Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

SAR What?

Sodium Adsorption Ratio (SAR) is a measure of amounts of Sodium relative to the amounts of Calcium and Magnesium. The natural amounts of Sodium in the soil can be altered by addition of excess Sodium (is some form). This may be by addition of composts or fertilizers with very high Sodium content or more usually by irrigation with water having high Sodium. This may be a particular problem of "reclaimed water". So what is happening? The surface of soil particles is covered with readily exchangeable (they come off and go back on) positively charged ions (cations). The most common are Calcium, Magnesium, Sodium and Potassium. If excess Sodium is in the irrigation water surrounding the soil particle, when a Calcium or Magnesium come off they can be replaced with a Sodium (Fig 1). This results is a change in the proportion of Sodium to Calcium plus Magnesium and, therefore, an increase in the soil SAR.

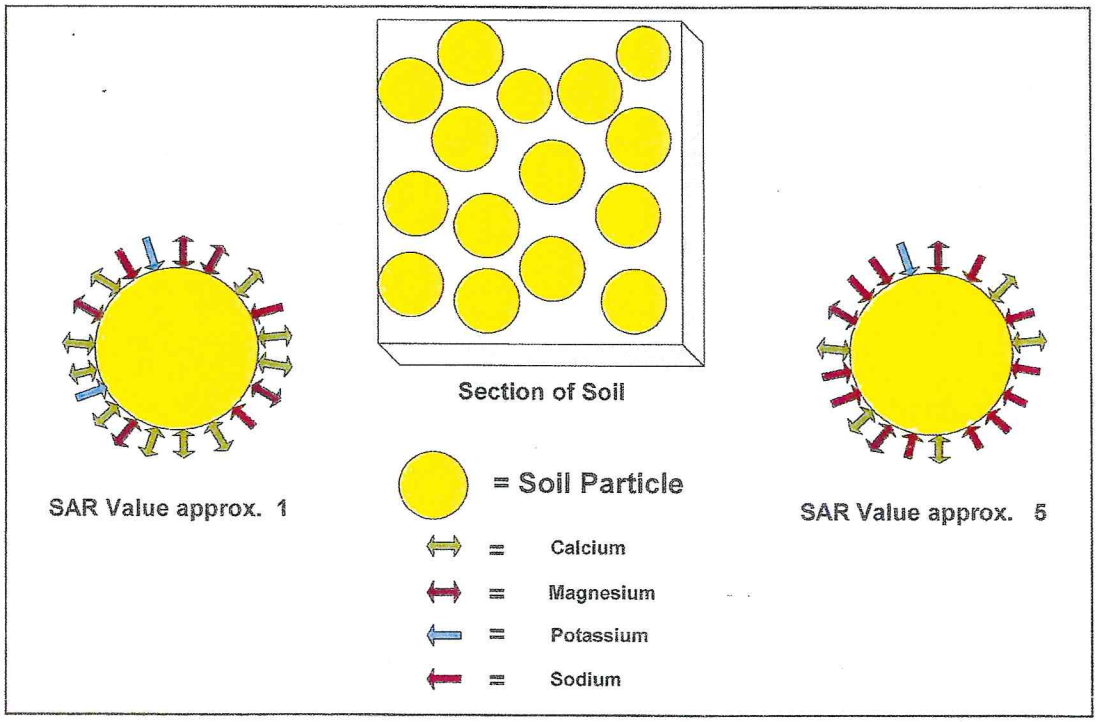

Fig. 1 Accumulation of Sodium on the Soil Particles

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When excess Sodium accumulates in the soil the soil collapses, that is the soil particles can be compressed together (Fig. 2) such that there is less space between the soil particles (where the water moves in the soil) causing poor water penetration. So what, water longer. Unfortunately, what happens is the water ponds on the soil surface, evaporates and the salt in the water accumulates in the soil (small in amount per gallon – large in amount when using thousands of gallons). The salt accumulates to the extent that it limits plant growth. Also there is typically an accumulation of Boron along with the salts elevating the soil pH. By the time the SAR reaches about 9 the soil is not usable for growing and extremely difficult to reclaim. The specific description for the soil is "Sodic Soil".

An easy way to understand what is occurring is to visualize Calcium as though it had two arms and could thus bind soil particles together (Fig.2). In

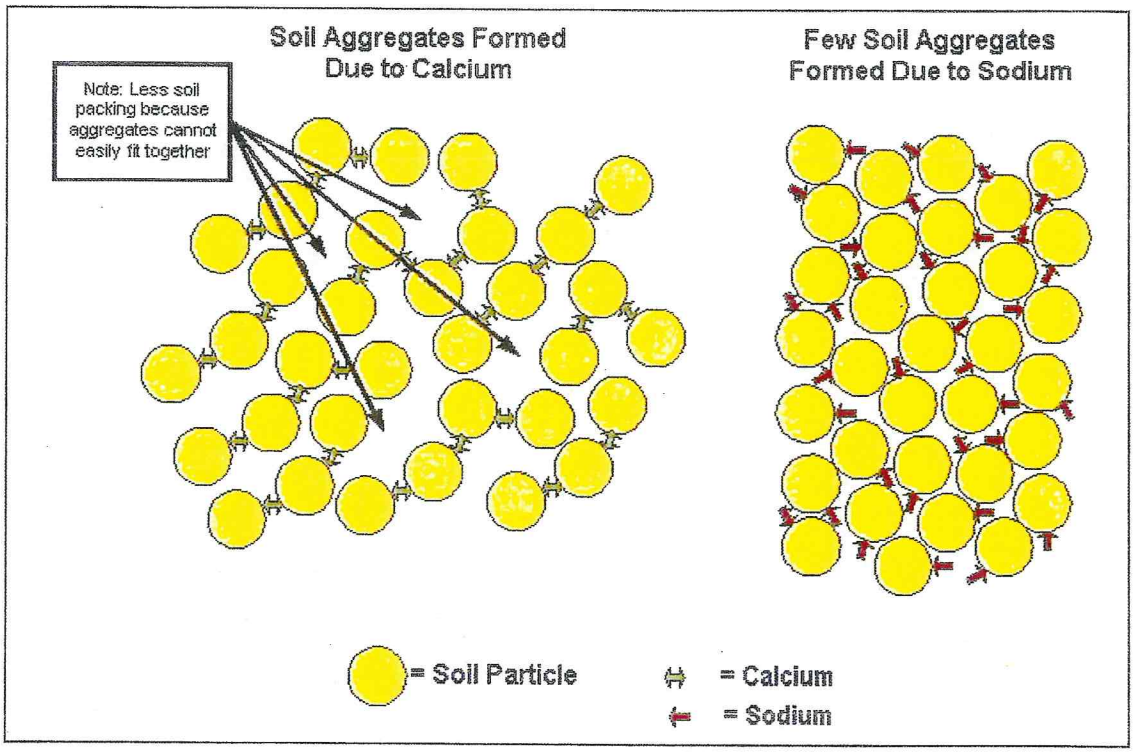

Fig 2. Difference is Soil Particle Packing with High Calcium or Sodium

contrast, Sodium with only one arm binds to particles, but does not hold them together. As a result, Calcium aggregates soil particles and Sodium will not. These calcium-aggregated particles can be considered more difficult to pack together than then non-aggregated particles bound to Sodium. This means that

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there may be more space between the Calcium aggregated particles and, thus, easier passage of water. In contrast, the non-aggregated particles bound to sodium compact well minimizing the space between them and limiting water flow (Fig.2).

Managing the soil SAR is initially to determine the value and watch for increases over time. Also either have the irritation water analyzed for the water SAR value or obtain the value from your water provider. If the water SAR exceeds 6 there is potential that, over time, it's use will cause the soil SAR to increase. The initial, maybe easy, fix would be to mix the water with a source having a lower SAR or changing the water source completely. Other management of the soil SAR is with application of Gypsum (see Sunland's article "When and Why to Use Gypsum") by adding the soluble Calcium in Gypsum to soil, a favorable ratio between the Sodium and the Calcium plus Magnesium can be maintained. As indicated above soils with a SAR of 9 are in very poor condition, Sunland suggests that management of the SAR begin if the soil SAR exceeds 5. Based on other soil characteristics, recommendations for the amount of Gypsum (seen in the Gypsum Requirement of the soil report) can be made to maintain a productive soil.

Finally, if you like to get down to the calculations SAR is the equivalents of Sodium in the soil solution (water around the soil particles) divided by the square root of the average of the equivalents of Calcium plus the equivalents of Magnesium also in the soil solution.

$$SAR = [Na] / (([Ca] + [Mg]) / 2)^{1/2}$$