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EFFECT OF AGGREGATE SIZE ON LEACHING OF SALTS FROM SOIL AGGREGATES*

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Abstract. The effect of size of aggregates on leaching of salts from aggregates was studied by making the soil aggregates with 10% $CaCl_2$ solution. The aggregates were graded into different sizes, packed in columns and leached under constant water head. The size of aggregates influenced the leaching pattern, salt being removed more rapidly from smaller aggregates.

Aggregate size distribution is measured to characterize soil structure and it affects plant growth. The most desirable size of aggregates from the point of view of plant growth lies in the range 1–5 mm.[1] Aggregate size affects the moisture and air relationship of soils. Evaporation from a wet, bare soil increases with increasing coarseness of aggregates[2] and as a result seedling emergence can be reduced.[3] Aggregate size also affects nutrient availability. Wiersum[4] showed that with increasing aggregate size, the uptake of phosphorus decreased, since the roots did not penetrate the aggregates. In contrast, the uptake of nitrogen was not affected by aggregate size as this nutrient moves with the soil water.

This paper reports the effect of aggregate size on leaching of salts from the aggregates.

Experimental

Chicot sandy loam soil was ground and sieved through a 0.5-mm sieve. Aggregates were made out of this sample with 10% $CaCl_2$ solution. The wet aggregates were wrapped in polyethylene bags and frozen at —15°C for three days, then thawed and air-dried at room temperature.[5] The aggregates were gently parted by hand when they began to dry, and, when quite dry, they were graded over round whole sieves to separate aggregates of 1–2, 2–3, 3–4, 4–5 5–6, 6–8 and 8–9 mm dia.

Thirty grams aggregates were packed in columns 22 mm inside dia to a uniform bulk density of 0.58 g/cm³. In order to reduce the macropores between the aggregates, fine sand was mixed with aggregates in the column. The final bulk density of the column was 1.54±0.04 g/cm³ and the porosity was reduced from 78 to 41%. The columns were leached with water under a constant head. The leachate was collected in fractions of 1 ml each and analyzed for Cl^- content. Chloride was determined by titrating the solution against $AgNO_3$ using K_2CrO_4 as indicator.

Results and Discussion

The size of aggregates influenced the leaching pattern (Fig. 1). The first ml fraction of leachate from 1 to 2 mm aggregates contained 2.5 me Cl^-/ml. This concentration decreased with increase in aggregate size. The leaching curve for the 1–2 mm size dropped off steeply while the curves for larger sizes showed that Cl^- concentration was sustained for a larger volume of leachate.

The higher concentration of Cl^- in the first fraction from smaller aggregates can be explained by the larger surface area exposed to water contact by smaller aggregates (Table 1), 35.8 cm²/g for 1–2 mm aggregates and 4.5 cm²/g for 8–9 mm aggregates. The longer distance which the salt had to move to come out of the larger aggregates caused a delay in salt removal from larger aggregates and consequently more water was required to remove an equal amount of salt.

The efficiency of water in moving salt from the aggregates can be calculated from the diameter of the aggregate using the following equation:

$$Y = 15.5 - 14.3 \log X \qquad (1)$$

where Y, salt removed in me/10 ml water; and X, dia of the aggregates (mm).

The good fit of the experimental results to this equation is shown in Fig. 2.

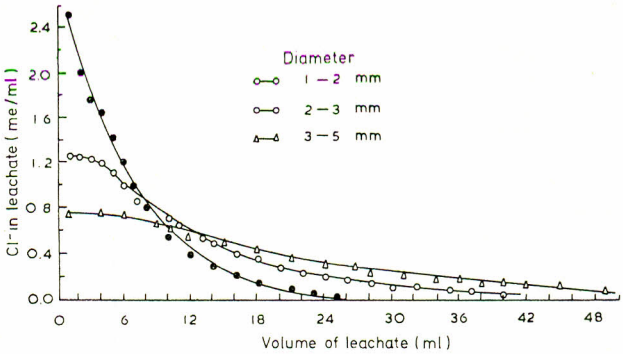

Fig. 1. Leaching of Cl^- from aggregates of different sizes.

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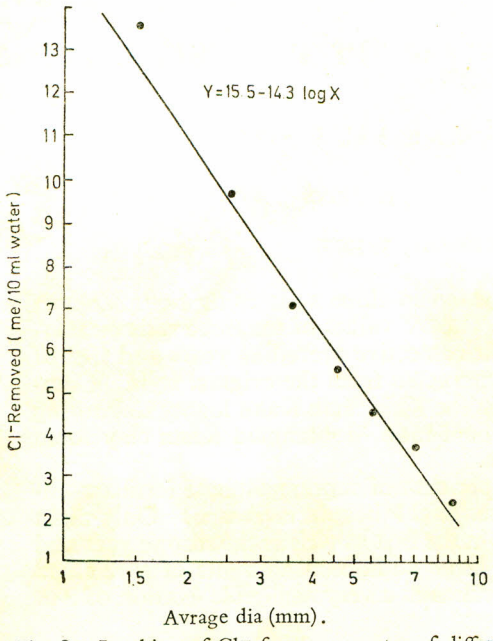

Fig. 2. Leaching of Cl^- from aggregates of different sizes per 10 ml water.

The results of this study show that size of aggregates plays an important role in the reclamation of saline soils. The leaching of salts would be more efficient if the size of aggregates is small. The aggregate size is important from soil fertility point of view as well. Although aggregate size has no effect on the availability of nutrient ions like NO^-_3 to plants,[4] the larger aggregates will retain the nutrients against leaching for a longer period especially under heavy irrigation or humid conditions where leaching of nutrients is a serious problem.

TABLE 1. PERTINENT DATA FOR AGGREGATES.

Dia (mm)	No. of aggregates/g aggregates	Surface area/g aggreagates (cm^2)
1–2	479	35.87
2–3	68	13.35
3–4	31	11.93
4–5	17	10.16
5–6	8	7.60
6–8	4	6.16
8–9	2	4.54

Conclusion

The size of the aggregates influenced the leaching pattern, salt being removed more rapidly from smaller aggregates.

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References

1. A.G. Dogarenko, Russian J. Agr. Sci., **1,** 451 (1924).
2. J.W. Holmes, E.L. Gruecen and C.G. Gurr, Trans. Seventh Intern. Congr. Soil Sci., **1,** 188 (1960).
3. W.E. Larson, Neth. J. Agr. Sci., **11,** 100 (1963).
4. L.K. Wiersum, Landbouwk. Tijdschr., **74,** 961 (1962).
5. R.J.B. Williams and G.W. Cooke, Soil Sci., **92,** 30 (1961).