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GENOTYPIC DIFFERENCES IN PHOSPHATE NUTRITION OF BARLEY (*hordeum vulgare* L.)

Abdlgader K.A[1], and Amgada S.A [2]

[1,2] Soil and Water Department, Faculty of Agriculture, Omar Al Mukhtar University, Libya

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ABSTRACT:

Phosphorus use by four genotypes of barley was studied at five phosphate levels in pot studies for 30 days. For all P levels, there were marked genotypic differences in the root, shoot and total dry matter accumulation and phosphorus use efficiency of shoots (PUE) (g shoot /mg plant in the shoot). There were significant genotypic differences in the root, shoot and total accumulation dry weight increased with increasing P levels. The magnitude of the increase resulting from phosphorus application of 125ppm P was 66.3%, 32.2% and 43.7% resp. compared with 0 ppm. Significant differences were observed in dry matter accumulation amongst barley genotypes, where the Rahan variety recorded the highest shoot and total dry matter at 125 ppm P (2.25 and 4.53 g/pot) resp. PUE was significantly influenced by P levels and by genotypes. Based on dry matter production of shoots at low P level, Rahan and M97 varieties recorded the highest PUE (0.75 and 0.72 g SDM/mg plant) resp.

الاختلافات الوراثية في تغذية الفوسفور في الشعير

كمال عبد السلام عبدالقادر[1] وسعاد أمقدع عبدالقادر[2]

[2،1] قسم التربة والمياه ، كلية الزراعة، جامعة عمر المختار – ليبيا

الكلمات المفتاحية:

الفوسفور– المجموع الخضري– المجموع الجذري– الكتلة الحيوية– المادة الجافة.

المستخلص:

استهدف البحث دراسة استخدام الفوسفور بواسطة أربعة أصناف من الشعير عند خمس مستويات من تسميده في تجربة أصص لمدة 30 يومًا. عند كل مستويات الفوسفور كانت هناك اختلافات وراثية بين الأصناف في تراكم المادة الجافة في المجموع الجذري والمجموع الخضري والكتلة الحيوية الكلية وكفاءة استخدام الفوسفور، وكانت هناك اختلافات معنوية بين الأصناف في تراكم المادة الجافة في المجموع الجذري والخضري والكتلة الحيوية الكلية التي كانت تزيد مع زيادة مستوى إضافة الفوسفور. الزيادة الناتجة من إضافة 125 جزءًا من المليون فوسفور كانت 66.3%، 32.2% و43.7% على التوالي مقارنة بعدم الإضافة. اختلافات معنوية كانت ملاحظة بين أصناف الشعير في تراكم المادة الجافة في المجموع الخضري والكتلة الحيوية الكلية، حيث سجَّل صنف ريحان أعلى تراكم في المادة الجافة في المجموع الخضري والكتلة الحيوية الكلية، إذ بلغت 2.25 و4.53 (جم / أصيص) على التوالي. كفاءة الاستخدام تأثرت معنويًا بمستوى الفوسفور. وعلى أساس إنتاج المادة الجافة في المجموع الخضري عند أقل مستوى من الفوسفور سجَّلت أصناف ريحان وM97 أعلى كفاءة في استخدام الفوسفور (0.75 و0.72 جم/ملجم نبات) على التوالي.

*Corresponding author:E-mail addresses: kamal.abdalsalam@omu.edu.ly and suad.amqadaa@omu.edu.ly

INTRODUCTION

Differences in nutrient relations between genotypes within a species are well known (Jiang et al.,2010; Aziz et al.,2011; Amgada et al.,2017). Two possible major components of such differences are the uptake of the nutrient from soil and physiological differences in the use of the nutrient in the plant, the former is determined by root dynamics and the physiology of nutrient uptake by the root, the component of the latter collectively defined as physiological nutrient use efficiency (g dry matter/mg absorbed nutrient). The objective of the present investigation was to examine some of these components with four genotypes of barley varying in their ability to grow in phosphate deficient soil.

MATERIALS AND METHODS

A pot experiment was carried out to evaluate the phosphorus use efficiency of four different barley genotypes were used: Tramilo, M97, B12-3 and Rahan for P-use efficiency (PUE) at five phosphorus levels (0, 50, 75, 100 and 125 ppm P/pot) as $(NH_4)_2HPO_4$.

The crop also received recommended amount of nitrogen and potassium (25N and 50K mg/kg soil) in each pot (30cm*25cm) containing 5 kg soil was applied to the soil at the time of soil preparation. A routine soil analysis was carried out to determine the mechanical composition, pH, electrical conductivity as well as organic matter content using the standard methods described by USDA (2011). Plants were harvested 30 days after sowing and analyzed for growth parameters. Shoots and roots samples were dried at 70° C in an oven. The dry weight (g/plant) of the shoot and root was recorded. The root and shoot samples were milled and phosphorus concentration in plant samples was determined by wet digestion in a mixture of H_2SO_4:H_2O_2 (2:1) (Bao, 2000), followed by using an atomic absorption spectrophotometer. Phosphorus use efficiency (PUE) in genotypes was calculated as:

PUE (g SDM mg plant) =Shoot dry matter(gP^{-1})/shoot P concentration (mgp^{-1}) (Amgada et al.,2017). A complete randomized design was used in a factorial arrangement and the treatments replicated three times were statically analyzed according to the method reported by (Gomez and Gomez, 1984).

RESULTS

The cultivated soil is characterized by a sandy texture, moderate pH (7.4), low salinity index; EC (0.38 dS m^{-1}), as well as high deficiency in organic content (0.2 %).

Table (1), represent the revealed data that, irrespective of barley genotypes, increase P levels up to 125 ppm. P significantly increased dry matter accumulation of roots, shoots and consequently total dry matter, the magnitude of the increase in roots, shoots and total dry matter resulted from phosphorus application of 125 ppm, P was 66.3%, 32.2%, and 43.7 % respectively, compared with 0ppm P.

Table:(1). The influence of P levels on roots, shoots and total dry matter yield of the different barley genotypes

Barley genotypes	Plant part	Phosphorus Levels (ppm) 0	50	75	100	125	Mean
Tramilo	(S) Shoot	0.89	1.08	1.27	1.43	1.99	1.33
	(R) Root	0.21	0.22	0.24	0.26	0.31	0.25
	(T) Total	1.10	1.30	1.51	1.69	2.30	1.58
M97	(S) Shoot	1.21	1.29	1.40	1.51	1.56	1.39
	(R) Root	0.11	0.22	0.31	0.32	0.33	0.26
	(T) Total	1.32	1.51	1.71	1.83	1.89	1.56
B12-3	(S) Shoot	1.16	1.26	1.38	1.40	2.15	1.47
	(R) Root	0.21	0.89	0.91	1.11	1.22	0.87
	(T) Total	1.37	2.15	2.29	2.51	3.37	2.34
Rahan	(S) Shoot	2.14	2.01	2.13	2.22	2.25	2.15
	(R) Root	0.88	0.97	1.99	2.01	2.25	1.62
	(T) Total	3.02	2.98	4.12	4.23	4.53	3.78
Mean (P)		1.70	1.99	2.41	2.41	3.02	
Mean (S)uas		1.35	1.41	1.55	1.64	1.99	
Mean (R)		0.35	0.58	0.68	0.93	1.04	
Mean (T)		1.7	1.99	2.41	2.55	3.02	
LSD at 50 %		(G) 0.21 (P) 0.19 (G*P) 0.01		(G) 0.01 (P) 0.011 (G*P) 0.11		(G0.34 (P) 0.12 (G*P) 0.04	

Data presented in table (2) showed that significant differences were observed in dry matter accumulation amongst barley genotypes, regardless of phosphorus levels. Generally, the Rahan variety recorded the highest shoots and total dry matter. On the other hand, the Tramilo variety recorded the lowest dry matter of roots, shoots and total dry matter.

Concerning the interaction effect of phosphorus levels and barley genotypes, data in the table (1) revealed significant differences in roots, shoots and whole plant dry weight between the different barley varieties at each phosphorus level. The highest shoots dry weight was recorded by the Rahan variety at 125 ppm P, followed by the B12-3 variety, where it reached about 1.1 times that of Tramilo and M97 (recording the lowest shoots dry weight at 125 ppm P).

PUE differed significantly among barley genotypes. The dry matter yield of shoots at low P levels also differed significantly among genotypes. Rahan and M97 varieties had the highest PUE, whereas Tramilo and B12-3 varieties had the lowest one at a low P level. This means that Rahan and M97 varieties can grow well under low P level and respond well to P application and these varieties can be utilized under low P as well as high technology with reasonably good yield.

Table (2). Genotypic differences in phosphorus use efficiency (g SDM/mg plant) of barley genotypes at different P levels

Genotypes (G)	P Levels (ppm) (P)				
	0	50	75	100	125
Tramilo	0.71	0.62	0.55	0.51	0.41
M97	0.72	0.66	0.56	0.52	0.44
B12-3	0.67	0.58	0.48	0.42	0.35
Rahan	0.75	0.68	0.61	0.51	0.33
LSD at 50%	0.04	0.06	0.05	0.03	0.03

DISCUSSION

We demonstrated that increasing P levels up to125 ppm P significantly increased dry matter accumulation of the whole plant (Amgada et al, 2017). The higher dry matter accumulation by the Rahan variety was mainly due to greater vegetative growth, particularly shoots than by other varieties (Aziz et al, 2011) who found that, the crop species and genotypes among various under phosphorus deficit and phosphorus adequate. The differences in dry matter accumulation by varieties may account for these differences in PUE among barley genotypes (Amgada et al.,2021). Who found that barley cultivars differ in their ability to grow in the soil of low available P, species differ in their ability of P to take up from the soil and these differences were attributed to the morphology and physiology of plants relative to their germplasm base. Similar results were obtained by (Jiang et al.,2010; Amgada et al., 2017).

CONCLUSION

Our study has demonstrated that the efficiency with which barley genotypes can extract and utilize P has been shown to vary markedly between cultivars of barley. Phosphorous efficiency arises from PUE which is the ability of plants to acquire P from the soil or the ability of plants to utilize P in shoots for the production of dry matter.

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