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Relative growth response of some barley genotypes to deficient and adequate phosphorus levels

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Relative growth response of some barley genotypes to deficient and adequate phosphorus levels

الملخص :

أقيمت تجربة أصص لدراسة الاختلافات الوراثية في امتصاص الفوسفور وكفاءة الانتفاع منه في أربعة أصناف من الشعير (Tramilo-Rahan-B12-3،M97) وذلك بإضافة الفوسفور عند مستويين الكفاية والنقص (0 ، 100 جزء من المليون من الفوسفور على التوالي). التداخل بين مستويات الفوسفور واختلافات الاصناف كان معنوياً لكل الصفات المدروسة تقريباً تم ملاحظة فروق أساسية بين الأصناف في تراكم المادة الجافة كل من المجموع الخضري والجذري والكتلة الحيوية الكلية والنقص النسبي في الكتلة الحيوية الخضرية وجد أن عامل إجهاد الفوسفور تراوح من 27.7% إلى 43.1% والذي يشكل ضعف الفروقات في النقص النسبي في الوزن الجاف لمجموع الخضري نتيجة لعامل إجهاد الفوسفور بين الأصناف المختلفة. كفاءة الانتفاع من الفوسفور كانت الضعف تقريباً في الأصناف التي نميت بدون إضافة فوسفور مقارنة بالتي نميت بإضافة 100جزء من المليون من الفوسفور. تركيز وامتصاص الفوسفور في الأصناف الوراثية المختلفة كانا مختلفين معنوياً عند كل من مستوى النقص والكفاية من الفوسفور.

الكلمات المفتاحية :الأصناف الوراثية ، عامل إجهاد الفوسفور، تراكم المادة الجافة ، الشعير، تركيز الفسفور

ABSTRACT :

A pot experiment was conducted to study genotypes variation for P Uptake and utilization efficiency in four barley genotypes (Tramilo, Rahan, B12-3 and M97) to P applied at adequate and deficient levels (0 and 100 ppm P resp). Phosphorus level and variety interaction was significant for almost all the parameters studied. Substantial differences were observed among genotypes for accumulation of shoot and root dry weight , total biomass and relative reduction in shoot biomass due to phosphorus stress.

Phosphorus stress factor ranged between 27.7% to 43.1% that is 2 folds differences in relative reduction in shoot dry weight due phosphorus stress factor among genotypes. Phosphorus utilization efficiency was almost doubled in the genotypes that were grown with no phosphorus supply compared to these grown with 100 ppm P supply. P concentration and uptake in genotypes were significantly different at deficient and adequate phosphorus levels.

Key word: genotypes-phosphorus stress factor-dry matter accumulation-barley-phosphorus-concentration.

INTRODUCTION :

phosphorus (P) is an essential nutrient for plant growth and development. Due to the diverse functional and structural roles of P in plants. In many soils ,P deficiency is a major limitation to crop production .Although the total amount of P in soils can be high , plant available P is often low [19]. As a result of high P fixation and/ or nutrient mining in traditional land use system [3]. P is most widely occurring nutrient deficiency in cereal crops around the world . For this reason , crops are supplied with inorganic P fertilizers .However , excess P added to crops may cause environmental and economic problems [20]. The development of sustainable agricultural systems will require new techniques that help to minimize application rates , with maintaining adequate crop yield. This might be achieved by developing crops that either acquire P or use P more efficiency , so that less P fertilizer is required.

Barley (*Hordeum Vulgare*) is a cereal grain that is used in bread making individually or in combination with wheat flour , and in preparation of many human foods [17]. It is a highly adaptable cereal grain and is the fourth most important cereal crop genotype in the world after maize, wheat and rice [6] selection of crop genotypes adapted to low nutrient input is relatively a new strategy to crops with the situation of low nutrient concentration in root environment [13]. In this experiment the current investigation was carried out to study the relative response of barley genotypes to deficient and adequate P levels.

MATERIALS AND METHODS :

This pot study was following a completely randomized factorial arrangement involving four barley genotypes: Rahan ,Tramilo, M97 and B12-3, grown in plastic pots (14cm*21cm). At two P levels i.e . 0 and 100 ppm, the plants also received recommended amount of nitrogen and potassium (25N and 50K mg/kg soil) was applied to the soil at the time of soil preparation. The characteristics of the soil under study were :pH 8.4, EC 0.38 ds/m , organic matter percent 0.3% and the soil texture was sandy clay. Seedlings were harvested at 30 day after sowing and analyzed for growth parameters. Shoots and roots samples were dried at 70^0C , dry weight of both shoots and roots were recorded. Shoots and roots were milled and digested according to method of [4]. Phosphorus was determined by an atomic absorption spectrophotometer. Phosphorus uptake in shoot/ root and relative reduction

in shoot dry matter yield, also called as phosphorus stress factor (PSF) were calculated by formulae recommended by [10].

PSF(%)=((SDM(adeq.P)-(SDM(def.P))/SDM(adeq.P)x100. Shoot/Root, P uptake(mgPplant^{-1}) = shoot/root P concentration (mgPg^{-1}) * shoot/root dry matter yield (g/ plant^{-1}) Here , SDM represent shoot dry matter (g plant^{1}) in the respective treatment . The following formula of [18] was used to calculate phosphorus utilization efficiency(PUE) of barley genotypes PUE: (g^{2} SDM mg^{-1}P)=Shoot dry matter (g plant^{-1}) / shoot P concentration(mgPg^{-1}). The data were subjected to analysis according the method reported by [9].

RESULTS AND DISCUSSION

There were significant differences among the plants affected by P levels and barley genotypes. The data presented in Table(1) revealed a significant effect of P levels , genotypes and their interaction on SDW,RDW, Root : Shoot ratio and total biomass production by the barley plants. Data revealed that SDM production by barley genotypes was considerably reduced from 2.25 to 1.40 g plant^{-1} (37.7% reduction) due to P deficiency stress .Rahan produced higher SDW (1.43 and 2.51 g plant^{-1}) at deficient and adequate P levels respectively .

On the other hand , M97 recorded the lowest SDW(1.25 to 1.73 g plant^{-1}) at deficient and adequate P levels , respectively . This was in harmony with the results obtained by [14] and [15] who found that genotypes demonstrated significant variations in SDW in response to P levels and these genetic differences can successfully be used for crop improvement in future.

Substantial genetic differences were observed in RDM production by barley varieties at both P levels . Plant grow in P deficient medium produced higher RDW (0.65 g plant^{-1}) than those (0.56 g plant^{-1}) supplied with adequate P levels. At deficient P levels , B12-3 produce maximum RDW(0.71 g plant^{-1}) , while Tramilo produce the minimum RDW (0.53g plant^{-1}). At adequate P supply RDW ranged between a minimum value of 0.47 g plant^{-1} (Tramilo) and maximum value of 0.63 g plant^{-1} (B12-3) .This was in agreement with the results obtained by [21] who illustrated that root growth of plants was comparatively less inhibited than shoot growth under P deficient condition .Root : shoot ratio (RSR) was also

significantly affected by P levels and barley genotypes as well as their interaction cultivars revealed almost two fold higher RSR(0.46) in P deficient medium than in P sufficient medium (0.24). M97 variety recorded the highest RSR (0.54 and 0.36) at deficient and adequate levels respectively .whereas, the lowest one was for Tramilo variety (0.38 and 0.20) at deficient and adequate levels respectively. The obtained result were similar to those obtained by [2] and [12] who found that the sustained root growth at the cost of shoot growth results from increased partitioning of photosynthates towards roots under low nutrient availability.

Table 1 .Shoot dry weight (SDW), Root dry weight (RDW) ,Phosphorus Stress Factor (PSF) and Root : Shoot Ratio(RSR) of barley genotypes grown at deficient and adequate P levels.

Barley varieties	SDW(g/plant)		RDW(g/plant)		PSF%	RSR	
	Def.p	Adeq.p	Def.p	Adeq.p		Def.p	Adeq.p
Rahan	1.43	2.51	0.69	0.52	43.1	0.48	0.21
Tramilo	1.39	2.40	0.53	0.47	42.1	0.38	0.20
M97	1.25	1.73	0.67	0.62	27.7	0.54	0.36
B12-3	1.51	2.35	0.71	0.63	35.7	0.47	0.27
Mean	1.40	2.25	0.65	0.56	37.2	0.46	0.24
LSDat5%	0.03	0.031	0.013	0.011	0.15	0.017	0.016

PSF indicated comparative decrease in SDW production of different varieties at low P level. Varieties varied significantly in their relative tolerance to P deficiency stress (Table1). PSF ranged between 27.7% (M97) and 43.1 (Rahan) , indicating the presence of genetic diversity in adaptability to deficient conditions.

This was in accordance with the findings of [1],[7] and [16] who found that, PSF is a useful indicator of relative tolerance of wheat cultivars to P deficiency stress and genotypes with relatively low PSF values can be suitable candidates for P deficient soils.

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

Barley varieties	Pconc. (mg/g)		P uptake (mg)		PUE	
	Def.P	Adeq.p	Def.P	Adeq.p	Def.P	Adeq.p
Rahan	1.51	3.12	2.16	7.83	0.95	0.81
Tramilo	1.30	3.00	1.81	7.20	1.10	0.80
M97	1.21	2.58	1.51	4.46	1.03	0.67
B12-3	1.36	2.17	2.10	5.10	1.11	1.08
Mean	1.35	2.72	1.90	6.15	1.05	0.84
LSDat5%	0.01	0.09	0.010	0.11	0.06	0.04

Various barley genotypes and P levels had a significant main and interactive effect on P concentration in plant shoots (Table2) . It ranged between 2.17 and 3.12 mg/g at adequate level of P supply .At deficient level P supply it ranged between 1.21 and 1.51 mg/g.

The highest P uptake at deficient P level was observed in Rahan variety (2.16mg) while the lowest in M97 variety (1.51mg) .Differences in PUE among the genotypes were significant in both P levels with deficient P supply the higher PUE was observed in B12-3 variety that had lower P concentration in shoot (Table2) , Similar findings were revealed by [5], [8] and [11] who reported that , plant physiologists linked lower shoot P concentration with more efficient utilization of P in metabolism.

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