

SOLUBLE SALTS INJURY TO PLANTS

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Fig. 1. Leaf-tip necrosis of citrus caused by excessive soluble salts.

Soluble salts refer to the total soluble minerals plus some soluble organic substances in soils or soilless mixes. Soluble salts are composed predominantly of ammonium, calcium, magnesium, potassium, sodium, bicarbonate, chloride, nitrate, and sulfate ions (2). Growers of plants use soluble salts measurements to get an indication of the fertility of their soils. Since such measurements do not distinguish between different fertilizer elements, other measurements such as pH, nitrate-nitrogen (N), phosphorus (P), potassium (K), etc., may also be needed (2). The Division of Plant Industry at Gainesville can measure soluble salts and pH. The County Extension Service can have the soils testing laboratory of the University of Florida perform complete nutritional analyses of soils.

EFFECTS OF HIGH SOLUBLE SALTS UPON PLANTS. High soluble salts damage (burn) plant roots and reduce their ability to absorb water and nutrients (3, 4). When the concentration of salts inside the root cells is higher than in the soil, water will continue to move into the root, and the plant appears normal. However, when the salts level in the soil exceeds that of the cell contents of the feeder roots, water fails to move into the cells and may even move out. As a result, the plants may show symptoms of dehydration. The high salts accumulate in the plant and together with the reduced water uptake cause chlorosis and necrosis of tips of recently expanded leaves and shoots (Fig. 1). In addition to the chlorosis and necrosis of new tissue, plants may wilt, become stunted, produce smaller than normal flowers, and in some instances die as a result of excess soluble salts.

Plants growing in soils of low soluble salts levels may grow poorly and exhibit various signs of nutrient deficiency which is related to a particular nutritional element. Often these deficiencies may not be the result of low nutrient levels but may be the result of an unfavorable soil pH. For most plants, if the pH value is below 5.0 or above 7.0, certain essential elements become unavailable to the plant, even though the soluble salts level may be acceptable. For this reason a pH test accompanies the soluble salts test.

High or low soluble salts weaken or stress plants. Plants under stress become increasingly vulnerable to root and foliar pathogens which are able to grow facultatively (saprophytically and parasitically) (1). For example, roots which are burned by high salts are more easily invaded by facultative species of fungi than are healthy roots, thereby compounding the water stress problem caused by high salts. To help control the secondary pathogen in the roots, it is essential to remove the stress by leaching the soils and by fertilizing less. It may then be advisable to control the fungus directly with a fungicide.

MANAGEMENT OF SOLUBLE SALTS. High soluble salts are more commonly a problem than are low soluble salts. High and injurious levels of soluble salts occur in soils for any number of the following reasons: a) excessive application of fertilizer (Plant species, season of year, initial level of soluble salts, and composition of soil are important considerations here.); b) failure to water and leach properly (Allow 10-15% of the applied water to drain.); c) use of irrigation water containing high levels of soluble salts (Table 2); and d) allowing soils which contain plants in high fertility programs to become dry (Salts may be concentrated four or more times the concentration achieved immediately following irrigation).

MEASURING AND INTERPRETING SOLUBLE SALTS. Soil or potting mixtures are analyzed for soluble salts by one of three different methods (3, 4). Growers should understand what procedure is being used and how to interpret the results. Each method has a different interpretation. The three procedures are (1) 1:2 soil to water dry weight, (2) 1:2 soil to water volume, and (3) the saturated paste. We have in the past used the 1:2 soil to water dry weight method. Beginning with this publication, we are using the 1:2 soil to water volume procedure. The acceptable concentration of soluble salts in parts per million (ppm) will be lower with this volume method than with the dry-weight method. The 1:2 soil to water volume method is the procedure that is most commonly used by growers who have facilities to measure soluble salts. There is less variation with this method than with the 1:2 dry weight method with soil media of varying bulk densities, such as the peat-soil mixes commonly used in the ornamental industry (3, 4). Soluble

salts in the volume procedure are estimated by mixing 1 part by volume air-dried soil to 2 parts water and reading on an instrument (Solu-Bridge) that measures electrical conductivity. Results are reported as ppm of salts in a volume of water which is equivalent to the volume of the soil sample. An interpretative guide for the 1:2 volume procedure is presented in Table 1.

Table 1. Interpretation of soluble salts readings (ppm) for 1:2 air-dry soil to water mixture by volume (4).

Media	ppm salts	Salts rating	Remarks
	0-325 0-460 0-700	Low	Need fertilizer
Sandy soils 1:1 peat:sand Peat or light wt. mixes	350-700 460-925 700-1400	Low to medium	Satisfactory for growth in upper range.
Sandy soils 1:1 peat:sand Peat or light wt. mixes	700-1400 975-1820 1400-2450	Medium to high	Desirable salt range no fertilizer needed, but light applications can be made.
Sandy soils 1:1 peat:sand Peat or light wt. mixes	1400-2100 1820-2800 2450-3850	High to very high	Do not fertilize or allow soil to become dry. Leach media if readings are near top of these ranges.

A classification guide for irrigation water based upon soluble salts measurements is given in Table 2.

Table 2. Classes of irrigation water and soluble salts levels (5).

Class of water	Total dissolved solids (salts) ppm
1. Excellent	175
2. Good	175-525
3. Permissible	525-1400
4. Doubtful	1400-2100
5. Unsuitable	2100

SPECIMEN SUBMISSION. For plants showing tip burn of leaves, wilting, stunting, smaller than normal flowers, and symptoms of nutrient deficiencies, submit one pint of a composite sample of soil along with roots and portions of the plant showing symptoms. Root-rotting pathogens can produce some of the same symptoms caused by high or low soluble salts. It is thus desirable to submit roots for a thorough diagnosis. If slow-release fertilizers are being used, remove the fertilizer from the soil surface before collecting the sample. The presence of slow-release fertilizers in the sample results in an abnormally high reading of soluble salts.

LITERATURE CITED.

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