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RESEARCH PAPER

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The effect of foliar fertilizers by phosphorus and potassium on growth and yield of barley

Ali H. Jasim, Haider M. Rashid
College of Agriculture, Al-Qasim Green University
Corresponding author: ajasim@gmail.com

ABSTRACT

A field experiment was carried out during 2014- 2015 growth season in a private farm located in the district of Al-Hashemia (20 km south of the province of Babylon center), to study the effect of foliar feeding by phosphorus and potassium on growth and yield of barley. Randomized Complete Block design (RCBD) was used in factorial experiment with three replications. The experiment included four concentrations of potassium: K0 (sprayed with distilled water only) as control , K1 , K2 and K3 (spraying 1000, 2000 and 3000 mg K.l^{-1}, respectively) and four concentrations of phosphorus: P0 (sprayed with distilled water only) as control , P1, P2 and P3 (spraying 1000, 2000 and 3000 mg K.l^{-1} respectively) . Local barley seed variety was seeded at 15/11/2014. The data were analyzed according to the design used and the average were tested by $LSD_{0.05}$. The results were summarized as follow: Foliar feeding with potassium K2 (2000 mg K. l^{-1}) was superior and caused a significant increases in root length (20.38 cm), plant height (104.88 cm), leaf area (29.03 cm^2), spike length (11.09 cm) and high grain yield (3.828 t.ha^{-1}). Spraying phosphorous P1 (1000 mg P.l^{-1}) caused a significant increases in root length (21.15 cm)K while spraying phosphorous P2 (2000 mg P.l^{-1}) was superior in plant height (104.97 cm), leaf area (29.97 cm^2), spike length (11.34 cm) and high grain yield (3.912 t.ha^{-1}). The interaction also had a significant effect on all traits studied.

Keywords: *barley, foliar feeding, potassium, phosphorous.*

INTRODUCTION

Barley (Hordeum vulgare L.) is the most important winter fodder grain crop in Iraq which is used as green fodder and seed production used in feeding for large animals and birds and also used in the malt industry and brown bread [1]. Plant and soil management were the most effective in improving growth and yield of barley. Nutrients were the most important factors. Phosphorus is necessary to create the process of photosynthesis energy [2] because of its important in root growth and development which helps to distribute their spread and increasing nutrients absorption. Potassium is contributes to the process of photosynthesis and in the transmission of sugars from the source to the sink [3], and plays an important role in the formation of protein and chlorophyll, carbohydrates metabolize and stomata opening and closing [4]. Due to the nature of most of the Iraqi soils characterized as calcareous soil, the cultivated crops are suffering from a lack of most of the nutrients, especially phosphorus, potassium, and the reason for that is not due to the total content of these elements, but to the lack of its availability [5]. So the studies tended to foliar application of nutrients as a process complementary to secure the appropriate level of these necessary nutrients for plant. Because of the importance of these two elements in growth and yield of barley, this study aims to find out foliar application of phosphorus and potassium on growth and yield of barley plants.

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MATERIALS AND METHODS

A field experiment was conducted during winter season of 2014 - 2015 in Al-Hashemia region (20 km south of the province of Babylon center) in silt clay soil (Table 1) in order to study the effect of spraying phosphorus and potassium nutrition on growth and yield of barley. Randomized complete block design (RCBD) was used as factorial experiment with three replications. Four concentrations of potassium and phosphorous were used , which included of control (spraying distilled water only) as K0, P0, three concentration of potassium (K1, K2 and K3) and phosphorous (P1, P2 and P3) which were 100, 200 and 300 $mg.l^{-1}$ of each of K and P respectively. Grain seed of local barley variety was seeded in 15 November, 2014 in the experimental units

The spraying process was adding at two times (at tillers stage and the second at booting stage).Metal cylinder (length of 0.4 m and a diameter of 0.3 m) was used to dislocation size of soil containing barley roots and then stripped the soil on a soft buckle and shed the water column to separate the roots from the soil and measure the length of the dense ones package, which represents the effective depth of the root system and then dried and weighed. Plant height measured from the surface of the soil level to the end of spike [6]. Flag leaf area ware measured according to [7]. Day's number from sowing to 50% flowering was calculated. Grain yield were calculated for the experimental unit and attribution to hectare. The Data were analyzed and the averages were compared according to less significant difference.

Table 1: Some soil characteristic of experimental Field

Characteristics	Value	Characteristics	Value
Sand	$g.kg^{-1}$ soil ١٠١	Available N	35.13 $mg.kg^{-1}$ soil
Silt	$g.kg^{-1}$ soil٥٣٤	Available P	13.80 $mg.kg^{-1}$ soil
Clay	$g.kg^{-1}$ soil٣٦٥	Available K	217.6 $mg.kg^{-1}$ soil
Soil texture	Silt-clay-sand	EC	4.6
pH	7.4		

RESULTS AND DISCUSION

Table 2 shows that spray phosphorus caused a significant increase in the rate of root length and P1 gave the highest rate (21.15 cm), while P0 gave the lowest rate (17.99 cm). This result attributed to increase root cells which lead to increase activity and growth of the root group and increase its complexity in the soil [8] this is consistent with [9] when spraying wheat with phosphorous fertilizer. The results also show that spraying potassium fertilizer caused a significant increase in root length and (K2) gave the highest rate of root length (20.38 cm), while (K0) gave the lowest rate (18.33 cm). This may be attributed to the role of potassium in increasing most of vegetative traits such as high plant. When increasing plant size baptizing to the formation of the total radical large unable to install the plant to the fact that the substrate root which it is based in the soil that reflected in increasing weight and length of roots [10]. This is consistent with the results of [11] on wheat plant. The results also showed that the interaction between spraying of phosphorus and potassium concentrations had a significant effect and P1K2 gave highest rate of root length (21.90 cm), while P0K0 gave lowest rate (17.21 cm). This was agreed with the results of [9] on wheat plant

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Table 2 : Effect of foliar feeding with P and K on root length (cm)

treatment	P concentrations				Average of K
K concentrations	P0	P1	P2	P3	
K0	17.21	20.33	18.16	17.61	18.33
K1	18.33	21.14	19.03	18.08	19.14
K2	18.93	21.90	21.23	19.47	20.38
K3	17.50	21.24	19.13	18.38	19.06
Average of P	17.99	21.15	19.39	18.38	
$LSD_{0.05}$	K*P=0.44		P=0.22		K = 0.22

Table 3 showed that spray phosphorus concentration caused a significant effect on the period to 50% flowering and (P2) was superior in giving fewer periods (109.68 days), while (P0) gave the highest period (113.30 days). On the other hand, spraying potassium caused a significant effect on period to 50% flowering and (K2) was superior in giving less period (110.40 days), while (K0) gave the highest period (112.39 days). This result may be attributed to the role of potassium in improving growth by achieving the status of continuous nutrient supply that pay to the acceleration in the physiological processes within the plant, which led to reduce the time from planting to 50% flowering that led to an improvement in most of the growth traits [13]. This result was consistent with the results of [14]. The interaction between phosphorous and potassium caused a significant effect and P2K2 gave the lowest period to 50% flowering (108.94 days), while P0K0 gave the highest period (115.00 days).

Table 4 showed that spraying phosphorus had a significant effect on plant height, and P2 gave the highest plant height (104.97 cm), while P0 gave the lowest rate (98.74 cm). This results due to the role of phosphorus in increasing roots growth which accelerates water and nutrient absorption as well as its participation in energy compounds and accelerate growth [15].

Table 3: Effect of foliar feeding with P and K on period to 50% flowering

treatment	P concentrations				Average of K
K concentrations	P0	P1	P2	P3	
K0	115.00	111.56	110.67	112.33	112.39
K1	112.32	111.57	109.33	110.99	111.05
K2	112.41	110.00	108.94	110.25	110.40
K3	113.49	110.23	109.78	112.25	111.44
Average of P	113.30	110.84	109.68	111.45	
$LSD_{0.05}$	K*P=0.84		P=0.42		K=0.42

This was consistent with the results of [9] on wheat. Spraying potassium had a significant effect and K2 was superior in plant height (104.88 cm), while K0 gave lower plant height (97.86 cm). This may be attributed to the role of potassium in the revitalization of a number of enzymes responsible for building materials synthetics that building a plant structure as well as its role in the hormonal balance process and increase the efficiency of plant growth regulators which contributed to the increase in the rate of plant height [16]. The interaction had a significant effect and P2K2 gave high plant height (108.56 cm), while P0K0 gave the lowest rate (95.15 cm). This was consistent with the results of [9] on wheat.

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Table 4 : Effect of foliar feeding with P and K on plant length (cm)

treatment	P concentrations				Average of K
K concentrations	P0	P1	P2	P3	
K0	95.15	98.35	100.14	97.80	97.86
K1	99.97	103.00	105.48	104.27	103.18
K2	99.84	104.13	108.56	106.99	104.88
K3	100.00	102.71	105.71	102.06	102.62
Average of P	98.74	102.05	104.97	102.78	
$LSD_{0.05}$	K*P=1.35		P=0.67		K=0.67

Table 5 showed that spraying phosphorus concentration had a significant effect on leaf area and P2 gave higher rate (29.97 cm^2), while P0 gave the lowest rate (26.48 cm^2) which may be due to phosphorus in increasing the activity events vitality and increase the division and growth of maristimatic cells, which leads to a dramatic growth with high efficiency in the absorption of nutrients, thereby increasing the leaf area [9]. The results also showed that spraying potassium concentrations had a significant effect and K2 gave the highest rate of leaf area (29.03 cm^2), while K0 gave the lowest rate (26.24 cm^2). This results may be due to the spraying process led to increase potassium uptake, which was reflected in the further opening stomata which means increasing the gaseous exchange process and the consequent raising the efficiency of the construction process optical as well as its role in the transfer of nutrients which contributed to the increase in leaf area [17]. The results showed that the interaction between phosphorus and potassium concentrations had a significant effect and P2K2 gave the highest leaf area (31.30 cm^2), while P0K0 gave the lowest rate (25.12 cm^2).

Table 5 : Effect of foliar feeding with P and K on leaf area (cm^2)

treatment	P concentrations				Average of K
K concentrations	P0	P1	P2	P3	
K0	25.12	25.06	28.71	26.08	26.24
K1	26.35	27.10	29.76	25.99	27.30
K2	27.18	28.30	31.30	29.33	29.03
K3	27.27	28.01	30.13	28.46	28.46
Average of P	26.48	27.12	29.97	27.46	
$LSD_{0.05}$	K*P=0.54		P= 0.27		K =0.27

Table 6 showed that spraying phosphorus caused a significant effect on spike length and P2 gave the higher length (11.34 cm), while P0 gave the lowest length (8.52 cm). This result may be attributed to phosphorus role in increasing plant growth, especially when it becomes available in the early stages of growth as the spike formed in the early stages of barley plant growth [12]. The results showed that spraying potassium caused a significant effect on spike length and K2 gave the highest rate (11.09 cm), while K0 gave the lowest rate (8.40 cm). This developments in growth of spike was a result of the continuous nutrient supply on the one hand and its role in raising the efficiency of the process of photosynthesis on the other hand, encouraging the best of the spike growth, which was reflected clearly on increasing spike length [18]. This is consistent with the results of [19] when spraying potassium 1% on wheat plants. The interaction had a significant effect and P2K2 gave the highest rate (12.04 cm), while P0K0 gave lowest rate (7.02 cm).

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Table 6 : Effect of foliar feeding with P and K on spike length (cm)

treatment	P concentrations				Average of K
K concentrations	P0	P1	P2	P3	
K0	7.02	8.55	10.18	7.86	8.40
K1	8.13	8.37	11.23	8.38	9.03
K2	9.98	10.68	12.04	11.70	11.09
K3	8.95	9.99	11.92	902	9.97
Average of P	8.52	9.39	11.34	9.24	
$LSD_{0.05}$	K*P=0.99		P=0.49		K = 0.49

Table 7 showed that spraying phosphorus caused a significant effect on grain yield and P2 gave the highest rate of grain yield (3.91 $t.ha^{-1}$), while P0 gave the lowest yield (3.19 $t.ha^{-1}$). This may be due to the phosphorus in increasing growth as a result of a direct role in cell division and root growth as well as its role in the formation phospholipids which inter in the composition of cell membranes, and nucleotides that are used in nucleic acids components [20], and has a role in the transfer of sugars from source to the seeds and this is reflected in increasing yield [21]. This result was consistent with the results of [22]. The results showed that spraying potassium caused a significant effect and K2 caused the highest rate of grain yield (3.83 $t.ha^{-1}$), while K0 gave the lowest yield (3.20 $t.ha^{-1}$).
This was due to potassium that contributes to the revitalization of a large number of enzymes involved in respiration and carbon metabolism. It plays a pivotal role in plant photosynthesis such as construction growth processes, by controlling the stomata opening, as well as on a direct role in improving the transfer of sucrose from source to the storage sites (sink) [17]. This was consistent with the results of [23] in increasing barley grain when spraying barley plants with potassium fertilizer. The results also showed that the interaction caused a significant effect and P2K2 gave the highest rate of grain yield (4.23 $t.ha^{-1}$), while P0K0 gave the lowest rate (2.98 $t.ha^{-1}$).

Table 7: Effect of foliar feeding with P and K on grain yield ($t.ha^{-1}$)

treatment	P concentrations				Average of K
K concentrations	P0	P1	P2	P3	
K0	2.980	3.110	3.563	3.150	3.201
K1	3.047	3.297	3.930	3.220	3.373
K2	3.623	3.533	4.227	3.930	3.828
K3	3.117	3.477	3.927	3.220	3.435
Average of P	3.192	3.354	3.912	3.380	
$LSD_{0.05}$	K*P=0.16		P=0.084		K = 0.084

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