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Response of Lettuce (*Lactuca sativa L., Ice-berg cv.*) Plant to Integrated use of Potassium Fertilizer

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Abstract: Two pots experiments were conducted for two successive seasons under sandy soil conditions to study the response of lettuce plants to the foliar spraying and soil application of potassium . potassium applied at a rate of 50-100-150 Kg/fed and sprayed at the rate of 1-2-3 % . Data reported that the vegetative growth characters of Lettuce plants were increased by increased the rate of potassium fertilizer. The highest vegetative growth characters were recorded with soil application of 150Kg potassium sulfate/Fed. In two seasons. Potassium foliar application had a significant effect on leaf number, leaf fresh weight and leaf dry weight, but had no significant effect on leaf number per plant. Foliar spraying of lettuce plants had astatically significant on pigments (chlorophyll a,chlorophyll b and carotenoids) compared to control plants. The highest value of lettuce root content (N, P, K, Ca and Mg contents) was recorded in 3% in two study seasons.
Key words: potassium fertilizer - sandy soil- lettuce plants.

Introduction

Romaine lettuce is one of the most popular of lettuces and Lettuce (*Lactuca sativa* L.) is the most popular among the salad crops .Romaine lettuce is an important vegetable crop for formers. It rich in vitamins and minerals[2]. Also, lettuce was grown in Egypt for local consumption and export.

Potassium is well recognized as the essential plant nutrient with the strongest influence on many quality parameters of fruits and vegetables[15]. Although K is not a constituent of any functional molecules or plant structures, it is involved in numerous biochemical and physiological processes vital to plant growth, yield, and quality[10]. Adequate K nutrition has been associated with increased yields, fruit size, increased soluble solids and ascorbic acid concentrations, improved fruit color, increased shelf life, and shipping quality of many horticultural crops[8,5] .

Foliar fertilization is a widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots.

Chemical potassium fertilizer became a high expensive fertilizer in Egypt, so farmers ignored using it. Foliar fertilization is more economical than root fertilization due to the higher degree of applied nutrients more efficiency. Such foliar applications could be used to avoid the depletion of these nutrients in the leaves and the resulting reduction in photosynthetic rate during this period due to poor nutrient uptake from the soil and translocation of these elements from the leaves to the developing seeds.

The aim of this work is to improve yield and quality by applying potassium fertilization as soil and foliar application on Lettuce plants.

Materials and Methods

Pot experiments were carried out in the Green house of the National Research Centre, Dokki, Egypt, to study the role of potassium application to minimize nitrate content in lettuce plants (*Lactuca sativa* L., Ice-berg cv.). Plastic pots (30 cm in diameter) were filled with 10 kg soil. Physical and chemical analyses of soils used in pot experiment were determined according to the methods reported by [13] and presented in Table 1.

Table 1 : Some physical and chemical properties of tested soil before sowing.

pH (1: 2.5)	**EC (dSm-1)**	**CaCO3 (%)**	**OM (%)**	**Physical properties**			**Texture class**
7.65	2.84	2.2	0.28	Sand	Silt	Clay	
Available nutrients (mg-100g soil)							Sandy Loam
				Cation and Anion (mg-100g soil)			

N	**P**	**K**	**Na+**	**K+**	**Ca++**	**Mg++**	**HCO3-**	**Cl-**	**SO4--**
6.22	0.85	11.32	5.53	1.41	2.60	1.82	2.11	7.33	1.71

Each pot received 2.2 g of calcium superphosphate (15.5% P2O5) before sowing and 3.0 g ammonium nitrate (33.5% N) added two weeks after sowing. In each pot, 3 grains of lettuce plants (*Lactuca sativa* L., Ice-berg cv.) were sown at 15 November 2013 in first season and 12 November 2014 in second season.

The experiments include seven treatments arranged as follow:

1. Control (recommended fertilizer),
2. 50 kg potassium sulphate /fed
3. 100 kg potassium sulphate /fed
4. 150 kg potassium sulphate /fed
5. 1% foliar addition
6. 2% foliar addition
7. 3% foliar addition

Potassium was applied to the soil surface beside plants after 1, 3 and 5 weeks after transplanting. Foliar of potassium was applied in the same times.

The plant samples were collected at 45 days after sowing. The chlorophyll a and b and carotene were estimated in the fresh leaves as described by [9]. Shoot weight, plant height and leaf area also estimated. Leaf area (LA) calculated by the model described by [3] using the leaflet length (L) and width (W). LA=- 1.6923+ (L*0.0161) + (W*0.0929) + (0.0062*L*W).

Total nitrogen, phosphorus, potassium, calcium and sodium estimated in the plant digest according to the method described by [4].

Data were statistically analyzed by using factorial completely randomized design. The means were compared using the least significant difference test (LSD) at 5% level according to [6]. Correlation studies were done and the values tested for their significance at 1 and 5 %.

Results

Data shown in table 2 reported that the vegetative growth characters of Lettuce plants were increased by potassium fertilizer.

Potassium as soil application had a significant effect on vegetative growth characters i.e. leaf number, leaf fresh weight and leaf dry weight. The highest vegetative growth characters were recorded with soil

application of 150Kg potassium sulfate/Fed. In two seasons. The obtained results were in a good accordance with those recorded by[14,16]. Potassium foliar application had a significant effect on leaf number, leaf fresh weight and leaf dry weight (Table 1), but had no significant effect on leaf number per plant. The positive effect of potassium foliar at concentration 3% application on growth parameters may be due to that potassium increased efficiency of the plant for utilization nitrogen which is essential for plant growth as well as other processes related to nitrogen metabolism. The low number, area and fresh weight of leaves of lettuce plants with none treated plants (control).

The presented data in tables 2 show clearly that all foliar potassium application which used in this study caused a promotion effect on plant growth (root fresh weight and root dry weight of lettuce plants compared with none treated plants (control).

Table 2: Effect of potassium fertilizer on vegetative growth of lettuce plants.

Treatments	Leaf number	Leaf area cm2	Leaf fresh weight g/plan	Leaf dry weight g/plant	Root fresh weight g/plant	Root dry weight g/plant
First season						
Control	55.08 c	6539.6 g	132.0 e	1.81d	11.35d	0.13d
50 Kg/fed K_2O	59.75 c	8757.6 d	260.0 d	2.67c	15.57c	0.16c
100 Kg/fed K_2O	62.78ab	10459.3c	326.6 c	3.46b	16.86bc	0.17c
150 Kg/fed K_2O	64.22 a	11789.6 c	388.0 ab	4.13a	18.57ab	0.20b
1% K_2O	60.50b	10333.6e	306.6 d	3.19b	17.43b	0.18c
2% K_2O	63.46ab	34649.0a	361.6 b	3.81b	18.34ab	0.64a
3% K_2O	64.15 a	11871.0b	394.3 a	4.29a	19.13a	0.27b
Second season						
Control	54.11 c	6534.0 f	131.3 e	1.82 e	11.33 f	0.13 d
50 Kg/fed K_2O	60.78b	8765.5 e	259.8d	2.67d	14.89 e	0.17 C
100 Kg/fed K_2O	63.23ab	11791.0 c	325.5 d	3.44ab	16.87 d	0.18 C
150 Kg/fed K_2O	61.87 b	11799.5 c	386.4ab	4.23 a	18.67 b	0.22 b
1% K_2O	61.34b	10452.7 d	304.3 c	3.20 C	17.45 c	0.19 c
2% K_2O	64.52ab	34659.7 a	359.9 b	3.87ab	18.53 b	0.65 a
3% K_2O	65.22 a	11881.0b	395.0 a	4.30 a	19.23 a	0.28 b

The values in the column having the same letter(s) are not significantly different at P= 0, 05 using LSD test.

Table 3: Effect of potassium fertilizer on quality of lettuce plants.

Treatments	Chlorophyll a	Chlorophyll b	Carotenoids	N-No3
First season				
Control	0.31c	0.12c	0.11d	1.52d
50 Kg/fed K_2O	0.37c	0.16b	0.14c	1.88c
100 Kg/fed K_2O	0.42b	0.20ab	0.17b	2.37b
150 Kg/fed K_2O	0.47ab	0.22a	0.20a	3.59a
1% K_2O	0.39c	0.18b	0.15c	2.44b
2% K_2O	0.49ab	0.22a	0.19b	3.30a
3% K_2O	0.51a	0.23a	0.21a	3.43a
Second season				
Control	0.32 e	0.12d	0.12d	1.41 d
50 Kg/fed K_2O	0.38 d	0.17 c	0.15 c	1.78 c
100 Kg/fed K_2O	0.42bc	0.22ab	0.18 b	2.38 b
150 Kg/fed K_2O	0.46 b	0.24 a	0.22 a	3.45ab
1% K_2O	0.40 c	0.19 b	0.16bc	2.56 b
2% K_2O	0.50ab	0.23 a	0.18 b	3.56ab
3% K_2O	0.52 a	0.24a	0.23 a	3.88 a

The values in the column having the same letter(s) are not significantly different at P= 0, 05 using LSD test.

Foliar spraying of lettuce plants had astatically significant on pigments (chlorophyll a,chlorophyll b and carotenoids) compared to control plants (tables 3).

The obtained results indicated that the best lettuce N, P, K, Ca and Mg contents of lettuce leaves was correlated with the plants that received the high level of potassium application during the two successive seasons. On the other hand the lowest values of growth were found in the control treatment (Table 4). Spraying lettuce plants with high level of potassium increased significantly lettuce root nutrient content(N, P, K, Ca and Mg contents). The highest value of lettuce root content was recorded in 3%in two study seasons. While the lowest value of than parameter was recorded in the control treatment (Table 4).

Table 4: Effect of potassium fertilizer on lettuce head and root nutrient content of lettuce plants.

Treatments	lettuce head nutrient content					lettuce root nutrient content				
	N%	P%	K%	Ca%	Mg%	N%	P%	K%	Ca%	Mg%
First season										
Control	1.73d	0.36d	4.36c	0.67c	0.24d	1.85d	0.49d	4.86e	0.74d	0.43d
50 Kg/fed K_{2O}	2.25c	0.55c	5.16b	0.85b	0.35c	2.45c	0.65c	5.37d	0.96c	0.64c
100 Kg/fed K_{2O}	2.58b	0.64b	6.38ab	0.89b	0.45b	3.65b	0.78b	5.87c	1.25b	0.72b
150 Kg/fed K_{2O}	2.91a	0.67ab	6.75ab	1.22a	0.49a	4.36ab	0.84a	6.49b	1.36a	0.85a
1% K_{2O}	2.61b	0.62b	5.91b	0.78b	0.41b	3.24b	0.75b	5.71c	1.15b	0.72b
2% K_{2O}	2.79b	0.68ab	6.82ab	1.13a	0.49a	4.57ab	0.82a	6.83b	1.35a	0.82a
3% K_{2O}	2.91a	0.71a	7.13a	1.29a	0.51a	4.88a	0.88a	7.21a	1.43a	0.89a
Second season										
Control	1.76d	0.35 c	4.44 c	0.66d	0.25d	1.86 e	0.50 d	4.92d	0.77 d	0.45 c
50 Kg/fed K_{2O}	2.22 c	0.54 b	5.20bc	0.84b	0.37 c	2.46 d	0.67 c	5.39cd	0.95 c	0.66 b
100 Kg/fed K_{2O}	2.54 b	0.65ab	6.34 b	0.88b	0.46 b	3.67 c	0.77 b	5.88 c	1.22 b	0.75 b
150 Kg/fed K_{2O}	2.89ab	0.68ab	6.77ab	1.23a	0.50 a	4.28 b	0.87ab	6.56b	1.38ab	0.84 a
1% K_{2O}	2.58b	0.61ab	5.87b	0.77 c	0.42 b	3.27 c	0.76 b	5.87 c	1.19 b	0.73 b
2% K_{2O}	2.82ab	0.66ab	6.98ab	1.34 a	0.50a	4.58 b	0.83ab	6.98ab	1.37ab	0.81ab
3% K_{2O}	2.94 a	0.73 a	7.23 a	1.28a	0.52a	4.89 a	0.89 a	7.23a	1.48 a	0.86 a

The values in the column having the same letter(s) are not significantly different at P= 0, 05 using LSD test.

Potassium acts as a catalyst or activator of enzymes and promotes growth [1]. This increased nutrients absorption leading to an increase in dry weights. These results are confirmed by [7, 11, 12]

Many studies have demonstrated benefits from foliar application to plants to alleviate stress Foliar K applications are supplemental to the major supply of nutrients through the roots.

From the obtained results it could be concluded that foliar spraying of the studied fertilization treatments caused an enhancement in plant growth parameters and nutrinte content of lettuce plant compared to control plant.

References

1. Buwalda, J.G., S.S. Rajan and J.C. Scheffer, 1987. Reducing fertilizer requirements for hybrid squash (Cucumber Maxima L.) with localized applications of phosphorus and potassium and use of partially acidulated phosphate rock. Fertilizer Research, 13: 169-180.
2. Choudhury, B., 1967. Vegetables. New Delhi: National Book Trust, pp: 176-179. Costat Software, 1985. User's Manual Version 3. Chort.Tusson, Arizona.
3. Erdogan, C., 2012. A leaf area estimation model for faba bean (Vicia faba L.) grown in the Mediterranean type of climate. Ziraat Fakültesi Dergisi - Süleyman Demirel Universitesi, 7(1): 58-63.
4. Faithfull, N.T., 2002. Methods in agricultural chemical analysis. A practical handbook. CABI Publishing. 84-95.

5. Geraldson, C.M. 1985. Potassium nutrition of vegetable crops.*In* Potassiumin Agriculture (Ed. R.D. Munson). ASA-CSSA-SSSA, Madison, WI.pp. 915- 927.
6. Gomez, K.A. and A.A. Gomez, 1984. Statistical procedures for agricultural research. John Willey and Sons, NEW York, pp: 680.
7. Hanan, S. Salm, M.R. Abd EL-moez and S.M. EL-ashry, 2008. Response of lettuce followed by sorghum to application of different types of phosphorus, compost and sulfur.
8. Lester, G.E., J.L. Jifon, and G. Rogers. 2005. J. Amer. Soc. Hort. Sci. 130:649-653.
9. Lichetoenthaler, H.K and A.R. Wellburn, 1983. Determination of total caroteniods and chlorophyll a and b of leaf extracts in different solvents. Biochem. Soc. Trans, 11: 591-952.
10. Marschner, H. 1995. Functions of mineral nutrients: macronutirents, p. 299-312.*In* H. Marschner (ed.). Mineral nutrition of higher plants 2nd Edition.Academic Press, N.Y
11. Mehala, H.L., E.A. Kirkby and M.S. Shaktawat, 2004. Effect of source and levels of phosphorus and FYM onyield attributes, yield and nutrient uptake of maize (*Zea mays* L.) Annals of Agric. Res., 25(4): 571-576.
12. Mengal, K. and E.A. Kirkby, 1987. "Principle of Plant Nutrition" International Potash Institute, Bern
13. Rebecca, B., 2004. Soil Survey Methods Manual. Soil Survey Investigations Report. No 42 Natural Resources Conservation Services.
14. Sanchez, C.A.; H.W. Burdine; V. L. Guzman and C.B. Hall (1987): Yield, quality and leaf nutrient composition of crisphead lettuce as affected by N, P and K on Histosios. Proc. of the Ann. Meeting of the Florida Stat Hort. Soc., 101:346-350(C.F. Hort. Abst., 61:6839).
15. Usherwood, N.R. 1985. The role of potassium in crop quality in Potassium in Agriculture (Ed. R.D. Munson).ASA-CSSA-SSSA, Madison, WI.pp. 489-513.
16. Yildirim, E., M. Guvene and A. Karata, 2007.Effect of foliar urea application on quality growth mineral uptake and yield of broccoli (*Brassica Oleracea* L.). Plant Soil Environ., 53(3): 1.

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