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SOLUBILITY OF DIFFERENT GYPSUM SIZE-GRADES IN SYNTHETIC SALINE-SODIC WATERS

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In a laboratory experiment, different size-grades of gypsum were shaken mechanically in the synthetic saline-sodic waters in order to monitor their dissolution. The results reflected significantly higher dissolution of finer gypsum size-grades, range being 24 to 25 me L^{-1} of Ca + Mg. The dissolution was also statistically improved with increasing the water SAR and EC levels.

INTRODUCTION

For reclaiming calcareous sodic and saline-sodic soils, various amendments like gypsum, calcium chloride, hydrochloric acid and sulphuric acid can be used. These amendments either change insoluble soil calcium to soluble form or supply calcium directly to replace the adsorbed sodium from sodic and saline-sodic soils. Out of all these amendments, gypsum is the most commonly used one due to its cheap availability in Pakistan (Ghafoor *et al.,* 1985 a, b).

The fineness to which gypsum must be ground is a matter of economic consideration. Grinding to a very fine size entails higher cost, though it will give higher availability of soluble calcium to replace the exchangeable sodium. Simultaneously, the higher sodium adsorption ratio (SAR) of sodium-problem soils as well as of irrigation waters may increase the solubility of gypsum due to decreased activity coefficient (Bohn *et al.,* 1985) which is the only its demerit.

The present study was planned to see the effects of different levels of water SAR

5-16 mesh (3.20 - 1.00 mm* diameter)	Fraction passed through 5 mesh sieve but retained by 16 mesh sieve.
16-25 mesh (1.00 - 0.64 mm diameter)	Fraction passed through 16 mesh but retained by 25 mesh sieve.
25-60 mesh (0.64 - 0.27 mm diameter)	Fraction passed through 25 mesh sieve but retained by 60 mesh sieve.
60-100 mesh (0.27 - 0.16 mm diameter)	Fraction passed through 60 mesh sieve but retained by 100 mesh sieve.
-100 mesh (<0.16 mm diameter)	Fraction passed through 100 mesh sieve.

*mm (millimeter) = 16/mesh

point *(V.S.* Salinity Laboratory Staff, 1954). All the determinations were made in triplicate.

Table 1. Salts (me L-I) to prepare a synthetic Ca:Mg ratio or 4:1

	Na_2SO_4	NaCI	$CaCh.2H_2O$	$MgS04.7H_2O$	Total me L-l
Ca	-	-	0.88	-	0.88
Mg	-	-	-	0.22	0.22
Na	4.78	4.12	-	-	8.90
Cl	-	4.12	0.88	-	5.00
S04	4.78	-	-	0.22	5.00
Total me L-l	4.78	4.12	0.88	0.22	-

Statistical analysis: The data collected were then subjected to statistical analysis by ANOVA technique. The treatment differences were tested according to DMR test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The dissolution of gypsum was the lowest (17.39 me L-l) in canal water (control) which increased to the highest value (26.16 me L-l) in solution having EC 0.7 dS m-l with SAR 5.2 (Table 3). Beyond this synthetic solution concentration, the dissolution decreased to 25.37 me L-l in solution having EC 4.0 aS m-I with SAR 28.8. In the solutions having EC 8.2 with SAR 43.5 and EC 12.2 with SAR 61.4, the dissolution of gypsum again gradually increased to 25.50 and 25.76 me L-t, respectively. The decreased dissolution might be due to common ion effects of Ca and S04 as well as due to low solubility product constant of gypsum, 6 x 10,5 at 25° C *(V.S.* Salinity Laboratory Staff, 1954; Bresler *et al.,* 1982). The increased dissolution in higher salinity/sodicity water may be due to dominant effect of Na which tended to lower the activity coefficient of Ca and *S04* (Bohn *et al.,* 1985). However, this water or EC = 1 dS m-I with SAR = 12 and aspect still needs studies at higher SAR with varying EC levels.

Table 2. Designed and obtained SAR and EC (dS m^{-1}) levels for the synthetic waters

Designed		Obtained	
EC	SAR	EC	SAR
0.6	6	0.7	5.2
1.0	12	1.1	11.0
2.0	18	2.2	18.8
4.0	30	4.0	28.8
8.0	45	8.2	43.3
12.0	60	12.2	61.4

The Ca + Mg concentration was lower (24.59 me L,t) for the 5-16 mesh particle size which increased to 24.68 me L-l for 16-25 mesh size-grade (Table 3). Further decrease in particle size significantly decreased the dissolution to 24.37 me L-t for 60-100 mesh powder. However, Ca + Mg concentration again increased to a statisti-

Table 3. [illegible] of gypsum size-grades (me L^{-1} of [illegible] + [illegible] by EC and SAR of [illegible] waters

Size-grade (Mesh)	[illegible]	EC 0.7 SAR 5.2	EC 1.1 SAR 11.0	EC 2.2 SAR 18.8	EC 4.0 SAR 28.8	EC 8.2 SAR 43.5	EC 12.2 SAR 61.4	Mean
5-16	17.48 l	[illegible]	[illegible]	[illegible]	[illegible]	25.22 jk	[illegible]	[illegible]
16-25	17.36 l	[illegible]	[illegible]	[illegible]	[illegible]	25.79 dh	[illegible]	[illegible]
25-60	17.44 l	[illegible]	[illegible]	[illegible]	[illegible]	25.22 jk	[illegible]	[illegible]
60-100	17.28 l	[illegible]	[illegible]	[illegible]	[illegible]	25.50 fk	[illegible]	[illegible]
-100	17.37 l	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mean	17.39 D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-
% increase		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-
[illegible]								

Figures followed by the same letter(s) are not statistically different at P = 0.05%. However, for simplicity only the first and last letter has been retained to indicate the significance e.g. ad is actually abcd.

$$\text{\% increase over control} = \frac{\text{Treated - Control}}{\text{Control}} \times 100$$

cally the highest value of 24.76 me L-l for the -100 mesh size-grade. According to physical laws, finer particles have higher surface area and hence because of more contact between solid and solvent, higher dissolution is expected. But the higher dissolution for 5-16 and 16-25 mesh particles than that of the 25-60 and 60-100 mesh size-grades appears to be due to hammering effect of particles during shaking. The larger particles would have collided with each other with a greater force than the finer ones. This collision might have caused mechanical disintegration of coarser particles. Hira and Singh (1980) noted higher efficiency of finer gypsum grades for sodic soil reclamation through releasing sufficient Ca for Na-Ca exchange. However, Chawla and Abrol (1980) reported higher hydraulic conductivity (HC) with coarser than that with finer gypsum particles. This sustained higher HC might be due to physical presence of gypsum particles which tended to keep the soil lose.

The interactive effects of gypsum size and solute concentration in waters on its dissolution are statistically significant. Higher EC and SAR caused more dissolution which increased further with gypsum fineness. The results are very similar to those reported by Rhoadcs (1982) from his soil reclamation experiments.

The results help opine that for soils and water of higher sodicity (SAR), coarser gypsum particles may release sufficient Ca to sustain the Na-Ca exchange and He. This may particularly be true for Pakistan soils where Na-Ca exchange is slower (Bear, 1964) partially because of illite type clays dominance (Ranjha, 1988) in soils.

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