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APPLICATION OF GYPSUM REQUIREMENT LEVELS AND WATER DEPTH FOR CORRECTION THE SODICITY AND SALINITY OF SALINE-SODIC SOILS

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ABSTRACT

To evaluate the effectiveness of applying different levels of gypsum, the recovery of saline-sodic soils and its influence on the chemical characteristics of soils fixed with plaster, an experiment was conducted in soil columns, installed in the soil mechanics laboratory Federal Rural University of Pernambuco. The treatments were arranged in a randomized block design with a factorial arrangement of 2 x 5 (two solos x five levels of need for plaste), with five replications. The levels were equivalent to 50, 100 , 150, 200 and 250 % of plaster need determined by the modified method of Schoonover (Schoonover M -1), incorporated into the first 12.5 cm of the soil column . Were evaluated exchangeable sodium, exchangeable sodium percentage (ESP), Electrical Conductivity (EC), soluble cations and sodium adsorption ratio (SAR) in the saturation extract. The application level of 100 % of the need to plaster, obtained by the method of Schoonover M- 1, followed by leaching depth was effective for the correction of soil sodicity (PST < 15 %). The blade leaching corresponding to three times the pore volume of the soil salinity corrected when the levels of 50 and 100% of plaster need were used (EC <4.0 dS m-1).

Keywords: electrical conductivity, exchangeable sodium, salinization.

APLICAÇÃO DE NÍVEIS DA NECESSIDADE DE GESSO E LÂMINA DE LIXIVIAÇÃO PARA CORREÇÃO DA SODICIDADE E SALINIDADE DE SOLOS SALINO-SÓDICOS

RESUMO

Com objetivo de avaliar a eficiência da aplicação de diferentes níveis de gesso, na recuperação de solos salino-sódicos e sua influência nas características químicas de solos

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corrigidos com gesso, realizou-se um experimento em colunas de solo, instaladas no laboratório de mecânica do solo da Universidade Federal Rural de Pernambuco. Os tratamentos foram dispostos em delineamento em blocos casualizados com arranjo fatorial de 2 x 5 (dois solos x cinco níveis da necessidade de gesso), com cinco repetições. Os níveis utilizados foram equivalentes a 50, 100, 150, 200 e 250% da necessidade de gesso, determinada pelo método de Schoonover modificado (Schoonover M-1), incorporados aos primeiros 12,5 cm da coluna de solo. Foram avaliados: sódio trocável, percentagem de sódio trocável (PST), Condutividade Elétrica (CE), cátions solúveis e a relação de adsorção de sódio (RAS) no extrato de saturação. A aplicação do nível de 100% da necessidade de gesso, obtido pelo método de Schoonover M-1, seguida de lâminas de lixiviação foi eficiente para a correção da sodicidade dos solos (PST < 15 %). A lâmina de lixiviação correspondente a três vezes o volume de poros corrigiu a salinidade dos solos quando foram utilizados os níveis de 50 e 100% da necessidade de gesso (CE < 4,0 dS m^{-1}).

Palavras-chave: condutividade elétrica, sódio trocável, salinização.

INTRODUCTION

The process of soil salinization has been an issue that deserves attention , because it is causing limitations on productivity , particularly in irrigated areas of arid and semiarid regions, thus reducing the area under cultivation . Silveira et al . (2008) and Barros et al. (2009) reported that salt affected soils contain soluble salts and / or exchangeable sodium that can significantly reduce the development and hence crop productivity , culminating almost always, with the abandonment of farmland , causing major damage to the regional economy by is necessary to recover these soils for them to be reincorporated into the production system.

The low rainfall and high evaporation favors the occurrence of salinity and / or sodicity of soils in arid and semiarid regions process, since the sodium salts are not leached and accumulate in large quantities in the soil. The high content of exchangeable sodium in the soil can cause degradation of the structure, clay dispersion , as well as toxicity in plants and preventing seed germination and root (Smith et al . , 2009) .

The recovery of saline , saline -sodic and sodic soils aims to decrease the concentration of soluble salts and exchangeable sodium in the soil profile , leaving the soil suitable for agriculture . Soil salinity can be reduced through the leaching of salts below listing process, since the decrease in sodicity requires the replacement of exchangeable sodium by calcium coming from the concealer and the product of this reaction is removed from the root zone by leaching (Barros et al. 2004).

For correction of saline- sodic and sodic soils can be used . In Brazil the plaster is the most used source of calcium , due to its lower cost , easier handling and greater availability in the market when compared to other corrective (Barros et al , 2004 and Ruiz et al ,2006)

The amount of gypsum required for correction of sodicity of saline- sodic and sodic soils can be calculated as a function of exchangeable sodium percentage (ESP) to be replaced, the cation exchange capacity of the soil

(CEC) and soil depth to be retrieved , or may be determined by a laboratory test involving the balance between the ground and a saturated solution of gypsum .

The national literature there is little information on the level of need for gypsum (NNG) most suitable to be applied in saline - sodic and sodic soils of Pernambuco to the process of recovery is achieved. Knowing that the salinity and/or sodicity soil is responsible for the reduction in agricultural production culminating almost always, with the abandonment of farmland, causing major damage to the regional economy. It is evident that the recovery of these soils is necessary for reintroduction to the production system.

This study aimed to evaluate the effect of different levels of gypsum requirement of soil chemical characteristics and correction of saline-sodic soils.

MATERIALS AND METHODS

Was performed on columns of soil an experiment at the Laboratory of Soil Mechanics , Department of Rural Technology UFRPE-PE. Were collected For this study two samples soil of affected by salts and sodium (S1 and S2) , in the Irrigated Perimeter of Ibimirim, sorted by Ribeiro et al (1999) as Fluvisols. The sampling depth was 0-40 cm. After the collected soil samples were air dried , and sieved destorroadas 2 mm mesh . Before this procedure, Undisturbed soil samples (lumps) to obtain the density of the soil were separated .

The characterization of the saturation extract was made by the procedure described by Richards (1954) and the results are shown in Table 1.

Following the methodology of EMBRAPA (1997) the physical and chemical charac-terization of soil samples (Tables 2 and 3) was performed . Using the Schoonover M- 1 (Barros and Magalhães, 1989) determined the method need for gypsum (NG) of soil. (Table 3).

Table 1. Characteristics in the extract in saturation of soils

Soils	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	EC[/1]
	----------------mmol$_c$ L^{-1}---------------				dS m^{-1}
S1	136,51	8,39	489,36	3,30	60,61
S2	69,40	5,63	291,65	3,71	36,16

[/1]EC- Electrical conductivity.

Table 2. Physical characteristics of the soil samples

Soils	Dp[/1]	Bp[/2]	Textural classification	TP[/3]
	----kg dm^{-3} ----			%
S1	2,52	1,36	Franco-argilo-siltoso	46,03
S2	2,45	1,45	Franco	40,08

[/1]Dp – Density of particle;[/2]Bp – Bulk density; [/3]TP – Total porosity.

Table 3. Chemical classification of soil samples

Solo	Cátions Trocáveis				NG[/1]	CTC	PST	pH
	Ca2+	Mg2+	Na+	K+				
	-------------------cmolc dm^{-3}-------------						%	
S1	3,28	1,28	8,13	0,85	9,38	13,52	60,13	7,18
S2	2,89	1,16	4,75	0,82	5,98	9,62	49,38	7,10

The treatments were arranged in a randomized complete block design with a factorial arrangement of 2 x 5, 2 soils and 5 levels of gypsum requirement (NNG) equivalent to 50, 100, 150, 200 and 250 NG with five replicates, totaling 50 experimental units .

The experimental units were comprised of PVC plastic tubes with 10 cm diameter and 30 cm in height, having at its base a drainage system, each soil column was divided into two layers, each with 12.5 cm of soil. Soil samples were packed in PVC columns so as to approach the bulk density of each sample. The plaster was incorporated into the first layer prior to packaging Then the soil columns were wetted slowly to saturation, keeping this humidity for 24 h to restore the balance of the system. To avoid evaporation losses, the PVC pipes were covered with plastic wrap. Then the columns were leached with distilled water, keeping a constant level 2.0 cm above the surface of the blade total of 3 times the volume of pores (2100m L) having been applied divided into three fractions (700 m L). After leaching, the soil in each column were air dried, destorroados and passed through a sieve of 2 mm mesh, by determining the exchangeable sodium and EC of the saturated paste extract, according to the methodology described above. With data exchangeable sodium and CTC, quantified the amount of exchangeable sodium percentage (ESP) and the efficiency of the replacement of exchangeable Na^+.

The data were interpreted by analysis of variance and regression, testing various models. The criteria for choosing the model were the highest coefficient of determination and significance of the coefficients of the regression (SAS, 2003) equation.

RESULTS AND DISCUSSION

The results obtained for exchangeable sodium and exchangeable sodium percentage (ESP) are shown in Table 4. Analyzing these figures it can be seen that regardless of the levels of need for gypsum (NG) used, there was a large decrease in the levels of exchangeable sodium in relation to the original values (Table 3). The values obtained for exchangeable sodium prove the efficiency of gypsum applied to the soil in the replacement of adsorbed sodium in the exchange complex by calcium concealer.

One can also observe that the application of the 50% level of need for gypsum was not enough to fix the sodicity of soils (S1 and S2), as it remained with exchangeable sodium percentage (ESP) > 15 %. The correction did not occur at this level probably due to the amount of correction applied is not sufficient to greater substitution of sodium by calcium occurs, consequently these soil samples still showed the sodium character. For other levels of NG applied (100 , 150 , 200 and 250%), we found the same trend of decreasing values PST to > 15%, which were originally 60.04% for soil S1 and 49.38% S2 to ground . It is confirmed that the level of 100 % of the NG determined by the method of soil Schoonover - M1 was effective for the correction of sodicity of soil samples (PST < 15%), but the other treatments did not ran such a marked reduction . Indicating that the use of higher levels as determined by the methodology Schoonover M- 1 (100%) is not recommended for result in more spending concealer . This behavior was also observed by Silveira et al. (2008), working with saline- sodic soils of Custody -PE adding gypsum in the irrigation water, the authors found that gypsum applied corrected PST to < 15% .

The values obtained for electrical conductivity (EC) of the saturation extract folder results demonstrate the efficiency of the embedded soil (Table 4) after applying the concealer and water depth for the first three levels gypsum (50, 100 and 150%) NG of both soils (S1 and S2), was reduced to values smaller or equal to 4.00 dS m^{-1}. When levels of 200 and 250% of NG were used, it is observed that the process of correcting salinity did not occur. These results indicate that a blade equal to three volumes of pores was not sufficient to leach out excess salts ($CaSO^4$ $2H_2O$) to the drain water.

Table 4. Exchangeable sodium percentage (ESP), exchangeable sodium (Na^+) e efficiency in the replacement Na+ exchangeable

Soils	NNG[/1]	Na^+ exchangeable Initial	Na^+ exchangeable Ultimate	ESP Initial	ESP ultimate	Efficiency in the replacement Na+ exchangeable
	%	--- $cmol_c$ dm^{-3} ---		---- % ----		%
	50		2,93		21,64	63,96
	100		1,54		11,60	80,69
S1	150	8,13	1,33	60,04	9,82	83,64
	200		1,10		8,12	86,47
	250		0,75		5,54	90,77
	50		1,85		19,23	61,06
	100		1,09		11,33	77,05
S2	150	4,75	0,87	49,38	9,04	81,69
	200		0,74		7,69	84,42
	250		0,53		5,50	89,41

According Ayeres and Westcot (1999), report that the cowpea is considered a moderately tolerant to salinity, with salinity threshold around 4.9 dS m^{-1} does not show a reduction in productivity. Dantas et al. (2002) in research for evaluation of cowpea genotypes under salinity using genotypes for these 50 studies , found that genotypes can be ranked for salinity tolerance based on reducing the percentage of the dry mass of shoots . The authors concluded that all genotypes showed statistically significant reductions in the production of dry matter in the shoot due to increased soil salinity, and the genotypes tested only the IPA 2001 and EPACE 10 were tolerant when subjected to CE 3.0 dS m^{-1}, all other genotypes showed a decrease in the dry weight of shoots when subjected to this CE.

It is also observed that when the level of 200 was used and 250% of NG a reduction in efficiency of 92% EC S1 to occur, while for S2 the reduction in the efficiency of EC was 88%, which probably have occurred because the texture of the soil.

The relationships between the independent variables, levels of gypsum requirement (NNG) and dependent efficiency of the percentage of exchangeable hatred (PST), showed high coefficients of determination ($R^2 = 0.92$ for soil S1 and $R^2 = 0.96$ for soil S2) can be described by a quadratic function (Figure 1). These results are due to the presence of exchangeable sodium in the calculation of soil PST. Similar behavior was observed by Tavares Filho (2012) working with the recovery of saline-sodic soils of Ibimirim-PE. This author coefficient of determination ranging from 0.97 to 0.98 ente.

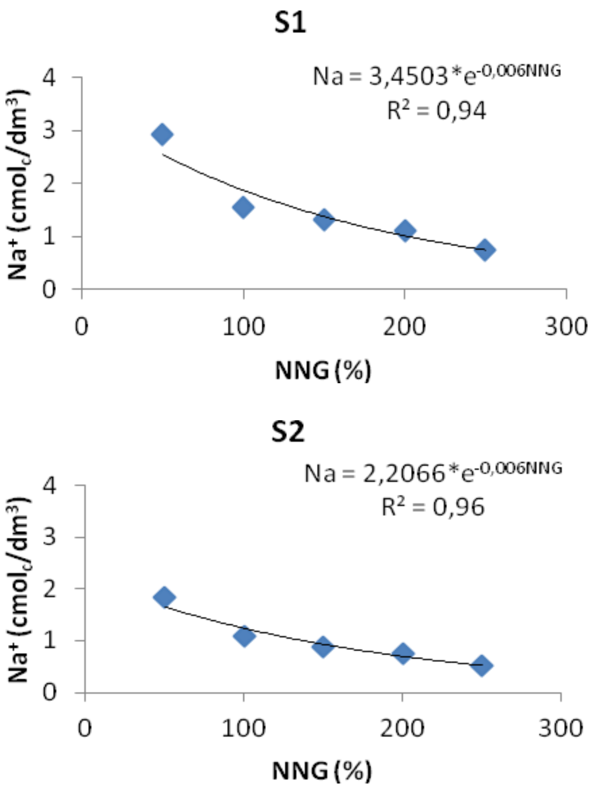

Figure 1 - Relationships between levels of gypsum requirement and of exchangeable sodium.

The relationship between the levels of NG and efficiency CE for the S1 and S2 were tested and the results are shown in Figure 2. Featuring high coefficient of determination of 0.95 and 0.98 for S1 and S2 respectively. Testing regression models to account for the removal of salts, Moura (1989) demonstrated that the quadratic model was effective to describe the leaching process of soluble salts saline-sodic soil.

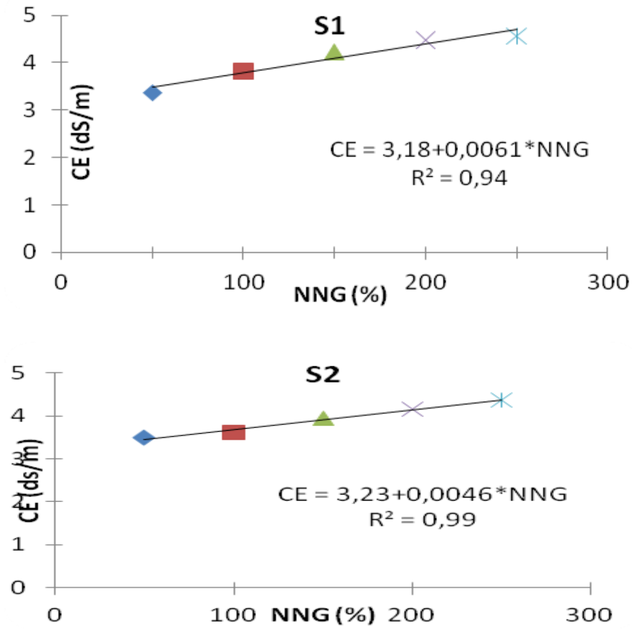

Figure 2 – Relationships between levels of gypsum requirement and of Electrical conductivity (EC) in saturation of the two saline-sodic soils (S1 e S2).

CONCLUSIONS

The application of the 100% level of necessity of gypsum (NG) obtained by the method of Schoonover M-1, then the leaching depths was effective for the correction of sodium problems of soil (PST <15%).

The water depth equal to three pore volumes (PV) corrected soil salinity S2, however, was not enough to fix the electrical conductivity to values less than 4.0 dS m^{-1} for soil S1, when it used levels of 150, 200 and 250% of plaster need.

REFERENCES

AYERS, R. S.; WESTCOT, D. W. A qualidade da água na agricultura. 2.ed. Campina Grande:

UFPB. 153p. FAO, Irrigação e Drenagem, 29. 1999

BARROS, M. F. C.; MAGALHÃES, A. F. Avaliações de métodos de determinação da necessidade de gesso em solos Salino-sódicos. **Revista Brasileira de Ciência do Solo**, 13:119-123, 1989.

BARROS, M. de F. C.; FONTES, M. P. F.; ALVAREZ, V.; V. H.; RUIZ, H. A. Recuperação de solos afetados por sais pela aplicação de gesso de jazida e calcário no Nordeste do Brasil. **Revista Brasileira Engenharia Agrícola e Ambiental**, 8: 59-64, 2004.

DANTAS, J.P., MARINHO, F.J.L., FERREIRA, M.M.M., AMORIMS, M. do S.N., ANDRADE, S.I. de O. & SALES, A.L. de; Avaliação de genótipos de caupi sob salinidade.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA.. **Manual de Métodos de análises de solo.** 2ª ed. Rio de Janeiro: EMBRAPA, 1997. 211p.

MOURA, R.F. **Lixiviação em material de solo salinizado do perímetro irrigado do projeto Gorotuba- MG. Viçosa**, UFV. 1989. 68p. Dissertação (Mestrado Engenharia Agrícola) – Universidade Federal de Viçosa, 1989.

RIBEIRO, M. R. **Caracterização e classificação dos solos de referência do estado de Pernambuco.** Recife:UFRPE, 1999. 82p.

RICHARDS, L. A. **Diagnosis and improvement of saline and alkali soils.** . U. S. Dep. Agric. Handbook 60 Washington: U. S. Government Printing, Office, D. C, 1954. 160p.

RUIZ, H. A.; SAMPAIO, R. A.; OLIVEIRA, M. de; FERREIRA, P. A. Características físicas de solos salino-sódicos submetidos a parcelamento da lâmina de lixiviação. **Revista de la ciencia del suelo y nutrición vegetal**, 6:1-12. 2006.

SILVEIRA,K.R. RIBEIRO, M. R.; OLIVEIRA, L.B.; HECK, R. J.; SILVEIRA, R. R. Gypsum saturated water to reclaim alluvial saline sodic and sodic soils. **Scientia Agrícola**, Piracicaba, v. 65, n.1, p. 69-76, 2008.

SCHOONOVER, W. R. **Examination of soil for alkali**. Berkeley: University of California. Extension Service.Mimeographed. 1952.

SMITH, A. P.; CHEN, D.; CHALK, P. M. N2 fixation by faba bean (Vicia faba L.) in a gypsum-amended sodic soil. **Biology and Fertility of Soils**, 45 329-333, 2009.

TAVARES FILHO, A. N.; BARROS, M. de F. C.; ROLIM, M. M.; SILVA, E. F. de F. Incorporação de gesso para correção da salinidade e sodicidade de solos salino-sódicos. **Revista brasileira de engenharia agrícola e ambiental. v.**16, n.3, 2012.