Plant Archives Volume 20 No. 1, 2020 pp. 132-136 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EVALUATION OF GROWTH AND PRODUCTIVITY OF BARLEY (*HORDEUM VULGARE* L.) GENOTYPE UNDER SOUTHERN IRAQ CONDITIONS

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Abstract

Three genotypes of Russian barley were assessed entering two sites in Iraq (Nasiriyah, Samawah), it was planted according to Complete Randomized Blocks *Design* with three replicates, during the agricultural season (2016-2017), to evaluate the growth and productivity of three strains of barley (ROSEE/H1, ROSEE/H2 and ROSEE/H3) and selecting the appropriate structure for each region depending on the study of grain yield and some traits such as plant height, leaf area, spike length, tillers number\m^2, spike number\m^2, grain number\spike, 1000 grains weight and protein percent. The results showed highly significant differences ($P<0.01$) on tillers number\m^2 in both sites, while Nasiriyah site distinguished from Samawah site of with differences ranging from high to significant ($P<0.05$) in the rest of the traits except the number of grains in the spike was non-significant, Samawah site was observed to have highly significant differences in grain yield compared to Nasiriyah site where significant differences occurred, the analysis of covariance showed highly significant differences in the interaction of sites with structures in leaf areas and yield, the ROSEE/H3 strain yielded the highest grain yield (2.63 t/h) at Nasiriyah site, while ROSEE/H2) strain was characterized by the highest yield (4.18 t/h) at Samawah site. In the study of the correlation coefficient, it was possible to improve the grain yield by the height plant improving, the number of grains in the spike and the number of tillers/ m^2 in both sites.

Key words: barley, grain yield, covariance, correlation, environmental sites.

Introduction

Hordeum vulgare L. is one of the world's major cereal crops, ranking fourth after maize (*Zea mays*), rice (*Oryza sativa*) and wheat (*Triticum* spp.) in terms of total production (Schulte *et al*., 2009). Barley is an important source of animal feed and feed mixtures, as well as in the fermentation industries. It spreads throughout the world, especially in the arid and semi-arid regions of North Africa, the Middle East and the Andean countries (Ben Ghanem *et al*., 2018), being adaptable in a wide range of environmental conditions with stress conditions at the early flowering stage, seed growth and maturity occur in an ideal time period (Gürel *et al*., 2016). Hailu *et al*., (2015) tested sixty-six genetically modified barley plants in different ecological regions in Ethiopia, the average grain yield of 36.13 tons / ha, the highest among the different sites. Ten varieties of barley (Guta, Harbu, Abdane, Dimtu, Shage, HB-1307, Biftu, Dafo, Dinsho and Ardu) were study compared to a local variety in two different locations in Ethiopia, the analysis of variance showed significant differences for the number of days to maturity, plant height, spike length and yield at both sites (Bakana *et al*., 2018). Al-Abdallat *et al*., (2017) evaluated 150 species of Jordanian barley in order to identify the Jordanian genotypes of barley distinguished in drought conditions, Three high yield types were identified with G69, G144 and G123 scoring the highest yield and highest acclimatization in different environments of Jordan. The objective of the research is to test the genotypes introduced in Iraq under different regions, identify traits that contribute to increased grain yield, to give a recommendation for each genotype when submitted for registration and accreditation.

Materials and Methods

Field experiment was carried out in winter season 2017-2016, in two locations, the first in of Shatrah city is

Table 1: Some physical and chemical properties of soil before planting in two locations.

properties	unit	Location	
		Samawah	Dhi-Qar
Electrical Conductivity (EC)	ds.m^{-1}	6.4	5.1
pH	Mg. kg^{-1}	7.6	7.1
Available nitrogen		114.8	123.3
Available phosphorus		2.4	3.1
Available potassium		38.2	29.5
Soil types			
Mud soil	%	26	32
Sandy soil		27	60
Granular soil		13	41
Soil Texture	Sand mixed		

located 54 km north of Nasiriyah city in Dhi-Qar province, the second in tAl-Bandar station, 8 km northeast of Samawah city in Muthanna province, to test three genotypes of barley crop, input from Russia, under the southern region of Iraq conditions (Nasiriyah and Samawah). The genotypes studied (GZMEB, GZMEMB, Cos-Al uetmrt pc 2 and samir for comparison), symbols took (ROSEE / H1, ROSEE / H2, ROSEE / H3, M-H), respectively, according to Randomized Complete Block Design with three replicates, Each unit included a pilot on 8 lines, distance between lines 20 cm, 2 m length of line. The field was prepared by plowing, harrowing and leveling. A sample of 20 cm depth was taken to determine the physical and chemical soil properties shown in table 1.

180 kg / ha^{-1} urea fertilizer (46% N) was twice added at planting and 30 days after planting, 60 kg /ha^{-1} potassium fertilizer (42% K), phosphate fertilizer when plowing at 80 kg /ha^{-1} in the sites. Measure for 10 plants at randomly from the middle lines of each genotype, Excluded peripheral plants. Traits studied were height plant (cm), leaf area (cm^2) according to equation (leaf science area = leaf length × leaf width from the wider area × 0.95), spike length of cm, 1000 grains weight (g), spike number/ m^2, grains spike number, tillers number / m^2, grains yield (ton /ha^{-1}) which was calculated in a half - metric and random way of each experimental unit and protein percentage in grains % by a protein-moisture measurement device (Cropcan, L.B., 2000). Data were analyzed in the statistical Genestat program, the LSD test was used at a probability level of 0.05 to compare averages.

Results and Discussions

Genotypes Performance

• Analysis of variance and covariance: The analysis of variance showed the similarity of both sites (Nasiriyah and Samawah) with high significance differences ($P<0.01$) for the tillers number/ m^2, while they differed with other studied traits, the site of Nasiriyah was characterized by significant differences in height plant, leaf area, spike length and spike number/m^2, while the Samawah site was distinguished only in grains yield (ton / ha^{-1}) (Tables 2 and 3), a significant difference ($P<0.05$) was observed in 1000 grains weight, protein ratio and grain yield at Nasiriyah site, compared to the spike length, spike number/ m^2 and the grains number/ spike in Samawah site. The observed variance between the varieties of the studied traits may be due to the genetic variation between the verities.

Table 4, also shows that the site had significant effects on the properties (leaf area, spike length, spike number / m^2 and yield), while the effect was significant on height plant, these effects were similar to the selected varieties, no significant effect was observed on the tillers number/ m^2, grains number/spike, 1000 grains weight and protein percentage. Due to the interaction of the site with genotype, a highly significant reaction was observed in leaf area and yield, while no interaction was observed in the other studied traits (Table 3).

• Averages comparison in the study sites: The results showed that the highest of plant height was obtained in the genotype (ROSEE / H3) 95.33 cm average, followed by ROSEE / H2, ROSEE / H1 and M-H (87.33, 85.66 and 76.66) cm respectively in Nasiriyah, The results were identical with the Samawah area where the genotype (ROSEE / H3) was 84.5 cm long, followed by ROSEE /

Table 2: Analysis of variation and CV (%) of genotypes of grain yield and associated traits in Nasiriyah region.

GY (ton/ha)	P %	1000G	GN/S	SN/m^2	TN	SL	LA	PH	DF	Source of Variation
0.071	0.812	27.01	49.75	15.25	5.08	0.363	4.68	6.25	2	Rep
0.267 *	2.55*	79.07*	47.86NS	7977.44**	11.88**	4.72**	151.16**	175.86**	3	Variety
0.035	0.309	11.96	65.19	337.69	0.972	0.24	6.38	14.69	6	Error
									11	Total
0.377	1.11	6.91	16.13	36.71	1.97	0.996	5.04	7.65		$LSD_{0.05}$
8.19	4.10	9.39	18.24	7.87	8.82	5.75	10.75	4.44		CV%

Significant differences for α = 0.05; **Significant differences for α = 0.01PH= Plant Height, LA=leaf area, SL= Spike length, TN= Tillers number/m^2, SN/m2= Spikes number/m^2, GN/S= Grain number/Spike, 1000G= 1000 grain weight, P%= Protein percentage; GY=Grain yield ton/ha.

H2, ROSEE / H1 and M-H with shorter lengths (Table 5).

These results were consistent with spike length readings (ROSEE / H3) with 10.1 cm compared to ROSEE / H2, ROSEE / H1, while the (M-H) genotype was shortest in the spike length, it was 7.06 cm in Nasiriyah, The spike length is 8.06, 8, 7.83, 5.93 cm for ROSEE / H1, ROSEE / H2, ROSEE / H3 and M-H respectively in Samawah. The ROSEE / H2 genotype was characterized by the highest number of grains with 49.33 followed by ROSEE / H1 and M-H with values of 44.66 and 43.33 respectively in Nasiriyah, while (ROSEE / H3) genotype was lowest 39.66, the results differed from Samawa, with M-H with 53.46, followed by ROSEE / H2 (40.53), ROSEE / H3 (ROSEE / H1) and 37.96 (37.8).

As for grain yield, the performance of compositions between the two sites varied, to record a production of 2.63 tons / h of (ROSEE / H3) and 1.99 tons / h for the

Table 3: Analysis of variation and CV (%) of genotypes of grain yield and associated traits in Samawah region.

GY (ton/ha)	P %	1000G	GN/S	SN/m²	TN	SL	LA	PH	DF	Source of Variation
0.071	0.415	96.90	27.12	3505.7	0.583	0.943	33.51	178.46	2	Rep
4.24**	0.794 NS	75.39 NS	166.7*	5810.7*	5.63**	3.12 *	2.93 NS	54.78 NS	3	Variety
0.298	0.873	52.84	24.48	925.7	0.472	0.452	1.29	60.39	6	Error
									11	Total
1.09	1.86	14.52	9.88	60.78	1.37	1.34	2.26	15.52		$LSD_{0.05}$
17.37	6.86	20.54	11.65	10.59	6.49	9.01	7.11	9.85		CV%

Significant differences for α = 0.05; **Significant differences for α = 0.01PH= Plant Height, LA=leaf area, SL= Spike length, TN= Tillers number/m², SN/m2= Spikes number/m², GN/S= Grain number/Spike, 1000G= 1000 grain weight, P%= Protein percentage; GY=Grain yield ton/ha.

Table 4: Analysis of the covariance of grain yield and associated traits at sites (Nasiriyah and Samawah).

GY (ton/ha)	P %	1000G	GN/S	SN/m²	TN	SL	LA	PH	DF	Source of Variation
0.10	1.195	102.25	6.66	1935.5	4.5	1.08	8.07	105.23	2	**REP**
4.21**	0.026	12.49	19.62	17334.3**	2.04	8.76**	339.30**	327.82*	1	**LOC**
2.57 **	2.85**	101.69	126.97	12034.7**	16.81**	6.98**	77.68**	207.48*	3	**Var**
1.93 **	0.501	52.77	87.65	1753.4	0.708	0.86	76.40**	23.15	3	**LOC*var**
0.148	0.511	30.87	48.46	767.9	0.785	0.332	7.59	43.53	14	**Error**
0.477	0.885	6.88	8.62	34.31	1.09	0.713	3.41	8.17		**$LSD_{0.05}$**
14.14	5.26	15.38	16.06	10.64	8.15	7.14	13.97	7.99		**CV%**

*Significant differences for α = 0.05; **Significant differences for α = 0.01PH= Plant Height, LA=Leaf area, SL= Spike length, TN= Tillers number/m², SN/m2= Spikes number/m², GN/S= Grain number/Spike, 1000G= 1000 grain weight, P%= Protein percentage; GY=Grain yield ton/ha.

Table 5: Comparison of grain yield and other studied barley traits at sites (Nasiriyah and Samawah).

Location Nasiriyah									Source of Variation
GY	P	1000G	GN/S	SN/m²	TN	SL	LA	PH	
2.12bc	13.76a	38.04a	43. 33a	177.33c	11.66 b	8.53b	16.9 c	85.66b	ROSEE/H1
2.47ba	14.26a	29.35b	49.33 a	225.67b	13.66 a	8.96 b	21.30 bc	87.33b	ROSEE/H2
2.63a	13.96a	38.93a	39.66a	302.33a	10.33cb	10.1a	33.58a	95.33a	ROSEE/H3
1.99c	12.2b	40.98a	44.66a	228.67b	9c	7.06c	22.04b	76.66 c	M-H
8.19	4.10	9.39	18.24	7.87	8.82	5.75	10.75	4.44	CV%
0.377	1.11	6.91	16.13	36.71	1.97	0.996	5.04	7.65	$LSD_{0.05}$
Location Samawah									**Source of Variation**
GY	**P**	**1000G**	**GN/S**	**SN/m²**	**TN**	**SL**	**LA**	**PH**	
1.46b	14.1a	34.86a	37.80b	277.3b	11ab	8.06a	15.6ab	76.40a	ROSEE/H1
4.18a	13.63a	34.33a	40.53b	243.3b	12.33a	8a	15.0b	79.70a	ROSEE/H2
3.21a	13.83a	30.13a	37.96b	348.3a	9.66bc	7.83a	15.8ab	84.50a	ROSEE/H3
3.71a	12.9a	42.2a	53.46a	280b	9.33c	5.93b	17.36a	74.83a	M-H
17.37	6.86	20.54	11.65	10.59	6.49	9.01	7.11	9.85	CV%
1.09	1.86	14.52	9.88	60.78	1.37	1.34	2.26	15.52	$LSD_{0.05}$

PH= Plant Height, LA=Leaf area, SL= Spike length, TN= Tillers number/m², SN/m2= Spikes number/m², GN/S= Grain number/Spike, 1000G= 1000 grain weight, P%= Protein percentage; GY=Grain yield ton/ha.

Table 6: Correlation between the studied traits at Nasiriyah site.

Traits	PH	LA	SL	TN	SN	GN	1000G	P %	GY
PH	1								
LA	0.573	1							
SL	.824**0	0.649*	1						
TN	0.364	-0.288	0.188	1					
SN	0.520	0.942**	0.576	-0.279	1				
GN	-0.152	-0.373	-0.313	0.428	-0.193	1			
1000G	-0.109	0.192	-0.319	-0.434	0.105	0.046	1		
P%	.683*0	0.048	0.489	.721**0	0.070	0.185	-0.339	1	
GY	.856**0	.600*0	.689*0	0.444	.628*0	0.167	-0.090	.688*0	1
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

* Significant differences for α = 0.05; **Significant differences for α = 0.01,PH= Plant Height, LA=Leaf area, SL= Spike length, TN= Tillers number/m^2, SN/m2= Spikes number/ m^2, GN/S= Grain number/Spike, 1000G= 1000 grain weight, P%= Protein percentage; GY=Grain yield ton/ha.

Table 7: The correlation between the studied traits in Samawah site.

Traits	PH	LA	SL	TN	SN	GN	1000G	P %	GY
PH	1								
LA	-0.577*	1							
SL	0.035	-0.372	1						
TN	0.030	-0.254	0.380	1					
SN	0.309	-0.400	0.163	-0.493	1				
GN	0.060	-0.003	-0.79**	-0.383	0.023	1			
1000G	0.204	-0.082	-0.75**	0.025	-0.229	.701*0	1		
P%	-0.411	-0.057	0.476	0.202	0.022	-0.580*	-0.406	1	
GY	0.275	-0.075	-0.277	0.070	-0.062	0.446	0.116	-0.440	1
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

* Significant differences for α = 0.05; **Significant differences for α = 0.01,PH= Plant Height, LA=Leaf area, SL= Spike length, TN= Tillers number/m^2, SN/m2= Spikes number/ m^2, GN/S= Grain number/Spike, 1000G= 1000 grain weight, P%= Protein percentage; GY=Grain yield ton/ha.

type (M-H) at Nasiriyah site, (ROSEE / H2) showed the highest yield of 4.18 t / h while the ROSEE / H1 had the lowest grain yield of 1.46 t / h (Table 5).

The genotypes of the barley crop used in this study are different genotypes, which have been reflected in the response of grain yield status and related traits, the variation in studied traits may be due in large part to the genotype, However, it was noted that the variation of the compositions in the studied characteristics of site comparison was due to environmental factors (Bakana *et al*., 2018). Tahir *et al*., (2008) found that plant height is a genetic characteristic of what is a factor controlled by the environment, yet the choice of the right species that can withstand environmental influences.

Study of correlations in the studied sites

• The correlation between traits in Nasiriyah site: It was observed by correlations between the grain yield and the studied traits at Nasiriyah site, that there is a positive correlation highly significant with plant height (r = 0.856), As the plant height enables it to participate in aerobic biomass, allowing for a guaranteed and stable yield in semi-arid areas (Benbelkacem and Kellou, 2000). The correlation was significantly positive between grain yield characteristics, leaf size characteristics, spike length, number of ears / m 2 and protein ratio, positive not significant with the number of grains / spike, as Garcia *et al*., (1991) found that the differences in grain yield between the genotypes of the barley crop were related to the yield of spike number/ m^2 and the number of grains in the spike, while the correlation was insignificant between the yield and the 1000 grains weight (Table 6.).

• The correlation between traits in Samawah site: Table 7, shows the correlation between the grain yield characteristics and the studied traits in the Samawah site, the relationship of the crop was associated with a positive correlation not significant with the characteristics of plant height, tillers number/ m^2, grains number / spike and the 1000 grains weight**.**

The rate of supply of dry matter of leaves and stems to grains increased during the time unit**,** which increases of grain filling then 1000 grains weight increases (Kayal *et al*., 2004). Hadjichristodoulou, (1990) compared the yield with 1000 grains weight, while the negative correlation was insignificant with the characteristics of the paper area, the length of the spike, spike number / m^2 and protein percentage.

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