University of Benghazi
Faculty of Education Al marj
Global Libyan Journal

جامعة بنغازي
كلية التربية المرج
المجلة الليبية العالمية

العدد الخامس والعشرون – 02 / أغسطس (2017)

DIFFERENCES AMONG BARLEY CULTIVARS IN POTASSIUM UPTAKE AND UTILIZATION

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الملخص:

أقيمت تجربة أصص لدراسة الاختلافات الوراثية في امتصاص البوتاسيوم وكفاءة الانتفاع منه في أصناف من الشعير و ذلك بإضافة البوتاسيوم عند كل من مستويي الكفاية و النقص (0 و 50 جزء من المليون من البوتاسيوم على التوالي). التداخل بين مستويات البوتاسيوم و اختلافات الأصناف كان معنوياً لكل الصفات المدروسة تقريباً. تم ملاحظة فروق أساسية بين الأصناف في تراكم وزن كل من المجموع الخضري الجاف، المجموع الجذري الجاف، الكتلة الحيوية الكلية و النقص النسبي في الكتلة الحيوية الخضرية و ذلك بسبب إجهاد نقص البوتاسيوم. وجد أن عامل إجهاد البوتاسيوم ترواح بين 9 إلى 41% والذي يشكل أكثر من 5 أضعاف الفروقات في النقص النسبي في الوزن الخضري الجاف نتيجة لعامل إجهاد البوتاسيوم بين الأصناف المختلفة. إن كفاءة الانتفاع من البوتاسيوم كانت الضعف تقريباً في الأصناف التي نميت بدون إضافة البوتاسيوم مقارنة بالتي نميت بإضافة 50 جزء من المليون من البوتاسيوم. إن تركيز و امتصاص البوتاسيوم في الاصناف الوراثية المختلفة كانا مختلفين معنوياً عند كل من مستويي النقص و الكفاية من البوتاسيوم.

الكلمات الدالة: الشعير، الأصناف الوراثية، عامل إجهاد البوتاسيوم، كفاءة الانتفاع – الكفاية.

ABSTRACT

A pot experiment was conducted to study genotypic variation for K–uptake and utilization efficiency in barley genotypes to K applied at adequate and deficient levels (50 and 0 ppm K resp.). Potassium level and variety interaction was significant for almost all the parameters studied. Substantial differences were observed among genotypes for accumulation of shoot dry weight, root dry weight, total biomass and relative reduction in shoot biomass due to potassium deficiency stress. Potassium stress factor ranged between 9 to 41 % that is more than 5-fold differences in relative reduction in shoot dry weight due to potassium stress factor among genotypes. Potassium utilization efficiency was almost doubled in the genotypes that were grown with no potassium supply compared to these grown with 50 ppm K supply. Potassium concentration and uptake in genotypes were significantly different at deficient and adequate potassium levels.

Key words: Barley, genotypes, potassium stress factor, utilization efficiency, adequate

INTRODUCTION

Barley (*Hordeum vulgare* L.) is a cereal grain that is used in bread making individually or in combination with wheat flour, and in preparation of many human foods (Shekhawat et al., 2013). Barley is a highly adaptable cereal grain and is the fourth most important cereal crop in the world after maize, wheat and rice (Gaesejwe .2015). Selection of crop genotypes adapted to low nutrient input is relatively a new strategy to cope with the situation of low nutrient concentration in root environment (Mahmood, 1999).

Potassium (K) is an important nutrient for barley which affects the quality of the grain (Lyubena et al, 2014). Plant species and even genotypes within a species differ in their K use efficiency (Bhadoria et al .2004) .Therefore, selection and use of barley genotypes capable of growing under low K availability might offer an alternate approach to enhance productivity of barley in K deficient areas or where K fertilizers are costly or unavailable. For the present paper we have compared some of barley varieties for their growth behavior and K relation.

MATERIALS AND METHODS

This pot study was following a completely randomized factorial arrangement involving four barley genotypes: M97, B12-3, Tramilo and Raihan, grown in plastic pots at two K levels i.e. .0 and 50 ppm. The crop also received recommended amount of nitrogen and phosphorus (25 N, 75 P_2O_5 mg/kg soil) was applied to the soil at the time of soil preparation. The characteristics of the soil under study were: Ph 7.4, EC 0.38 dS/m, organic matter percent 0.2%, and the soil texture was sandy. Seedlings were harvested at 21 and 30 days after sowing and analyzed for growth parameters. Shoot and root samples were dried at 70°C for 2 days in an oven. Dry weight (g/plant) of shoot and root was recorded. The root and shoot samples were milled and total potassium in plant samples was determinated by wet digestion in a mixture of H_2SO_4:H_2O_2 (2:1) (Bao, 2000) followed by using an atomic absorption spectrophotometer. Potassium uptake was computed using the following formula: (K conc. in shoot mg/g)*SDW (mg/g dry wt). Potassium utilization efficiency (KUE) in genotypes was calculated as: (1/K conc. in shoot)*SDWg/plant. Potassium Stress Factor (KSF) was calculated by using the following formula: ((SDW adeq.K – SDW def.K) / (SDWadeq.K))*100 (Siddiqi and Glass ,1981). The data were subjected to analysis according the method reported by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

There were significant differences among the plants affected by K levels and barley genotypes. The data presented in Table (1) revealed a significant effect of K levels, genotypes and their interaction on SDW, RDW, Root/Shoot Ratio and total biomass production by the barley plants. This was in harmony with the results obtained by Gill et al (1997) and Mahmood (1999) who reported that, genotypic difference in response of different crop cultivars to K application. On an average SDW production in barley genotypes reduced 1.5 times due to K deficiency. Amongst different parameters, SDW is considered to be the most sensitive plant response parameter to nutrient deficiency and is given a pivotal in screening experiments (Fageria et al, 1988). This study disclosed a considerable variation in SDW production among barley genotypes at both K levels. The highest SDW was exhibited by B12-3 genotype at both K levels. On the other hand, Raihan genotype recorded the lowest dry weight. There was significantly main and interactive effect of barley genotypes and potassium levels on RDW production. RDW was reduced 1.1 times due to K deficiency. It was ranged between 1.10 to 2.21 g at deficient while it ranged between 1.63 to 2.50 g at adequate K supply. At deficient K supply B12-3 genotype produced highest RDW while Raihan produced lowest RDW. KSF reflects relative reduction in SDW of the genotypes due to K stress. It also indicates the responsiveness of the genotypes to adequate K supply. A higher positive value of KSF higher response of a genotype to adequate K supply. Whereas, a negative or lower value shows no or little response to K supply. Wild variations for KSF was observed among genotypes and it ranged from 9 to 41 % indicating more than 5fold difference among the genotypes in relative reduction in SDW due to deficient K supply (Table 1). B12-3 genotype being the most efficient at deficient K supply showed high stress due to K deficiency because it is efficient but also responsive to K application. This was in accordance with Brouwer (1983) who stated that, all plants invest relatively more in their root when grown conditions of nutrient stress but the magnitude of response is species and nutrient dependent. Root/Shoot ratio was significantly affected by K levels, genotypes and their interaction (Table 1). It increased in genotypes grown with deficient compared to adequate K supply.

Table 1. Shoot and root dry weight, potassium stress factor and root/shoot ratio of barley genotypes grown at deficient and adequate K levels

GENOTYPES	SDW (g/pot)		KSF (%)	RDW (g/plant)		Root/Shoot Ratio	
	Def. K	Adeq. K		Def. K	Adeq. K	Def. K	Adeq. K
M97	1.60	2.55	38	1.88	2.19	1.22	0.87
B12-3	1.81	3.04	41	2.21	2.50	1.22	0.78
Tramilo	2.13	2.35	9.0	2.00	1.63	0.96	0.70
Raihan	1.50	2.08	28	1.10	1.72	0.73	1.20
Mean	1.76	2.51	29	1.80	2.01	1.03	0.88
LSD at 5%	0.05	0.08	0.16	0.23	0.04	0.07	0.12

Table 2. Potassium concentration, uptake and utilization efficiency of barley genotypes grown at adequate and deficient K levels

GENOTYPES	K Conc. (mg/g)		K uptake (mg)		KUE	
	Def. K	**Adeq. K**	**Def. K**	**Adeq. K**	**Def. K**	**Adeq. K**
M97	10.7	29.2	17.1	74.4	0.16	0.09
B12-3	9.33	36.0	16.1	109.5	0.19	0.09
Tramilo	10.0	29.7	21.4	69.3	0.22	0.08
Raihan	8.67	31.7	13.9	78.5	0.19	0.08
Mean	9.70	31.7	17.1	82.9	0.19	0.09
LSD at 5 %	0.051	0.082	0.16	0.03	0.05	0.09

Various barley genotypes and K levels had a significant main and interactive effect on K concentration in plant shoots (Table 2). It ranged between 29.2 and 36.0 mg/g at adequate level of K supply. At deficient level K supply it ranged between 8.7 and 10.7mg/g. The highest K uptake at deficient K level was observed in Tramilo genotype while the lowest in Raihan genotype. Differences in KUE among the genotypes were significant in both K levels. With deficient K supply the highest KUE was observed in Tramilo genotype (Table 2). Whereas, the lowest KUE was observed in M97 genotype that had highest K concentration in shoot (Table 2).This was in harmony with the results obtained by Yang et al (2003) who demonstrated that, a positive correlation was found between KUE at low available K and relative SDW at deficient/adequate K supply at the tillering stage. Similar results were also obtained by Chachar et al (2015) who reported that wheat genotypes differ in growth response and potassium utilization when grown at deficient and adequate potassium levels.

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