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POTASSIUM EFFICIENCY FOR WHEAT CROP UNDER THE CONDITIONS OF EL-SHARKIA GOVERNORATE SOILS

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ABSTRACT

A pot experiment was carried out to study potassium efficiency for wheat crop as affected by soil type (clay loam and sandy loam), and K fertilizer levels under conditions of El-Sharkia Governorate soils.

The observed results can be summarized as follows:

1-Potassium addition tended to increase the dry weight (g pot^{-1}) of wheat plant during different growth stages.

2-Values of potassium uptake (mg pot^{-1}) were increased in clay loam soil more than sandy loam soil. The highest values were at harvest and at fertilizer level K_2, compared with control treatment.

3-Addition of potassium fertilizer for wheat crop led to significant in creases in the grain and straw yields in both studied soils.

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

INTRODUCTION

Potassium is a basic element in plant fertilizers. Plants fall flat without it. They need potassium to control the water content of their stems and leaves. Without enough potassium, plant leaves become limp and cells can't elongate. Potassium is not a constituent of any plant structures or compounds; it plays a part in many important regulatory roles in the plant (Marschner, 1995).

It is essential in nearly all processes needed to sustain plant growth and reproduction. It plays a vital role and has many functions in plant growth: - Photosynthesis, Translocation of photosynthesis and this agree with Gardener *et al.*, (1985), so the rationale for potassium additions must be to maintain soils just about the critical level. Wheat (*Triticum aestivm s.sp. vulgare*) is one of the most important cereal crops in the world; it is very important to increase wheat production because the local production is not sufficient to supply the annual demand of local requirements. Genaidy and Hegazy (2001) results showed that 24 kg K_2O/fed... (As K_2SO_4 fertilizer) significantly increased the yields of wheat. Tahir *et al.*, (2001) pointed out that potassium deficiency substantially decreased grain yield, straw yield, total biomass, K concentration in cell sap, grain and straw and K uptake in grain, straw and total K uptake. Saifullah and Classen (2003) found that application of potassium significantly affected sodium concentration in both grain and straw of wheat, maximum concentration being at control. Zhang *et al.*, (2004) showed that potassium applications at 37.5-112.5 kg K_2O/ha increased chlorophyll content and photosynthetic rate of the leaf and kernel filling rate and 1000-seed weight.

Therefore, the objective of this investigation was to study the effect of different levels of potassium on growth, yield and potassium uptake by cotton 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 uptake efficiency on the growing wheat crop on two soil types of (clay loam soil and sandy loam soil), and K fertilizer levels under 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 was put in each pot on two sides by different deeps to improve the soil aeration. 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).

Wheat experiment:

Twenty wheat grains (Sakha 93.V.) were cultivated in each pot for each type of soil in 15/11/2004.

- P_2O_5 was added at the rate of 15 kg fed^{-1} (4.9 g single superphosphate 15.5% P_2O_5 pot^{-1}) before sowing.
- The nitrogenous fertilizer was added in two doses level after 30 and 60 days from sowing at the rate of 75 kg N fed^{-1} as ammonium sulphate (18.2 g ammonium sulphate 20.5 % pot^{-1}).

Potassium treatments:

Potassium sulphate (39.8% K) was added at two doses level, after 30 and 70 days from sowing as follow:

1. No fertilizer K (control).
2. 18 kg. K fed^{-1} (900 mg. K pot^{-1}). The recommended dose.
3. 27 kg. K fed^{-1} (1350 mg. K pot^{-1}). The recommended + 50%.

For irrigation, the pots were irrigated at 70% of the field capacity or according to needing of plants.

Plant and soil samples were taken after 45 days from cultivation (green growth), 90 days from cultivation (opening of the flowers) and 150 days at harvest. Plant samples were oven dried (at 70 ^{0}C), crushed for analysis, prepared for K determination and measuring the ratio of protein in grain.

Soil analyses:

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.

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	٤٦,٤٣
	ESP%	5.45	7.75
	C %	0.21	٠,٠٦٣
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.

- 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 ($CO3^{=}$, HCO_3^{-}, 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).

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.

The following analysis was done in 0-30 cm samples:

- Water soluble potassium was determined in saturation extract according to Richards (1954).
- Exchangeable potassium was determined by extracting 5 g soil with one N NH_4OAC (pH 7), and subtracting water soluble K according to Hesse (1971).

Plant uptake calculation:

The uptake of nutrients by plant organs was calculated by multiplying element concentration by dry weight of plant.

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 wheat plant:

1.1. Effect of soil type:

Data in Table 2 and Fig. 1 reveal that the dry weight means of wheat plants were increased high significantly in clay loam soil more than sandy loam soil at all growth stages. This is due to the better growth for wheat in clay loam soil more than sandy loam soil, potassium application and root existence beefy for wheat in clay loam soil. This result could be enhanced by that obtained by El-Dessougi *et al.*, (2002).

1.2. Effect of potassium levels:

Data in Table 2 and Fig. 1 reveal that the dry weight of wheat 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 Tahir *et al.*, (2001).

1.3. Effect of the interaction:

Data in Table 2 and Fig. 1 reveal the highly significant effects were observed on the dry matter due to interaction between soil types and K led of wheat plants at both growing stages on both soil types. This result could be enhanced by that obtained by Wong *et al.*, (2001).

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

A- Soil type	Potassium levels	Days after sowing 45	90
Clayey loam	Control	13.77	14.34
	K_1	15.07	18.53
	K_2	17.64	25.25
Mean		15.49	19.37
Sandy loam	Control	11.85	11.36
	K_1	14.83	16.62
	K_2	16.35	18.07
Mean		14.34	15.35
F Test A		**	**
LSD B		0.08**	0.05**
LSD A x B		0.10**	0.07**

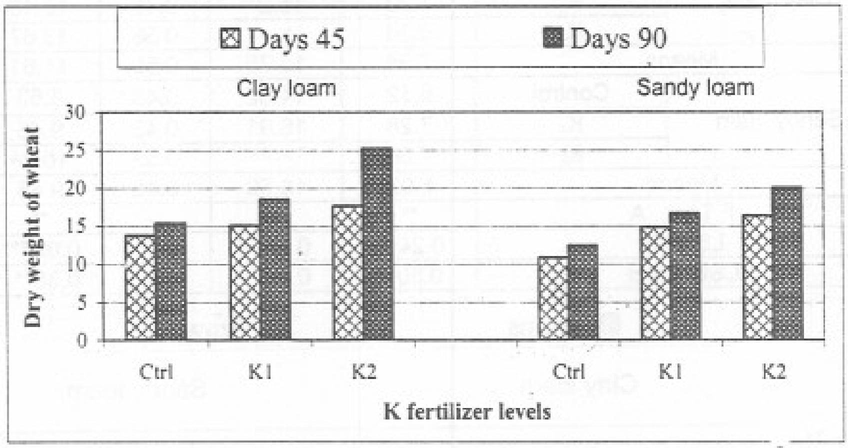

Fig. 1: Means of dry weight (g pot^{-1}) of wheat plants as affected by soil type and K levels at different growth stages.

2. Dry weight of grain and straw:

2.1. Effect of soil type:

The dry weight means of grain and straw were increased high significantly in clay loam soil more than sandy loam soil at all growth stages. This is due to the better growth for wheat in clay loam soil more than sandy loam soil, potassium application and root existence beefy for wheat in clay loam soil. This result could be enhanced by that obtained by Tahir *et al.*, (2001).

2. 2. Effect of potassium levels:

Data in Table 2 and Fig. 1 reveal that the dry weight of grain and straw 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 Abiye-Astatke *et al.*, (2004).

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 grain and straw due to interaction between soil types and K led of wheat plants at both growing stages on both soil types. This result could be enhanced by that obtained by Kanzikwere *et al.*, (2001).

Table 3: Means of grain and straw dry weights (g pot^{-1}) of wheat plants as affected by soil type and K levels at different growth stages.

A- Soil type	Potassium levels	Dry weight (g pot^{-1})		G/S Ratio	Protein %
		Grains	Straw		
Clay loam	Control	6.56	14.52	0.45	9.06
	K_1	7.22	15.2١	0.48	12.10
	K_2	8.36	١٧,٥٢	0.58	13.67
Means		7.38	15.75	0.50	11.61
Sandy loam	Control	6.12	14.32	0.43	8.63
	K_1	7.28	16.91	0.43	9.45
	K_2	7.56	١٨,٥٢	0.53	10.2٨
Means		6.92	16.58	0.46	9.45
F Test A		**	**	--	**
LSD B		0.24*	0.18**	--	0.027**
LSD A x B		0.30**	0.27**	--	0.30**

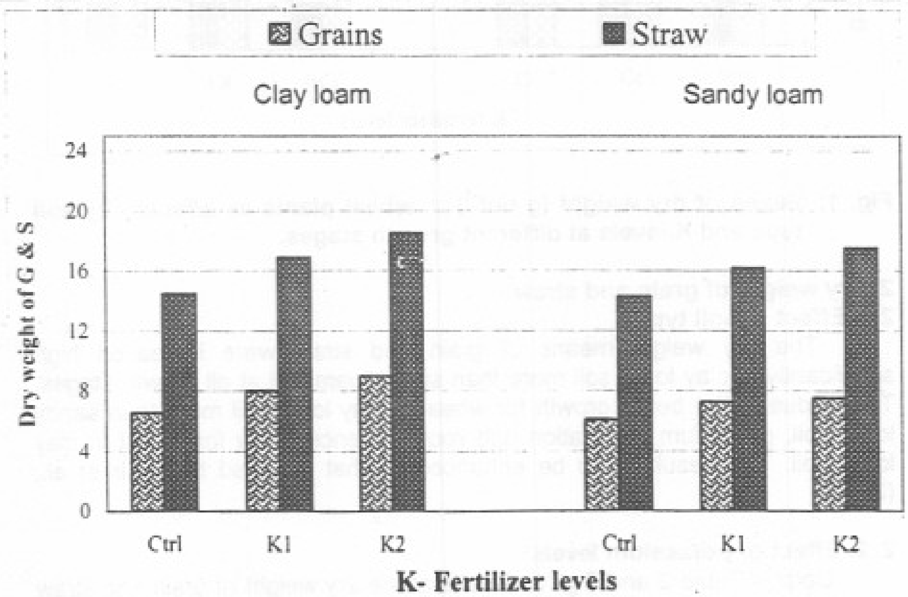

Fig. 2: Means of grain and straw dry weights (g pot^{-1}) of wheat plants as affected by soil type and K levels.

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

3.1. Effect of soil type:

Data in Table 4 and Fig. 3 show the K % means of wheat plants were increased high significantly in clay loam soil more than sandy 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 Genaidy *et al.*, (2001).

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

A- Soil type	Potassium levels	Days after sowing 45	90
Clay loam	Control	1.40	2.16
	K_1	2.24	2.18
	K_2	2.87	2.19
Mean		**2.17**	**2.18**
Sandy loam	Control	1.70	1.93
	K_1	2.08	1.94
	K_2	2.28	2.14
Mean		**2.02**	**2.00**
F Test A		**	**
LSD B		0.15**	0.25**
LSD A x B		0.80 **	0.30*

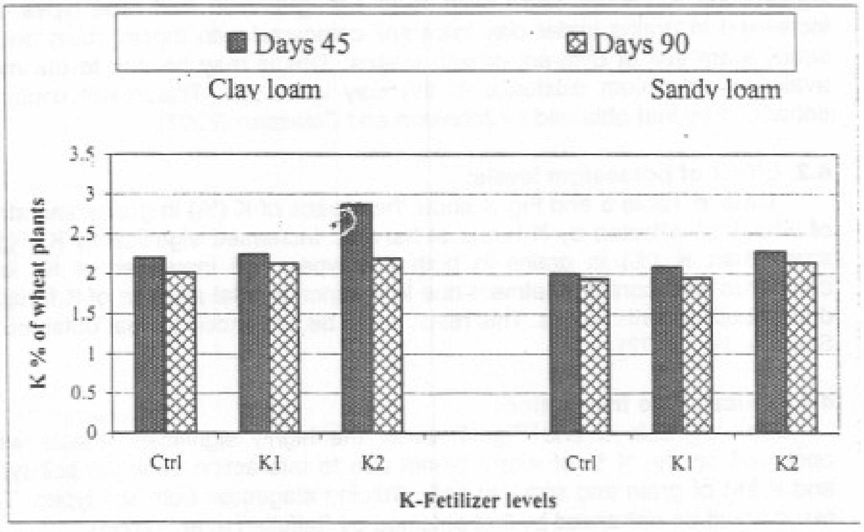

Fig. 3: Means of K (%) in wheat as affected by soil type and K levels at different growth stages.

3.2. Effect of potassium levels:

Data in Table 4 and Fig. 3 reveal that the K % in tops of wheat plants were increased gradually due to the incremental addition of K fertilizer during both growth stages. The increase reached to the level of significance. These results agree with those found by Genaidy *et al.*, (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 wheat 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 similar result was obtained by Genaidy *et al.*, (2001).

3.4. Effect of the interaction:

Data in Table 4 and Fig. 3 reveal the highly significant effects were observed on the K % of wheat plants due to interaction between soil types and K led of wheat plants at both growing stages on both soil types. These results agree with those found by Wong *et al.*, (2001).

4. K (%) in grains and straw of wheat:

4.1. Effect of soil type:

Data in Table 5 and Fig. 4 show that the means of K (%) in grains and straw of wheat as affected by soil type and K levels at harvest. Increased significantly K (%) in straw than K (%) in grains in both soil types and increased in grains under clay loam soil compared with those grown on the sandy loam soil at different growth stages. This is may be due to the more available potassium existence in the clay loam soil. This result could be enhanced by that obtained by Johnston and Claassen (2003).

4.2. Effect of potassium levels:

Data in Table 5 and Fig. 4 show the means of K (%) in grains and straw of wheat as affected by K levels at harvest. Increased significantly K (%) in straw than K (%) in grains in both soil types and increased at K_2 level compared with control treatment due to the incremental addition of K fertilizer during both growth stages. This result could be enhanced by that obtained by Singh *et al.*, (2002).

4.3. Effect of the interaction:

Data in Table 5 and Fig. 4 reveal the highly significant effects were observed on the K % of wheat plants due to interaction between soil types and K led of grain and straw at both growing stages on both soil types. This result could be enhanced by that obtained by Saifullah *et al.*, (2003).

Table 5: Means of K (%) in grains and straw of wheat as affected by soil type and K levels at harvest at different growth stages.

A- Soil type	Potassium levels	K %	
		Grains	Straw
Clayey loam	Control	0.64	1.22
	K_1	1.19	2.25
	K_2	1.33	2.40
Mean		**1.05**	**1.95**
Sandy loam	Control	0.51	1.20
	K_1	0.69	1.69
	K_2	0.80	2.59
Mean		**0.67**	**1.83**
F Test A		**	**
LSD B		**0.03****	**0.04****
LSD A x B		**0.04****	**0.05****

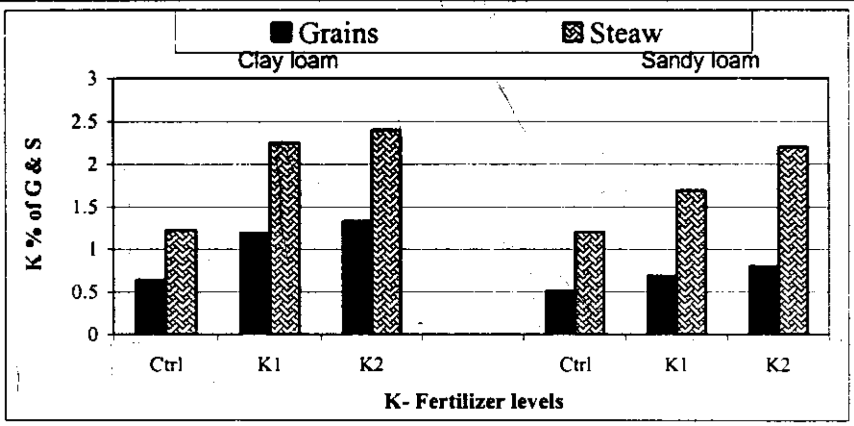

Fig. 4: Means of K (%) in grains and straw of wheat as affected by soil type and K levels at harvest of 2004 season.

5. K uptake of wheat plants

5.1. Effect of soil type:

Data in Table 6 and Fig. 5 show the K uptake (mg pot^{-1}) by plants as affected by type and K levels at different growth stages. Potassium uptakes was increased high significantly in both soil types and in clay loam soil more than sandy loam soil. This result is due to K application and of potassium availability by clay loam soil than sandy loam soil. These findings fully confirm the results of Genaidy *et al.*, (2001), Johnston and Claassen (2003).

5. 2. Effect of potassium levels:

Data in Table 6 and Fig. 5 show that K uptake (mg pot^{-1}) of plants as affected by K levels at different growth stages. The highest value was at K_2 level in both soil types compared with control treatment, while the lowest value was in sandy loam soil and control treatment, this may be due to the incremental addition of K fertilizer during both growth stages. These findings fully confirm the results of Genaidy *et al.*, (2001) and Johnston and Claassen (2003).

5.3. Effect of growth stages:

Data in Table 6 and Fig. 5 show the K uptake (mg pot^{-1}) of plants as affected by K levels at different growth stages. The results reveal values K uptake were increased high significantly from 45 day to 90 days in both soil types due to K application during different growth stages and of potassium availability by clay loam soil than sandy loam soil. These findings fully confirm the results of Johnston and Claassen (2003).

5.4. Effect of the interaction:

Data in Table 6 and Fig. 5 reveal the highly significant effects were observed on the K uptake of wheat plants due to interaction between soil types and K led of wheat plants at both growing stages on both soil types. This result could be enhanced by that obtained by Wong *et al.*, (2001).

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

A- Soil type	Potassium levels	Days after sowing	
		45	90
Clayey loam	Control	193.00	310.25
	K_1	339.05	404.15
	K_2	506.20	552.04
Mean		**346.08**	**422.15**
Sandy loam	Control	204.15	219.00
	K_1	308.54	322.12
	K_2	373.25	386.23
Mean		**295.31**	**309.12**
F Test A		**	**
LSD B		**58.00****	**60.75****
LSD A x B		**69.00****	**78.31***

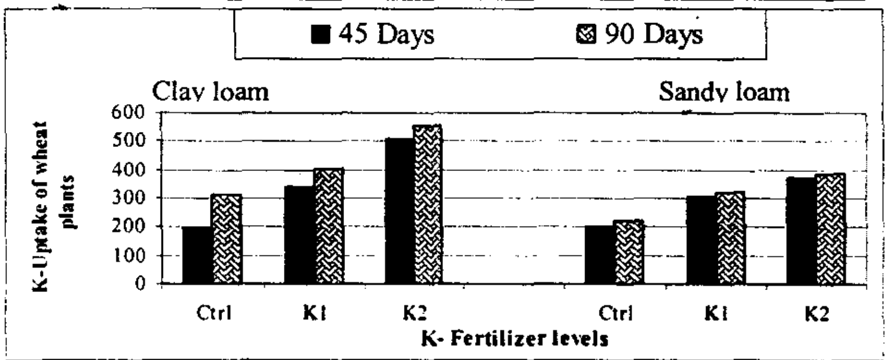

Fig. 5: Means of K uptake (mg pot^{-1}) of wheat plants as affected by soil type and K levels at different growth stages.

6. K uptake by grain and straw of wheat plants:

6.1. Effect of soil type:

Data in Table 7 and Fig. 6 show the K uptake (mg pot^{-1}) by grain and straw of wheat plants as affected by soil type and K levels. Potassium uptake was increased high significantly in straw than grain in both types of soil, and increased in clay loam of soil than sandy loam soil was due to K uptake increase in the plants. This result could be enhanced by that obtained by Genaidy *et al.*, (2001).

Table 7: Means of K uptake (mg pot^{-1}) of grain and straw wheat plants as affected by soil type and K levels.

A- Soil type	Potassium levels	K uptake (mg pot^{-1})		Total
		Grain	Straw	
Clayey loam	Control	42.00	310.78	352.73
	K_1	86.12	342.23	428.35
	K_2	111.00	420.48	531.48
Mean		**79.71**	**357.81**	**437.52**
Sandy loam	Control	31.00	191.89	222.89
	K_1	49.25	285.78	335.12
	K_2	60.00	479.67	539.67
Mean		46.75	319.11	365.89
F Test A		**	**	**
LSD B		**21.00****	**42.98****	**24.46***
LSD A x B		**30.12****	**58.33****	**30.07****

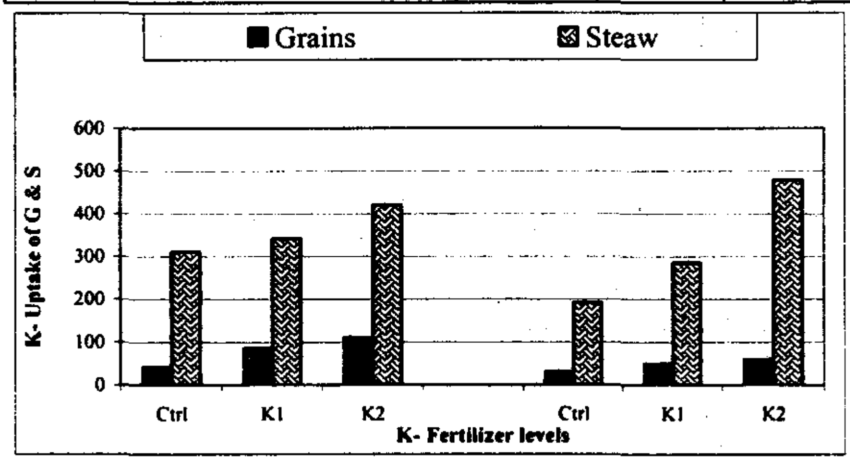

Fig. 6: Means of K uptake (mg pot^{-1}) of grain and straw wheat plants as affected by soil type and K levels.

6.2. Effect of potassium levels:

Data in Table 7 and Fig. 6 show the K uptake (mg pot^{-1}) by grain and straw cf wheat plants as affected by K levels, K uptake increase at K_2 levels compared with control treatments this may be due to the incremental addition of K fertilizer during both growth stages. This result could be enhanced by that obtained by Hu-ChengXiao *et al.*, (2000).

6.3. Effect of the interaction:

Data in Table 7 and Fig. 6 reveal the high significantly effects were observed on the K uptake of wheat plants between both soil types and potassium fertilizer level. The highest means of interaction were in the straw than the grains and were due to the potassium uptake increase in the in plants. These findings fully confirm ed by the results of Wong *et al.*, (2001).

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 wheat crop was increased in clay loam soil. These conclusions lead to increase in the yield.

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كفاءة البوتاسيوم لمحصول القمح تحت ظروف أراضي محافظة الشرقية

حسن عبد الله مشرف ، سامي عبـد الحميـد حمـاد ، خالـد حسن الحامـدي و محمد راجح محمود عشري
قسم علوم الأراضي، كلية الزراعة، جامعة المنصورة

أجريت تجربة أصص بلاستيكية علي نوعين من التربة لدراسة كفاءة البوتاسيوم بواسطة محصول القمح تحت ظروف محافظة الشرقية، في عام (٢٠٠٤).

ويمكن تلخيص النتائج المتحصل عليها فيما يلي:

١. مالت إضافة البوتاسيوم إلي زيادة الوزن الجاف (جرام أصيص $^{-1}$) لنبات القمح أثناء مراحل النمو المختلفة.
٢. زادت قيم البوتاسيوم الممتص في العينات النباتيةوالحبرب والقش في التربـة الطمييـة الطينية عن التربة الطميية الرملية في نبات القمح، وكانت القيم الأعلى عند الحصـاد، وعند مستوي التسميد K_2 مقارنة بمعاملة الكنترول، وفي كل مراحل النمو للمحصول.
٣. إضافة التسميد البوتاسي أدت إلي زيادة المحصول من الحبوب والقش في كلا نـوعي التربة.