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POTASSIUM INFLUENCE ON POTATO CROP UNDER SHARKIA GOVERNORATE CONDITIONS.

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ABSTRACT

A pot experiment was carried out to study the potassium influence on the growing potato crop on two types from soil (clay loam soil, sandy loam soil) under Sharkia Governorate conditions, during 2004 season. The main results were as follows:

1. Potassium addition tended to increase the dry weight (g pot^{-1}) of potato plant during different growth stages.
2. Values of potassium uptake (mg pot^{-1}) were increased in sandy loam soil more than clay loam soil. The highest values were at harvest and at the fertilizer level K_2 compared with control treatment.
3. The increasing in potassium fertilizer was lead to increasing the yield, where was due to the cells stimulation and nutrients uptake increase by plants.

Keywords: Potassium, Potato, Soil types, Sharkia Governorate soil.

INTRODUCTION

Potassium fertilizer affecting growth and yield of most vegetable crops, especially tuberous edible aroids vegetable crops such as potato. The effects of K on potato and other tuber plants (growth, yield, chemical composition) were studied by several investigators in different soil types. The following review shows these effects.

Potato (*Solanum tuberosum*) is considered as one of the major and the most important vegetable crops in Egypt. There is a high demand on potato for local market, processing as wall as exportation Arisha, H.M. and A. Bardisi (1999).

Mukhopadhyay *et al.*, (2002) found that increasing rates of K_2O resulted in increasing yield and marketable yield.

The dry matter accumulation, leaf area index, crop growth rate and tuber bulking rate increased significantly with increasing level of potassium in combination with sulfur Saha *et al.*, (2001).

Savitha *et al.*, (2000) pointed out that potassium uptake in the haulm and tuber, increased with increasing rates of K_2O.

Therefore, the objective of this investigation was to study the effect of different levels of potassium on growth, yield and potassium uptake by potato crop grown on two soil types (clay loam soil and sandy loam soil) under the Sharkia Governorate conditions.

MATERIALS AND METHODS

A pot experiment was conducted in Bilbies, EL-Sharkia Governorate Egypt to study potassium influence on the growing potato crop on two soil types of (clay loam soil and sandy loam soil) under the conditions of El-Sharkia Governorate, during 2004 season.

Studied soils:

Two surface soil samples (0-30 cm) were collected from Bilbies District, Sharkia Governorate. The soil samples represented two types (clay loam soil and sandy loam soil).

Containers:

Plastic pots of 55 cm. diameter were used. Two plastic tube of 60 to 70 cm length were put in each pot on two sides by different deeps to improve soil aeration for soil. Each pot was filled with 50 kg air-dried soil.

Statistical design:

The experiment included 2 soil types (clayey loam soil and sandy loam soil), and 3 levels of potassium having 6 treatments, arranged as randomized block with 4 replications and giving a total of 24 pots. The statistical analysis of the data was done according to Snedcor and Cochran (1990).

Potato experiment:

Three potato tubers (Diamont .V.) were cultivated in each pot for each type of soil in 25/2/2004.

- Phosphorus was added at the rate of 65 kg P_2O_5 fed^{-1} (6.7g. single superphosphate pot^{-1} before cultivation).
- The nitrogenous fertilizers were added in two doses as follow:
  1. 150 kg as ammonium sulphate 20.6%, 30 days after cultivation.
  2. 50 kg as ammonium nitrate 33.5%, 50 days after cultivation.

Potassium treatments:

Potassium sulphate (39.8% K) was added after 30 and 50 days from cultivation as follow:

1. No fertilizer K (control).
2. 40 kg. K fed^{-1} (4000 mg. K pot^{-1}). The recommended dose.
3. 60 kg. K fed^{-1} (6000 mg. K pot^{-1}). The recommended + 50%.

* The pots were irrigated at 70% of the field capacity or according to needing of plants.

* Plants and soil samples were taken after 45 days from cultivation, (green growth), 75 days from cultivation (tuber composition) and 110 days at harvest.

* Plants samples were cleaned, then oven dried (at 70 ^{0}C), crushed for analysis, prepared for K determination.

Soil analysis:

General soil analyses:

Table 1 shows some physical and chemical proper ties of the experimental soils. These methods were used according to the global standard methods of soil studies.

- Mechanical analysis for soil was carried out using the pipette method as described by Dewis and Fertias (1970).
- Soil organic matter content was determined by Walkley and Black method described by Hesse (1971).
- Soil reaction (pH) was measured in soil paste using combined electrode pH meter as mentioned by Richards (1954).

- Total Soluble Salts were determined by measuring the electrical conductivity in the extract of saturated soil paste in dSm^{-1} as explained by Jackson (1967).
- The amounts of water soluble cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+}) & anions ($CO3^{=}$, $HCO3^{-}$, Cl^{-} and $SO4^{=}$) were determined in the extract of saturated soil paste by the methods described by Hesse (1971).
- Soluble potassium (K^{+}) was determined by using flame photometer.
- Available potassium was determined by extracting soil with 1.0 N ammonium acetate at pH 7.0 as described by Hesee (1971).

Table 1: Some physical and chemical properties of the experiment soil before cultivation.

Soil characteristics		Clay loam soil	Sandy loam soil
Mechanical analysis	Coarse Sand%	33.82	58.94
	Fine Sand%	9.45	11.46
	Silt%	24.26	12.38
	Clay%	32.47	17.22
	Texture Class	Clay loam	Sandy loam
Some physical and chemical properties of the studied soils	pH* (in suspension)	8.73	8.76
	EC** dSm^{-1} (soil Paste extract)	0.35	0.38
	$CaCO_3$	1.98	3.32
	OM%	1.06	0.87
	SP (saturation %)	70.06	56.13
	CEC	52.86	46.43
	ESP%	5.45	7.75
	C %	0.21	0.063
Soluble Cations (meq L^{-1} solution)	Ca^{++}	0.55	0.60
	Mg^{++}	0.20	0.05
	Na^{+}	1.17	2.73
K forms (meq 100g $soil^{-1}$	Total K^{+}	11.03	8.95
	Soluble K^{+}	0.016	0.009
	Exch K^{+}	1.60	0.98
Soluble Anions (meq L^{-1} solution)	CO_3^{-}	0.00	0.00
	HCO_3^{--}	0.22	0.36
	Cl^{-}	0.35	0.05
	SO_4^{--}	0.74	0.59
Available nutrients (ppm)	Nitrogen (N)	9.02	4.16
	Phosphorus (P)	3.20	156
	Potassium (K)	26.6	13.05

* pH was determined in saturated soil paste.
** EC and soluble ions were determined in soil paste extract.

Analyses of soil potassium:

Total potassium in soil was determined by digesting 0.1 g of fine soil 0.2 mm with concentrated HF and $HClO_4$ acid Jackson (1958). Also total potassium in soil fractions of 0-30 cm samples (total sand (coarse fine, silt and clay) was determined by the some method.

Potassium in plant tissue:

* 0.2 g dry ground plant material was digested by a mixture of H_2SO_4 and $HCLO_4$ acids as described by Peterburgski (1968).
* Potassium in all soil extractions and plant acid digestion was determined using a flame photometer.

RESULTS AND DISCUSSION

1. Dry weight of potato plant:

1.1. Effect of soil type:

Data in Table 2 and Fig. 1 reveal that the dry weight means of potato plants were higher in the sandy loam soil than the clay loam soil at all growth stages. The differences reached to the level of significance. This may be due to the better growth of potato in the sandy loam soil than the clay loam soil. This result could be enhanced by that obtained by Marton (2001).

1.2. Effect of potassium levels:

Data in Table 2 and Fig. 1 reveal that the dry weight of potato plants were increased gradually due to the incremental addition of K fertilizer during both growth stages. The increase reached to the level of significance. This result could be enhanced by that obtained by Saha *et al.*, (2001).

1.3. Effect of growth stages:

Data in Table 2 and Fig. 1reveal that values were increased at 110 day more than 45 days, due to the better growth for potato in sandy loam soil, potassium application and K uptake increasing. This result could be supported by those obtained by Saha *et al.*, (2001).

Table 2: Means of top dry weights (g pot^{-1}) of potato plants as affected by soil type and K fertilizer levels at different growth stages.

A- Soil type	K levels	Days after sowing		
		45	75	110
Clayey loam	Control	11.08	11.91	13.19
	K_1	13.41	14.02	16.48
	K_2	14.40	15.75	18.74
Mean		**12.96**	**13.89**	**16.14**
Sandy loam	Control	11.93	15.02	14.74
	K_1	14.25	15.89	18.72
	K_2	16.31	17.27	19.42
Mean		**14.16**	**16.06**	**17.63**
F. Test A		**	**	**
LSD B		**0.30****	**0.70****	**0.40****
LSD A x B		**0.40****	**1.00****	**0.50****

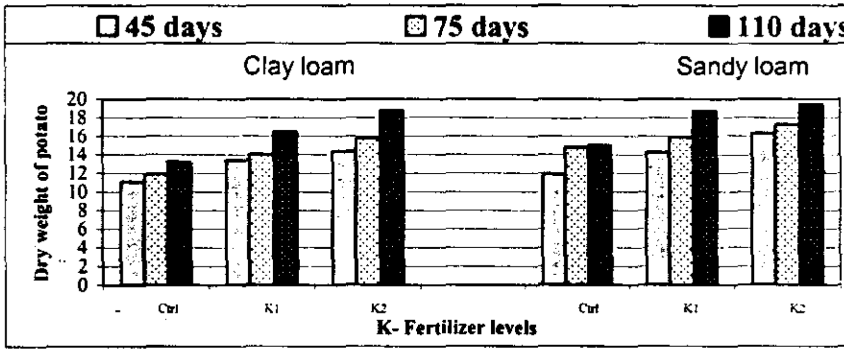

Fig 1: Effect of top dry weights (g pot^{-1}) of potato plants as affected by soil type and K fertilizer levels at different growth stages.

1.4. Effect of the interaction:

Data in Table 2 and Fig. 1 reveal the highly significant effects were observed on the K of potato plants due to interaction between soil types and K led of potato plants at both growing stages on both soil types. This finding fully confirms the results of Marton *et al.*, (2001).

2. Dry weight of tuber:

2.1. Effect of soil type:

Data in Table 3 and Fig. 2 reveal that the dry weight means of potato plants were increased high significantly in sandy loam soil more than clay loam soil at all growth stages. This is due to the better growth for potato in sandy loam soil more than clay loam soil, potassium application and root existence beefy for potato in sandy loam soil. This finding fully confirms with the results of Kanzikwere *et al.*, (2001).

Table 3: Means of tuber dry weight (g pot^{-1}) of potato plants as affected by soil type and K fertilizer levels at different growth stages.

A- Soil type	K levels	Days after sowing	
		75	110
Clayey loam	Control	14.32	22.80
	K_1	15.73	38.81
	K_2	17.29	43.36
Mean		**15.78**	**34.99**
Sandy loam	Control	14.23	25.75
	K_1	17.76	60.80
	K_2	18.30	61.44
Mean		**16.76**	**49.33**
F Test A		**	**
LSD B		0.05**	0.04**
LSD A x B		0.07**	0.06**

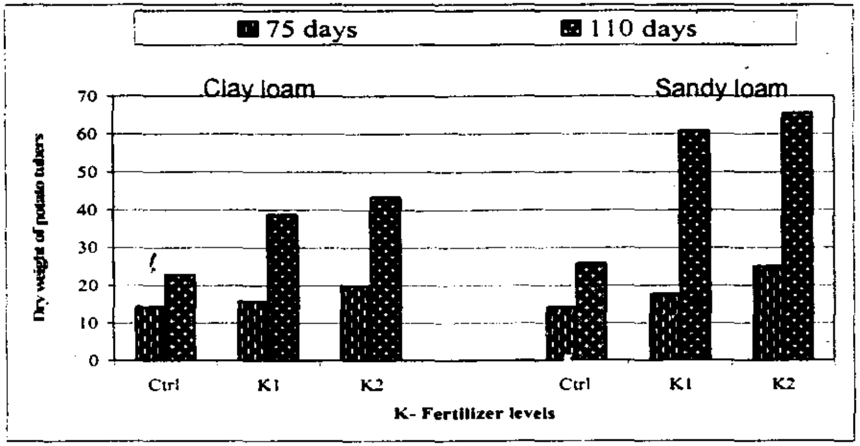

Fig 2: Means of tuber dry weight (g pot^{-1}) of potato plants affected by soil type and K fertilizer levels at different growth stages.

2.2. Effect of potassium levels:

Data in Table 3 and Fig. 2 show the values of tuber dry weight (g pot^{-1}) of potato plants as affected by soil type and K fertilizer levels at different growth stages. Values of dry weight (g pot^{-1}) were increased in tubers high significantly by addition of potassium fertilizer in both studied soils and the highest mean concentrations obtained at the level of K_2 compared with control treatment. This result could be enhanced by that obtained by Marton *et al.*, (2001).

2.3. Effect of the interaction:

Data in Table 3 and Fig. 2 reveal the highly significant effects were observed on the dry matter of tubers due to interaction between soil types and K led of potato tubers at both growing stages on both soil types. This finding fully confirms the results of Kanzikwere *et al.*, (2001).

3. K (%) in tops of potato plant:

3.1. Effect of soil type:

Data in Table 4 and Fig. 3 show the K % means of potato plants were increased high significantly in sandy loam soil more than clay loam soil at all growth stages. This is due to potassium concentration in the first stage of growth is higher and result for dilution effect by age advancing. These results agree with those found by Tawfik (2001).

3.2. Effect of potassium levels:

Data in Table 4 and Fig. 3 reveal that the K % in tops of potato plants were increased gradually due to the incremental addition of K fertilizer during both growth stages. The increase reached to the level of significance. This finding fully confirms the results of Tawfik (2001).

3.3. Effect of growth stages:

Data in Table 4 and Fig. 3 reveal that values of K % means in the dry matter of potato plants were decreased with the advance of the season in both soil types. This result could be attributed to the dilution effect, where the production of dry matter tended to increase with the advance of the season. This result could be supported by those obtained by Tawfik (2001).

3.4. Effect of the interaction:

Data in Table 4 and Fig. 3 show the highly significant effects were observed on the K % of potato plants due to interaction between soil types and K led of potato plants at both growing stages on both soil types. These results agree with those found by Tawfik.

Table 4: Means of K (%) in tops of potato plants as affected by soil type and K fertilizer levels at different growth stages.

A- Soil type	K levels	Days after sowing		
		45	75	110
Clayey loam	Control	3.025	2.563	1.900
	K_1	3.288	3.125	2.663
	K_2	3.663	3.738	2.850
Mean		**3.325**	**3.142**	**2.471**
Sandy loam	Control	4.275	2.513	2.770
	K_1	4.388	3.525	3.088
	K_2	4.538	3.725	3.225
Mean		**4.400**	**3.254**	**3.028**
F. Test A		**	*	**
LSD B		**0.03****	**0.02****	**0.04****
LSD A x B		**0.04****	**0.03****	**0.05****

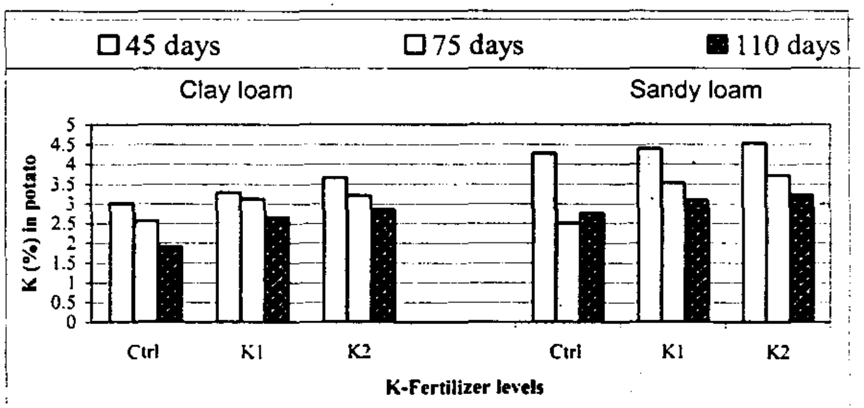

Fig. 3: Means of K (%) in tops of potato plants as affected by soil type and K fertilizer levels at different growth stages during.

4. K (%) in tops of potato tubers:

4.1. Effect of soil type:

Data in Table 5 and Fig. 4 show that the K % in potato tubers under the effect of soil types. The highest means of K % in tubers was at in sandy loam soil at 110 days from sowing, while was lowest at 75 days from sowing at clay loam soil. These results are due to the better growth for potato in sandy loam soil more than clay loam soil, potassium application and root existence beefy for potato in sandy loam soil. This finding fully confirms the results of Mansour *et al.*, (2002).

4.2. Effect of potassium levels:

Data in Table 5 and Fig. 4 show that, the values of concentrations increased at potassium level K_2 in both soil types compared with control treatment, due to the potassium application and growth speed. This finding fully confirms the results of Mansour *et al.*, (2002).

4.3. Effect of growth stages:

Data in Table 5 and Fig. 4 show that, the K % in potato tubers under the effect of soil types and K fertilizer levels at different growth stages. The values increased at 110 day than 75 days, and were due to the potassium application and increase of storage root which were obtained by the potassium fertilization in sandy loam more than clay loam soil. This result could be supported by those obtained by Kanzikwere *et al.*, (2001).

4.4. Effect of the interaction:

Data in Table 5 and Fig. 4 show that high significantly interaction between both soil types and potassium fertilizer level. The highest means of interaction at 110 days after sowing was due to the potassium fertilizer increase in the great tubers. This finding fully confirms the results of Mansour *et al.*, (2002).

Table 5: Means of K (%) in tubers of potato plants as affected by soil type and K fertilizer levels at different growth stages.

A- Soil type	K levels	Days after sowing 75	Days after sowing 110
Clayey loam	Control	1.988	1.990
	K_1	2.113	2.475
	K_2	2.350	2.638
Mean		**2.150**	**2.368**
Sandy loam	Control	2.013	1.630
	K_1	2.200	2.438
	K_2	2.813	3.150
Mean		**2.342**	**2.406**
F Test A		**	**
LSD B		**0.03****	**0.05****

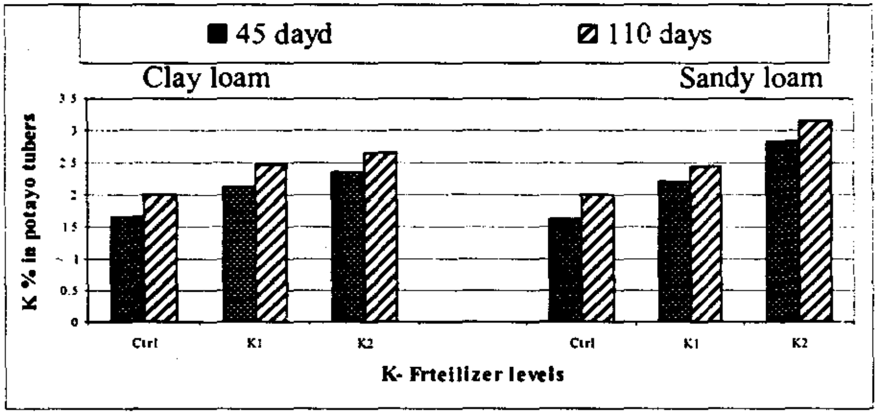

Fig 4: Means of K (%) in tubers of potato plants as affected by soil type and K fertilizer levels at different growth stages.

5. Potassium uptake by potato tops:

5.1. Effect of soil type:

The data uptake (mg pot^{-1}) by potato tops as affected soil type and K fertilizer levels at different growth stages are recorded in Table 6 and illustrated in Fig. 5. The data reveal that potassium uptake (mg pot^{-1}) values were increased high significantly in both soil types. Also uptake was increase in sandy loam soil more than clay loam soil. The more potassium uptake was due to potassium application, fast growth and the increase of plant branches and root existence beefy for potato by sandy loam soil. This finding fully confirms the results of Trehan and Claassen (2004).

5.2. Effect of potassium levels:

Data in Table 6 and Fig. 5 reveal that K uptake (mg pot-1) was increased high significantly in both soil types at K_2 compared with control treatment due to K application this result could be supported by those obtained by Savitha *et al.*, (2000).

5.3. Effect of growth stages:

The data uptake (mg pot^{-1}) by potato tops as affected by soil types and K fertilizer levels at different growth stages are recorded in Table 6 and Fig. 5 show that values K uptake were increased from 45 day to 110 days in both soil types due to K application during different growth stages. These results agree with those found by Savitha *et al.*, (2000).

5.4. Effect of the interaction:

Data in Table 6 and Fig. 5 reveal high significantly interaction between both soil types and potassium fertilizer level. The highest means of interaction at 45 days after sowing was due to the potassium concentration increase in the plants. This finding fully confirms the results of Trehan and Claassen (2004).

Table 6: Means of K uptake (mg pot^{-1}) of potato tops as affected by soil type and K fertilizer levels at different growth stages.

A- Soil type	K levels	Days after sowing		
		45	75	110
Clayey loam	Control	317.00	331.25	250.61
	K_1	423.01	469.52	581.22
	K_2	492.30	597.52	698.52
Mean		**410.77**	**476.10**	**510.12**
Sandy loam	Control	338.80	378.41	408.30
	K_1	433.10	565.24	588.20
	K_2	508.00	653.00	726.00
Mean		**426.63**	**563.22**	**574.17**
F. Test A		**	**	**
LSD B		8.90**	3.68**	6.75**
LSD A x B		6.14**	4.00**	4.90**

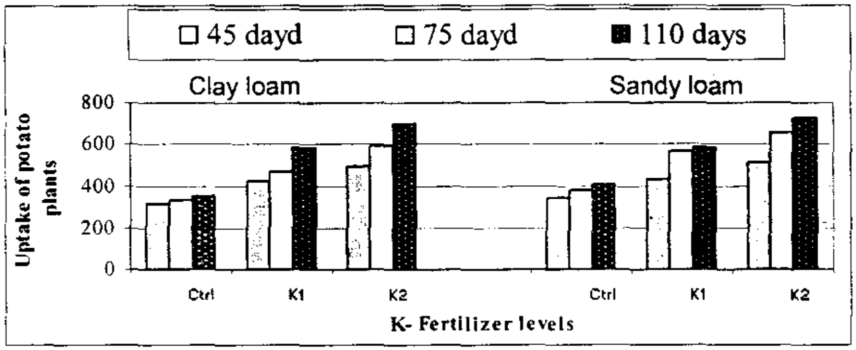

Fig. 5: Means of K uptake (mg pot^{-1}) of potato tops as affected by soil type and K fertilizer levels at different growth stages.

6. Potassium uptake by potato tubers:

6.1. Effect of soil type:

The value of uptake (mg pot^{-1}) in potato tubers as affected by soil type and K fertilizer levels at different growth stages are recorded in Table 7 and illustrated in Fig. 6. The data show that potassium uptake values were increased high significantly in both soil types. Also uptake was increase in sandy loam soil more than clay loam soil, was due to the increase in potassium application and the root existence beefy in sandy loam soil. This results findings similar as Savitha *et al.*, (2000).

6.2. Effect of potassium levels:

Data in Table 7 and Fig. 6 reveal that K uptake increased high significantly at K_2 level compared with control treatment in both soil types due to potassium application and root existence beefy for potato by sandy loam soil. This finding fully confirms the results of Savitha *et al.*, (2000).

6.3. Effect of growth stages:

The value uptake in potato tubers as affected by soil type and K fertilizer levels at different growth stages are recorded in Table 7 and illustrated in Fig. 6. The data show that values K uptake were increased high significantly from 75 day to 110 days in both soil types and was due to the potassium concentration increase in the tubers. This finding fully confirms the results of Trehan and Claassen (2004).

6.4. Effect of the interaction:

Data in Table 7 and Fig. 6 reveal the highly significant effects were observed on the K uptake of potato plants due to interaction between soil types and K led of potato plants at both growing stages on both soil types due to the potassium concentration increase in the tubers. This finding fully confirms the results of Trehan and Claassen (2004).

Table 7: Means of K uptake (mg pot^{-1}) of potato tubers as affected by soil type fertilizer levels at different growth stages.

A- Soil type	K levels	Days after sowing	
		75	110
Clayey loam	Control	283.12	453.72
	K_1	346.12	961.52
	K_2	486.36	1144.00
Mean		373.57	853.08
Sandy loam	Control	288.23	419.70
	K_1	375.41	1482.00
	K_2	430.25	1953.00
Mean		362.93	1284.90
F Test A		**	**
LSD B		4.61**	22.41**
LSD A x B		6.45**	30.00**

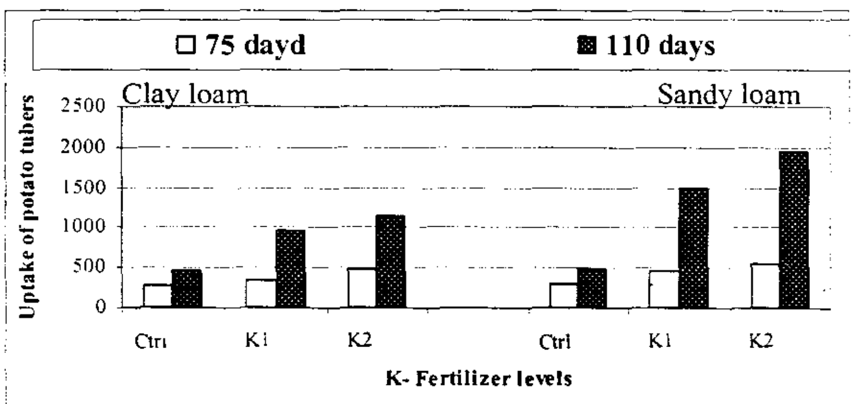

Fig.6: Means of K uptake (mg pot^{-1}) of potato tubers as affected by soil type fertilizer levels at different growth stages.

CONCLUSION

It can be concluded that most of the studied soils increased in its content from available potassium by addition of potassium fertilizer and the crop was increased by best form at the occasion soil for cultivation, where potato crop was increased in sandy loam soil more than clay loam soil. This conclusion leads to increase in the yield.

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تأثير البوتاسيوم علي محصول البطاطس تحت ظروف محافظة الشرقية

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أجريت تجربة أصص بلاستيكية علي نوعين من التربة بمحافظة الشرقية، في عام ٢٠٠٤ م لدراسة تأثير البوتاسيوم علي محصول البطاطس بنوعين من التربة تحت ظروف محافظة الشرقية.

ويمكن تلخيص النتائج المتحصل عليها فيما يلي:

١- زادت قيم الوزن الجاف في نباتات ودرنات البطاطس في التربة الطميية الرملية عن التربة الطميية الطينية، وكانت القيم الأعلى عند الحصاد، وعند مستوي التسميد K_2، مقارنة بمعاملة الكنترول أثناء مراحل النمو المختلفة.

٢- زادت قيم البوتاسيوم الممتص في العينات النباتية والدرنات في التربة الطميية الرملية عن التربة الطميية الطينية في نباتات ودرنات البطاطس، وكانت القيم الأعلى عند الحصاد، وعند مستوي التسميد K_2، مقارنة بمعاملة الكنترول أثناء مراحل النمو المختلفة.

٣- زادت إضافة السماد البوتاسيوم إلي زيادة محصول البطاطس بسبب تنشيط الخلايا وزيادة امتصاص العناصر المغذية للنبات.