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Gypsum Solubility as Affected by Varying Composition and pH of Soil Water Extract

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The efficiency of added gypsum in sodic soil depends upon its solubility, which eventually affects the sodic soil reclamation (Oster 1982). In practice, large volume of water is needed to solubilise the gypsum applied in the field due to its sparingly soluble nature, which is mainly governed by alkalinity of water (Richards 1954). The ionic composition of soil water extract is likely to change soil pH, which may affect the solubility of gypsum in varying proportions. The present investigation was therefore undertaken to study the solubility of gypsum in relation to varying ionic composition of water extract of soils differing widely in pH.

Six hundred surface (0-15 cm) soil samples were collected from contiguous belt of salt affected soils from Varanasi district of Uttar Pradesh with the aim to obtain the soils of different pH under natural condition. The collected soil samples were screened through 2 mm sieve, analysed for pH and on the basis of variation in pH, 30 soil samples were finally selected for the proposed study. The soils varied in pH from 7.3 to 10.8, EC 1.6 to 70.5 dSm^{-1}; water soluble cations dominated by Na from 6.0 to 800.0, Ca + Mg 4.0 to 8.0 and K 0.05 to 0.22 c mol $(P^+)\ L^{-1}$ and water soluble anions rich in CO_3 + HCO_3 from 7.0 to 522.0, SO_4 0.14 to 98.2 and Cl from 4.5 to 72.0 c mol $(P^+)\ L^{-1}$.

Water extract of 30 soil samples were collected by subjecting saturation pastes to suction pump. One gram of $CaSO_4.\ 2H_2O$ in 40 mL of water extract were shanken on mechanical shaker for 2h. Such a high ratio of gypsum water extract was taken, considering the very low solubility of gypsum in water. Calcium + magnesium content was determined in the extracts titrimetrically and solubility of gypsum was expressed on the basis of amount of Ca + Mg present in water extract of soil samples. Sodium, K and soluble anions were also determined. Solution phase sodicity indices (SAR and RSC) were worked out as per methods described by Richards (1954).

It was observed that solubility of gypsum was almost unchanged from 0.25 to 0.23% between pH of soil water extract 7.3 to 9.9. But there was a dramatic downfall in gypsum solubility from 0.23 to 0.13% with increase in pH of soil solution from 10.1 to 10.8 (Table 1). This may be attributed to sharp increase in concentration of CO_3 + HCO_3 from 4.0 to 522.0 c mol $(P^+)\ L^{-1}$ in soil solution, which reduced the activity of Ca ions by coating the gypsum particles with CO_3 + HCO_3 ions. In a regression analysis, gypsum solubility reduced at the rate of 0.025% per unit increase in pH of soil solution ($Y = 0.445 - 0.025\ X$, where X and Y stand for soil solution pH and gypsum solubility respectively). The solubility of gypsum was highly and positively correlated with EC ($r = 0.786^{**}$) than the negative correlation with pH of soil solution ($r = -0.773^{**}$), indicating that ionic composition of soil solution was of more importance than alkalinity of soil solution in governing the solubility of gypsum. Keren and Shainberg (1981) observed increase in gypsum solubility with increase in ionic concentration of water.

The dissolution rate of gypsum was influenced by Ca and/ or SO_4 concentration in the solution medium (Kemper *et al.* 1975). The gypsum solubility in the present study, was positively correlated with Ca + Mg ($r = 0.352^{*}$) due to decrease in Ca + Mg content from 8.0 to 4.0 c mol $(p^+)\ L^{-1}$, thereby increasing the ratio of Na and CO_3 + HCO_3 in comparison to Ca + Mg. This inturn increased the solution phase indices such as SAR and RSC of soil solution, apart from pH. The above

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Table 1 *Gypsum solubility in relation to pH and EC of soil water extract*

pH	EC (dSm^{-1})	Gypsum solubility (%)
7.3–8.7	1.6–3.4	0.24–0.26
*(7.9)	(2.0)	(0.25)
9.2–9.9	2.3–5.3	0.23–0.25
(9.5)	(3.3)	(0.24)
10.1–10.2	18.8–70.5	0.17–0.23
(10.1)	(36.5)	(0.20)
10.4–10.8	10.2–22.8	0.13–0.17
(10.6)	(15.0)	(0.13)

* Data in parenthesis indicate their mean values

observations were clearly evident from the presence of negative correlations of gypsum solubility with SAR (r = -0.367*) and RSC (r = -0.328). On an average, soluble Na and CO_3 + HCO_3 accounted for rise in pH and was highly, significantly and negatively correlated with gypsum solubility (r = -0.869 ** and – 0.616 ** respectively). The observations, hence suggested that the solubility of gypsum was dominantly influenced by Na and CO_3 + HCO_3 ions instead of common ions like Ca or SO_4 ions due to reduced activity of Ca ions with increase in alkalinity of the soil solution.

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