STUDY ON SOME K-RICH SEDIMENTS PRESENT IN THE EASTERN DESERT OF EGYPT

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Abstract

It has been demonstrated that the potassium rich rocks and/ or minerals contain potassium ions in the form of K_20 most of it are able to be released. Therefore the main objective of this research is to study the chemical and mineral constitutes of three sediments from: Rod Ishab, Umm Kheiam and Wadi El Gemal in the Eastern Desert of Egypt. The obtained results indicate that the soluble and exchangeable forms of potassium are quite sufficient for plant growth. The detailed petrographic examination of the thin sections under the polarizing microscope indicated the dominance of feldspar groups (microcline, orthoclase and plagioclase) with some quartz and micas. These minerals show cleavage and cracks due to alteration and weathering in different degrees. The total K content, originated mainly from orthoclase and microcline $KAlSi_3O_8$ that dominate in the studied deposits, is found in considerable proportions (6.96 - 8.60 % K_2O). The mobilization of potassium from these potassium rich rocks can occur through grinding and mixing with organic materials. The recommended application can substitute partly or completely the chemical fertilizers (e.g. K_2SO_4) which is rather expensive and easily soluble and can be lost through drainage.

INTRODUCTION

The proper fertilization program is one of the important factors in agricultural production of most crops. Potassium is one of sixteen essential nutrients required for plant growth and reproduction. It is classified as a macronutrient as nitrogen and phosphorus. It plays a vital role in photosynthesis carbohydrate transport, protein formation, control of ionic balance, regulation of plant stomata and water use, activation of plant enzymes and many other processes (Thompson, 2004). Consequently, the uptake of potassium from soil increases crop yield in various ranges. One of the most common signs of potassium deficiency is the yellow scorching or firing (chlorosis) along the 1eaf margin. However, these symptoms are different from one crop to another.

The most common fertilizer applied in Egypt is potassium sulfate (50 % K_2O and 18% sulfur). The product is completely water-soluble in some cases and has a high salt index. Therefore, when placed too close to seeds or transplants, they can decrease seed germination and plant survival. This fertilizer injury is most severe on sandy soils under dry conditions (Thompson, 2004).

From the economical point of view the potassium sulfate fertilizer is rather expensive since the prices are successively increasing and became a burden on agricultural production particularly in Egypt (1200 - 1500 LE/Ton).

For all these considerations, attention has been directed to the application of potassium bearing minerals and rocks which have been excavated and recognized in many areas in the Eastern Desert and Sinai in considerable amounts. These sediments consist mainly of feldspar group, which are regarded as one source of potassium in soil besides other minerals as micas and specific clay minerals.

The main objective of this research is to through some lights on the chemical and mineral constituents of some sediment, particularly with respect to potassium bearing rocks and/or minerals, in three locations in the Eastern Desert of Egypt, These sediments can be applied as slow release sources of available potassium (potash fertilizers).

MATERIALS AND METHODS

According to geological data (Abdel Aziz and El Sharkawi, 1990), three locations represent sediments of potassium feldspars were selected in the Eastern Desert of Egypt, between Ras Benas and Quseir named: Rod Ishab, Umm Kheiam and Wadi El Gemal (Figure 1).

Samples from these three locations were collected for analyses.

Chemical analyses

The selected samples were prepared and subjected to the following determinations:

- The electrical conductivity in 1 : 5 sediment water extract (USDA, 1991).
- PH in 1 : 2.5 sediment to water suspension.
- $CaCO_3$ % and gypsum % (Nelson, 1982).
- Potassium forms: water soluble potassium in 1 : 5 extract and ammonium acetate extract (USDA, 1991) and total potassium (Soltanpour *et al.*, 1996).

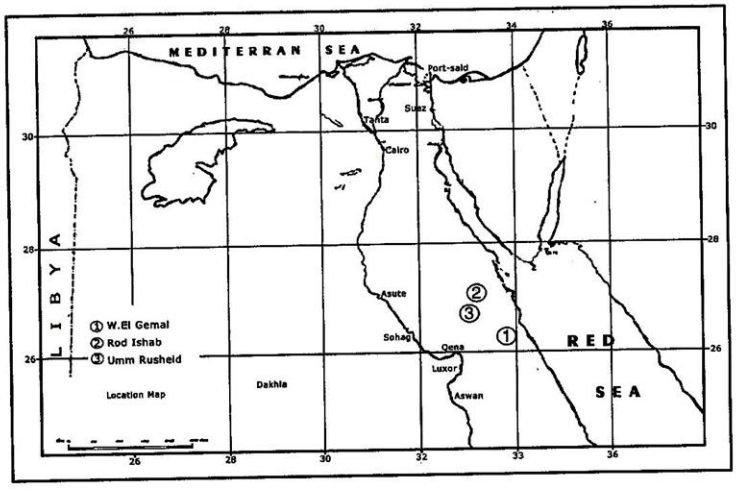

Figure 1. Locations of the studied sediments

Petrographic examination

Thin sections of undisturbed sediments were prepared according to the method of Stoops (1976) which are applied for soil micro morphological studies. The prepared thin sections were examined and described according to the terminology explained by Milner (1962) and Bullock *et al.*, (1985), and photographed by a polarizing microscope (Zeiss).

RESULTS AND DISCUSSION

Data presented in Table 1 show that the tested sediments are nearly free of gypsum and calcium carbonates (very low amount of $CaCO_3$ are detected in Rod Ishab).

Table 1. Some chemical characteristics of the tested sediments' samples

No	Location	pH (1 : 2.5)	EC (dS/m)	$CaCo_3$ %	Gypsum %
1	Rod Ishab	7.95	3.85	0.9	-
2	Umm Kheiam	7.83	0.66	-	-
3	Wadi El Gemal	8.41	0.31	-	-

With regard to salinity, the samples are considered non-saline, except Rod Ishab sample, (EC are 3.85, 0.66 and 0.31 dS/m for Rod Ishab, Umm Kheiam and

Wadi El Gemal, respectively). Sediment reactions tend to be alkaline, as pH values are 7.95, 7.83 and 8.41 for the three samples, respectively.

Since these samples are considered as potassium source which can substitute the chemical fertilizers, analysis were carried out to assess the forms of potassium in these samples (Table 2).

Table 2. Forms of potassium status in the tested samples

No	Location	Water soluble K (ppm)	Ammonium acetate extract K (ppm)	Total K %
1	Rod Ishab	890	2590	7.14
2	Umm Kheiam	910	3800	7.60
3	Wadi El Gemal	340	1000	5.80

The total potassium found to be 7.14, 7.60 and 5.80 % in Rod Ishab, Umm Kheiam and Wadi El Gemal, respectively, which correspond to 8.60, 9.12 and 6.96% K_2O, respectively.

The exchangeable part of potassium, the major bioavailability forms of potassium in soil is ranging between 1000 and 3800 ppm. Barak (1999) mentioned that there is a rapid equilibrium between soluble potassium and potassium ammonium acetate extract which can be described by Gapon equation, as follows:

$$K^{+}_{ex} / Ca^{2+}_{ex} + Mg^{2+}_{ex} = K_G [(K^{+}_{sol}) / \sqrt{(Ca^{2+}_{sol} + Mg^{2+}_{sol})}] / 2$$

The water-soluble potassium represents a very minute portion of the total potassium. The obtained figures are 890, 910 and 340 ppm in the samples from Rod Ishab, Umm Kheiam and Wadi El Gemal, respectively (Table 2). These concentrations of soluble potassium are quite adequate for most of plant growth if occurred in the soil (Thompson, 2004).

In an experiment carried by Rahim (2003) using Umm Keiam sediments, found that adding 7% to the soil resulted in 550.2 ppm of soluble potassium while the rate of 5% gave 310.2 ppm of water soluble potassium and 390 ppm of exchangeable potassium, which are considered as a beneficial concentration for potassium supply in soil.

Petrographic examination

Rod Ishab Sample (Figure 2. a and b)

The microscopic observations indicate that the sediment is almost pure composed of megacrystals with crosshatched pattern of microcline. These crystals are mostly cemented, non-oriented and clearly weathered showing many random cracks. Some grains of plagioclase with distinct parallel laminar twinning, micro crystals of

quartz scattered in the groundmass of the rock and very few minute opaque impurities are observed. The limited voids between crystals are mostly showing planes.

This sediment of microcline seems in the nature as dykes or pockets within pegmatitic rocks. These dykes or pockets are of various dimensions and may extend for more than 1 km. They are either pure microcline or contaminated with quartz; calcite and barite (Abdel Aziz and El Sharkawi, 1990).

Umm Kheiam Sample (Figure 2. c)

The rock is composed of perthites, which are intergrowths of sodium-rich feldspars within potassium rich feldspar host. These intergrowths are either crypto- or micro-perthitic intergrowths.

The perthites are in the form of dykes associated with granitic rocks and pegmatites of the Eastern Desert.

Under the microscope, the rock is composed of meso grains of perthites showing fine strings which are sometimes interlocked (Fig.2.c) without voids. The perthites encloses plagioclase crystals characterized by lamenar twinning together with micro quartz grains. Some perthites show replacement by large patches of sodium-rich feldspars (mainly albite).

Abdel Aziz and El Sharkawi (1990) concluded that the estimated reserves of microcline and perthites dykes are still unknown and feldspar production is up till now low. Only 37,000 tons were exploited in 2000/2001.

Wadi El Gemal Sample (Figure 2. d).

The rock is related to the younger granite, which are widely distributed all over Egypt, constituting 30% of the basement rocks (Said, 1990).

Younger granites predominate in north Eastern Desert and South Sinai and occur mostly as isolated bodies of 1 to 10 Km diameters. They show characteristic red to pink colour caused by the prevalence of potash feldspar variably stained by hematitic dust.

Younger granites show uniformity in mineralogical and chemical composition. They are composed of feldspars (60 % vol.) and quartz of (about 40 % vol.) with very small proportions of micas. The feldspars are represented by both orthoclase and plagioclase the first dominates over the second.

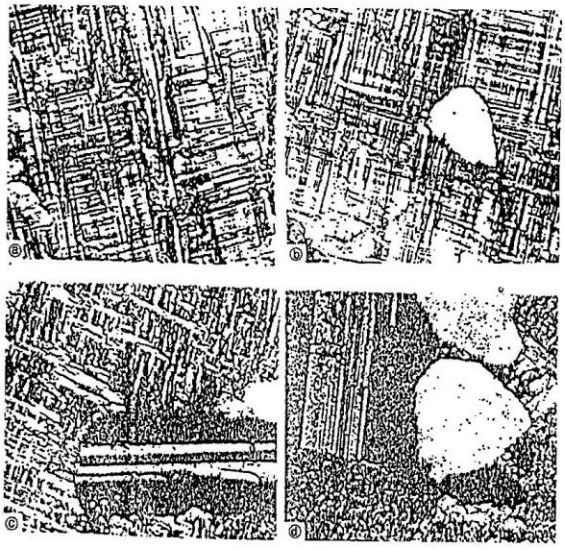

Figure 2. The microscopic photograph of the studied samples [a and b Rod Ishab; c Umm Kheiam and d Wadi El Gemal sample]. (C.N... x=70)

Under the microscope, the orthoclase shows turbid appearances due to alteration and simple twinning and is distinguished from plagioclase by the absence of lamenar twinning (Fig. 2 d). Most of the constituent minerals are in the range of 1-2 mm in diameter with perfect crystal faces.

CONCLUSION

The obtained results on chemical composition of the rock samples, from the widespread sediments outcrop in the Eastern Desert, and the mineralogical observations of thin sections indicate that these rocks are considered as potassium sources that can amend the soil with this essential element.

As the results indicate, the soluble and exchangeable forms of potassium are quite sufficient for most of the plants. The total potassium content (6.96 - 8.60 % K_2O) originated mainly from orthoclase and microcline $KAlSi_3O_8$ which dominate in the studied rocks. This potassium in the minerals can be released to plants during weathering and destruction of those minerals. These processes may be enhanced by grinding the rocks into minute grains before mixing with soil. Also mixing these ground rocks with composted organic materials, in which high degrees of temperature are produced from biological reactions, may lead to potassium release from feldspar

minerals. Adding such mixtures to the soil of the tree pits or the soils cultivated with field crops, particularly in sandy soils poor in nutrients, can substitute the potassium chemical fertilizers which are easily soluble and can lost through drainage.

However, more detailed field experiments are required to study the possibility of adding such potassium bearing rocks and/or minerals, as slow available potassium source to the soils especially sandy ones, to substitute partly or completely the chemical K-fertilizers.

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دراسة عن بعض الترسيبات الغنية بالبوتاسيوم الموجودة فى الصحراء الشرقية فى مصر

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فى بعض مناطق صحارى مصرتم التعرف على بعض الترسيبات التى تحتوى على صخور غنية بعنصر البوتاسيوم فى صورة أكسيد بوتاسيوم. ولذلك فإن الغرض من هذا البحث هـو دراسـة بعض الخواص الكيميائية والمعدنية لهذه الصخور فى ثلاثة مناطق فى الصحراء الشرقية (أم الخيام – وادى غدير – روض الشعب).

وتشير النتائج المتحصل عليها أن هذه الرواسب تحتوى على البوتاسيوم فى صـورة ميـسرة وقابلة للامتصاص بكميات كافية لنمو معظم النباتات إذا ما أضيفت للتربة.

أوضحت الدراسة البتروجرافية لشرائح الرواسب أن المعادن السائدة بالعينات المدروسة هـى الميكروكلين والأرثوكلاز والبلاجيوكلاز مع بعض بلورات من الكوارتز والميكا. وهذه المعادن يوجد بها تشققات تدل على تعرضها لعوامل التجوية. ودلت النتائج على أن البوتاسيوم الكلى فى العينـات تحت الدراسة يتراوح بين٦,٩٦ ، ٨,٦٠ بو٢أ% وأن تحلل وتحرك صور البوتاسيوم من هذه المعادن يمكن أن يحدث نتيجة طحن هذه الصخور وخلطها مع المادة العضوية حيث ترتفع درجـة حرارتهـا نتيجة التفاعلات البيولوجية مما يساعد على تحلل هذه المعادن.

هذا ويجب أن تجرى التجارب على إضافة نسب مختلفة من هذه الصخور إلى المادة العضوية وإضافتها إلى التربة سواء فى جور الأشجار أو المحاصيل الحقلية لكي نستبدل كليا أو جزئيا بعـض الأسمدة البوتاسية الغالية الثمن التى تزيد من تكاليف الإنتاج الزراعي وخاصة فى مصر.