EFFECT OF SOME SOIL AMENDMENTS ON CHEMICAL PROPERTIES OF SALINE ALKALI SOIL

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ABSTRACT

Two filed experiments were carried out at Sanhour and Rahil farms Fayoum Governorate to evaluate (the influence of some soil amendments) either gypsum or sulphur, on some chemical properties of saline alkali soils. The treatments of soil amendments were applied at rate of 0 and 100% gypsum requirement, while were added at rate of 100% sulphur requirement with leaching after using subsoiling tillage. Nitrogen was added as anhydrous ammonia (82%N) by soil injection at three levels 80,100 and 120kg N/ fed. At the end of experiments soil sample from each plot was taken to determine EC, pH, soluble ions and exchangeable cation.

The main results of this study could be summarized as follows:

1. The values of EC were slightly decreased as results of adding soil amendments either gypsum or sulphur to saline alkali soil during the two seasons.

2. The addition of soil amendments to saline alkali soil under subsoiling tillage increased the amount of salts removed from the soil by leaching process. It can be noticed a slight decrease in soil salinity which was accompanied by a decrease in soil pH, soluble sodium, soluble chloride, exchangeable sodium and ESP as compared with untreated soil. In contrary, soluble and exchangeable calcium were increased.

INTRODUCTION

Reclamation of salt affected soils is an important part of the agricultural security program. In Egypt one million hectare of irrigated area should be reclaimed by using soil amendments for its cultivation to meet demand of increasing population. Application of gypsum and sulphur as soil amendments in salt affected soils led to reclaim chemical properties and availability of nutrients. Shehata *et al.*, (1983) and Batra and Ghai (1987) found that addition of gypsum with leaching to saline alkali soil led to decrease pH value and exchangeable sodium. Also, Laila (1993) and Saffa (1998) found that application of gypsum to saline alkali soil caused a clear decreased in the values of pH, EC and soluble and exchangeable Na^+. On the other hand, soluble Ca^{2+}, SO_4^{2-} and exchangeable Ca^{2+} were increased as results of gypsum application. Khafagi and Abd El-Hadi (1990), Abd El-Fattah *et al.*, (1990) and Dawood *et al.*, (1990), indicated that sulphur application lead to reduce soil pH.

This work aim to evaluate the effect of either gypsum or sulphur as soil amendments as well as injection of anhydrous ammonia as a source of nitrogen on some chemical properties of salt affected soils.

MATERIALS AND METHODS

The present study was carried out at Sanhour and Rahil farms which far from Karron Lake 350m (Fayoum Governorate) to evaluate the effect of gypsum, sulphur as soil amendments and nitrogen fertilization under subsoiling tillage on some chemical properties.

The treatments of soil amendment were applied at rate of 0, 100% gypsum requirement (6 and 11.3 ton/fed) or 100 % of sulphur requirement (1.12 and 2.1 ton/fed) with leaching after using subsoiling tillage. For two soils under study nitrogen was added as anhydrous ammonia (82%N) was injected in the soil at three levels (80, 100 and 120 kg N/fed) Physical and chemical properties of the experimental site were analyzed (Table 1).

Soil samples were taken at the surface layer (0-30cm) from each plot before and after treatments. The samples were air dried, ground through 2 mm sieve, and chemical analyzed for total soluble, salts, soil pH, soluble ions (sodium, potassium, calcium, magnesium, chloride, carbonate and bicarbonate) and exchangeable cations according to Richards (1954), Black (1965) and Jackson (1973).

RESULTS AND DISCUSSION

Effect of gypsum or sulphur on soil chemical properties:

The results of chemical analysis of the soil at the beginning and end of the experiment are listed in Table (2 and 3), it could be noticed that

Table (1) : Some physical and chemical analysis of the soils under study.

Soil location	Particle size distribution				Ca CO_3 %	Exchangeable cations (meq/100g soil)				ESP %	CEC meq/100 g soil
	Clay %	Silt %	Sand %	Texture		Ca^{++}	Mg^{++}	Na^{+}	K^{+}		
Sanhour	51.5	28.7	19.8	Clay	2.6	10.5	8.7	8.0	1.3	26.50	30.2
Rahil	46.8	27.6	25.6	Clay	2.4	10.1	11.2	11.9	1.4	33.50	35.5

Soil location	SP %	EC e dSm^{-1}	pH 1:2.5	Soluble ions in soil paste extract(meq/L)								GR* Ton/fed	SR** Ton/fed.
				Soluble anions				Soluble cations					
				CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	Ca^{++}	Mg^{++}	Na^{+}	K^{+}		
Sanhour	73.0	4.9	8.6	-	2.7	28.2	17.9	11.3	12.1	24.2	1.2	6.0	1.12
Rahil	77.0	4.8	8.5	-	3.4	28.2	16.4	8.3	6.0	33.1	0.6	11.3	2.1

GR*: Gypsum requirements

SR Sulphur requirements**

Table(2) : Some chemical properties of different tested soils treated with soil amendments and anhydrous ammonia fertilization Sanhour farm

Treatment (Soil amendments / Ammonia)		SP %	pH 1:2.5	Ec e dSm⁻¹	Soluble ions in soil paste extract (meq/L)								Exchangeable cations (meq/100g soil)				ESP
					Soluble anions				Soluble cations								
					CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+	Ca^{++}	Mg^{++}	K^+	Na^+	
Gypsum treatment																	
80	Gypsum	76.00	8.3	3.1	-	2.0	8.9	20.1	14.5	9.2	6.3	1.0	15.8	8.6	4.1	1.3	13.6
100		74.00	8.3	3.0	-	1.8	7.6	20.2	14.3	9.1	5.2	1.0	15.7	8.2	4.1	1.3	13.6
120		73.00	8.3	2.9	-	1.7	7.0	20.9	14.9	9.1	4.6	1.0	15.5	8.4	4.1	1.3	13.6
Sulphur treatment																	
80	Sulp hu-	72.00	8.1	3.2	-	1.7	7.8	22.6	13.0	10.2	7.8	1.1	13.1	8.8	5.3	1.4	17.6
100		73.00	8.1	3.2	-	1.7	7.8	21.9	12.8	10.2	7.4	1.0	12.9	8.9	5.5	1.3	18.2
120		77.00	8.2	3.1	-	1.8	7.2	22.0	13.1	10.2	6.7	1.0	13.1	8.8	5.5	1.2	18.2
Untreated treatment																	
80	Untreated	79.00	8.5	3.8	-	2.3	20.1	15.2	11.2	11.2	14.1	1.1	11.6	8.8	6.9	1.3	22.9
100		80.00	8.4	3.7	-	2.4	19.1	15.8	11.0	11.2	14.0	1.1	11.6	8.7	7.0	1.3	23.2
120		80.00	8.5	3.8	-	2.3	20.7	15.1	10.9	11.2	14.9	1.1	11.7	8.6	6.8	1.3	22.5
Gypsum requirements = 6.0 ton/ fed.																	
Sulphur requirements = 1.12 ton/ fed.																	
Initial soil		73.00	8.6	4.9	-	2.7	28.2	17.9	11.3	12.1	24.2	1.2	10.5	8.7	8.0	1.3	26.5

Table (3): Some chemical properties of different tested soils treated with soil amendments and anhydrous ammonia fertilization.

Rahil farm

Treatment: Soil / mendments / Ammonia		SP %	pH 1:2.5	EC e dSm^{-1}	Soluble ions in soil paste extract(meq/L)								Exchangeable cations (meq/100g soil)				ESP
					Soluble anions				Soluble cations								
					CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+	Ca^{++}	Mg^{++}	K^+	Na^+	
Gypsum treatment																	
80		81.00	8.0	3.0	-	1.7	10.6	17.7	15.9	6.1	7.7	0.3	17.2	11.2	5.1	1.2	14.4
100		79.00	8.1	2.9	-	1.9	9.7	18.1	16.1	6.1	7.2	0.3	16.5	11.4	5.2	1.5	14.7
120	Gypsum	80.00	8.1	2.8	-	1.7	9.1	17.2	15.7	6.1	5.9	0.3	16.5	11.0	5.4	1.6	15.2
Sulphur treatment																	
80		75.00	7.9	3.0	-	1.9	9.0	19.1	11.8	6.1	11.5	0.6	14.3	11.0	6.4	1.5	18.0
100	Sulp hur	74.00	7.9	3.1	-	1.9	9.8	19.1	12.0	6.3	11.9	0.6	14.0	11.4	6.5	1.4	18.3
120		77.00	7.9	3.1	-	1.9	9.7	19.2	12.0	6.3	11.9	0.6	13.3	12.2	6.6	1.4	18.6
Untreated treatment																	
80		78.00	8.4	3.8	-	3.0	20.4	14.2	9.2	6.0	22.0	0.4	12.1	11.7	8.4	1.2	23.7
100	Untreated	78.00	8.4	3.7	-	2.9	19.9	13.9	9.4	6.0	20.8	0.5	12.1	11.6	8.6	1.1	24.2
120		79.00	8.4	3.7	-	2.9	19.9	13.7	9.6	6.0	20.4	0.5	11.2	11.5	9.1	1.5	25.6
Gypsum requirements = 11.3 ton/ fed.																	
Sulphur requirements = 2.1 ton/ fed.																	
Initial soil		77.00	8.5	4.8	-	3.4	28.2	16.4	8.3	6.0	33.1	0.6	10.1	11.2	11.9	1.4	33.5

the addition of gypsum or sulphur under leaching process decreased soil salinity expressed as electrical conductivity. The initial electrical conductivity values of the soils at the two seasons dropped at the end of experiment. Where, the values of decrease in soil EC due to the application of either gypsum or sulphur reached about 3.00 and 3.17 in the first season and 2.9 and 3.07 dS^{-1} for the second one respectively. However, gypsum application was more effective in decreasing soil salinity than sulphur. This was due to its effect on neutralizing the alkali reaction, which results in increasing the permeability of the soil, and thus increased salt removal by subsequent leaching. In addition, the decrease of total salts due to application of these soil amendments could be attributed to the high loss of ions caused by leaching at the beginning, repeated irrigation and ion absorption by growing plant. In contrary, the soil, which leached without soil amendments, may be changed to alkali soil.

With regard to soil pH, the highest decrease was obtained in case of sulphur treatments. This means that this material had more acidic effects and hence it reduced soil pH values. Besides the improvement of soil properties caused by the application of these materials to soil, the decrease of soil pH could be attributed to one or more the following reasons:

The presence of $SO_4^{=}$ due to gypsum application which converted to H_2SO_4 beside the presence of Ca^{++} ions led to decrease both soluble and exchangeable Na^{+} in the soil.

The decrease of soil pH due to sulphur application was related to its oxidation to sulphuric acid by specific soil microbes and hence reducing soil alkalinity.

With regard to the effect of gypsum or sulphur on soluble ions of saline alkali soil at the two seasons. The results presented in Tables (2 and 3) showed that gypsum markedly increased the concentration of soluble Ca^{++} and $SO_4^{=}$ while, it sharply decreased Na^{+} concentration. The relative increase in Ca^{++} concentration at the two seasons was 28.9% and 91.6% compared with the initial value. At the same time, the Na^{+} concentration dropped to about 5.37 and 6.93 meq/L .(in soil paste), respectively its initial values were 24.2 and 33.1 meq/L). This is in agreement with the results obtained by Saffa (1998) who found that leaching of saline alkali soil in the presence gypsum was more effective in increasing soluble calcium. At the same time, this treatment decreased soluble sodium. However, the beneficial effects of gypsum on physical characteristics increased the removal of Na^{+} by soil leaching indicating that sodium ion was the highest cation to be removed from the soil.

On the other hand, the results of Table (2 and 3) did not show any appreciable effect of either gypsum or sulphur on soluble Mg^{++} and K^{+}, where, the difference was almost negligible.

Also, application of gypsum or sulphur alone or in combination of injection of anhydrous ammonia reduced the amount of soluble bicarbonate and chloride.

The results of exchangeable cations as influenced by application of either gypsum or sulphur are presented in Tables (2 and 3). Generally, there is a close relationship between these soil amendments and exchangeable cations of the soil. Where, the obtained results indicated that there was a high decrease in exchangeable Na^{+} compared to initial values. The application of gypsum was more effective in decreasing exchangeable cations particularly exchangeable Na^{+}. A similar trend was noticed in case of ESP as compared with the initial values. For gypsum treatment the ESP values at two seasons decreased by about 13.6 and 14.8% respectively. In contrary the application of aforementioned soil amendments was associated by a considerable increase in exchangeable Ca^{++}. The relative increase of exchangeable Ca^{++} in the first season was 49.21 and 24.13% for gypsum and sulphur, respectively. While these values reached to 65.68 and 37.29% at the second one. On the other hand, the decreasing percent of exchangeable sodium were 48.75 and 32.08% for either gypsum or sulphur in the first season and 56.02 and 45.38% in the second season as compared to initial soil.

From the above discussion it can be concluded that the beneficial effect of gypsum in improving soil chemical properties was more effective than sulphur.

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الملخص العربي

تأثير بعض محسنات التربة على بعض الخواص الكيميائية للأراضي القلوية الملحية بمحافظة الفيوم

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أقيمت تجربتان حقليتان في أرض سنهور وراحيل بالقرب من بحيرة قارون بمحافظة الفيوم لدراسة تأثير بعض محسنات التربة (جبس وكبريت) والتسميد بالأمونيا الغازية على أهم الخواص الكيميائية للأراضي القلوية الملحية.

تم دراسة الصفات الكيميائية للتربة وتم تقدير:-

١- درجة التوصيل الكهربي (EC) ودرجة الحموضة للتربة (pH) قبل إضافة محسنات التربة وكذلك في نهاية التجربة.

٢- تقدير الكاتيونات والانيونات الذائبة (بالمللي مكافئ/لتر)

٣- الكاتيونات المتبادلة بالمللي مكافئ/١٠٠جم تربة للمعاملات المختلفة

فيما يلي أهم النتائج المتحصل عليها:-

أدى إضافة الجبس أو الكبريت إلى نقص واضح في مقدار التوصيل الكهربي وكذا رقم تفاعل التربة كما انخفضت قيمة نسبة إدمصاص الصوديوم في التربة تحت الدراسة وكان تأثير إضافة الجبس أكبر من تأثير الكبريت. كما تبع ذلك زيادة في النسبة المئوية لكل من الكالسيوم الذائب والمتبادل وانخفضت النسبة المئوية للصوديوم الذائب والمتبادل.