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EFFECT OF SOIL FERTILIZATION AND FOLIAR SPRAYS OF POTASSIUM ON QUALITY, AND STORAGE ABILITY OF SWEET POTATO ROOTS.

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ABSTRACT

The experiments were carried out at a private farm in Dakaelte village neighbor the experimental farm of Faculty of Agriculture, Kafrelsheikh University, Egypt during two successive summer seasons 2008 and 2009. The main objective of the research was to study the effect of soil application of different potassium levels (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 quality (morphological characters and chemical constituents) and storage ability of sweet potato roots cv. Abees. The experimental design was a split-plot with four replications. Potassium sulphate fertilizer was used for soil and foliar application.

The results indicated that, increasing soil K levels from 25 up to 100 Kg K_2O/fed. Significantly increased root diameter, dry matter, total carbohydrates , crude protein, carotene ,vitamin C contents of roots and K content of leaves and roots. Likewise, increasing K levels up to 75kg K_2O/fed. significantly increased total sugars content of roots. On the contrary, raising K levels from 25 up to 100 significantly decreased root length, root shape index, (L/D ratio), nitrate content, total weight loss (%)and decay percentage of roots and retarded sprouting date root in both seasons. Foliar application of K significantly increased root diameter, dry matter (%) , total sugars , total carbohydrates , crude protein vitamin C contents of roots and K content of leaves and roots. However, it significantly decreased root length, root shape index (L/D ratio) nitrate content, total weight loss (%) and decay percentage of root and retarded sprouting date of root compared with the control (no spray) in both seasons. K spray did not effect on roots carotene content in both seasons.

The combined interaction between soil K levels and foliar application of K had insignificant effects on quality (morphological characters and chemical constituents) and storage ability of roots in both seasons.

Keywords: Sweet potato , *Ipomoea batatas*, potassium level , foliar potassium spray, fertilization, chemical constituents , storage ability , quality, vegetable crops.

INTRODUCTION

Sweet potato (*Ipomoea 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. Besides using its roots for human food and animal feed, both of 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 exten- sively through Kafrelsheikh province with relatively medium yield (15.3 ton/fed.) such productivity is low and should be improved. The total cultivated 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.

Effect of K levels on sweet potato has been studied by many researchers, their results indicated that increasing levels of potassium increased diameter of roots (Haque *et al*., 1998) dry matter of roots (George *et al*., 2002), total sugars content (Wanas *et al*., 1993), starch content (Sharfuddin and voican, 1984, Wanas *et al*., 1993 and Patil *et al*., 2006), total carbohydrates content (Etman *et al*. 2002)., crude protein content (Sharfuddin and Voican 1984; Patil *et al*. 1990 and Etamn *et al*., 2002), carotene content George *et al*., 2002), potassium
content (Padmaja and Raju 1999) and storage ability of roots (Wanas *et al*., 1993; El-Denary, 1998 and Etman *et al.,* 2002).

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).

The effect of foliar K fertilization on potato and tomato plants was studied by many investigators, they found that foliar spraying with potassium solution increased dry matter of potato tuber (El-Sawy, 2000c), total sugars and vitamin C of tomato fruit, (Hewedy 1988 and Adam *et al*., 1996) and potassium content of potato tubers (El-Sawy *et al*., 2000b). However, there is no research has been carried out to study the effect of foliar application of K on sweet potato under Kafrelshiekh conditions (its soil had high pH, Na and salts and low K content, Table 1).
Therefore, the main objective of this research was to study the effect of soil K level fertilization and foliar spray of K on morphological characters, chemical constituents and storage ability of sweet potato roots.

MATERIALS AND METHODS

Two field experiments were carried out at a private farm in Dakaelte village neighbor the permanent farm of the faculty of Agriculture, Kafrelsheikh University, Egypt during two successive summer seasons 2008 and 2009. The main objective of this research was to study the effect of soil K levels and foliar spraying with K on quality (morphological and chemical constituents) and storage ability of sweet potato roots cv. Abees. The soil of the Experimental farm is 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/25c^o mmhos(cm)	Soluble N,P,K and Na (mg/100g 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, 75, 100 kg K_2O/fed) were added to soil (as potassium sulphate fertilizer, 48% K_2O):

Amount of K fertilizer for each level was divided in 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.

1.2 Foliar K application: Two concentration of foliar application were used viz, zero and 0.5% K_2O (6kg K_2O/fed as potassium sulphate fertilizer, 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-plot 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 (17.75m^2) consisted of five ridges, each ridge was 71cm in width and 5m in length. Top and sub-top stem cutting (20-25 cm length) were transplanted on April 1st in both seasons (2008 and 2009). Stem cuttings were set up at 25 cm apart (buried one node vertically in the soil) .

Nitrogen was added as ammonium sulphate fertilizer (21% N) at the level of 40 Kg N/fed, and this quantity was divided into two equal parts and applied as side dressing after three 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 45kg P_2O_5/fed. Other cultural practices (irrigation and weeds and pests control) were carried as locally recommended for sweet potato production.

Data recorded:

Morphological characters such as root length (L), root diameter(D) and root shape index (L/ D ratio):

Chemical constituents:

potassium content in dry weights of roots and leaves (the fifth leaf from the shoot growing tip) was determined using a flame photometer (Jackson 1967). Moreover, chemical constituents of fresh and dry weights of roots were determined as follows: dry matter was recorded. Total sugars contents were determined according to Nelson (1974). Total carbohydrates content was determined according to Dubais *et al*., (1956). Nitrogen content was estimated using the semi- Micro Kjeldhle method (Piper, 1950), then crude protein content was calculated using the factor (N x 6.25) as described by Pregl (1945). Carotene content was assayed according to Wettstein (1957). Vitamin C content (as ascorbic acid was determined as described in A.O.A.C. (1980). Nitrate content (ppm) was determined in the fresh roots according to method of Cataldo *et al.,* (1975).

Storage ability (shelf life): twenty marketable storage roots were taken randomly from each experimental plot and cured for one week, then packed in net plastic bags and stored (for 90 days) at normal room temperature (25-28^{o}C) and 60-65% RH. Determinations of weight loss (%) and decay (%)

were calculated according to the following formula: weight loss (%) = (initial weight- weight at sampling date x 100) / initial weight of roots.

Decay (%) = number of decayed roots x 100/total roots number.

Determination of sprouting (as number of days from storage date till sprouting of the first root) was achieved. Weight loss (%) was recorded at 30 days after storage date.

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
Roots quality
Morphological characteristics

Data listed in Table (2) indicate that the differences in root length and root shape index (L/D ratio) were significant in both seasons, as both characters were decreased with increasing K levels from 25 up to 100kg K_2O/fed. in both seasons, hence the tallest root and the highest value of root shape index were resulted of fertilization with the low level of K (25 K_2O/fed.) compared with the other K levels, especially the highest level of K (100 kg K_2O/fed.) which gave the lowest values of both root length and root shape index (L/D ratio) in both seasons. Similar results were obtained by El-Denary (1998), Haque *et al.,* (1998) Etman *et al*. (2002) and Sharaf El-Din (2002).

Table (2): Effect of soil K levels fertilization on morphological characters, storage ability and K content of sweet potato roots and leaves during 2008 and 2009 seasons

Characters / Treatments K level (K_2O/fed.)	Root morphological characters			Roots storage ability			K content (%)		Roots NO_3 in f.w. (ppm)
	Length (cm)	Diameter (cm)	Shape index (l/D ratio)	Decay (%)	Weight loss (%)	Sprouting date (days)	Leaves	Roots	
	2008 season								
25	17.6a	5.1b	3.5a	14.5a	17.35a	55.5d	2.66c	1.38b	121.4a
50	17.3ab	5.2b	3.3ab	10.7b	16.38a	65.5c	2.92b	1.56a	118.0b
75	16.9b	5.5a	3.1bc	7.9c	12.53b	79.0b	3.11ab	1.64a	103.7c
100	16.8b	5.7a	2.9c	6.5c	12.53b	86.5a	3.25a	1.69a	95.7d
F test	*	*	*	**	*	**	*	*	**
	2009 season								
25	17.9a	5.4c	3.3a	11.9a	16.24a	60.0c	2.70c	1.45b	117.0a
50	17.60b	5.7bc	3.1ab	7.3b	15.88a	67.5b	2.94bc	1.60a	114.6a
75	17.4bc	6.1ab	2.9bc	4.8c	13.59b	81.5a	3.24ab	1.67a	103.2b
100	17.2c	6.2a	2.8c	3.2c	13.64b	82.5a	3.37a	1.67a	94.2c
F test	*	**	*	**	*	**	*	*	**

With respect to root diameter, it was significantly increased with increasing K levels from 25 up to 100 kg K_2O/fed., hence the highest and next highest root diameter values were obtained from fertilization with the high K Levels 100 and 75 kg K2O/fed., respectively, with insignificant differences between them in both seasons. These results are in agreement with those obtained by El-Denary (1998), Etman *et al*., (2002) and Sharaf El-Din (2002). Haque *et al.,* (1998) found that increasing K levels from 0 up to 150kg K_2O/ha increased root diameter of potato.

The increase in root diameter as a result of K application was due to the increase in plant leaf area (El-Sawy, 2011; under publishing) and root: top ratio which led to greater amount of photosynthetic translocation to the storage roots causing their increase in size (Russell, 1988 and George *et al*, 2002).

Chemical constituents:

Dry matter content (D.M. %):

Data presented in Table (3) show that the differences were highly significant in both years. Therefore, raising K levels from 25 up to 100 kg K_2O/fed. increased dry matter percentage of storage roots in both seasons. Hence, the highest and next highest dry matter (%) in storage roots were recorded in sweet potato plants which were fertilized with 100 kg and 75 kg K_2O/fed (without significant differences between them). However, the lowest value of dry matter (%) was recorded from using the low level of K (25 kg K_2O/fed.) in both seasons. Similar results were obtained by many workers (El-Sawy *et al*., 2000b on potato and Etman *et al*., 2002; George *et al*., 2002 and Sharaf El-Din, 2002).on sweet potato.

The favorable effect of K fertilization may be due to its role in plant leaf area (El-Sawy, 2011) enhancing photosynthesis, improving the translocation and accumulation of synthesized carbohydrates in roots (Mishra *et al*., 1992 and El-Denary, 1998).

Table (3): Effect of soil potassium levels fertilization on chemical constituents of potato roots during 2008 and 2009 seasons

Characters / Treatments / K level (K_2O/fed.)	D.M. of roots %	Total sugars (%)		Total carbohydrates (%)		Crude protein (%)		Vit.C mg/100g (fresh wt.)	Carotene mg/100g (fresh wt.)
		In dry wt.	In fresh wt.	In dry wt.	In fresh wt.	In dry wt.	In fresh wt.q		
	2008 season								
25	21.53c	9.54b	2.06b	79.40c	17.1c	4.73c	1.02c	19.88c	7.39b
50	22.61bc	9.83b	2.22ab	79.81bc	18.0bc	4.88bc	1.10bc	20.49bc	7.79b
75	23.78ab	10.73a	2.56a	80.22bc	18.9ab	5.35ab	1.28ab	21.02ab	9.11a
100	24.53a	10.50a	2.56a	80.86a	19.85a	5.75a	1.41a	21.54a	9.40a
F. test	**	*	*	*	*	*	*	*	**
	2009 season								
25	23.03c	10.77b	2.48b	79.82b	18.4c	4.83c	1.11b	20.74b	7.54b
50	24.76bc	11.09b	2.75b	80.14b	19.8bc	5.06bc	1.26b	21.17a	7.96b
75	26.83a	12.05a	3.25a	80.69a	21.7ab	5.54ab	1.49a	21.42a	9.24a
100	26.99a	11.89a	3.21a	80.96a	21.9a	5.90a	1.60a	21.39a	9.86a
F. test	**	*	*	*	*	*	*	*	**

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

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

Total sugars content (%):

Data in Table (3) reveal that total sugars (%)of roots were significantly increased with raising K level from 25 kg up to 75 kg K_2O/fed. However, further increase in K level up to 100kg K_2O/fed tended to insignificant decrease this parameter in both seasons. Where the highest value of total sugars was recorded with applying K level of 75 kg K_2O/fed. followed by using the high K level (100 kg K_2O/fed.) compared with the low K level (25kg K2O/fed.) which had the lowest values of total sugars % (in fw and dw) in both seasons. In this concern, many researchers reported that increasing K level (in combined with NP) increased total sugars content of sweet potato roots (Abdel-Razik and Gabr 1999; Etman *et al*., 2002 and Sharf El-Din, 2002).

The increase in total sugars of sweet potato roots (in fw and dw) by soil K fertilization at the level of 75 kg K2O/fed. may be a resultant of increase in leaf area (YiBing *et al*., 2006) and net assimilation rate (Chakrabarty *et al*., 1993) subsequently increase in total sugars of storage roots.

Total carbohydrates content (%):

Date in Table (3) indicate that raising K level from 25 up to 100 kg K_2O/fed. significantly increased total carbohydrates content (%) of roots in both season. Thus, the highest and next highest total carbohydrates percentage of roots were resulted from application of 100 and 75 kg K_2O/fed., respectively, (with insignificant differences between them) compared with the low level of K (25 kg K_2O/fed.) which had the lowest value of total carbohydrates (%) of roots in both seasons. Similar results were obtained by El-Denary (1998), Abdel-Razik and Gabr (1999), Etman *et al*., (2002), Sharaf El-Din (2002) and Patil *et al*., (2006). The improving effect of both K levels (75 and 100 kg K_2O/fed.) on total carbohydrates content in roots may be due to that K is required for synthesis of simple sugars and starch and translocation of sugars from leaves to roots (Russell, 1988).

Crude protein content (%):

Data in Table (3) show that increasing K level from 25 up to 100 kg K_2O/fed. significantly increased crude protein content (%) of roots in both seasons. Applying 100 and 75 kg K_2O/fed. to the soil produced roots having the highest and next highest values of crude protein content, respectively, (with insignificant difference between them), but the lowest crude protein content was obtained from using the low K level (25 kg K_2O/fed.) in both seasons. In this concern, many researches demonstrated that increasing K levels (in the presence N or NP) increased crude protein of sweet potato roots (Sharfuddin and Voican 1984; Patil *et al*., 1990; Etman *et al*., 2002 and Sharf El-Din, 2002). The favorable effect of K application on crude protein in the roots may be due to its role in protein content (Russell, 1988).

Carotene content (%):

Data in Table (3) indicate that raising K levels from 25 up to 100 kg caused a highly significant increase in carotene content of roots in both seasons. The highest value of carotene content was recorded when the sweet potato plants were fertilized with K at the rates of 100 kg K_2O/fed. Followed by 75kg K_2O/fed., respectively, (with insignificant difference between them) compared with the low K rate which had the lowest value of carotene in both seasons. In the same line, George *et al*., (2002) reported that carotene content of sweet potato roots increased with increasing K application.

Vitamin C content:

Data in Table (3) show that fertilization of sweet potato plants with K at both levels of 75 and 100 kg K_2O/fed. significantly increased vitamin C content of roots compared with the low K level which recorded the lowest value of vitamin C in both seasons. In this respect, many researchers found that application of K improved vitamin C content of tomato fruits (Dimitrov and Rankov, 1979; Khalil, 1982 and Hewedy, 1988).

Potassium content:

Data in Table (2) show that potassium content in leaves and roots was significantly and gradually increased with increasing K level from 25 up to 100kg/fed. in both seasons. Therefore, the highest and next highest K contents (%) in leaves and roots was resulted from using K levels of 100 and 75 kg K_2O/fed. (with insignificant differences between them) compared with the low level (25 kg K_2O/fed.) which had the lowest values of K content in leaves and roots in both seasons. These results are in accordance with those obtained by Mukhopadhyay and Sen, (1993), Etman *et al*., (2002) and Sharaf El-Din (2002) on sweet potato and El-Sawy *et al*., (2000a) on potato. Likewise, Padmaja and Raju (1999) reported that increasing K rate increased K concentration and total K of sweet potato.

Nitrate content:

Data in Table (2) indicate that nitrate content in root was significantly decreased with increasing N level from 25 up to 100 kg K_2O/fed. in both seasons. Thus, the lowest nitrate content was obtained from fertilizing K at the level of 100 kg K_2O/fed., but the highest NO_3 content was found with K at the level of 25 kg K_2O/fed. in both seasons. Similar results were obtained by El-Sawy (2000a)

The favorable effect of K fertilization on decreasing nitrate content of roots may be due to the role of K in stimulate the activity of nitrate reductase (Beringer, 1979) and it more efficient in the reduction of NO_3 and conversion of amino acids into proteins.

Storage ability:

Total weight loss %:

Data listed in Table (2) reveal that application of K at both levels of 75 and 100 kg K_2O/fed. caused a significant decrease in percentage of total weight loss of roots compared with the other levels, especially at low level of K (25 kg K_2O/fed.) which recorded the highest weight loss (%)in both seasons. The obtained results are harmony with those reported by Wanas *et al*., (1993), Etman *et al*., (2002) and sharaf El-Din (2002) on sweet potato. Likewise, Okwuowulu and Asiegbu (2002) showed that K fertilizer application did not significantly induce more loss in weight of sweet potato roots.

Decay percentage:

Data in Table (2) indicate that raising K levels from 25 up to 100 kg K_2O/fed. significantly decreased decay percentage of roots in both seasons.

Therefore, the lowest decay percentage of roots was achieved when the sweet potato plants were fertilized the high level of K (100 kg K_2O/fed.) compared with the low level of K (25 kg K_2O/fed.) which recorded the highest percentage of decay in roots in both seasons. In the same line, many investigators noted that increasing K levels (in the presence N or NP) reduced decay percentage of sweet potato roots (Wanas *et al*., 1993; El-Shimi, 1996; El-Denary, 1998; Etman *et al*., 2002 and Sharaf El-Din, 2002).

Sprouting date:

Data in Table (2) reveal that application of K at high level (100 kg K_2O/fed.) caused a highly significant delay in sprouting of the first root compared with the other K levels, especially at the low level of K (25 kg K_2O/fed.) which hastened the sprouting of the first root. Similar results were obtained by El-Gamal (1988) and El-Sawy *et al*., (2000b) who showed that K fertilization retarded and decreased sprouting of potato tubers. The reduction of roots sprouting may be due to increase in K content, K: N ratio and K: P ratio in roots (El-Sawy *et al*., 2000b). Moreover, Okwuowulu and Asiegbu (2000) showed that K fertilizer application increased duration of storage to three months and decreased rate of sprouting.

Effect of foliar potassium application:

Roots quality:

Morphological characteristics:

Data in Table (4) show that foliar application of K decreased root length and root shape index compared with the unsprayed control in both seasons, such reduction in both characters was significant in the second season only. On the other hand, foliar spray with K significantly increased root diameter higher than that of unsprayed control in both seasons.

Table (4): Effect of foliar application of K on morphological characters storage ability and K content of sweet potato roots during 2008 and 2009 seasons.

Characters / Treatments / K spray (K_2O)	Root morphological characters			Roots storage ability			K content (%)		Roots NO_3 in f.w. (ppm)
	Length (cm)	**Diameter (cm)**	**Shape index (l/D ratio)**	**Decay (%)**	**Weight loss (%)**	**Sprouting date (days)**	**Leaves**	**Roots**	
	2008 season								
0.0 (cont.)	17.2	5.3	3.3	10.73a	15.82a	66.3b	2.86b	1.49b	113.8a
0.5%	17.1	5.5	3.1	9.18b	13.50b	77.0a	3.10a	1.64a	105.6b
F test	**NS**	**NS**	**NS**	*	*	**	*	*	*
2009 season									
0.0 (cont.)	17.7	5.67b	3.1a	7.83a	16.37a	66.5b	2.91b	1.54b	111.8a
0.5%	17.4	6.00a	2.92b	5.73b	13.30b	79.3a	3.21a	1.66a	102.7b
F test	**NS**	*	*	*	*	**	*	*	*

Chemical constituents:

Dry matter content (DM %):

Data in table (5) reveal that foliar application of K significantly increased dry matter content in roots higher than that of the control in both seasons. Similar results were obtained by El-Sawy *et al*., (2000b) who found that foliar spray with K_2O (1%) increased DM (%) of potato tuber .

Table (5): Effect of foliar fertilization of potassium on chemical constituents of sweet potato roots during 2008 and 2009 seasons.

Characters / Treatments / K spray (K_2O)	D.M. of roots (%)	Total sugars (%)		Total carbohydrates (%)		Crude protein (%)		Vit.C mg/100g (fresh wt.)	Carotene mg/100g (fresh wt.)
		In dry wt.	In fresh wt.	In dry wt.	In fresh wt.	In dry wt.	In fresh wt.q		
	2008 season								
0.0 (cont.)	22.23b	9.77b	2.17b	79.78b	17.73b	4.95b	1.10b	20.5b	8.26
0.5%	24.00a	10.15a	2.53a	80.36a	19.20a	5.40a	1.30a	20.97a	8.59
F. test	*	*	*	*	*	*	*	*	**NS**
	2009 season								
0.0 (cont.)	24.57b	11.04b	2.72b	80.16b	19.70b	5.10b	1.26b	20.91b	8.61
0.5%	26.22a	11.85a	3.12a	80.64a	21.2a	5.57a	1.47a	21.44a	8.69
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.

Total sugars content:

Data in Table (5) show that foliar K application had significantly higher total sugars content of roots than that of control in both seasons. In the same line, Hewedy (1988) showed that foliar nutrition with K sulphate (2 and 5%) increased TSS % of tomato fruits. Similarly, Adam *et al* (1996) found that foliar application of K_2O at 1 or 1.5% increased TSS % of tomato fruits.

Total carbohydrates content (%):

Data in Table (5) indicate that foliar sprays of K resulted in significantly higher roots total carbohydrates content than the control in both seasons

Crude protein content:

Data in Table (5) reveal that root crude protein content was significantly higher with foliar spray of K than that in the unsprayed treatment in both seasons. In the same trend, El-Sawy *et al.,* (2000a) observed that foliar application of K twice or thrice significantly increased crude protein content of potato tuber.

Carotene content:

Data presented in Table (5) show that roots carotene content was insignificantly affected by foliar K application in both seasons.

Vitamin C content:

Data in Table (5) indicate that foliar application of K significantly increased vitamin C content in roots compared with the control in both seasons. In the same direction, Hewedy (1988) showed that foliar nutrition with potassium sulphate (2 and 5%) increased vitamin C. More-over, Adam *et al*., (1996) reported that foliar application of K_2O at 1or 5% increased ascorbic content of tomato compared with the control.

The favorable effect of foliar K application on the previous chemical constituents may be attributed to role of K in reduction of nitrate, synthesis of simple sugars and starch and translocation of sugars and protein from leaves to roots (Russell, 1988).

Potassium content:

Data in Table (4) show that potassium content (%) in leaves and roots was significantly higher with foliar K application than that of the control in both seasons. In the same tendency, El-Sawy *et al*., (2000a) found that leaves k content of potato increased from foliar spraying of K (1% K_2O) twice. Furthermore, El-Sawy *et al*., (2000b) showed that foliar sprays of K (1% K_2O) twice significantly increased tuber K content of potato.

Nitrate content:

Data in Table (4) indicate nitrate content in roots was significantly higher with foliar application of K than that of unsprayed treatment (control) in both seasons. Similar results were obtained by El-Sawy *et al*., (2000a) found that foliar spraying with K twice at 1% K_2O significantly decreased NO_3 content of potato tuber. Potassium is required in plants for stimulating the activity of nitrate reductase and it efficient in the reduction of NO_3 and conversion of amino acid into proteins (Beringer, 1979).

Storage ability:

Total weight loss (%):

Data in Table (4) show that foliar spray of K significantly decreased total weight loss (%) of roots compared with the control (no spray) in both seasons. Similar result was obtained by El-Sawy *et al*., (2000b) who found that foliar sprays of K (twice) decreased weight loss (%) of potato tuber. The reduction in weight loss as a result from foliar K application may be attributed to reduction in N: P and K : P ratios and increase in K : N ratio which lead to decrease in a natural respiratory loss of dry matter during storage as well as a respiratory (or wilting) loss of water

Decay percentage:

Data in Table (4) reveal that foliar application of K caused a significant decrease in decay percentage of roots compared with the control (no spray) in both seasons. The reduction in decay percentage by applying foliar sprays of K may be due to that it increased uptake of potassium, hence increased roots K content (Table 4) and subsequently decreased attack of microorganisms as fungi and bacteria.

Sprouting date:

Data in Table (4) indicate that foliar K application caused a highly significant retarding sprouting date compared with the unsprayed treatment in both seasons. In the same line, El-Sawy *et al*., (2000b) found that foliar sprays of K twice significantly decreased sprouting percentage of potato tubers. The reduction of sprouting percentage induce by this treatment may be due to reducing N: P, K: N and K: P ratios and increasing K: N ratio of potato tuber.

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

Data in Tables (6 and 7) indicate that the combined interaction between soil K levels and foliar K application had insignificant effects on morphological characters of roots (roots length, root diameter and root shape index), chemical constituents of leaves (K content) and roots (DM%, total sugars %, total carbohydrates %, crude protein %, carotene content, vitamin

C, K content and NO_3 content) and storage ability of roots (total weight loss%, decay percentage and sprouting date) in both seasons.

Table (6): Effect of the interaction between soil K levels and foliar K application on morphological characters, storage ability and K content of sweet potato roots during 2008 and 2009 seasons.

Characters / Treatments: K level (kg/fed.)	K spray (K_2O%)	Root morphological characters: Length (cm)	Diameter (cm)	Shape index (L/D ratio)	Roots storage ability: Decay (%)	Weight Loss%	Sprouting date (days)	K content (%): Leaves	Roots	Roots NO_3 in f.w. (ppm)
2008 season										
25	**0.0**	17.66	4.98	3.55	15.6	18.90	51.0	2.51	1.26	124.5
	0.5%	17.60	5.20	3.38	13.4	15.79	60.0	2.81	1.51	118.3
50	**0.0**	17.55	5.15	3.41	11.5	17.55	60.0	2.78	1.49	120.6
	0.5%	17.05	5.33	3.20	9.8	15.21	71.0	3.05	1.62	115.4
75	**0.0**	16.95	5.30	3.20	8.6	13.95	70.0	2.99	1.58	111.9
	0.5%	16.88	5.65	2.99	7.1	11.11	88.0	3.22	1.69	95.5
100	**0.0**	16.81	5.61	3.00	7.2	13.18	84.0	3.17	1.65	98.1
	0.5%	16.72	5.88	2.84	6.4	11.90	89.0	3.33	1.70	93.2
F test		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
2009 season										
25	**0.0**	17.92	5.23	3.43	13.6	18.05	55.00	2.60	1.33	119.6
	0.5%	17.88	5.54	3.23	10.6	14.42	65.00	2.80	1.57	114.4
50	**0.0**	17.77	5.50	3.23	8.4	18.21	63.00	2.75	1.55	116.7
	0.5%	17.50	5.92	2.96	6.2	13.55	72.00	3.12	1.65	112.5
75	**0.0**	17.55	5.90	2.97	5.5	14.67	73.00	3.07	1.63	113.8
	0.5%	17.30	6.22	2.78	4.0	12.50	90.00	3.41	1.71	92.6
100	**0.0**	17.38	6.05	2.87	3.8	14.56	75.00	3.22	1.63	97.2
	0.5%	17.11	6.31	2.71	2.5	12.72	90.00	3.51	1.70	91.1
F test		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

NS: indicates not significant differences, according to F test.

Table (7): Effect of the interaction between soil k levels and foliar K application, on chemical constituents of sweet potato roots during 2008 and 2009 seasons.

Characters / Treatments: K level (kg/fed)	K spray (K_2O%)	D.M. of roots (%)	Total sugars (%): In dry wt.	In fresh wt.	Total carbohydrates (%): In dry wt.	In fresh wt.	Crude protein (%): In dry wt.	In fresh wt.	Vit. C mg/100g (fresh wt.)	Carotene mg/100g (fresh wt.)
2008 season										
25	**0.0**	20.86	9.22	1.92	79.11	16.5	4.60	0.96	19.81	7.22
	0.5%	22.20	9.85	2.19	79.68	17.7	4.85	1.08	19.95	7.56
50	**0.0**	21.56	9.66	2.07	79.66	17.1	4.79	1.03	20.12	7.68
	0.5%	23.66	9.99	2.36	79.95	18.9	4.96	1.17	20.85	7.90
75	**0.0**	22.68	9.90	2.24	79.85	18.1	4.89	1.11	20.66	8.92
	0.5%	24.88	11.55	2.87	80.58	19.7	5.80	1.44	21.38	9.30
100	**0.0**	23.80	10.31	2.45	80.50	19.2	5..52	1.31	21.40	9.22
	0.5%	25.25	10.68	2.70	81.22	20.5	5.98	1.51	21.68	9.58
F test		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
2009 season										
25	**0.0**	22.11	10.55	2.33	79.66	17.6	4.77	1.05	20.55	7.36
	0.5%	23.95	10.99	2.63	79.98	19.2	4.89	1.17	20.92	7.72
50	**0.0**	23.52	10.86	2.55	79.79	18.8	4.85	1.14	20.88	7.82
	0.5%	25.99	11.32	2.94	80.48	20.9	5.26	1.37	21.45	8.10
75	**0.0**	25.77	11.11	2.86	80.41	20.7	5.11	1.32	20.99	9.52
	0.5%	27.88	12.98	3.62	80.96	22.6	5.97	1.66	21.84	8.96
100	**0.0**	26.86	11.65	3.13	80.77	21.7	5.65	1.52	21.23	9.74

0.5%	27.11	12.12	3.29	81.15	22.0	6.15	1.67	21.54	9.98
F test	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

NS: indicates not significant differences, according to F test.

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تأثير التسميد الأرضى والرش بالبوتاسيوم على الجودة والقدرة التخزينية لجذور البطاطا

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أجريت تجارب حقلية في حقل بقرية دقلت مجاور للحقل التجريبي بكلية الزراعة جامعة كفرالشيخ في الموسمين الصيفيين المتتاليين لعام 2008 ، 2009، وكان الهدف الرئيسي من هذا البحث هو دراسة تأثير مستويات التسميد الأرضى بالبوتاسيوم عند المستويات 25 ، 50، 75 ، 100كجم بو 2أ/فدان والرش الورقي بالبوتاسيوم (مرتين) عند التركيزين صفر ، 0.5% بو$_2$أ والذى يعادل 6كجم بو $_2$أ على الجودة (والتى تشمل الصفات المورفولوجية والمكونات الكيماوية) والقدرة التخزينية لجذور البطاطا صنف أبيس، وكان التصميم المستخدم هو تصميم القطع المنشقة مرة واحدة في أربع مكررات. وقد استخدم سماد سلفات البوتاسيوم (48% بو$_2$أ) للتسميد الأرضى والتسميد بطريقة الرش الورقي.

ولقد أوضحت النتائج أنه تسبب ازدياد مستوى تسميد البوتاسيوم الأرضى من 25 إلى 100كجم بو$_2$أ للفدان في زيادة معنوية في كل من قطر الجذر ، ومحتوى الجذور من المادة الجافة، والكربوهيدرات الكلية والبروتين الخام، والكاروتين، وفيتامين ج ومحتوى الجذور والأوراق من البوتاسيوم، وبالمثل تسبب أزدياد محتوى البوتاسيوم حتى 75كجم بو $_2$أ/فدان في زيادة معنوية المحتوى الجذور من السكريات الكلية. وعلى النقيض من ذلك ، تسبب أزدياد مستوي التسميد البوتاسي من 25 إلى 100كجم بو $_2$أ/فدان في نقص معنوى لكل من طول الجذر ودليل شكل الجذر (النسبة بين طول الجذور وعرضه) ومحتوى الجذر من النترات، والفقد الكلى فى وزن الجذور ونسبة تلف الجذور، وتأخير تاريخ تنبيت الجذور في كلا الموسمين.

تسبب الرش الورقي بالبوتاسيوم في زيادة معنوية لكل من قطر الجذر، ومحتوى الجذور من المادة الجافة، والسكريات الكلية ، والكربوهيدرات الكلية، والبروتين الخام، وفيتامين ج ومحتوى الجذور الأوراق والجذور من البوتاسيوم ، بينما تسببت تلك العاملة في نقص معنوي لكل من طول ودليل شكل الجذر، والفقد الكلي فى وزن الجذور ونسبة تلف الجذور وتأخير تاريخ تنبيت الجذور وذلك بالمقارنة بمعاملة الكنترول (بدون رش) في كلا الموسمين. ولكن لم يؤثر الرش الورقي على محتوى الجذور من الكاروتين.

لم يؤثر التفاعل المشترك بين التسميد الأرضى بالبوتاسيوم والتسميد الورقي بالبوتاسيوم على كل من صفات الجودة (الصفات المورفولوجية والمكونات الكيماوية) والقدرة التخزينية للجذور في كلا الموسمين.

قام بتحكيم البحث

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