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EFFECT OF SOIL FERTILIZATION AND FOLIAR SPRAY OF POTASSIUM ON VEGETATIVE GROWTH AND YIELD AND ITS COMPONENTS OF SWEET POTATO

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ABSTRACT

Two field experiments were carried out at a farm in Dakaelte village neighbor the experimental farm of Faculty of Agriculture, Kafrelsheikh University during two successive summer seasons of both years 2008 and 2009. The main objective of this research was to study the effect of soil K levels fertilization (25, 50, 75 and 100 kg K_2O/fed and foliar spraying (twice) with K (zero and 0.5% K_2O equal 6 kg K_2O/fed.) on vegetative growth and root yield and its components of sweet potato cv. Abees. The experiment's design was a split-plot with four replications. K-sulphate fertilizer was used as soil and foliar fertilization.

The results indicated that, raising K levels from 25 up to 75kg K_2O/fed. significantly increased vegetative growth and roots yield. Application of either soil K level of 75kg K_2O/fed. (alone) or foliar spraying with K (twice) at concentration of 0.5% K_2O (alone) significantly increased vegetative growth characters (stem length, numbers of leaves and branches, leaf area/plant, vine fresh weight, dry matter(%) of vine and total chlorophyll of the 5^{th} leaf), total roots yield (as number, weight and increase %), marketable roots yield (as number, weight, increase % and percentage of marketable yield from the total yield) and average root weight for total yield, but application of either K levels of 75 and 100 kg K_2O/fed. or foliar spray of K significantly decreased non-marketable roots yield (as weight and decrease % and its percentage from the total yield).

The increases (%) in weight of total and marketable yields resulted from using 75 kg K_2O/fed. over low K level were 22.7 and 33.1% (as average of two seasons), respectively. Likewise, the increases % in total and marketable yields from using foliar spraying with K (at 0.5% K_2O) over the unsprayed were 18.9% and 25.1% (as average of two seasons), respectively.

The combined interaction between soil K levels fertilization and foliar K application caused non-significant effects on vegetative growth characters and root yield and its components on both seasons. Although interaction treatment of 75 kg K_2O/fed (as soil application) plus foliar spraying with K at 0.5% K_2O (equal 6 kg K_2O/fed) tended to increase most of the previous vegetative growth characters, total yield (42.7%), marketable yield (68.0%) and average root weight of total yield, but decreased non-marketable yield in both seasons. Such treatment of the interaction saved K fertilization by 19-25 kg K_2O/fed. compared with the high soil k level (100kg K_2O/fed.) alone or foliar K application .

Keywords: Sweet potato, *Ipomea batatas*, growth, yield, potassium levels, foliar K spray, fertilization, vegetable crops.

INTRODUCTION

Sweet potato (*Ipomea batatas* L. Lam) is a root crop in the family of *Convolvulaceae***.** It is grown for many uses. The sweet potato root is primarily used for human consumption because of its high nutritional value. Beside using its roots for human food and animal feed, both its vine and leaves are occasionally cooked as green vegetable. Recently, the roots are used in the industry for producing starch, sugar and ethanol alcohol (Byju and George, 2005). Sweet potato plant is grown extensively throughout Kafrelsheikh province with relatively medium yield (15.3 ton/fed.), such productivity is low and should be improved. The total area in Egypt and Kafrelsheikh were 29802 and 4951/feddans, respectively, according to statistics of M.A.L.R. (2009). Potassium is the most important nutrient element needed by sweet potato in terms of nutrient uptake per unit area and per unit tuber production (Byju and George, 2005).

Effect of K levels on sweet potato has been studied by many workers, their results indicated that increasing K levels from 0 to 100 kg or 150 kg K_2O/fed increased vegetative growth, total and marketable root yields (Fathy, 1979, Purcell *et al*., 1982; Wanas *et al*., 1993; Abdel-Razik and Gabbr, 1999; George *et al*., 2002; Etmain *et al*., 2002; Quan, 2007; El-Baky *et al*., 2010 and DaiXing *et al*., 2010. Foliar application of nutrients has several advantages compared with soil application. Foliar fertilization is more economical than root application due to the higher degree of applied nutrient utilization, which makes the nutrients more efficient. It is a quick and efficient method of supplying microelements in particular. It can however, also be used to satisfy acute needs of macro-elements. Moreover, some of soil fertilization problems can only be solved by foliar application (Alexander, 1986). Foliar application may also overcome the block of nutrient uptake and enrich the target organs (viz, the foliage) directly with appropriate amount of nutrients (Blachinski *et al*., 1996).

Recently, there is a great interest in foliar fertilization for vegetable crops due to the high cost of fertilizer materials concern for ground water quality, availability of new formulations of compounds, newer surfactants that increase efficiency of foliar absorption,..etc. are factors that give reason to consider this fertilization method (Hiller, 1995).

There are some researches about the effect of foliar fertilization on potato and tomato plants done by some investigators, they found that foliar spraying with 1% K_2O aqueous solution increased vegetative growth and yield of potato (El-Sawy *et al*., 2000 a, b and c) and tomato (Masoud, 1998 and El-Faramawy, 2002). However, there is no research has been done on the effect of foliar K application on sweet potato under Kafrelsheikh conditions (its soil having low K content and high pH, salts and Na content) (Table 1). Therefore, the main objective of this work was to study the effect of soil K levels fertilization and foliar spray of K on growth, root yield and its components of sweet potato plants.

MATERIALS AND METHODS

Two field experiments were carried out at a farm in Dakaelte village neighbor the experimental farm of the Faculty of Agriculture, Kafrelsheikh University during two successive summer seasons of both years 2008 and 2009. The main objective of this research was to study the effect of soil K levels and foliar spraying with K on growth, root yield and its components of sweet potato cv. Abees. The soil of the Experimental Farm had a clayey texture. Soil analyses were done according to Jackson (1967) and Piper (1950) are presented in Table (1).

Table (1):Some chemical properties of the experimental soil (0-30 cm depth)

Season	pH 1:2.5 soil water extract	Organic matter %	EC/25°C (mmhos/cm)	Soluble N, P, K and Na (mg/100 g soil)			
				N	P_2O_5	K_2O	Na
2008	8.0	1.5	3.3	3.5	1.5	5.8	32.2
2009	7.8	1.8	2.5	4.8	2.2	6.5	20.5

The treatment used:

Soil K fertilization levels:

Four potassium levels (25, 50, 100 kg K_2O/fed) were added to soil (as potassium sulphate 48% K_2O).

Amount of K fertilizer for each level were divided into two equal portions, the first was added to the soil as a side dressing after three weeks from the transplanting and the second was added seven weeks later.

Foliar K application:

Two concentrations of foliar application were used viz, zero and 0.5% K_2O (6 kg K_2O/fed) as potassium sulphate 48% K_2O. The K-sulphate fertilizer was divided into two equal portions and each portion dissolved in water, then the aqueous solution of K fertilizer sprayed twice at 60 and 75 days after transplanting.

The experiment included 8 treatments which were arranged in a split design with four replications. The four soil K levels were arranged at random in the main plots and the two concentrations of foliar K application were assigned at random to the sub-plots. Each experimental unit (17.75 m^2) consisted of five ridges, each ridge having 71 cm width and 5 m in length. Transplants (top and sub-top stem cutting, 20-25 cm length) were transplanted on April 1st in both seasons (2008 and 2009). Transplanting was done in hills (buried one node vertically in the soil) at space of 25 cm. Nitrogen was added as ammonium sulphate (21% N) at the level of 40 kg N/fed. and this quantity was divided into equal parts and applied as side dressing after three weeks and seven weeks from transplanting date. Phosphorus fertilizer (as calcium superphosphate 15.5% P_2O_5) was broadcasted during soil preparation at the level of 45 kg P_2O_5/fed. Other cultural practices (irrigation, weed and pests control) were done as locally recommended for sweet potato production.

Data recorded

Vegetative growth:

Five plants were randomly selected from two ridges of each experimental unit of 90 days after transplanting to determine the following vegetative growth characters. Plant length (cm), number of leaves, number of branches, fresh weight of vine/plant and dry matter percentage of vine. Plant leaf area (dm^2) was measured using leaf area meter

Total chlorophyll (mg/100 cm^2) content was determined using a SPAD-501 leaf chlorophyll meter on fully expanded leaves (the fifth leaf from the shoot growing tip) without destroying them (Marquard and Timpton, 1987).

Root yield and its components:

At harvesting time (120 days after transplanting) tuberous roots were taken from the two middle ridges of each experimental unit. The following roots yield and its components were recorded as total, marketable and non-marketable roots yields (as number and weight)/plant and /fedden, as well as percentage of marketable and non-marketable yields from the total roots yield (as weight). Increase % in total yield or marketable yield and increase % or decrease % in non-marketable yield (small and malformed roots) were calculated according to the following formula:

$$\text{Increase in yield} = \frac{\text{Treatment value - low K level or no K spray value}}{\text{Low K level or no K spray value}} x100$$

Average root weight was calculated in total and marketable roots yields. Number of transplants per feddan were 21281.

Data were tested by analysis of variance using Duncan's multiple range test (Duncan, 1955) for the comparison among treatment means.

RESULTS AND DISCUSSION

Effect of soil potassium levels:

Vegetative growth:

Data in Table (2) indicate that increasing K levels from 25 up to 75 kg K_2O/fed significantly increased stem length, number of leaves, number of branches/plant, plant leaf area, vine fresh weight, vine dry weight percentage (DM%) and total chlorophyll content of the 5^{th} leaf from shoot growing tip. Further increase in K level up to 100 kg K_2O/fed tended to insignificant effects in the previous characters of vegetative growth in both seasons. Whereas, the highest values of the previous vegetative growth characteristics were recorded when the sweet potato plants were fertilized with 75 kg K_2O/fed, followed by 100 kg K_2O/fed. without significant differences between them in both seasons. These results are in agreement with those obtained by El-Sawy *et al*. (2000 b & c) who found that increasing soil K application from 50 to 100 kg K_2O/fed. increased stem length, leaf area, number of leaves and number of main stems of potato plants. Moreover, Etman *et al*. (2002) and Sharaf El-Din (2002) reported that fertilization of sweet potato with K levels of 90 and 120 kg K_2O/fed (in presence NP) increased plant length, number of branches, vine, fresh weight and dry weights, total chlorophyll content of leaves, plant leaf area and net assimilation.

The improvement of vegetative growth of sweet potato resulting from adding K to soil at the level of 75 and 100 kg K_2O/fed might be due to both the levels were sufficient for optimum vegetative growth, where available K in the soil was higher after addition of K at either 75 or 100 kg K_2O than that the lower levels use (Byju *et al*., 2002). Moreover, it might be attributed to the role of K in several physiological and biochemical interior processes, i.e., it required for photosynthate, synthesis of simple sugars and starch, translocation of carbohydrate, reduction of nitrate and synthesis of proteins, particularly meristem tissues and normal cell division (Black, 1960 and Russell, 1988) which in turn led to increase dry matter and improve the growth.

Table (2):Effect of soil potassium levels on vegetative growth of sweet potato during 2008 and 2009 seasons.

Characters Treatments soil K levels (kg K_2O/fed)	Plant stem length (cm)	No. of leaves/ plant	No. of branches/ plant	Plant leaf area (dm^2)	Vine fresh wt./plant (g)	D.M. of vine %	Total chlorophyll (mg/100 cm^2)
2008 season							
25	165.2 c	216.1 c	22.4 c	209.16 d	1131.4 c	12.53 b	4.14 b
50	173.4 bc	230.6 bc	25.5 b	227.37 c	1290.0 bc	12.97 b	4.20 b
75	182.6 a	244.7 ab	28.1 a	272.83 a	1406.2 ab	13.80 a	4.33 a
100	179.2 ab	250.5 a	27.6 ab	248.78 b	1425.0 a	14.10 a	4.30 a
F. test	**	**	**	**	**	**	**
2009 season							
25	167.8 c	230.3 b	23.7 c	214.97 b	1247.15 c	13.62 c	4.22 b
50	175.7 b	275.7 a	25.7 b	229.25 b	1403.7 b	14.11 b	4.27 ab
75	182.4 a	300.6 a	27.4 a	268.55 a	1529.4 a	14.65 a	4.43 a
100	181.6 ab	293.2 a	26.8 ab	263.72 a	1516.8 a	14.24 ab	4.34 a
F. test	**	**	*	**	**	*	**

**** and * indicate significant differences at P<0.01 and P<0.05, respectively, according to F test.**
Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's test.

Root yield and its components:

Data in Table (3) show that the differences of total yield of storage roots (as number and weigh)/plant and /fed., marketable roots yield (as number and weigh)/plant and /fed. and non-marketable roots yield (as number and weight)/plant and /fed. were highly significant in both seasons. Raising K levels from 25 up to 75 kg K_2O/fed. increased total yield and marketable yield of roots. Further increase in K rate up to 100 kg K_2O/fed. tended to insignificant decreases in total roots yield (in both seasons) and marketable roots yield in the first season only, but fertilization of K at the level of 100 kg K_2O/fed. caused an insignificant increase in marketable roots yield in the second season. Similar results were obtained by many researchers working on K levels on root yield and its components of sweet potato (Purcell *et al*., 1982; Wanas *et al*., 1993; Etman *et al*., 2002; George *et al*., 2002; Sharaf El-Din,2002; Quan, 2007; DaiXing *et al*., 2010 and El-Bakry *et al*., 2010) and potato (El-Sawy *et al*., 2000 a, b & c).

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The heaviest total roots yield (as number and weight) and marketable roots yield (as number and weight) were produced from the plants fertilized with the level of 75 kg K_2O/fed., followed by the plants fertilized with level of 100 kg K_2O/fed., compared with low K level (25 kg K_2O/fed.) which had the lowest total and marketable roots yields in both seasons. Moreover, the increases percentage in weight of total roots yield which resulted from fertilizing K level of 75 kg K_2O/fed. over the low level of K (25 kg K_2O/fed.) were 21.9% in the first season and 23.4% in the second one with an average 22.65% for both seasons. Also, the increases percentage in weight of marketable roots yield which resulted from fertilizing levels of 75 and 100 kg K_2O/fed. over the low level of K (25 kg K_2O/fed.) were 32.4 and 26.8% in the first season and 35.7 and 40.0% in the second one with averages 34.1 and 33.4% (as av. both seasons), respectively.

It could be noticed that soil K fertilization at a rate of 75 kg K_2O/fed. was suitable level for producing the maximum total and marketable roots yield of sweet potato. The increment in total and marketable roots yield due to fertilizing the sweet potato plant with a rate of 75 kg K_2O/fed. may be attributed to increase in vegetative growth characteristics, i.e, number of leaves and leaf area (Mannan *et al*., 1992) (Table 2),subsequently enhancing photosynthesis and improving the translocation and accumulation of synthesized carbohydrates in the storage roots (Mishra *et al*., 1992 and El-Denary, 1998) causing their increase in size (George *et al*., 2002). The percentage of marketable roots yield from total roots yield (as wt.) was significantly increased with raising K levels from 25 up to 75 kg K_2O/fed. in the first season and up to 100 kg K_2O/fed. in the second one. The percentages of marketable roots yield from the total roots yield (as weight) resulted from using K levels of 75 and 100 kg K_2O/fed. were 86.7 and 84.1% in the first season and 89.8 and 93.8% in the second one, respectively, with averages 88.2 and 89% for both seasons, respectively.

As regards non-marketable roots yield, the differences of non-marketable (as weight and % from the total yield) were highly significant in both seasons. The highest non-marketable roots yield (as wt.) was recorded when the plants were fertilized with 25 and 50 kg K_2O/fed., but the lowest non-marketable roots yield was produced from using K levels of 100 and 75 kg K_2O/fed. in both seasons. However, number of roots for marketable yield was not significantly affected by soil K levels in both seasons. The percentages of non-marketable roots yield from the total roots yield (as weight) resulted from using K level of 75 and 100 kg K_2O/fed. were 11.8 and 11.0% (av. both seasons), respectively.

Average root weight for total and marketable yields was significantly affected by K levels in both seasons. Increasing K levels from 25 up to 75 kg K_2O/fed. increased average root weight of total yield, whereas the highest value was showed when the sweet potato plants were fertilized with K level of 75 kg K_2O/fed. compared with the other K levels, especially the lowest level of K (25 kg K_2O/fed.) which gave the lowest value in both seasons.

Similar results were obtained by Haque *et al*. (1998) who found that root fresh weight increased with increasing K rate (up to 120 kg K_2O/ha).

Likewise, El-Denary (1998) reported that adding K at the level of 110 kg K_2O/fed. increased root weight.

With respect to average root weight of marketable yield, it had no constant trend. Nevertheless, application of K at the level of 50 kg K_2O/fed. in the first season and 100 kg K_2O/fed. in the second one gave the highest average root weight of marketable yield.

Effect of foliar potassium application

Vegetative growth:

Data listed in Table (4) show that foliar application of K caused highly significant increases in vegetative growth characteristics, viz stem length, number of leaves, number of branches, leaf area/plant and vine fresh weight/plant, and it caused a significant increase in dry matter percentage (DM%) of vine and total chlorophyll content of the 5th leaf, compared with the unsprayed (control).

Table (4):Effect of foliar potassium sprays on vegetative growth characters of sweet potato during 2008 and 2009 seasons.

Characters Treatments soil K levels (kg K_2O/fed)	Plant stem length (cm)	No. of leaves/ plant	No. of branches/ plant	Plant leaf area (dm^2)	Vine fresh wt./plant (g)	D.M. of vine (%)	Total chl. (mg/100 cm^2)
2008 season							
No spray	170.5 b	205.8 b	21.0 b	217.91 b	1151.7 b	12.83 b	4.18 b
0.5% K_2O	179.7 a	265.1 a	30.8 a	261.15 a	1474.6 a	13.88a	4.30 a
F. test	**	**	**	**	**	*	*
2009 season							
No spray	172.7 b	259.3 b	21.5 b	221.90 b	1305.3 b	13.83 b	4.22 b
0.5% K_2O	181.0 a	290.6 a	30.3 a	266.35 a	1543.3 a	14.49a	4.41 a
F. test	**	**	**	**	**	*	*

0.5% K_2O = 6 kg K_2O/fed

**** and * indicate significant differences at $P<0.01$ and $P<0.05$, respectively, according to F test.**

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's test.

In the same line, many workers reported that foliar spraying with K significantly increased vegetative growth characters of potato (El-Sawy, 2000 a & b), eggplant (Al-Said and Kamal, 2005) and tomato (Masoud, 1998 and El-Faramay, 2002). Moreover, foliar application of K (in presence of N, P or other nutrients) increased vegetative growth characters of tomato and cucumber (Fath El-Bab, 2006) and cucumber plants (El-Sawy, 2007). The increment in vegetative growth characters due to foliar sprays with K (0.5% K_2O = 6 kg K_2O/fed.) may be attributed to the role of K in increase nitrate absorption by roots from external medium, activated 46 separate enzymes, protein synthesis (Bould *et al*., 1984) and enhancing photosynthesis and consequently dry matter production (FAO, 1984) and that led to increase plant leaf area and vine fresh and dry weight (Table 4).

Root yield and its components:

Data presented in Table (5) illustrate that foliar fertilization of K caused highly significant increases in total roots yield (as number and weight) and marketable roots yield (as number, weight and percentage from the total yield)/plant and /fed. when compared with the control (unsprayed) in both seasons.

On the other hand, foliar sprays with K led to a highly significant reduction in non-marketable roots yield (as weight and % from the total yield/plant and /fed.), compared with the unsprayed treatment which recorded the highest values of non-marketable characters in both seasons. In this concern, many researchers found that foliar application with K increased total and marketable yields, but it decreased unmarketable yield (Masoud, 1998 and El-Faramawy, 2002 on tomato; El-Sawy, 2000 a & b on potato and El-Sawy, 2007 on cucumber plants). The increase percentage in weight of total roots yield and marketable roots yields which resulted from using foliar K application over unsprayed (control) were 18.8 and 24.6% in the first season and 19.0 and 25.6% in the second one, with average 18.9 and 25.1% for both seasons, respectively. On the other hand, foliar sprays of K depreciated non-marketable by -6.4% in the first season and -18.2% in the second one with an average 12.3% for both seasons compare with the control,. The increment in total and marketable roots yield by foliar application of K may be due to stimulatory effect on vegetative growth characteristics (increasing number of leaf and branches, leaf area, chlorophyll content, … etc.) (Table 4) which led to increase photosynthesis and carbohydrates accumulation and in turn increased roots yield.

Foliar application of K resulted in highly significant increase in average root weight of total and marketable yields compared with the non-sprayed in both seasons. In this respect, Al-Said and Kamal (2005) found that foliar application of eggplant with 3 g/L of potassium citrate and 2 g of Fe chelats significantly increased average fruit weight. Also, El-Sawy (2007) recommended that foliar application with K citrate plus yeast significantly increased average fruit weight of cucumber.

Effect of interaction between soil K levels and foliar K application:

Vegetative growth

Data in Table (6) show that the combined interaction between soil K levels fertilization and foliar K application had no significant effects on vegetative growth characteristics, i.e., stem length, number of leaves, number of branches, plant leaf area, vine fresh weight/plant, vine dry matter % (DM%) and chlorophyll content of the 5^{th} leaf in both seasons. In spite of the fact that, the sweet potato plants fertilized with 75 kg K_2O/fed. (as soil) and sprayed with K at 0.5% K_2O (6 kg K_2O/fed.) tended to give the highest values for all the previous vegetative growth characteristics in both seasons. In the same line, El-Sawy (2000 b) found that the interaction between soil applied K levels and foliar K application had no significant effect on vegetative growth characters of potato plant. Although, using the combined interaction treatment of 100 kg K_2O/fed. (as soil) + foliar K application (1% K_2O) tended to give the highest stem length, number of main stems and number of branches of potato plant.

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Table (6):Effect the interaction between soil K levels and foliar K sprays on vegetative growth characters of sweet potato during 2008 and 2009 seasons.

Characters Treatments		Plant stem length (cm)	No. of leaves/ plant	No. of branches / plant	Plant leaf area (dm^2)	Vine fresh wt./plant (g)	D.M. of vine (%)	Total chl. (mg/100 cm^2)
Soil K levels Kg K_2O/fed.	K sprays (K_2O%)							
2008 season								
25	No. spray	160.6	198.8	18.2	188.90	1002.2	12.11	4.06
	0.5%	169.8	233.4	26.5	229.41	1260.6	12.95	4..22
50	No. spray	168.6	205.5	20.8	198.52	1123.0	12.75	4.12
	0.5%	178.2	255.6	30.2	256.21	1457.0	13.20	4..28
75	No. spray	176.8	208.8	22.8	256.92	1211.0	13.10	4..26
	0.5%	188.4	280.6	33.3	288.73	1601.3	15.50	4.40
100	No. spray	176.1	210.1	22.2	277.31	1270.6	13.34	4..29
	0.5%	182.2	290.8	33.0	270.24	1579.4	1 4.85	4..30
F-test		NS	NS	NS	NS	NS	NS	NS
2009 season								
25	No. spray	161.4	220.2	20.2	195.50	1181.3	13.25	4.14
	0.5%	174.2	240.4	27.1	234.44	1313.0	13.98	4..30
50	No. spray	172.7	260.6	21.5	208.11	1246.1	13.77	4.18
	0.5%	178.6	290.8	29.8	250.38	1561.3	14.44	4..36
75	No. spray	178.8	280.8	22.1	246.64	1407.7	14.32	4..28
	0.5%	185.9	320.4	32.6	290.46	1651.1	14.98	4..58
100	No. spray	178.0	275.7	22.0	237.33	1385.9	13.96	4..27
	0.5%	185.0	310.6	31.6	290.11	1647.7	14.52	4.40
F-test		NS	NS	NS	NS	NS	NS	NS

0.5% K_2O = 6 kg K_2O/fed.
NS indicates non- significant differences, according to F test.

Root yield and its components:

Data in Table (7) illustrate that combined interaction between soil K levels fertilization and foliar K application had non-significant effects on root yield and its components. Although, the sweet potato plants fertilized with K at the level of 75 kg K_2O/fed. (for soil) and sprayed (twice) with K at 0.5% K_2O (equal 6 kg K_2O/fed.) tended to give the highest total roots yield (as number and weight of roots and increase %, marketable roots yield (number and weight of roots, increase % and percentage from the total yield) and average root weight for total yield in both seasons. Regarding average root weight for marketable yield, the highest value of average root weight for marketable yield was recorded when the sweet potato were fertilized with K at the level of 50 kg K_2O/fed. and sprayed with K at concentration of 0.5% K_2O, followed by the combined interaction between 75 kg K_2O/fed. (for soil) and K spray at 0.5% in both seasons. However, the differences were highly significant in the first season only. In the same line, El-Sawy (2000b) indicated that the interaction between soil applied K levels and foliar K application had no significant effect on tuber yield of potato.

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Therefore, the best combined interaction treatment was 75 kg K_2O/fed (to soil) plus foliar sprays of K (twice)at 0.5% kg K_2O (equal 6 kg K_2O/fed.) where the total amounts of K in the previous treatment of interaction were 81 kg K_2O/fed. Hence, it was economic and better than soil K fertilization at high level (100 kg K_2O/fed.) alone or with foliar application of K at 0.5% K_2O (with sum 106 kg K_2O/fed.), and subsequently, and rationalization of K fertilization by 19-25 kg K_2O.

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تأثير التسميد الأرضى والرش الورقى بالبوتاسيوم على النمو الخضرى والمحصول ومكوناته للبطاطا

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أجريت تجربتان حقليتان فى حقل بقرية دقلت مجاور للحقل التجريبى بكلية الزراعة ، جامعة كفرالشيخ فى الموسمين الصيفين التاليين لعامى 2008 ، 2009م وكان الهدف الرئيسى من هذا البحث هو دراسة تأثير مستويات التسميد الأرضى بالبوتاسيوم عند المستويات 25 ، 50 ، 75 ، 100كجم بو$_{2}$أ للفدان، والرش الورقى بالبوتاسيوم (مرتين) عند التركيزين صفر ، 0.5% (بو$_{21}$أ والتى تعادل 6كجم بو$_{2}$أ/فدان) على النمو الخضرى والمحصول ومكوناته للبطاطا صنف أبيس.
وكان التصميم المستخدم هو تصميم القطع المنشقة فى أربع مكررات ، وقد استخدم سماد سلفات البوتاسيوم (48% بو$_{2}$أ) للتسميد الأرضى والتسميد بطريقة الرش الورقى.
ولقد أوضحت النتائج أن النمو الخضرى والمحصول زاد معنويا مع زيادة مستويات التسميد الأرضى بالبوتاسيوم من 25 إلى 75كجم بو$_{2}$أ/فدان أو التسميد الورقى (منفردا) بالبوتاسيوم عند تركيز 0.5% بو$_{2}$أ (مرتين) فى زيادة معنوية لكل من صفات النمو الخضرى (المتمثلة فى طول الساق ، عدد الأوراق ، وعدد الفروع ، والمساحة الورقية للنبات ، والوزن الطازج للعرش ، ونسبة

المادة الجافة بالعرش ، والمحتوى الكلوروفيلى الكلى للورقة الخامسة) ، ومحصول الجذور الكلى (وزن ، وعدد الجذور ، ونسبة الزيادة المئوية ، والمحصول الصالح للتسويق والتمثل فى عدد ووزن الجذور ، والنسبة المئوية للزيادة فى المحصول الصالح للتسويق ، ونسبة المحصول المسوق من المحصول الكلى ، ومتوسط وزن الجذر للمحصول الكلى ، وعلى العكس ، أدى استخدام أى من التسميد الأرضى بالبوتاسيوم عند كل من المستويين 75 ، 100كجم بو $_2$أ/فدان أو التسميد الورقى بالبوتاسيوم عند التركيز 0.5% بو $_2$أ فى خفض معنوى لمحصول الجذور الغير صالح للتسويق (وزن ونسبته المئوية) فى كل من الموسمين.

ولقد كانت النسبة المئوية للزيادة فى المحصول الكلى عند المستوى 75كجم/ بو $_2$أ/فدان هى: 22.7 ، 33.4% على التوالى ، وذلك مقارنة بمعاملة التسميد الأرضى بالبوتاسيوم عند المستوى المنخفض 15كجم بو $_2$أ/فدان ، وأيضا كانت النسبة المئوية للزيادة فى المحصول الكلى والمحصول الصالح للتسويق للجذور (كمتوسط للموسمين) الناتجة عن التسميد الورقى بالبوتاسيوم عند التركيز 0.5% بو$_2$أ هى: 18.9 ، 25.1% وذلك بالمقارنة بدون رش.

ولقد تسبب التفاعل المشترك بين مستويات التسميد الأرضى بالبوتاسيوم والرش الورقى بالبوتاسيوم فى تأثير غير معنوى على كل من الصفات النمو الخضرى والمحصول ومكوناته ، وبالرغم من ذلك اتجهت معاملة التفاعل المشترك بين مستوى التسميد الأرضى بالبوتاسيوم عند المعدل 75كجم بو$_2$أ/فدان والتسميد الورقى بالبوتاسيوم عند التركيز 0.5% بو$_2$أ رشا مرتين (يعادل 6كجم بو $_2$أ/فدان) إلى زيادة كل من معظم صفات النمو الخضرى والمحصول الكلى للجذور (42.7%) ، والمحصول الصالح للتسويق (68%) ومتوسط وزن الجذور للمحصول الكلى ، واتجهت تلك المعاملة لتقليل محصول الجذور الغير صالح للتسويق فى كل من الموسمين وبالتالى رشدت تلك المعاملة ووفرت فى تسميد البوتاسيوم بـ 19-25كجم بو $_2$أ/فدان، وذلك بمقارنة بمعدل العالي من التسميد البوتاسي الارضي (100 كجم بو$_2$أ/فدان) بمفرده او مع الرش الورقي بالبوتاسيوم .

قام بتحكيم البحث

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Table (3):Effect of soil potassium levels on total, marketable and non-marketable roots yields of sweet potato during 2008 and 2009 seasons.

Characters	Total roots yield					Marketable roots yield						Non-marketable roots yield (small and malformed roots)				
Treatments soil K levels (kg K_2O/fed.)	No. of roots/ plant	Wt./ plant (g)	Increase %	Wt. /fed (ton)	Av. root wt. (g)	No. of roots/ plant	Wt./ plant (g)	Increase %	Wt./fed (ton)	% from total yield (as wt)	Av. root wt. (g)	No. of roots/ plant	Wt/ plant (g)	Decrease or increase %	Wt./ fed. (ton)	% from total yield (as wt)
2008 season																
25	6.4 b	946.2 b	0.0	20.130 b	147.8 b	4.9 b	755.4 c	0.0	16.076 c	79.84 c	154.2 b	1.5	190.8 a	0.0	4.060 a	20.16 a
50	6.9 a	1098.4 a	16.1	23.375 a	159.2 a	5.4 b	900.3 b	19.2	19.159 b	82.00 b	166.7 a	1.5	198.1 a	3.8	4.216 a	18.00 b
75	7.1 a	1153.1 a	21.9	24.539 a	162.4 a	6.1 a	1000.0 a	32.4	21.281 a	86.70 a	163.9 a	1.0	153.1 c	-19.8	3.260 b	13.3 d
100	7.1 a	1133.3 a	20.3	24.224 a	160.3 a	5.9 a	957.8 ab	26.8	20.383 ab	84.10 a	162.3 a	1.2	180.6 b	-5.3	3.843 b	15.90 c
F. test	*	**		**	**	*	**		**	*	*	N.S.	**		*	*
2009 season																
25	6.9 b	980.7 b	0.0	20.870 b	142.1 a	5.7 c	800.5 c	0.0	17.035 c	81.63 c	140.4 b	1.2	180.2 a	0.0	3.835 a	18.37 a
50	7.7 a	1089.8 ab	11.1	23.192 ab	141.0 a	6.5 b	905.0 b	13.1	19.259 b	83.04 bc	139.2 b	1.2	184.8 a	2.6	3.933 a	16.96 b
75	8.2 a	1210.6 a	23.4	25.763 a	147.5 a	7.1 a	1086.6 a	35.7	23.124 a	89.80 ab	153.0 a	1.1	124.0 b	-28.4	2.639 b	10.20 c
100	8.1 a	1194.7 a	21.8	25.424 a	147.5 a	7.1 a	1120.9 a	40.0	23.854 a	93.80 a	157.9 a	1.0	73.9 c	-59.0	1.573 c	6.20 d
F. test	**	**		**	**	**	**		*	**	**	NS	**		**	**

***** and NS indicate significant differences at P<0.01 , P<0.05 and not significant, respectively, according to F test.**
Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's test.

Table (5):Effect of foliar potassium sprays on total, marketable and non-marketable roots yields of sweet potato during 2008 and 2009 seasons.

Characters	Total roots yield					Marketable roots yield						Non-marketable roots yield (small and malformed roots)				
Treatments Soil K levels (kg K_2O/fed.)	No. of roots/ plant	Wt./ plant (g)	Increase %	Wt. /fed (ton)	Av. root wt. (g)	No. of roots/ plant	Wt./ plant (g)	Increase %	Wt./fed (ton)	% from total yield (as wt)	Av. root wt. (g)	No. of roots/ plant	Wt/ plant (g)	Decrease or increase %	Wt./ fed. (ton)	% from total yield (as wt)
2008 season																
No spray	6.4 a	991.0 b	00.0	21.089 b	154.8 b	5.2 b	804.3 b	0.0	17.116 b	81.16 b	154.7 b	1.2	186.7	0.0	3.973	18.84 a
0.5% K_2O	7.3 a	1177.0 a	18.8	25.048 a	161.2 a	6.0 a	1002.4 a	24.6	21.332 a	85.17 a	167.1 a	1.4	174.6	-6.4	3.716	14.83 b
F. test	**	**		**	**	*			**	**	**	NS	NS		NS	*
2009 season																
No spray	7.2 b	1022.1 b	0.0	21.751 b	142.0 b	6.1 b	867.3 b	0.0	18.457 b	84.85 b	142.2 b	1.1	154.8 a	0.0	3.294 a	15.15 a
0.5% K_2O	8.2 a	1215.8 a	19.0	25.873 a	148.3 a	7.1 a	1089.2 a	25.6	23.180 a	89.58 a	153.4 a	1.1	126.6 b	-18.2	2.694 b	10.42 b
F. test	*	*		**	**	*	**		**	**	**	NS	*		*	*

**** ,* and NS indicate significant differences at P<0.01, P<0.05 and not significant, respectively, according to F test.**
Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's test.

Table (7):Effect of the interaction between soil K levels and foliar potassium sprays on total, marketable and non-marketable roots yields of sweet potato during 2008 and 2009 seasons.

Characters		Total roots yield					Marketable roots yield						Non-marketable roots yield (small and malformed roots)				
Soil K level kg K_2O/fed	K spray K_2O%	No. of roots/ plant	Wt./ plant (g)	Increase %	Wt. /fed (ton)	Av. root wt. (g)	No. of roots/ plant	Wt./ plant (g)	Increase %	Wt./fed (ton)	% from total yield (as wt)	Av. root wt. (g)	No. of roots/ plant	Wt/ plant (g)	Decrease or increase %	Wt./ fed. (ton)	% from total yield (as wt)
2008 season																	
25	0.0%	6.1	891.2	00.0	18.966	146.1	4.6	690.5	0.0	14.695	77.48	150.2 d	1.5	200.7	0.0	4.271	22.5
	0.05%	6.7	1001.2	12.3	21.307	149.4	5.2	820.2	18.8	17.455	81.92	157.7 c	1.5	181.0	-9.8	3.852	18.1
50	0.0%	6.2	976.6	9.6	20.783	157.5	5.2	780.3	13.0	16.606	79.90	150.1	1.0	196.3	0.0	4.177	20.10
	0.05%	7.6	1220.2	36.9	25.967	160.6	5.6	1020.3	47.8	21.713	83.62	182.2 a	2.0	199.9	1.8	4.254	16.38
75	0.0%	6.6	1055.8	18.5	22.468	160.0	5.6	870.8	26.1	18.531	82.48	155.5 c	1.0	185.0	0.0	3.937	17.52
	0.05%	7.6	1250.4	40.3	26.610	164.5	6.6	1129.1	63.5	24.028	90.30	171.1 b	1.0	121.3	-34.4	2.581	9.70
100	0.0%	6.7	1040.4	16.7	22.141	155.3	5.4	875.5	26.8	18.632	84.17	162.1 c	1.3	164.9	0.0	3.509	15.83
	0.05%	7.4	1236.2	38.7	26.308	167.1	6.4	1040.0	50.5	22.132	84.13	162.5 c	1.0	196.2	19.0	4.175	15.87
F. test		NS	NS		NS	NS	NS	NS		NS	NS	**	NS	NS		NS	
2009 season																	
25	0.0%	6.7	910.8	0.0	19.383	135.9	5.5	720.5	0.0	15.333	79.11	131.0	1.2	190.3	0.0	4.050	20.89
	0.05%	7.0	1050.5	15.3	22.356	150.1	5.9	880.5	22.2	18.738	83.82	149.0	1.1	170.0	-10.7	3.618	16.18
50	0.0%	7.2	988.6	8.5	21.038	137.3	6.0	810.0	12.4	17.238	81.93	135.0	1.2	178.6	0.0	3.800	18.07
	0.05%	8.1	1190.9	30.8	25.344	147.0	7.0	1000.0	38.8	21.281	83.97	142.9	1.1	190.9	6.9	4.063	16.03
75	0.0%	7.5	1100.4	20.8	23.418	146.7	6.4	930.0	29.1	19.791	84.51	145.3	1.1	170.4	0.0	3.626	15.49
	0.05%	8.8	1320.8	45.0	28.108	150.0	7.8	1243.2	72.5	26.457	94.12	159.4	1.0	77.6	-54.5	1.651	5.88
100	0.0%	7.4	1088.6	19.5	23.166	147.1	6.4	1008.6	40.0	21.464	92.65	157.6	1.0	80.0	0.0	1.702	7.35
	0.05%	8.7	1300.8	42.8	27.682	149.5	7.7	1233.1	71.1	26.242	94.80	160.1	1.0	67.7	-15.4	1.440	5.20
F. test		NS	NS		NS	NS	NS	NS		NS	NS	NS	NS	NS		NS	NS

**** and NS indicate significant differences at $P<0.01$ and not significant, respectively, according to F test.**

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's test.