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تأثير الجبس فى التربة على حركة البوتاسيوم والكلسيوم والمنغنيزيوم ومحتوى الذرة الصفراء المزروعة فيها من العناصر المعدنية

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موجز البحث

اضيف الى تربة حمراء متوسطة خالية من الكلس والجبس كميات متزايدة من صخور الجبس المطحونة والمنخلة بمنخل اقطار فتحاته ٢ م م لتحضير اتربة فيها ٠,٥,١٠,٢٠,٤٠ ٪ بالمائة من الجبس.

أجري على الأتربة الجبسية المحضرة اعلاه نوعين من التجارب. التجربة الأولى: مخبرية تم فيها ملء عمود من البلاستيك قطره ٥ سم من الأتربة المختلفة بـ ٢٥٠ غرام من التربة المجففة هوائياً، وغسيل اعمدة التربة بخمس دفعات متعاقبة من الماء المقطر، حجم كل دفعة منها ٢٥٠ سم٣. جمع محلول الغسيل من كل دفعة وتم تحليل البوتاسيوم، الكلسيوم والمنغنيزيوم فيه. اما في التجربة الثانية فقد زرع في اصص مملوءة بست كيلوغرامات من الأتربة الجبسية المختلفة والمجففة هوائياً كل من محصولي الذرة الصفراء والفصة. سمدت الأتربة المختلفة جميعها بكميات موحدة من الفوسفور (بمعدل ١ غرام سوبر فوسفات مثلث لكل كغ من التربة(من البوتاسيوم (بمعدل ١ غرام من سلفات البوتاسيوم لكل كغ تربة) ونصف غرام من نترات الأمونيوم عيار ٣٣٪ من الأزوت لكل كغ تربة) قبل الزراعة مباشرة. اما بالنسبة للأصص المزروعة بالذرة الصفراء فقد اضيف اليها ثلاث دفعات اخرى اضافية من السماد الآزوتي خلال فصل النمو بمعدل غرام واحد نترات الأمونيوم لكل كغ من التربة وللدفعة الواحدة.

زرع في اصص الذرة تسع بذرات، ترك منها ثلاث بادرات فقط كما زرع ١,٥ غرام من الفصة للأص الواحد منها. حصدت نباتات الذرة في مرحلة الأزهار، وزنت وجففت كما اخذ خمس قطفات متعاقبة من الفصة عند مرحلة الأزهار باخذ وزنها، جففت وطحنت.

اجري تحليل المواد النباتية المحصودة من الذرة والقطفة الأولى من الفصة وقدر فيها الفوسفور، البوتاسيوم، الكلسيوم، والمنغنيزيوم.

لقد بيّنت نتائج التجربة المخبرية بان اضافة الجبس للتربة بمعدل ٥ الى ٢٠٪ من وزنها الجاف قد ادى الى مضاعفة تركيز البوتاسيوم في محلول الغسيل والى زيادة تركيز المنغنيزيوم

والكلسيوم في محلول الغسيل من ٢,٤ ، ٣,٦ مليمكافىء باللتر الى ١٢ و١,٢٨ مليمكافىء باللترة على التوالي.

أما بالنسبة للتجربة الثانية فقد تبينّ بان الجبس لم يؤثر على محصول الذرة الصفراء حتى اذا وصلت نسبته في التربة الى ٢٠ بالمائة وزناً، الا ان المحصول انخفض بسرعة عندما كانت نسبة الجبس فيها ٤٠٪ من وزن التربة. اما محصول القطفات الخمس للفصة فلم تتأثر بمستوى الجبس في التربة بصورة معنوية.

بينت نتائج تحليل النباتات المزروعة بان نسبة الفوسفور، البوتاسيوم، الكلسيوم والمنغنيزيوم في الفصة لا تتأثر بزيادة نسبة الجبس في التربة في حين ان نسبة الفوسفور والبوتاسيوم في الذرة الصفراء قد انخفضت كثيراً مع زيادة نسبة الجبس. اما الكلسيوم والمنغنيزيوم في الذرة فلم يتأثرا بالجبس بصورة معنوية.

لقد بينت الدراسة الحالية:

اولا ـ بان وضع الأراضي الجبسية تحت الري يساعد الجبس فيها على فقد كميات كبيرة من الكاتيونات الغذائية كالبوتاسيوم والمنغنيزيوم وغيرها عن طريق الغسيل بعملية تبادل كاتيوني بين الكلسيوم الذائب من الجبس والكاتيونات المدمصة على سطوح غرويات التربة.

ثانياً ـ يحتاج تسميد الأراضي الجبسية المروية الى استعمال معادلات سمادية تختلف كثيراً عما يستعمل عادة للأراضي غير الجبسية لأن المحافظة على خصوبة الأراضي الجبسية يحتاج الى تعويض الكاتيونات المفقودة عن طريق الغسيل كالمنغنيزيوم والبوتاسيوم وغيرها لتبقى مثل هذه الأراضي منتجة.

Second, the application of leaching requirement principle to control salinity in the gypsiferous irrigated soils, would lead to a large loss of mineral nutrients such as K, Mg and other nutrients. If one assumes a leaching requirement of the order of 15 percent, and a water requirement of the order of 1 meter depth per year; then the calculated amount of potassium lost to drainage water would range between 186 to 324 kg of K per hectare, for various gypsiferous soils and the calculated loss of Mg would range between 1160 and 2160 kg per hectare per year. These extreme values of loss of both K and Mg should only emphasize the significant amount of loss of various nutrient cations when the gypsiferous soils are put under irrigation. Loss gradually diminish as the amount remained on the adsorption complex or in soluble form becomes less.

From the pratical point of view crops, grown in the gypsiferous soils, require a good fertilizer formula, applied regularly, to the soils, to balance the amount of these nutrient cations lost deep drainage or absorbed by the plants. Further research is needed to study the loss of other nutrient cations and anions required by plants, grown in gypsiferous soils.

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Table (4)

Effect of level of gypsum in soil on fresh weight yield and mean nutrient contents of corn grown in pots.

% gypsum in soil	top fresh weight	P	K	Ca	Mg
		g% of D.W.			
0	219.0	0.64	7.9	1.73	0.46
5	187.7	0.32	4.6	1.74	0.27
10	204.0	0.35	6.4	1.64	0.50
20	214.0	0.32	6.2	1.57	0.52
40	71.0	0.19	3.7	1.30	0.46
Level of significance	1%	1%	1%	N.S.	N.S.

Concerning the nutrient content of both corn and alfalfa plants, it was abvious that alfalfa as a tolerant plant to gypsum, resisted any significant change in its nutrient content. Phosphorus, potassium, calcium and magnesium contents in plants remained unaffected by the level of gypsum in soils, in spite of a slight tendency for an increase in magnesium content in pressence of gypsum.

The nutrient content of corn plants was vastly disturbed by pressence of gypsum in soils. Phosphorus and K are more affected nutrient than calcium or magnesium by gypsum in soils. Although the soils were fertilized with potash and phosphate, their relative content in plants decreased significantly (at 0.01 level) as the gypsum content of soils increased.

The high concentration of Ca in the soil solutions would possibly block the uptake of P by roots (5), and the possible accumulation of Ca at surface of roots as shown by Riley and Black (9) could lead to a great reduction in P absorption by plant roots.

The content of calcium and magnesium in corn plants, remained unaffected by gypsum, although their concentration in the soil solution was greatly increased when gypsiferous soils were put under irrigation or leached.

As a result, apparently, potassium and phosphate in plants remained two of the major macronutrient studied which were associated with tolerance of plants to gypsum in soils. The question which remained to be answerd is whether one could practically improve the tolerance of plants to gypsum by raising the rate of potash and phosphate added to the soil.

As a result of both leaching and growth experiments two main conclusions concerning the managment and fertilization of gypsiferous soils could be drawn:

First, the irrigation or leaching the gypsiferous soils would lead to a substantial mobilization of K and Mg and presumably other adsorbed cations to the liquid phase of soil by a kind of cation exchange process and consequently increase their relative concentration in the soil solution.

The nutrient fresh weight of corn plants grown in various gypsiferous soils were grouped in table (4). Yields of corn remained unaffected by level of gypsum up to 20 percent of gypsum. However a very significant drop in yield (at 0.01 level) is noticed with soil of 40 percent of gypsum in soil. The tolerance of corn to gypsum was found to be somewhere between 20 and 40 percent. This was in agreement with the work of Smith and Robertsen (9) who found that yield of corn dropped when level of gypsum in the rootzone exceeded 25 percent.

Table (2) Effect of level of gypsum in soil pots on fresh weight of 5 consecutive cuts of alfalfa[1].

% gypsum in soil	Fresh weight of 5 cuts in g /pot					total weight of cut in g /pot[2]
	1	2	3	4	5	
0	40.7	22.5	30.5	54.0	86.3	233.5
5	39.8	28.2	26.3	41.0	85.6	220.9
10	37.7	29.6	28.7	45.2	100.9	242.1
20	34.0	36.9	25.9	39.1	107.7	243.6
40	24.5	38.3	28.6	44.5	102.8	238.7

1. Average of 3 replicates.

2. Insignificant at 5% level.

Table (3)
Effect of gypsum in soil on nutrient content of alfalfa grown in pots.

%gypsum in soil	P	K	Ca	Mg
	%			
0	0.36	2.98	3.11	
5	0.29	2.92	2.73	0.38
10	0.26	2.78	2.99	0.40
20	0.28	2.90	2.88	0.48
40	0.30	3.76	2.51	0.45

Level of significance N.S. N.S. N.S. N.S.

Table (1) Cation concentration of soil leachates after addition of increasing amount of gypsum to soils.

Leachate N° % gypsum in soil		Cation concentration in leachate K	Ca m.e./l	Mg	Ratio K/Ca 100	x Mg/Ca
0	1	0.29	2.3	5.4	12.6	2.3
	2	0.22	2.8	1.3	7.9	0.5
	3	0.22	5.2	2.3	4.2	0.4
	4	0.35	4.5	0.5	8.8	0.1
	mean	0.27	3.6	2.4	8.4	0.8
5	1	0.58	26.1	14.3	2.2	0.5
	2	0.58	26.0	14.0	2.2	0.5
	3	0.49	28.0	14.0	1.8	0.5
	4	0.55	29.7	4.0	1.9	0.1
	mean	0.55	27.4	11.6	2.0	0.4
10	1	0.67	27.9	14.1	2.4	0.5
	2	0.49	26.4	15.6	1.9	0.6
	3	0.55	24.0	14.0	2.3	0.6
	4	0.58	29.8	4.2	1.9	0.1
	mean	0.57	27.0	12.0	2.1	0.5
20	1	0.53	29.5	14.0	1.8	0.5
	2	0.49	28.2	15.3	1.7	0.5
	3	0.45	24.8	14.2	1.8	0.6
	4	0.56	28.7	6.1	2.0	0.2
	mean	0.51	27.8	12.4	1.8	0.5
40	1	0.40	30.2	8.5	1.3	0.3
	2	0.28	30.8	5.2	0.9	0.2
	3	0.27	29.5	8.5	0.9	0.3
	4	0.29	30.6	3.6	0.9	0.1
	mean	0.31	30.3	6.5	1.0	0.2

The drop in K or Mg removed from soils with very high gypsum content (40 percent of gypsum) as compared to soils with less gypsum could be explained on the basis that gypsum particles or gypsum dissolved could line up soil micropores where water flow. That could lower the rate of cation echange between the dissolved Ca and the K or Mg absorbed.

The results of alfalfa harvest were grouped in table (2). That would show clearly, that except in one pot with 40 percent of gypsum badly affected by drainage difficulties during growth, the cumulative weight of five cuts of alfalfa, was unaffected by level of gypsum in soil up to 40 percent by weight. No sign of any nutrient deficiency was noticed on plants. Alfalfa is considered with high tolerance to gypsum. The results of nutrient composition of alfalfa were grouped in table (3). That include phosphorus, potassium, calcium and magnesium content.

The first leachate was turbid and was discared. Potassium, Ca and Mg in leachates were analyzed. Potassium was determined by flame photometry, and Ca and Mg by the EDTA compleximetric method.

Second a greenhouse experiment was carried out, by growing corn and alfalfa in cylindrical plastic pots. Soils with various levels of gypsum were used to fill cylindrical plastic pots with 6 kg of air-dried soils. A basic dressing of fertilizers were added before sowing, and mixed with the soil. Each kg of soil was fertilized with 1 g of treble superphosphate (21% P) 1 g of K_2SO_4 and 0.5 g of NH_4NO_3 (22% N). Three additions of NH_4NO_3 as top dressing of 1 geach, were added to each kg of soil during the growing period of corn.

Nine seeds of hybrid corn were sown per pot, and the number of seedling was cleared to three, 10 days after emergence. Harvest of corn tops was done at the tasseling stage; and fresh weight recorded.

Alfalfa pots were sown with 1.5 g of seeds per pots. Five consecutive cuts of alfalfa were taken at flowering stage. Fresh weight of various cuts were recorded. The growth experiment of both corn and alfalfa were run in triplicates.

Plant analysis was carried out on total plant materiel harvested of corn and the first cut of alfalfa. Plants were oven-dried at 70° C; ground finely and plant sample was digested with a mixture of concentrated sulfuric acid, selenium and hydrogen peroxide. Phosphorus was determined by the phospho-vanadate method, Ca and Mg by the atomic absorption method and K by flame photometry (5).

RESULTS AND DISCUSSION

The results of leaching experiment were reported in table (1). It shows clearly that concentration of soluble K in the leachates is almost doubled by the addition of gypsum to soils in the range of 5 to 20 percent of gypsum. An insignificant increase in K concentration is noticed in soils, with 40 percent of gypsum. Similarly, the magnesium concentration increased from a level of 2.4 meq/1 in the gypsum free treatment to a level of 12 meq/1 in soils with 5 to 20 percent of gypsum. However the increase in Mg concentration was as much (6.5 me/1) in soils with 40 percent of gypsum.

Calcium concentration in the leachates, increased from a level of 3.6 meq/1 to an average concentration of 28.1 meq/1 for all soils with various gypsum concentration.

Consequently the cation ratio in the soil leachates was greatly affected as calculated in table (1). The K/Ca ratio dropped significantly from 8.4 percent in the gypsum free soil to a level of 1 percent only for soils with 5 to 20 percent of gypsum. The Mg/Ca ratio dropped as well from 0.80 to 0.22.

INTRODUCTION

The relation between plant growth and gypsum content of soils had been untill recently of little interest to most research workers. Crops were found to respond differently to level of gypsum in the root zone. Several authors assumed that soils with less than 25 percent of gypsum are arable for most crops. Hernando (4) found that yield of corn grown in pots, were not negatively affected, until gypsum level in soil exceeded 50 percent. Bureau and Roederer (2) assumed that soils containing more than 30 percent could be toxic to plant growth. Discrepancies between authors could be attributed, either to differences in particle size distribution of gypsum particles in soils, or to presence of salts, usually associated with presence of gypsum in the field. Fine particle gypsum could be more surface-active and has higher effect on growth of plants. Matar (6) in a recent study carried out in pots showed that tolerance of plant to gypsum was quite variable. Alfalfa, trifolium, mexican wheats and lentil were found tolerant to gypsum; sugarbeet, broad bean, soybean and corn semi-tolerant while, Burley tobacco was extremely sensitive to gypsum.

The effect of gypsum on the disturbance of plant growth, was attributed to, either a mechanical or a nutritional mechanism. Van Alphen (1) considered that hardness of a gypsic layer in the field, is an important factor limiting crop yield on gypsiferous soils. The subsequent induration of a shallow gypsic layer could lead to a mechanical resistance, impeding, roots from growing deeper.

On the other hand, the high solubility of gypsum in soil, would lead to a change in the K/Ka or Mg/Ca ratio in the soil solution, and disturb plant growth. Most nutritional work on the effect of gypsum on ion absorption by plant, was carried out on non saline sodic soils. Poonia (8) found that application of gypsum to sodic soils increased the total uptake of K and Mg by barley and improved yields. Carlson (3) found that gypsum is a good displacing agent to move downward K added to a surface soil, to deeper horizons and consequently correcting K deficiencies on deciduous fruit trees.

The purpose of the present work, is to study first effect of gypsum on the concentration of major macronutrient cations in the soil solution and second, the effect on yield and mineral content of a tolerant crop such as alfalfa, as compared to a less tolerant crop like corn.

MATERIELS AND METHODS

Two simultaneous experiments were carried out on a non-calcareous soil, Rhodoxeralf, to which was added an increasing amount of ground gypsum crystals and sieved through a 2 mm diameter sieve to prepare soils with 0, 5, 10, 20, and 40% by wt of gypsum. The purity of the gypsum was estimated and taken into consideration when preparing the various soils. The original Rhodoxeralf soil used is a silty loam (surface sample) air-dried. The soil PH of the saturated paste was 6.7 The NH_4 acetate extractable-K was about 5.6 meq/100 g of soil and the cation exchange capacity equivalent to 28.6 meq/100 g of soil.

First, a leaching experiment was carried out in the laboratory, by filling in a 5 cm inside diameter plexiglass tubes with 250 g of each of the various gypsiferous soils prepared. Soils in the columns were leached at 5 consecutive intervals, with 250 ml of distilled water each. A constant rate of leaching was maintained at nearly 10 ml/min.

Effect Of Soil Cypsum On Leaching Of K,Ca and Mg from Soil, Growth and Mineral Content Of Alfalfa and Corn1.

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ABSTRACT

A reddish brown non-calcareous soil (Rhodoxeralf) was mixed with an increasing amount of ground gypsum rocks, sieved with a 2 mm diameter screen, to have soils with 0, 5, 10, 20 and 40% of gypsum by wt.

Two simultaneous experiment were carried out. The first, is a laboratory experiment where 250g of the various gypsiferous soils prepared, were filled in a 5 cm inside diameter plexiglass tube, and leached with five 250 ml increments of distilled water. Soil leachates were analyzed for K, Ca and Mg. The second is a greenhouse growth experiment, carried out on alfalfa (Medicage sativa) and corn (Zea mays L.). Plastic pots were filled with 6 kg of air-dried soil each. All soils in pots were fertilized with a basic dressing of 1 g of treble superphosphate (21% P), 1 g of K_2SO_4 (41.5% K) and 0.5 g of NH_4NO_3 (33% N) per kg of soil, before sowing.

Three additionnal dressing of 1 g each of NH_4NO_3 per kg of soil, were added to pots planted with corn during the growing period. Corn pots were sown with 9 seeds of corn, cleared to 3 seedlings after emergence. Alfalfa pots were seeded with 1.5 g of seeds. Corn tops were harvested at tasseling stage anf five consecutive cuts of alfalfa were taken at flowering stage. Fresh weight of plant harvests was recorded.

Plant analysis was carried out on total plant materiels harvested and P,K, Ca and Mg were determined.

Results of the leaching experiment have shown that K concentration in leachates was significantly double for soils with 5 to 20% of gypsum as compared to non-gypsiferous soils. Similarly Mg and Ca raised as well from 2.4 and 3.6 meq/1 to a concentration of 12 and 28.1 meq/1 successively.

Yields of corn plants remained unaffected by level of gypsum up to 20% by wt; but dropped very significantly (at 1% level) for soils with 40% of gypsum. The cumulative fresh weight of the 5 consecutive cuts was unaffected by levels of gypsum in soil.

Results of plant analysis have shown that K, Ca, Mg and P contents of alfalfa remained significantly unchanged in presence of gypsum in soil. However the P and K content of corn tops dropped very significantly as the level of gypsum in soil increased. Calcium and Mg in corn plants remained unaffected.

It was concluded first, that presence of gypsum in irrigated soils leads to a substantial mobilization of K and Mg from the adsorption complex with a possible loss through deep percolation if the principle of leaching requirement is applied; second alfalfa, as a gypsum tolerant plant has resisted the change in its ionic equilibrium, as compared to corn.