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SALINITY CONTROL IN GREENHOUSE SOILS

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In our semi-arid climate, the sources of good quality water are becoming increasingly expensive, and restrictions may be placed on consumption. The use of lower quality water will also be necessary. This will result in production problems for growers because of salt buildup in soils. The use of excessive amounts of water to reduce these salt levels will not be practical and efficient salt control will be a major concern. The information available on the leaching of excess salts from greenhouse growing media is virtually non-existent. For this reason, leaching studies have been initiated at Colorado State University. Our objectives will be to determine when irrigation water becomes too salty to use for leaching, the effect of various types of salts (hard water, soft water, nutrient solutions) on the rate of leaching, and the best leaching method. The following is a review of the current information available on soil salinity and its control.

Salts are deposited in soils by the irrigation water and by dry applications of fertilizers. These salts consist mostly of sodium, calcium, magnesium, potassium, bicarbonate, carbonate, sulfate, nitrate, and chlorine. All irrigation waters contain some salts, but the quantity and types of salts present vary from one source to another. Electrical conductivity (EC) measurements are used to determine the total salt concentration of the water. Table 1 shows a classification of irrigation water on the basis of EC alone. However, beyond total salt content, one should also consider several other characteristics of the irrigation water, such as the relative proportion of sodium to other cations, the concentration of boron or other elements that may be toxic, and the bicarbonate concentration as related to the concentration of calcium plus magnesium. Injection of fertilizer salts into the irrigation water further increased the amounts of salts applied (about 1.0 to 3.0 mmhos additional).

The increased salt concentrations in the soil result in the soil water becoming less available for plant utilization and symptoms include those typical for water stress. High salts may also adversely affect the physical condition of the soil and may produce nutritional imbalances and toxicities.

Table 1: Classification of Irrigation Water Applied to Bench, Including any Fertilizer Injected.

	Electrical Conductivity Mhos × 10-5	Milli mhos	Micro mhos
Excellent	< 25	< .25	< 250
Good	25 - 75	.25 - .75	250 - 750
Permissible	75 - 200	.75 - 2.0	750 - 2000
Doubtful	200 - 300	2.0 - 3.0	2000 - 3000
Unsuitable	> 300	> 3.0	> 3000

Table from Waters, et al. 1972.

The point at which the salt content of the soil begins to affect plant growth is influenced by a number of factors. These include the location of the salts in the soil profile, the types of salts present, and the tolerance of the cultivar being grown. The type of growing media is also important. Shrubs grown in bark mixes are injured at a lower salt level than those grown in soil or finely ground peat-vermiculite mixes (1).

Before the level of salts in the soil reaches this damaging level, we try to reduce the concentration by leaching. Leaching is the passage of water through a soil to control salinity. Leaching removes soluble salts by dissolving them and transporting them downward, out of the root zone. The leaching requirement is the quantity of water needed to control salinity at a specific level. Methods of calculating the leaching requirement can be found in C.F.G.A. Bulletin 318 (2). Various factors influence the leaching requirement. Among these are the salt concentration of the irrigation water, the initial salt content of the soil, the maximum salt concentration permissible in the soil, the methods of applying leaching water, the initial moisture content of the soil, the physical and chemical characteristics of the growing media, and the types of salts

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present in the soil and irrigation water. Several of these factors deserve further comment.

As noted above, the method of application of the water used in leaching is important in determining its effectiveness. In one of the few studies on greenhouse soils, Hanan et al. (1982) concluded that continuous flooding may not be the best method for salt removal. This is probably because the water just runs right through the many large pore spaces, leaving the smaller pores undisturbed and, therefore, full of concentrated salt solution. Furuta (1976), on the other hand, stated that leaching appears to be accomplished best in container crops by a rapid application of large volumes of water. This may be difficult in practice, as pointed out by Hanan, et al. (1982), because no bench irrigation system now in use could supply enough water to flood highly porous greenhouse mixtures.

Sprinkling has been found to be the most efficient way to leach field soils. This is due to the increased water movement through the smaller pores and the improved mixing and diffusion which takes place. With sprinkling, there is more of a "piston" effect by the irrigation water in removing the soil solution. Although no data is available for greenhouse mixes, the same reasoning probably holds true for them also.

Drip and trickle irrigation have been suggested for use in salinity control because they maintain a relatively high water content around the plant roots, thereby minimizing the concentrating effect of soil drying. When using these irrigation systems, salt accumulation does occur on the soil surface and on the periphery of the moistened root zone. Therefore, it will be necessary to leach the entire soil volume periodically. It has been shown that increasing the amount of water applied by drip irrigation will not satisfactorily control salinity (1). The water from a single trickle or drip emitter would move in a column directly below the emitter with little lateral movement and, consequently, have no effect on salt concentration except in the region immediately below the emitter (3). Sprinkling, therefore, should be used to leach the salts.

The type of growing media used, and its chemical and physical properties also have an effect on the efficiency of leaching. The water retention and water conduction properties of soil mixes are very important in relation to problems of salinity control. Under continuous flooding, leaching from mixtures that have low percolation rates is much more efficient than leaching mixes that have high percolation rates (3). Another soil property which determines salt retention is the cation exchange capacity (CEC). This is the ability of the negatively charged surface of the soil particles to adsorb positively charged cations. If the CEC of a soil mix is very high, the salts will be held tightly in the mix and leaching will be much more difficult.

The mixes used in greenhouse production have not been sufficiently tested for salt removal characteristics. It is known, however, that organic matter, with its high CEC and large pore spaces, retards salt removal. The specific type of organic matter also plays a role. Fir bark, for instance, caused greater salt retention than peat. Peat-sand mixtures are more leachable than peat substrates made with finer textured loam. Vermiculite significantly reduces the loss of nutrient salts by leaching because of its high CEC, as compared to sand.

Besides leaching, there are other procedures that should be initiated when high salt problems develop. First, keep the soil mix from drying out, as this can dramatically increase the concentration of salts in the soil solution, increasing the salt problem. Second, adjust fertilizer components to reduce the input of unnecessary amounts of chlorine, sodium, and sulfate. If bicarbonate is a problem in the irrigation water, it can be neutralized by the addition of acids to the fertilizer. Third, provide adequate drainage for the leachate. Fourth, the use of indicator plants (salt sensitive species or varieties) gives a warning of when salinity control measures become inadequate. And, finally, test irrigation water and soil regularly. Keep a "soluble salts log book" so that you can become aware of trends as they develop and alter cultural practices accordingly.

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