4	18.4	13

* Significant at 5% level of probability, KEY: PH: plant height (cm), NT: Number of Tillers per plant, NS: Number of Spikes per square meter, SL: Spike Length (cm).

Table 4. *Analysis of variance of studied traits in irrigated condition.*

Geno.	NGS	SW	TGW	GY
Egypt	33.1	ab 1017	39.3 ab	4.84
Sakha-93	34.5	a 1083	36.1 bcd	4.43
Giza -11	38.3	ab 857	a 46.6	3.77
Giza -168	40.3	b 793	bcd 31.7	3.82
Synthetic 10	31.0	a 1090	d 27.0	2.60
Synthetic 13	31.0	ab 833	cd 28.7	2.97
Synthetic 38	33.5	b 747	abc 37.5	2.84
Bohouth -22	34.3	ab 850	bcd 31.7	3.22
Apa -99	32.7	ab 1005	bcd 29.3	2.62
American	42.3	ab 983	bcd 30.6	4.66
Mean	35.1	926	33.8	3.58
L.S.D at 0.05	12.36^{NS}	285.5^{*}	10.39^{*}	2.307^{NS}
C.V%	20.5	18	17.9	37.6

* Significant at 5% level of probability, KEY: NGS: Number of Grains per Spike, SW: Spikes Weight per stem (g), TGW: 1000-grains weight (g), GY grain yield ($t.ha^{-1}$).

Correlation Analysis

Simple correlation between different traits is reflected in Table 5.

In this study grain yield showed positive and significant correlations with its components such as number of spikes per square meter ($r=0.514^{**}$), spikes weight per stem ($r=0.419^{*}$) and it had a highly significant positive correlation with the number of grains per spike ($r=0.647^{**}$) and 1000-grains weight ($r=0.582^{**}$). Therefore, these traits could be used as indirect criteria for the selection for high grain yield under supplemental irrigation condition. With increasing value of these traits, grain yield increases as well. Similar results had been reported by Ali et al. (2008) and Farzaneh (2013). Besides, There was non-significant positive correlation between plant height and grain yield (r= 0.209). Whereas, There were negative correlations indicated among grain yield with tillers per plant (r=-0.004) and Spike Length (r=-0.080). These results did not match the findings of Wang et al. (2001) who observed that genotypes with high spike had high yield in normal condition because of more photosynthetic capacity.

The yield components exhibited varying trends of association among themselves. Plant height revealed non-significant positive correlations to all traits but it showed negative correlation with Number of Tillers per plant (r=-0.074) and Number of Spikes per square meter(r=-0.030). Number of Tillers per plant had a positive non-significant correlation with Number of Grains per Spike (r=0.179) and this finding is in agreement with Khan and Dar (2010). Whereas there was a negative non-significant correlation between Number of Grains per Spike and 1000 grain weight (r=-0.179) .Spike length exhibited positive association with spike weight and 1000 grains weight. El-Ameen et al. (2013) reported strong positive association among spike length, 1000 grain weight and number of grains per spike. There was positive non-significant between Number of Grains per Spike and 1000-grains weight (r=0.258).

Table 5. *Simple Correlation coefficients between studied traits in bread wheat under normal conditions.*

Trait	PH	NT	NS	SL	NGS	SW	TGW	GY
NT	-0.074							
NS	-0.030	0.083						
SL	0.117	-0.085	-0.281					
NGS	0.155	0.179	0.089	-0.185				
SW	0.358	0.140	0.615^{**}	0.170	0.157			
TGW	0.351	-0.179	-0.239	0.303	0.258	-0.054		

Trait	PH	NT	NS	SL	NGS	SW	TGW	GY
GY	0.209	-0.004	0.514**	-0.080	0.647**	0.419*	0.582**	

* and ** Significant at $p < 0.05$ and < 0.01 respectively.
KEY: PH: plant height, NT: Number of Tillers per plant, NS: Number of Spikes per square meter, SL: Spike Length, NGS: Number of Grains per Spike, SW: Spikes Weight per stem, TGW:1000-grains weight , GY: grain yield.

4. Discussion

The grain yield, a major selection criterion, is a complex trait that determined by several physiological, biochemical and metabolic plant processes and its genetics and associations are greatly ambiguous (Ali *et al.*, 2011). The traits such as plant height, number of spikes per square meter, number of grains per spike, spikes weight per stem and 1000-grains weight had positive correlations with grain yield, indicating its importance for selection and higher yields. This findings are in agreement with the findings of Gulmezoglu *et al.* (2010) who revealed that grain yield of wheat depended on plant height, length of spike and spike weight, but disagree with Dagustu (2008) who indicated significant and positive correlations between grain yield and spike length. De-Vita et al. (2007) reported that increasing number of seed per spike effect on the speed of photosynthesis, therefore, the potential produce of photosynthesis material increase and then yield increase.

The results of correlation coefficients, suggest that to increase grain yield under irrigated condition, more focus should be on morphological traits such as number of grains per spike and 1000-grains weight which have a high correlation with grain yield and also should utilize them as primary selection criteria for improving grain yield in wheat in normal well watered conditions. This result was also similar to research of Shamsi *et al.* (2011) who showed that the most important yield component on grain yield was 1000 grain weight. The influence of 1000 grains weight on grain yield seems to cause the fact that grains yield in wheat is frequently the sink limited (Fischer, 1985) and for this reason, the 1000 grains weight has been reported as a promising trait in increasing grain yield in wheat in irrigated conditions. The potential wheat grain yields at filling stage are dependent to limitation of sink and enlarging sink capacity can cause grain yield increasing.

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