Desalinization of Saline Soils Aimed at Environmentally Sustainable Agriculture: A New Thought

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Abstract: This article describes the desalinization of saline soils aimed at environmentally sustainable agriculture. [Journal of American Science 2009;5(5):197-198]. (ISSN: 1545-1003).

Salinity, defined as the concentration of dissolved mineral salts present in the soil or water, is one of the most severe environmental factors limiting the productivity of agricultural crops. Most of the crops are sensitive to salinity caused by high concentrations of salts in the soil. Salinization commonly occurs as an outcome of agricultural practices. Salinization associated with agriculture occurs when salts build up in the root zone, either because the soil is inherently saline or because the drainage of water from the sub-soil is not adequate to prevent saline waters rising into the root zone.

Increasing salinity is a major abiotic stress affecting approximately 7 % of the world's total land area (Munns, 2005) resulting in billion dollar losses in crop production around the globe (Norbors and Dykes, 1984). Without proper agricultural and ecological practices salt problems and/or salt accumulation can occur under virtually any climate regime. However, arid land climates and poorly draining soils are particularly susceptible to salinization due to evaporation that leaves the salt behind. World wide, approximately one third to one half of all the irrigated lands has salt problems; the majority of which is in less developed arid regions. And, every year, millions of acres of irrigated lands go out of production due to salt. Indeed, there is already twice as much salty land as the irrigated land. If this trend will continue, we will have finally reached the point where there are no new 'virgin' lands left to salinize.

In amelioration of saline-sodic soils, gypsum is used as agricultural lime but it is to some extent expensive. Moreover, the efficiency of gypsum application is reduced because it is precipitated by dissolved CO_3^{2-} and HCO_3^-, forming insoluble $CaCO_3$. However, this option applicable only when pH of soil > 8.5 (sodic soil), claimed by many scientists. In recent decades, phytoremediation has also proved to be as efficient, inexpensive and environmentally acceptable strategy to ameliorate saline-sodic soils (Qadir and Oster, 2002). But it reduces sodicity very slowly than chemical treatments. Moreover, it has very limited application under condition of high level of soil salinity and sodicity (ECe >20 dSm^{-1}, ESP >70). As a result, farmers often become reluctant to ameliorate saline soils. Unfortunately, fertilizers do not solve the salinity problems. Fertilizers are just plant nutrients and do not remove salt from the soil. However, organic fertilizers and mulching may help reduce soil salinity by improving soil structure and therefore increasing percolation. It may be tempting to remove the surface clay/silt layer as the quickest way to get rid of the salt. However, bear in mind that just one centimeter of sediment per hectare equals 100 cubic meters. One cubic meter is approximately 15 full wheel barrows, and a standard large truck load is eight to ten tons. This option can only be justified under exceptional circumstances, such as clearing for high value cash crops. In this case, the economic cost/benefit should be calculated first. Moreover, appropriate disposal of saline soil is also a great problem; coastal dumping may be effective from a salinity point of view, but carries other environmental risks.

One way to remove salt from soil is to leach it out. Here, a drain system is installed in the field. Large amounts of fresh water are added to the field and the salt dissolves in the water which is moved off the field by the drain system. The collected water can then be treated further to remove the dissolved salt. Moreover, the continuous irrigation over the years has resulted in a rise of the ground water table in turn resulted in development of salinity and water-logging and also leaching the nutrients of the soil. In another way, the soil can be dug up, then literally washed like in a washing machine and then put back into place. Obviously, the last alternative is not very realistic because of costs, however it could be done.

In improving those saline soils to find out the effective (an efficient and low cost) method is required. Slaking is the process of soil aggregates collapse when they are rewetted after drying. Soil slaking has long been studied from the stand point of stability of aggregates. However, it has not been studied from that of salt removal. Drying followed by rewetting and slaking is commonly found in a natural soil processes. During the process, salt in the soil moves and accumulates to the inter and outer surface of soil blocks and released to outer solution. Recent study revealed that the maximum salt is released at the soil moisture of maximum slaking. In addition, the amount of salt released into equilibrium water after 24 hours slaking was proportional to the slaking rate[1]. The $EC_{1:5}$ of the equilibrium water surrounding the slaked soil blocks were measured, which is an exact measure of the amount of salt released[2] from the soil block. Here, we can find a chance to improve the saline soil by simply rewetting the soil at the proper soil moisture by land drying practice. Moreover, proper amount of water management can limit salinization. This is because the salt concentration and amounts of irrigated water content in soil is dependent each other. If saline soil is irrigated by too much water like ponding irrigation, salt concentration decreases abruptly to cause dispersion and swelling of soil particles and plugging percolation pores. It results in great drop in water movement. On the other hand, if soil is irrigated by small amount of water enough to slake and flush the salt under relatively dry condition, the salt will decrease smoothly because water can moves well without plugging pores by dispersion. It is also environmentally sound and economic as well as saving water resource.

In this respect, it is imperative to focus at soil dryness or soil moisture content at which slaking initiates and is mostly enhanced. Accordingly, the specific points are (1) to identify the optimum soil moisture content for slaking, (2) to evaluate salt released accompanied by slaking and (3) to discuss the effect and mechanism of drying on slaking, which deserve attention due to increasing global water shortage and awareness of the environmental impacts associated with irrigation.

[1]Slaking Rate of Soil
The slaking rate was calculated by using the following equation;

Slaking rate (%) = Weight of slaked soil/Weight of soils (slaked + unslaked) X 100

Where, slaked soil refers 'the soils which fell down through sieve with 4.75 mm openings' and unslaked soil refers 'the soils which was left on the sieve' after 24 hours wetting.

[2]Released Salt
The salt left in the soil blocks (after 24 hours immersion) was calculated using $EC_{1:5}$ of soil and EC of solution by the following equation;
Salt in slaked soil = k ($EC_{1:5}$ X 5 X Ws)/ρw… (1)
Salt in unslaked soil = k ($EC_{1:5}$ X 5 X Ws)/ρw… (2)
The total salt remains in the soil = (1) + (2)… (3)
Salt released into the water after 24 hours immersion = k (EC X Vw)… (4)
Proportion of salt remaining in soil (%) = (3)/ {(3) + (4)} X 100… (5)
Proportion of salt released in water (%) = (4)/ {(3) + (4)} X 100... (6)

Where, Ws represents the weight of soil; Vw refers to the volume of bulk water for slaking test; k indicates the co-efficient of proportionality between salt concentration and EC of solution, ρw means the density of water.

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