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QUANTITY-INTENSITY RELATIONS OF POTASSIUM IN SOILS OF TOSHKA REGION

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ABSTRACT: Surface soil samples were taken from 8 profiles in Toshka Region to investigate their potassium Q/I relation. Moreover, soluble, exchangeable and total potassium content of the profiles were determined. The amounts of soluble K ranged from 0.98 to 5.08 me/100g soil, these values showed no clear trend with the clay content of the soil profiles. Exchangeable K ranged from 0.43 to 2.09 me/100g soil, it tended to be relatively high in the fine and medium textured soils and low in coarse textured ones. Total K ranged from 9.80 to 38.00 me/100 g soil, it tended to be high with increasing the silt fraction comparing with the other soil mechanical fractions. The obtained data of potassium Q/I showed that potassium activity ratio (AR_{Ke}) becomes lower as the soil texture become finer, yet it is not indication for K-supplying ability of the tested profiles. The K-potential buffering capacity (PBC_k) ranged from 7.88 to 101.85 [me/100g soil/ $(M/L)^{1/2}$]

Key words: K status, potential buffering capacity.

INTRODUCTION

Toshka area is one of the largest and most important project in Egypt's recent history. So a spot light on the status of potassium should be made to some profiles in this virgin area. The ability of a soil to maintain an adequate concentration of K, or intensity, in the soil solution when this element is either added to or removed from the solution is known as the "K-Buffering capacity" (PBC). Several workers have used the quantity/ intensity (Q/I) concept to asses the status of soil-K (Schofield, 1947; Beckett, 1964; Le Roux and Sumner, 1968; Koch *et al.,* 1970; Fergus *et al.,* 1972 and Evangelou *et al.,* 1986). The slopes and shapes of the Q/I sotherms, are useful to describe several soil K parameter. These isotherms are constructed by equilibrating a soil sample with a solution of $CaCl_2$ and increasing amounts of Cl. A net change, ΔK, in soil K content takes place as the soil equilibrates with the solution to attain a characteristic activity ratio for K, AR_K, defined by the ratio $^aK/\sqrt{^aCa + {^aMg}}$. The AR_K at which $\Delta K = 0$ is the equilibrium activity ratio for K which is a measure of the degree of K availability of a solution in equilibrium with the soil. The value of ΔK when $AR_K = Q$ is an estimate of size of the exchangeable pool (Beckett, 1964). The slope of the linear portion of the Q/I curve represents the potential buffering capacity, PBC_K. The present work is focused on determing the potassium buffering capacity of Toshka area.

MATERIAL AND METHODS

Soil surface samples (0-20) were collected from 8 profiles which represent the different soils of Toshka region. The particle size distribution of the studied samples is reported in Table 1.

Water soluble-K in soil paste extract and exchangeable-K as extracted by 1 N NH_4-OAc were determined using flame photometer. Total-K was determined in the HF-$HClO_4$ digestion extract (Jackson, 1958) in the tested soil samples and their mechanical separates were determined according to the method described by Jackson (1965).

Potassium potential (p.p.) was calculated by relating the negative logarithm of potassium activity to the negative logarithm of the sum of calcium and magnesium activities: in the equilibrated solution of a single sample without adding KCl to the $CaCl_2$ solution. p.p.= pk-0.5p (Ca+Mg). The potential buffering capacity for potassium in the soil samples was determined using the method reported by Beckett (1964) as modified by Singh *et al.* (1978); by equilibrating a series of 5 g soil samples with 50 ml of 0.01 M $CaCl_2$ containing a range of K concentration from zero to 0.01, 0.05, 0.10, 0.50, 1.00, 1.50, 2.00 and 3.00 mmol/l. The suspentions were shaken for an hour and allowed to stand overnight, the equilibrated solutions were separated by filtration. The filtrate was analyzed for Ca^{++} and Mg^{++} by titration with versenate. K^+ was determined flamephotometrically. The activity coefficients were calculated using the Debye Huckel formula:

$$- \log \gamma i = (0.509)\, Z_i^2 \,(I)^{1/2}$$

$$I = 1/2\, \Sigma\, C_i Z_i^2$$

Where :

γi = activity coefficient,
I = ionic strength,
Z_i = valence of the ion,
C_i = concentration in molarity

The difference between added and recovered in the final solution which is defined as ΔK was also calculated. The K activity ratio ($AR_K = {}^aK/\sqrt{{}^a(Ca + Mg)}$) for each solution was calculated using the formula $\gamma i = C_i a_i$, where (a) is the activity of an ion in solution. The potential buffering capacity for K (PBC_K) was calculated from the slope of the linear part of the curve (dQ/dI).

Table (1): Particle size distribution of the studied samples.

Prof. No	Soil Fraction (%)				Texture
	Clay	Silt	Fine sand	Coarse sand	
1	6.51	5.02	27.04	61.43	Sand
2	8.72	4.35	24.33	62.60	Loamy sand
3	17.55	10.52	28.05	43.88	Sandy loam
4	37.77	29.98	27.50	4.75	Clay loam
5	7.57	6.28	29.14	57.01	Loamy sand
6	18.57	12.69	23.44	45.30	Sandy loam
7	50.58	34.22	12.35	2.85	Clay
8	22.87	17.18	34.25	25.70	Sandy clay loam

RESULTS AND DISCUSSION

Forms of soil potassium: The results of different forms of K are reported in Table 2.

Soluble-K: The amounts of soluble K (Table 2) ranged from 0.98 to 5.08 me/100g soil. These values showed no clear trend with the clay content of the soil samples.

Exchangeable-K: The amounts of exchangeable K ranged from 0.43 to 2.09 me/100g soil, it tends to be relatively high in the fine and medium textured samples and become low in coarse textured ones.

Total-K: Ranged from 9.80 to 38.0 me/100g in the studied soil samples, the lowest value was associated with sample No. 3 representing the sandy loam texture, while the highest value was recorded in the clayey textured sample.

Q/I Parameters: The range of the potassium potential values goes from 1.98 to 2.37. Woodruff (1955). Suggested that potassium potential values of 2.57, 2.20 and 1.47 indicate that soil potassium is deficient, adequate, and excessive, respectively. Therefore, most of the studied profiles have a fairly adequate potassium content.

The minus (-) ΔK is a measure for the K-labile pool that is located on the planer surfaces of the micaceous minerals (Beckett *et al.*, 1966). It ranged from 0.22 to 1.23 me/100g, the actual quantity of -ΔK for studied sample was less than the exchangeable K.

The measured AR_K ranges between 0.012 and 0.033 $(M/L)^{1/2}$. it becomes lower as the texture becomes finer. According to Woodruff (1955), the tested samples may have balanced potassium nutrition as their AR_K lie in the range of 0.0027-0.034 $(M/L)^{1/2}$. All the studied soil samples are within this wide range.

Table (2): Distribution of different potassium forms of the investigated soil samples

Prof. No	Soluble-K	Exchangeable-K (me/100 g soil)	Total-K
1	0.98	0.43	23.00
2	1.38	0.58	20.02
3	5.08	1.10	9.80
4	2.45	2.09	26.40
5	1.22	0.47	24.20
6	3.58	1.90	26.10
7	1.08	2.07	38.00
8	2.06	1.73	15.70

Table (3): Potassium quantity-intensity parameters of the studied soil samples.

Prof. No	P.P	(-) ΔK me/100g Q	AR_{Ke} $(M/L)^{1/2}$ I	PBC_k me/100g/ $(M/L)^{1/2}$ Q/I
1	2.37	0.26	0.033	7.88
2	2.21	0.22	0.013	22.31
3	2.08	1.23	0.028	43.93
4	2.11	1.22	0.012	101.85
5	2.29	0.55	0.014	39.29
6	1.98	1.19	0.019	62.63
7	2.20	1.17	0.013	90.00
8	2.15	1.09	0.018	60.56

P.P.= Potassium Potential

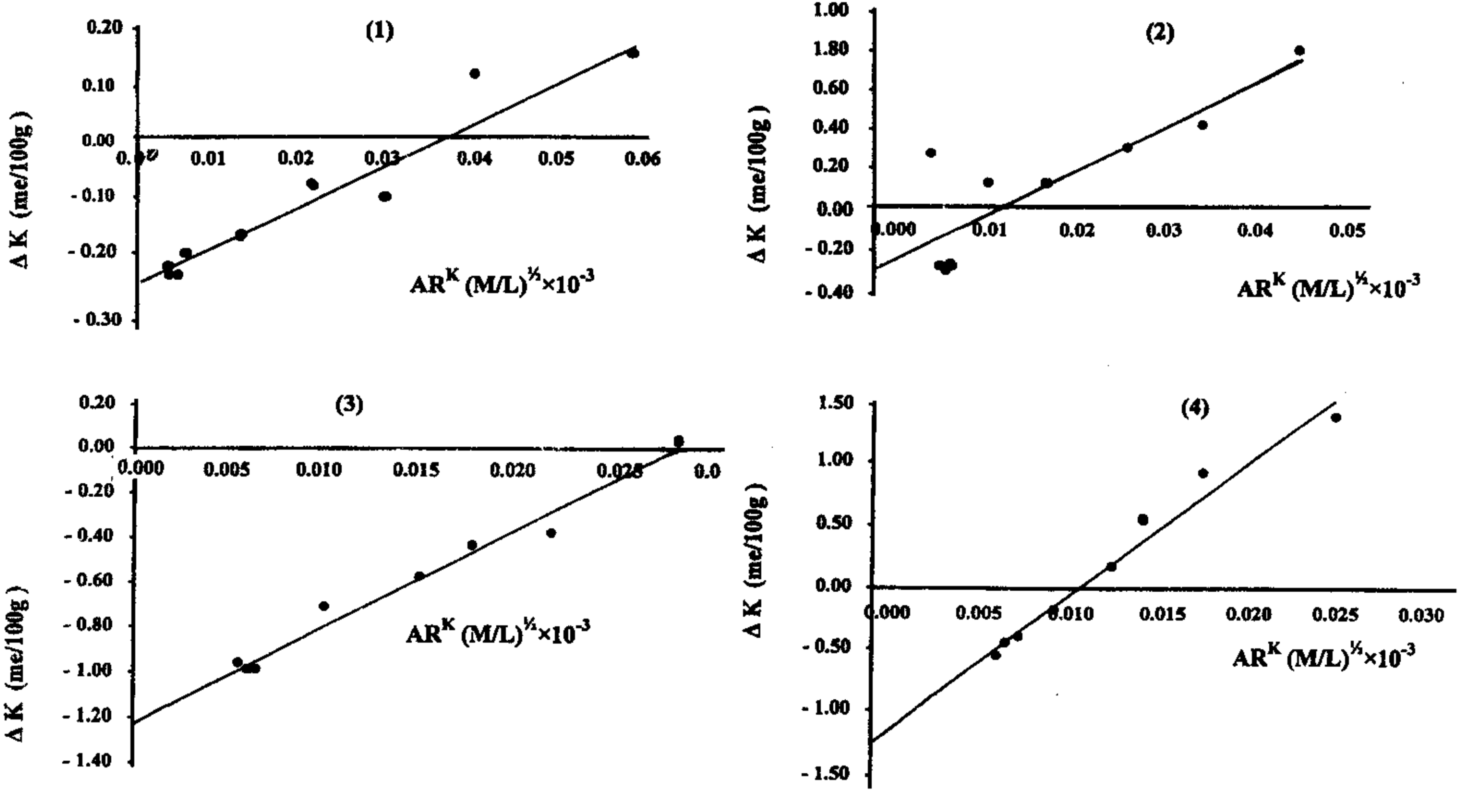

Fig. (I-a) The Q/1 Curves of the investigated profiles

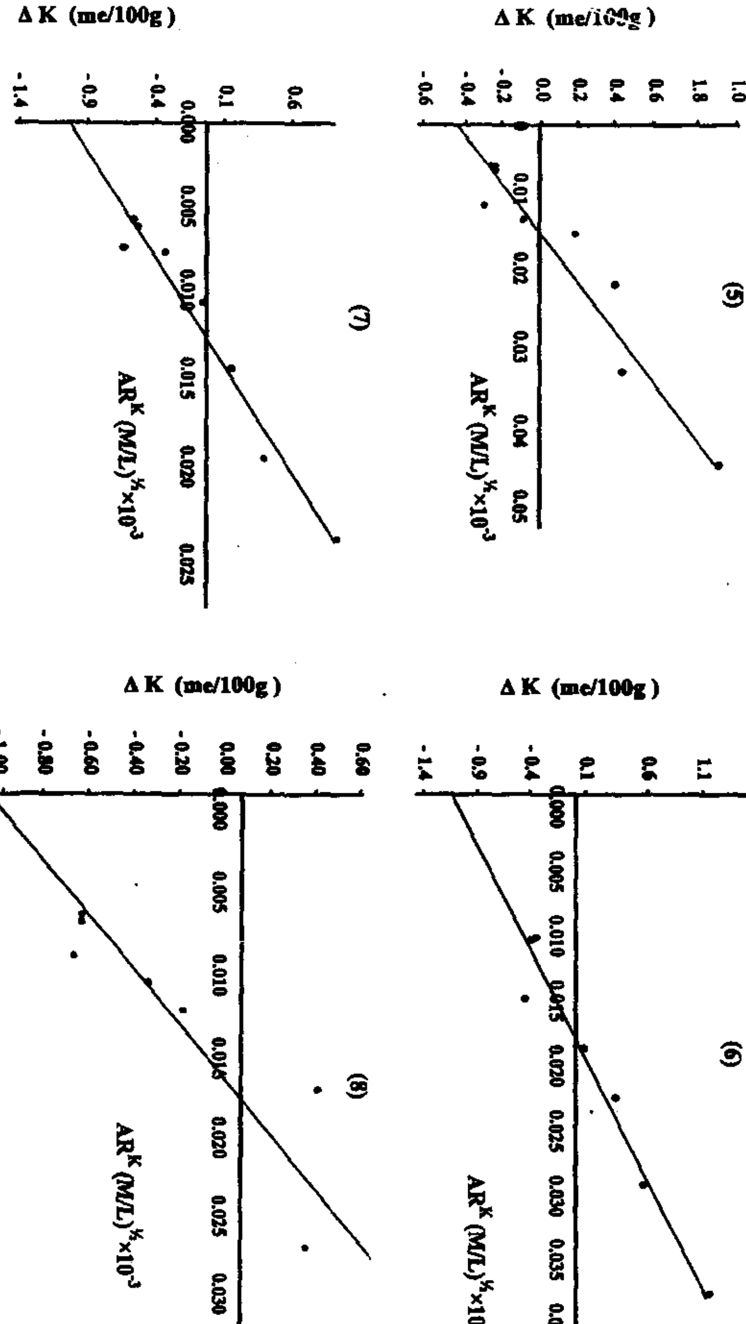

Fig. (I-b) The Q/I Curves of the investigated profiles

The potential buffering capacity (PBC_K) is a measure of the soil resistance to change their K-potentials (Parra and Torrent, 1983), and it ranges between 7.88 and 101.85 (me/100g)/ $(M/L)^{½}$ for the tested soil samples. The higher values are found in the fine textural samples, while the lower values are found in the coarse textural ones.

CONCLUSION

From the aforementioned results, it could be concluded that in spite of the relatively high amounts of the immediately available potassium in the soils of Toshka Region, yet their potential buffering capacity of potassium (PBC_K) are low compared with those of the different soils of the Nile valley and Delta, which reaches to [444 (me/100g) / $(M/L)^{½}$]. Therefore, these soils will need K-fertilization upon extensive-cropping. Because of the coarse texture of most of these soils, thus K-fertilizers should be applied in small frequent doses, or slow release K-fertilizers to avoid the lossing of added K by leaching.

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علاقات الكمية/التركيز الفعال للبوتاسيوم فى أراضى منطقة توشكى

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اجرى هذا البحث على عينات لرض سطحيه أخذت من ٨ قطاعات مختلفة من أراضى توشكى حيث تم تقدير علاقة الكمية/التركيز الفعال للبوتاسيوم ، وكذلك تم تقدير كل من البوتاسيوم الكلى والمتبادل والذائب وتراوحت قيم البوتاسيوم الذائب من ٠,٩٨ إلى ٥,٠٨ مليكافئ/١٠٠جم تربه ولم ترتبط هذه القيم مع محتوى الطين فى العينات.

وتراوحت قيم البوتاسيوم المتبادل من ٠,٤٣ إلى ٢,٠٩ ملليمكافئ /١٠٠جم تربه وكانت القيم المرتفعه مع القوام الناعم والمتوسط للتربة بينما القيم المنخفضة كانت مع القوام الخشن.

وتراوحت قيم البوتاسيوم الكلى من ٩,٨ إلى ٣٨ ملليمكافئ/١٠٠ جم تربه وتزيد قيمه البوتاسيوم الكلى مع زيادة نسبة السلت.

أما نسبه النشاط الكيماوى بالنسبة للبوتاسيوم (AR_{Ke}) وجد انها تقل كلما كان قوام التربة ناعما وهذا لا يدلنا على مقدرة التربة على الإمداد بالبوتاسيوم وبالنسبة لقيم السعه التنظيمية الكامنة فقد تراوحت من ٧,٨٨ إلى ١٠١,٨٥ (ملليمكافئ/ ١٠٠جم تربه /(مول/لتر)^{½}.