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INFLUENCE OF SOME ENVIRONMENTAL FACTORS ON RELEASE OF POTASSIUM FROM FELDSPAR ROCK

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ABSTRACT

The selected feldspar rock for this investigation is well known as orthoclase sediment at Gebel Rod Ashap. It is estimated that the reserves of this deposit are about 1.2 million ton. This deposit is slightly alkaline, low salinity and almost free of gypsum and carbonates accumulations. The total potassium content is relatively high (7.14%). This sediment includes several members of feldspars. The heavy metals (Ni, Pb) in this sediment are very rare. The results indicated that the increase of the concentration of water soluble potassium after 1 day is very distinct (from 890 to 1560 ppm). However, continuous increment of solubility, but in lower rate until the 7 th day. Also the exchangeable potassium enhanced from 2590.0 ppm to 3600.0 ppm after 7 days. The water-soluble potassium reached the maximum (1080.0 ppm) at 45°C and decreased at higher temperatures. While the exchangeable form of potassium has slight increase until 60°C. Regarding the influence of pH, it is found that increasing pH favors the solubility of potassium and the maximum value (895.0 ppm) was at pH 8.0. However, the addition of feldspar rock to the soil to obtain the adequate concentration of water soluble potassium, refer to the rate of 7% resulted in 550.2 ppm of soluble potassium. However, the rate of 5% gave 310.2 ppm of water soluble potassium and 390.0 ppm of exchangeable which is considered as a beneficial concentration for potassium supply in the soil. According to these results it can be recommended that the feldspar rock can substitute the application of chemical potassium fertilizers, which is economically quite expensive.

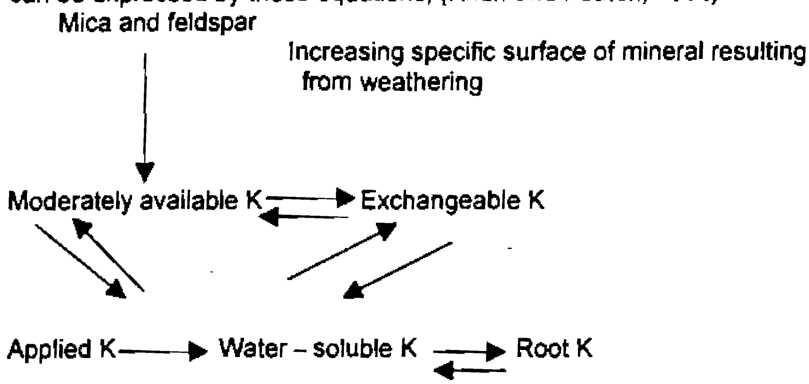
INTRODUCTION

There is a great trend in the last decades for the clean farming to most of the crops through the application of organic fertilization and biological control of pests. Among the essential elements for plant growth is potassium, which is supplied through chemical fertilizers containing various ranges of K – content. To avoid the contamination of soil and water by these chemical fertilizers and their impurities besides the high costs of applying such products, natural products can be added to the soil as K amendment.

The capacity of a soil to supply potassium for growing plants from both exchangeable and non-exchangeable forms is known as K – supplying power of the soil. The feldspars and mica are the main K – bearing minerals in soils. Orthoclase is one of K – feldspars, which is used as raw material for the extraction of potash and in ceramic industry. The deposits of this mineral were thus prospected and studied. These deposits are usually accrued as dikes transecting younger granites. They are widespread in central and northern Eastern Desert, e.g. El-Fawaghir, Bir Mineih, El- Bakriya and others.

In this respect, *Abdel Aal et al., (1991)* found that the total K is correlated with soil content of K – bearing minerals (r = 0.99**) i.e. mica and K – feldspars. Also *Shahin et al (1989)* concluded that the amounts of the non – exchangeable – K which recovered during the latter periods of intensive cropping, are significantly correlated to the K – bearing minerals content (for mica r = 0.96** and for K – feldspars, r = 0.922**). The amount of K in a soil is a function of the parent material, degree of weathering and the quantity and analysis of K – fertilizer applied, minus losses due to crop removal, erosion and leaching *(Bertsch and Thomas, 1985)*. The same authors added that potassium availability is further dependant on the dynamics among various K – bearing minerals and the rate of transformation among minerals. Similar results have been found by *Yadav et al (1999)*. They found positive and significant relationships between exchangeable, soluble and total K indicated the existence of dynamics equilibrium between these forms of K – clay and silt + clay.

The chemical relationships between the various forms of soil potassium can be expressed by these equations, *(Khan and Feuton, 1996)*



The main objective of this research work is to find out the influence of some environmental factors such as temperature, time and pH on the release of potassium from feldspar rock in soil. The final goal, which may extend to further investigation, is to apply these natural sediments containing feldspars to substitute K – fertilization for different crops.

MATERIALS AND METHODS

The used orthoclase is located at Gebel Rod Ashab, near Barramiya at Idfu – Mersa Alam asphaltic road. It lies at the intersection of longitude 34° 05' E and latitude 25° 09' N. The reserves of the selected orthoclase deposits are about 1.2 million ton.

The undisturbed sample was crushed, grounded and sieved through 2mm sieve and used for the following determinations according to *Black et al (1982)*.

- pH was measured in sample water suspension 1:2.5.
- EC (dS/m) measured in water extract 1:1.
- $CaCO_3$ content (%).
- Gypsum content (%).
- Water-soluble potassium and sodium in sample – water extract 1:5.
- Exchangeable potassium in ammonium acetate extract

- Total potassium and sodium determined by digestion of mineral with HNO_3, HF, $HClO_4$ and HCl (*Soltanpour et al., 1996*).

Spectrographic semi – quantitative analysis of the applied rock sample was done according to *Soltanpour et al., (1996)*.

The effect of time on release of potassium from the mineral was studied after 1,3,5 and 7 days in water extract 1:5 and ammonium acetate. The determination of soluble and exchangeable potassium is carried out by flamephotometer.

The effect of temperature on release of potassium from the mineral was studied under different temperature degrees (20, 25, 30, 35, 40, 45, 50, 60, 70 and 80°C). Then soluble and exchangeable potassium was measured.

The effect of pH on release of both soluble and exchangeable potassium was measured under different pH values (5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5 and 9.0).

The influence of rate of application of feldspar rock on release of potassium in soil was studied by adding and mixing 1, 2, 5, 7, 10, 12 and 15% of feldspar to sandy soil poor in potassium supply.

RESULTS AND DISCUSSION

The selected feldspar rock for this investigation is well known as orthoclase sediment at Gebel Rod Ashab, near Barramiya. It is estimated that the reserves of the selected orthoclase deposit are about 1.2 million ton.

The main chemical criteria of this sediment are recorded in Table (1).

Table (1): Some chemical analysis of feldspar rock.

Sample	pH (1:2.5)	EC dS/m (1:1)	$CaCO_3$ %	Gypsum %	Water soluble K,ppm	Exch. K, ppm	Total K%	Total K_2O%	Total Na%	Total Na_2O %
Feldspar	7.95	3.85	0.09	-	890.0	2590.0	7.14	8.60	4.53	6.10

This deposit is slightly alkaline, low salinity and almost free of gypsum and carbonates accumulations. The total potassium content is relatively high (7.14 %) and the estimated K_2O is 8.60 %. The exchangeable potassium as extracted by ammonium acetate is 2590.0 ppm. However, this sample contains a considerable amount of sodium (4.53 %) and Na_2O is 6.10%. These results indicate that this sediment includes several members of feldspars (K, Na and Ca feldspars, i.e. orthoclase, albite and anorthite). These findings are supported by the spectrographic semi – quantitative analysis (Table 2).

Table (2): Spectrographic semi-quantitative analysis of feldspar rock.

Concentration	Element
Major elements > 10 %	Al, Ca, K, Na and Si
Minor elements 1-10 %	Cr
Faint traces 0.01 – 0.1 %	Ba, Fe, Mg, Mn, Ni and Pb
Very faint traces 0.001 – 0.01 %	Cu

The figures indicate that K, Na and Ca are major elements (> 10%) besides silicon and aluminum. The heavy metals (Ni, Pb) in this sediment, as shown by spectrographic analysis, are very rare (0.01 – 0.1 %).

There are several factors that may influence the release of pctassium from feldspar rock. The figures in Table 3 refer to the increase of the concentration of water-soluble potassium particularly after 1 day of mixing with water (figure 1a). However, continuous increment of solubility, but in lower rate until the 7 th day of experiment. Also the exchangeable potassium enhanced from 2590.0 ppm to 3600.0 ppm after 7 days. This result indicates that adding the feldspar rock to the soil will give continuous supply of potassium.

Regarding the impact of temperature on the solubility of potassium, in the range from 20°C to 80°C; it is observed from the values in Table 3 and figure 3b that water soluble potassium reached the maximum (1080 ppm) at 45°C and decreased at higher temperatures when the feldspar rock was mixed with the soil. While the exchangeable form of potassium has slight increase until 60°C (from 2590.0 to 2800.0 ppm). It can be concluded that the beneficial action of potassium release will be more distinct for summer crops when mixing the feldspar rock to the soil.

Another important factor which may influence the release of potassium is the soil reaction, it was found that increasing pH favors the solubility of potassium and the maximum value (895.0 ppm) at pH 8.0 (figure 3c).

Table (3): Effect of time, temperature and pH on release of potassium

K (ppm)	Time (day)				
	0	1	3	5	7
Soluble	890.0	1550.0	2100.0	2200.0	2320.0
Exch.	2590.0	3100.0	3300.0	3500.0	3600.0

	Temperature, °C										
	20	25	30	35	40	45	50	55	60	70	80
Soluble	890.0	930.0	990.0	998.0	1100.0	1080.0	940.0	850.0	800.0	770.0	700.0
Exch.	2590.0	2670.0	2740.0	2750.0	2780.0	2770.0	2775.0	2780.0	2800.0	2650.0	2500

	PH value								
	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
Soluble	328.4	419.1	550.0	555.0	570.0	600.0	895.0	822.0	835.0

A laboratory experiment was conducted to assess the favorable rate of adding feldspar rock to the soil to obtain the adequate concentration of water-soluble potassium. The obtained values in Table (4) refer to the rate of 7% resulted in 550.2 ppm of soluble potassium. However, the rate of 5 % gave 310.2 ppm of water soluble potassium and 390.0 ppm of exchangeable which is considered as a beneficial concentration for potassium supply in the soil.

According to the *Authority of Land Reclamation in Egypt (1989)* the levels of the available potassium (ppm) are as follows:

V. Poor	poor	medium	adequate
< 200	200-300	300-400	> 400

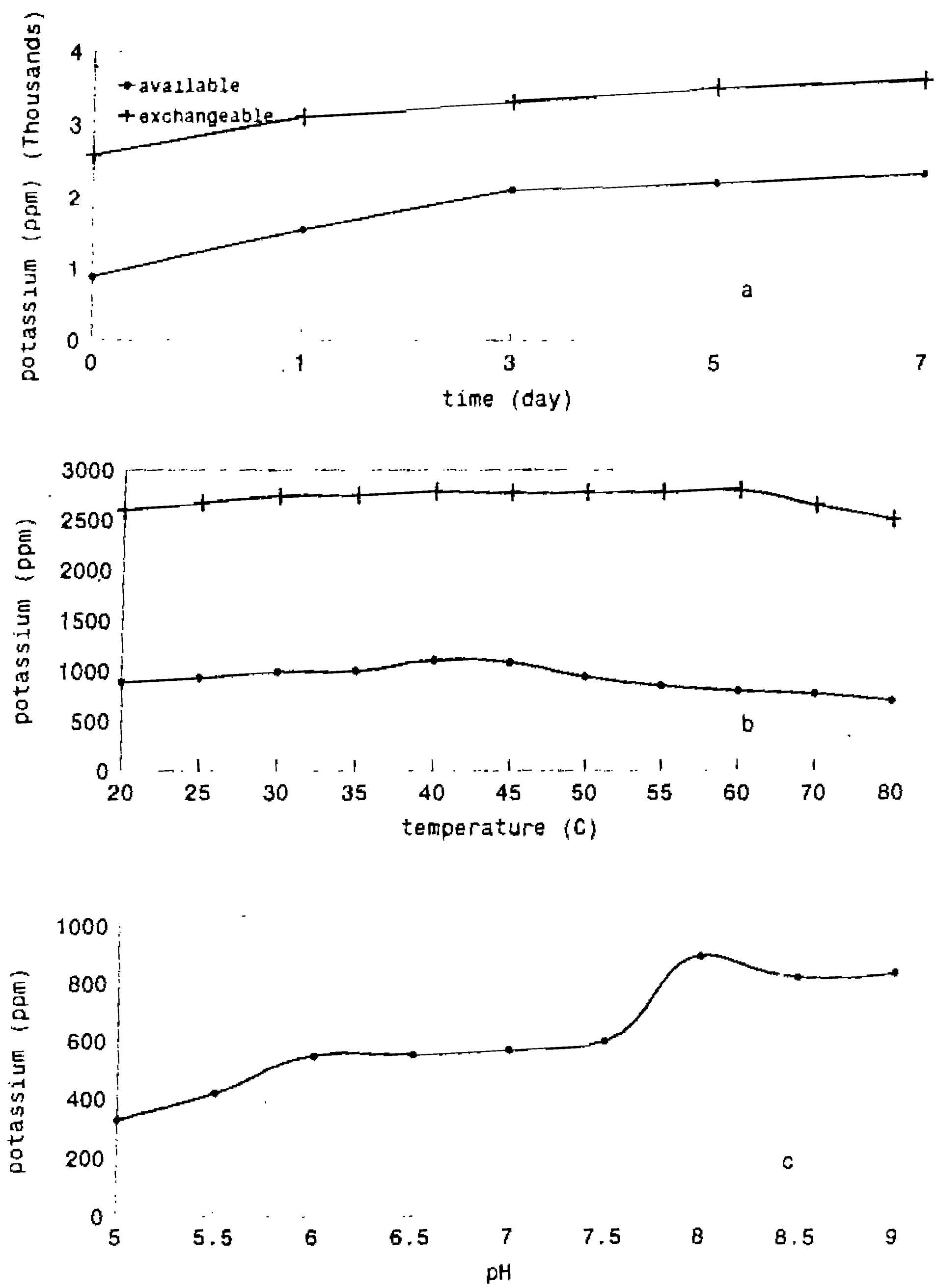


Fig (1): Effect of time, temperature and pH on release of potassium from feldspar

Table (4): Influence of rate of application of feldspars on release of potassium.

K (ppm)	0	Rate of application (%)						
		1	2	5	7	10	12	15
Soluble	40.3	195.9	235.4	310.2	550.2	640.8	680.0	692.3
Exch.	135.8	246.3	250.0	390.0	700.0	730.0	750.0	800.0

CONCLUSION

The reserve of the selected feldspar rock at Gebel Rod Ashab is about 1.2 million ton. The total potassium content in this rock is relatively high. The results indicated that adding the feldspar rock to the soil will give continuous supply of potassium. Also, it can be concluded that the beneficial action of potassium release will be more significant for summer crops when the feldspar rock is mixed with the soil. The rate of 5% is considered as a beneficial concentration for potassium supply in the soil. Consequently the amendment of potassium to the soils can be achieved through these natural sediments instead of the application of chemical fertilizers which are costly.

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تأثير بعض العوامل البيئية على انطلاق البوتاسيوم من صخر الفلسبار

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يوجد صخر الفلسبار المستخدم في هذه الدراسة في منطقة جبل عشاب وتقدر كمية هذا الصخر بحوالي ١,٢ مليون طن. وقد بينت التحليلات الأولية على هذا الصخر انه يميل إلى القلوية وانه قليل الملوحة وخالي تقريبا من الجبس وكربونات الكالسيوم. كما أن المحتوى الكلي من البوتاسيوم مرتفع (٧,١٤ %) وكذلك الصوديوم والكالسيوم مما يدل على أن هذا الصخر يحتوى على عدة أفراد من الفلسبارات. كما أن المحتوى من العناصر الثقيلة قليلة. وبدراسة تأثير كل من الزمن ودرجة الحرارة ودرجة تفاعل التربة (pH) على انطلاق البوتاسيوم من هذا الصخر وجد انه بزيادة الزمن يزيد البوتاسيوم الذائب في الماء بعد يوم واحد ويستمر الذوبان ولكن بدرجة اقل حتى ٧ أيام. وتصل نسبة انطلاق البوتاسيوم من الصخر إلى أقصى معدل لها عند درجة حرارة ٤٥م° وتقل بارتفاع درجة الحرارة. بينما في البوتاسيوم المتبادل تكون الزيادة قليلة حتى ٦٠ م° . كما تبين النتائج المتحصل عليها انه بزيادة ال pH يزيد معدل انطلاق البوتاسيوم وان أقصى زيادة كانت عند pH ٨ . وبإضافة هذا الصخر إلى التربة وجد انه يمكن الوصول إلى الكمية الكافية من البوتاسيوم الصالح للنبات عند إضافة نسبة ٥% من الصخر إلى التربة. وبناء على هذه النتائج يمكن التوصية بإضافة هذا الصخر بعد طحنه بدرجة مناسبة الى التربة والاستغناء عن الأسمدة البوتاسية المكلفة اقتصاديا.