Growth, Yield and yield component Response of two Barley (*Hordeum vulgare L.*) Genotypes to Different Levels of NPK Fertilizer under Sulaimani Conditions

Shara Jalal Hama[1], Dayan Majid Ibrahem[2], Kazhal Rashed Ahmad[3]and Shangin Hama Salh Nadir[4]
[1] Ph. D in Industrial Crops, [2] MSc. in Crop Production, MSc. in Crop Production and [3] MSc. in Weed Control
Department of Field Crops Sciences, College of Agricultural Sciences, University of Sulaimani, Iraq,
(E-mail: Shara.hama@univsul.edu.iq)

ABSTRACT

This investigation was conducted during the winter seasons of 2016-2017 at Bakrajo Agriculture Research Station, College of Agricultural sciences, University of Sulaimani, using split plot design the main plots conducted in Randomized Completely Block Design (RCBD) with three replicates to study the effect of three levels of NPK fertilizer on the growth, yield and yield component of barley varieties. The two genotypes [ATACO/BERMEJO/HIGO/3/CLN-B/80.5138//… CBSS99M00320T-L-2M-1Y-1M-0Y (ATACO...) and- ALPHA-BAR/DURRA//CORACLE/3/ALELI/4/… CBSS99Y00032S-11Y-2M-2Y-1M-0Y (ALPHA…)] were implemented in the main plots, three NPK fertilizer levels (0, 150 and 300) kg / ha from NPK fertilizer complex source (15-15-15) were implemented in the sub plot. Comparisons between means were carried out by the lease significant difference (L.S.D) at 5 % level of significance. The results of this investigation confirm that (ATACO...) produced the best values for most characters, and the application 300 Kg NPK /ha was found to be the best level to this crop. The characters grain yield recorded highly significant and positive correlation with plant height ,spike length ,average spike weight ,number of grains /spike ,grain weight /spike,1000 grain weight and biological yield with(0.939, 0.965, 0.905,0.922, 0.883,0.829 and 0.977) respectively .

Key words: Barley genotypes, NPK fertilization, Growth, yield and yield component, correlation and path analysis.

إستجابة النمو و الحاصل ومكوناته لصنفين من الشعير و ثلاثة مستويات من السماد المركب تحت ظروف منطقة السليمانية

شارا جلال حمه[1]، دايةن ماجد ابراهيم[2] كه ذال رشيد احمد[3] و شه نكين حمة صالح نادر[4]

[1] دكتوراه في المحاصيل الصناعية، [2] ماجستير في الانتاج المحاصيل الحقلية، [3] ماجستير في الانتاج المحاصيل الحقلية و ماجستير في المقاومة الادغال

قسم العلوم المحاصيل الحقلية، كلية العلوم الزراعية، جامعة السليمانية/ العراق

(E-mail: shara. hama@univsul.edu.iq)

الخلاصة:

نفذ البحث في حقل تجارب كلية العلوم الزراعية /جامعة السليمانية في بكرجو, خلال موسم النمو 2016-2017. بهدف دراسة تأثير ثلاث مستويات من السماد المركب(NPK)على نمو و حاصل و مكوناته لصنفين من الشعير .تم تطبيق هذه التجربة بأستخدام نظام الالواح المنشقة في تصميم القطلعات كاملة التعشية (CRBD) و بثلاث مكررات .شملت عامل الأصناف [ATACO/BERMEJO/HIGO/3/CLN-B/80.5138//… CBSS99M00320T-L-2M-1Y-1M-0Y (ATACO...) and- ALPHA-BAR/DURRA//CORACLE/3/ALELI/4/… CBSS99Y00032S-11Y-2M-2Y-1M-0Y (ALPHA…)]في الألواح الرئيسية (RCBD) أما عامل مستويات التسميد المركب (0,150,300 كغم/هكتار) فوضعت كألواح ثانوية . تم إجراء المقارنات بين متوسطات بأستخدام أقل فرق معنوي (L.S.D) عند مستوى 5% . بيين النتائج بأن (Genotype 1) أثر معنوياً على معظم المعيير النمو و الأنتاج , و مستوى التسميد (300 كغم /هكتار) أثر معنوياً على كافة معايير النمو و الأنتاج . سجلت صفة حاصل الحبوب إرتباط عالي المعنوية و موجب مع صفات إرتفاع النبات و طول السنبلة و معدل وزن السنبلة و عدد حبوب/سنبلة و وزن الحبوب /سنبلة و وزن الف حبة و الوزن البايولوجي ب (0.939 ,0.965 , 0.905, 0.922 ,0.883,0.829,0.977) على التوالي .

TNTRODUCTION

Barley (*Hordeum vulgare* L.) is a common cereal used as food and as a feed crop. It is one of the main crops of old world agriculture. Remains of barley seeds found at archeological sites in the Fertile Crescent indicate that about 10000 years ago the crop was domesticated there from its wild prorated *Hordeum spontaneous* **[1].** Barley is grown in nearly all the cultivated areas of the world. In Kurdistan region, it is an important cereal crop, ranked second after wheat both in acreage and in production. It ranks fifth among crops in grain production in the world after maize, wheat, rice and soybean **[2, 3, 4 and 5**]. In 2013-2014, the total production of barley in the world was 140.10 million metric tons. The yield of barley in the farmer's field is much lower than that in the research farm **[6]**. The yield and yield component of barley seed is known to be influenced by several factors such as variety, time of sowing, seed rate, fertilizer doses, water and nutrient management, harvesting time and other agronomic practices. Variety has also played an important role in producing better yield and seed quality of barley. Varieties, however, respond differently to nutrient with respect to their genetic make up and physiological life processes **[7]**. Fertilizers play an important role in increasing yield and improving the quality of crops. The combined application of N, P and K has proved to be more effective in increasing yield of barley as compared to sole application of either N or P or K **[8]**. Increased grain yield of wheat by fertilizer application [9] .Similarly, many other studies indicated that the application of NP fertilizer significantly increased the yield of different crops compared to control treatment **[10, 11]**. Ahmad and Rashid **[12]** reported that the application of recommended level of NPK significantly increased the yield of wheat by 224% over control.

The present studies were executed to determine astute NPK requirements for two barley genotypes, grown under agro ecological conditions of Sulaimani region.

MATERIALS AND METHODS:

Studies were carried out during the winter seasons of 2016-2017, in Experimental Farm of the faculty of Agriculture, University of Sulaimani at Bakrajo. The study area is located in the southwest of Sulaimani city (Latitude: 35º 33' N; Longitude 45º 27' E at altitude of approximately 830 m). The experimental area plots were ploughed twice, harrowed and well leveled. A brief account of some physical and chemical properties of the experimental soil is given in Table (1). Moreover, the temperature and monthly rainfall precipitation at Bakrajo is shown in Table (2). The experiment was laid out in a randomized complete block design with split plot arrangement. The two genotypes [ATACO/BERMEJO/HIGO/3/CLN-B/80.5138//… CBSS99M00320T-L-2M-1Y-1M-0Y (ATACO...) and- ALPHA-BAR/DURRA//CORACLE/3/ALELI/4/… CBSS99Y00032S-11Y-2M-2Y-1M-0Y (ALPHA…)] were implemented in the main plots with 3 replications, different levels of NPK fertilizer levels (0,150 and 300 kg /ha) from NPK fertilizer complex sources (15-15-15) were implemented in the sub plot. Each main plot consisted of three subplots with 4 m width by 4 m length, each subplot size was 1*4 m and 0.25 m between rows .Seeds cultivated at rate 200 kg /ha**[13]** on February 6, 2017 . Whole of NPK fertilizer complex was applied at sowing time. All other agronomic practices were kept normal for all the treatments. Statistical analyses were conducted using JMP, version 7 [14]. The LSD test was done to find the significant differences between treatments at 5% probability level. The mature plants were harvested on 25 June 2017 to estimate biological yield, seed yield and yield components.

Studied Characteristics:

The studied characters were Plant height (cm), Number of tiller per plant , Number of leaves per plant, Dry matter (g/plant), Spick length (cm), Average spick weight (g), Number of grain per spick , grain weight per spick (g),

1000 seed weight (g), Harvest Index, Biological yield (kg /ha), Seed yield (kg /ha).

Correlation Analysis:

The correlation coefficient was conducted to determine the degree of association of characters with yield and also among themselves. Phenotypic correlations were computed between characters in the growing season using the formula given by Singh and Chaudhary (1985) **[15]**.

Table 1: Physical and chemical properties of the studied soil:

Soil properties	***Values***
Soil texture (P.S.D)	Silty Clay
Sand ($g.kg^{-1}$)	48.5
Silt ($g.kg^{-1}$)	449.8
Clay ($g.kg^{-1}$)	501.7
E.C. ($dS.m^{-1}$)	0.33
pH	7.44
O.M. ($g.kg^{-1}$)	21.02
CaCO3 ($g.kg^{-1}$)	337.6
Total N (ppm)	19.93
K+ ($g.kg^{-1}$)	2.67
Na+ (ppm)	27.66
Ca++ ($Meq.l^{-1}$)	2.66
Mg++ ($Meq.l^{-1}$)	1.98

Table 2: Average air temperature and rainfall during the growing seasons of 2016-2017 at Bakrajo Location

Months	***Average Air Temperature (°C)***		***Rainfall (mm)***
	Max.	***Min.***	
November	21.3	7.6	44.5
December	11.1	3.0	158.0
January	11.10	1.46	59.2
February	13.02	0.26	96.5
March	17.73	7.45	111.5
April	23.89	10.97	54.5
May	31.63	13.48	27.7
Total			551.9

RESULTS AND DISCUSSION:

Data in Table (3) conform that the differences among genotypes were significant for the characters plant height cm, number of leaves per plant, Average spick weight g, 1000 seed weight g and grain yield kg /ha, while it was non-significant for the rest. It was observed that the genotype (ATACO...) recorded maximum values with 68.319 cm, 29.744, 1.737 g, 37.299g and 5898.667for the characters plant high, number of leaves per plant, average spick weight ,1000 seed weight g and seed yield t/ha respectively. The genotype (ALPHA…) produced minimum values for almost all of the characters excepted dry matter weight, recording 63.094, 22.978, 1.292, 33.436 and 4553.000 for the characters plant height cm, number of leaves per plant, average spick weight g, 1000 seed weight g and grain yield kg /ha respectively. Different genotypes of barley affect the quality and quantity of barley growth, yield and yield component production which was typically

characteristic of species, variety and their genetic buildup of the different genotypes under the study and their variation may be due to the potential among genotypes. This finding was closely related with Banna, and Ryan *et al.* who stated that there were significant differences among barley genotypes in their grain weight and other characters **[16, 17** and **18]**.

The effect of NPK fertilizer application was found to be significant for all characters except number of tillers per plant, number of leaves per plant, dry matter weight, 1000 grain weight and harvest index (Table 4). The application of 300 Kg/ha recorded the best values for all characters, recording 71.248, 6.673, 1.653, 35.133, 1.325, 20480.00 and6338.667 for the characters plant high, spick length, average spick weight, number of grain per spick, grain weight per spick, biological yield and seed yield respectively, while the control treatment recorded the lowest values for all the character with 62.360, 5.600, 1.365, 28.983, 1.023, 14464.167 and 4288.167 for plant high, spick length, average spick weight, number of grain per spick, grain weight per spick, biological yield and seed yield respectively. Genotypes, however, respond differently to nutrient with respect to their genetic make up and physiological life processes **[7]** .Fertilizers play a pivotal role in increasing yield and improving the quality of crops. Ali et al. **[19]** reported that P application along with N resulted in a significant increase in number of tillers, plant height, and number of grains per spike, 1000-grain weight and grain yield. The increased in grain yield with higher NPK levels was also reported by Hayee et al., Kausar et al., Gwal et al., Maqsood et al. and Ali et al. [**20,21,22,23,24]**. Higher grain weight (g) was in the fertilizer treated plants than in the control. Increased grain weight (g) was produced by increasing fertilizer levels. Rahman and khaleque **[25, 26]** reported similar findings in wheat.

Data in table (5) confirms that there were no significant interaction between genotypes and NPK fertilizer application levels on all yields and yield components characters.

Data in table (6) illustrate the simple correlation coefficient among characters. There are highly significant and positive correlations between plant height, spike length, average of spike, number of grain spike^{-1}, biological yield and grain yield recording (0.907,0.812,0.905,0.962 and 0.939) respectively . Spike length correlated high significantly and positively with biological yield and grain yield with (0.936 and 0.965) respectively.
Average spike weight recorded high significant and positive correlation with number of grain spike^{-1}, grain weight spike^{-1}, 1000 grain weight , biological yield and seed yield with (0.957,0.997,0.953and 0.872) respectively .Highly significant and positive correlation were represented between number of grain spike $^{-1}$,grain weight spike $^{-1}$, 1000 grain weight , biological yield and grain yield recording (0.949,0.963, 0.934, and 0.922) respectively .
Highly significant and positive correlations were recorded between grain weights spike -1 , 1000 grain weight ,biological yield and seed yield with (0.961,0.843 and 0.883) respectively .Highly significant and positive correlation represent between 1000 grain weight and biological yield and seed yield with (0.811 and 0.829) respectively . Biological yield record highly significant and positive correlation with grain yield recording (0.977). There was positive correlation between kernel yield and each of spike number/m2, number of kernels/spike, while negative and significant correlation between the number of spike/m2 and kernel weight was recorded by [27]. Grain yield showed positive correlation with above-ground biomass, number of spikes/m2 and no. of grains/spike.. The character biological yield recorded high significant and positive correlation with harvest index and grain yield/plant showing 0.695 and 0.580 respectively, the character biological weight correlated high significantly and positively with all characters , similar results recorded previously by [28, 29].

Table 3: The averages of barley genotypes for the studied characters.

Genotypes	*Pant height (cm)*	*No .of tiller/Plant*	*No. of leaves/plant*	*Dry matter (g/ plant)*	*Spike length (cm)*	*Average spike weight (g)*	*No. of Grain/ pike*	*Grains Weight g/spike*	*1000 Grain weight (g)*	*HI*	*Biological yield (Kg/ha)*	*Grain yield (Kg/ha)*
ATACO …	*68.319*	*6.000*	*29.744*	*6.041*	*6.271*	*1.737*	*35.578*	*1.447*	*37.299*	*0.312*	*19073.33*	*5898.667*
ALPHA…	*63.094*	*4.222*	*22.978*	*6.360*	*5.878*	*1.292*	*28.078*	*0.900*	*33.436*	*0.297*	*15575.11*	*4553.000*
L.S.D (P≤0.05)	*3.296*	*N.S*	*2.050*	*N.S*	*N.S*	*0.360*	*N.S*	*N.S*	*1.559*	*N.S*	*N.S*	*904.834*

Table 4: NPK-fertilizer levels effect on the studied characters.

NPK Fertilizer Levels Kg /ha	*Pant height (cm)*	*No .of tillers/Plant*	*No. of leaves/plant*	*Dry matter (g/ plant)*	*Spike length (cm)*	*Average spike weight (g)*	*No. of Grain/ spike*	*Grains Weight g/spike*	*1000 Grain weight (g)*	*HI*	*Biological yield (Kg/ha)*	*Grain yield (Kg/ha)*
0	*62.360*	*4.750*	*29.250*	*5.797*	*5.600*	*1.365*	*28.983*	*1.023*	*34.695*	*0.298*	*14464.167*	*4288.167*
150	*63.512*	*5.667*	*25.800*	*6.485*	*5.950*	*1.525*	*31.367*	*1.172*	*35.100*	*0.303*	*17028.500*	*5050.667*
300	*71.284*	*4.917*	*24.033*	*6.320*	*6.673*	*1.653*	*35.133*	*1.325*	*36.307*	*0.312*	*20480.000*	*6338.667*
L.S.D (P≤0.05)	*5.992*	*N.S*	*N.S*	*N.S*	*0.486*	*0.192*	*4.269*	*0.231*	*N.S*	*N.S*	*2306.673*	*1085.414*

Table 5: The interaction effects of barley genotypes and NPK-fertilizer levels on the studied characters.

Genotypes	*NPK Fertilizer Levels Kg /ha*	*Pant height (cm)*	*No .of tillers/Plant*	*No. of leaves/plant*	*Dry matter g/ plant*	*Spike length (cm)*	*Average spike weight (g)*	*No. of Grain/spike*	*Grains Weight g/spike*	*1000 Grain weight (g)*	*HI*	*Biological yield (Kg/ha)*	*Grain yield (Kg/ha)*
ATACO …	*0*	65.090	6.000	28.167	5.427	5.633	1.510	33.000	1.200	36.670	0.293	16152.000	4682.667
	150	66.367	6.000	32.000	6.113	6.100	1.783	34.967	1.490	36.827	0.307	18733.333	5680.000
	300	73.500	6.000	29.067	6.583	7.080	1.917	38.767	1.650	38.400	0.337	22334.667	7333.333
ALPHA …	*0*	59.630	3.500	30.333	6.167	5.567	1.220	24.967	0.847	32.720	0.303	12776.333	3893.667
	150	60.657	5.333	19.600	6.857	5.800	1.267	27.767	0.853	33.373	0.300	15323.667	4421.333
	300	68.997	3.833	19.000	6.057	6.267	1.390	31.500	1.000	34.213	0.287	18625.333	5344.000
L.S.D (P≤0.05)		N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Table 6: Correlation analysis among the studied characters.

Characters	*Pant height (cm)*	*No. of tillers/ Plant*	*No. of leaves/ plant*	*Dry matter (g/ plant*	*Spike length (cm)*	*Average spike weight (g)*	*No. of Grain / spike*	*Grains weight(g /spike*	*1000 Grain weight (g)*	*HI*	*Biological yield (Kg/ha)*	*Grain yield (Kg/ ha)*
Pant height (cm)	**1.000**											
No. of tillers/ Plant	0.382 n.s	**1.000**										
No. of leaves/ plant	0.065 n.s	0.325 n.s	**1.000**									
Dry matter (g/ plant	-0.014 n.s	-0.015 n.s	-0.317 n.s	**1.000**								
Spike length (cm)	**0.907****	0.320 n.s	0.031 n.s	0.387 n.s	**1.000**							
Average spike weight (g)	**0.812****	0.720 n.s	0.506 n.s	-0.001 n.s	0.767 n.s	**1.000**						
No. of Grain/ spike	**0.905****	0.719 n.s	0.296 n.s	-0.075 n.s	0.795 n.s	**0.957****	**1.000**					
Grains weight(g /spike	0.793 n.s	0.723 n.s	0.556 n.s	-0.049 n.s	0.736 n.s	**0.997****	**0.949****	**1.000**				
1000 Grain weight (g	0.790 n.s	0.805	0.478 n.s	-0.186 n.s	0.661 n.s	**0.953****	**0.963****	**0.961****	**1.000**			
HI	0.521 n.s	0.444 n.s	0.478 n.s	0.483 n.s	0.744 n.s	0.713 n.s	0.587 n.s	0.712 n.s	0.613 n.s	**1.000**		
Biological yield (Kg/ha)	**0.962****	0.518 n.s	0.057 n.s	0.166 n.s	**0.936****	**0.872****	**0.934****	**0.843****	**0.811***	0.598 n.s	**1.000**	
Grain yield (Kg/ha)	**0.939*****	0.516 n.s	0.192 n.s	0.230 n.s	**0.965****	**0.905****	**0.922****	**0.883****	**0.829*****	0.749 n.s	**0.977****	**1.000**

Values in bold are different from 0 with a significance level alpha=0.05

CONCLUSION

Both the varieties differed significantly for their growth, yield and yield components at all different levels of fertilizer application. An improved (ATACO…) responded more efficiently to fertilizer than (ALPHA…). Thus, it can be concluded that the farmers can adopt improved (ATACO…) of barley with appropriate dose of 300 kg ha^{-1} NPK fertilizer application to obtain an economical yield under rainfed condition.

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