



Plant Health Care Inc.

440 William Pitt Way
Pittsburgh, PA 15238

Technical Bulletin

045 07/05/01

SALT INDEX AND SODIUM

Sodium

There is a lot of negative innuendo about sodium content in soil, and as a result, many assume that sodium is somehow very toxic. In fact, it is not the sodium itself that causes the problem. It is the amount of salts in the plant tissue or in the soil around the roots and the effect they have on water uptake that causes problems. These salts can be sodium chloride (a most common one), or can also be other salts that do not involve sodium, including salts of calcium, magnesium and potassium. All these contribute to the salt index to different degrees. So when people are expressing concern over the sodium content, they are really referring to a concern about excessive salts in the soil. Salts act like a drawing salve, by drawing water out of the tissue into the salt. So tissues tend to "burn" as they lose water to the salt.

Plasmolysis and Wilting

If a plant cell is placed in a salt water solution, the cell undergoes plasmolysis. This term is used to describe the physical change that occurs with the excessive loss of water from the cell. Plant cells are very much like an inflated water balloon fitting tightly inside a cardboard box. The box represents the cell wall, and the water balloon represents the living cell interior with its surrounding membrane. If the wall were not there, the cell would continue to imbibe water until it burst. This water intake occurs principally by osmosis, since the salt concentration is typically much higher inside the cell than outside. But the wall exerts some reverse pressure, limiting the size of the cell and the amount of water it can take in, and giving the cell the rigidity (or "turgidity") of an over-inflated balloon. In a salty solution, the salt draws the water out of the plant cell. The cell wall does not collapse, as it is rather rigid. But the inner cell does collapse as the membrane and its contents deflate, and the cell membrane pulls away from the cell wall. This is readily seen under the microscope. It literally looks like a partially deflated balloon inside a box. Without this water pressure to give the cell firmness, it loses its turgidity, and the whole tissue wilts. Unless the water pressure can be restored, the plant eventually dies of thirst.

In cases where the salt concentration in the soil is moderately high, it will not cause plasmolysis, but it does make the process of water intake slower and less effective. The salt concentration is still higher inside the plant cells, but the difference is less striking, so water diffuses into the cell more slowly and less forcefully. The pressure exerted against the cell wall is lower, and so the plant is less turgid.

Salt Injury

Plant injury resulting from excessive soluble salts may first occur as a mild chlorosis of the foliage, later progressing to a necrosis of leaf tips and margins. Other symptoms of "salt" or "fertilizer" injury may be variable, but usually include: slow and spotty seed germination, stunted growth, sudden wilting, leaf yellowing, marginal burn on leaves (especially lower, older leaves), leaf fall, restricted root development, dead roots, and sudden or gradual death of plants. This is largely attributed to the mobility of soluble salts within the plant. As these salt solutions are rapidly translocated throughout the plant, they accumulate at the leaf tips and margins, where they evaporate at these points. As these salt water droplets at the leaf tips dry out, the salt in these drops will concentrate and might even crystallize, leaving a salty deposit. This causes the characteristic burn at the leaf tips.

Roots may also be injured by the presence of excessive soluble salts. This often predisposes the roots to a wide range of diseases (*Pythium*, *Fusarium*, etc.). Extreme injury may also interfere with water uptake and result in excessive wilting of the plant. While the major effect of high soil salts are to the roots, the tops of plants may show "salt injury" while the roots appear to be unaffected. In this case, the soluble salts enter the roots and are moved through the plant vessels to the leaves where the water evaporates and gradually concentrates the salts. When soil soluble salts are excessively high, the roots are unable to absorb water and the plant wilts. The problem is apt to be more pronounced after fertilizing, or during excessively dry conditions. Allowing the soil to become too dry for even a few hours can result in "salt injury" because the salts become concentrated.

Plants may recover from "salt injury" provided the high salt level in the soil is reduced by dilution. This may occur naturally after a rain, or be alleviated by irrigation.

The presence of excessive soluble salts is perhaps the most limiting factor in the production of greenhouse crops. Generally speaking, salt accumulations result from the use of poor quality irrigation water, over fertilization, or growing media with an inherently high salt content. Although soluble salts can inhibit plant growth, when managed properly their effects may be reduced.

Irrigation Water

Quite often, irrigation water is a major contributor of soluble salts to the growing medium. These occur primarily as salts of Na, Ca, and Mg, although others may be present. Soluble salts in irrigation water are measured in terms of electrical conductivity (EC). The higher the salt content the greater the EC. In general EC values exceeding 2.0 milli-mhos/cc are considered detrimental to plant growth. Water quality should be monitored on a frequent basis in order to avoid potential problems from soluble salts. Rain water is very low in salt.

Fertilizers

Fertilizers have a salt characteristic, and therefore contribute to the total soluble salt content of the growing medium. Depending on the inherent salt content of the irrigation water used, fertilizer applications should be adjusted to avoid salt accumulations.

Fertilizers are often classified by the amount of total salts they contain. This "salt index" can be used to determine the amount of salts contributed by the fertilizer to the growing

medium. For comparison purposes, the salt index of sodium nitrate was arbitrarily set at 100, and all other materials are compared to this standard. The lower the salt index value, the smaller the contribution the fertilizer makes to the level of soluble salts.

Actively growing annual crops require a continuous supply of balanced nutrients in the soil. These are usually provided by the application of fertilizers which include soluble salts. However, if the concentration of any soluble salt in the soil, including those from fertilizers, becomes too high, the roots and later the plant tops are injured. As mentioned earlier, the majority of soluble salt problems originate from the improper use of fertilizers, or by using irrigation or municipal water high in salts.

Growing Media

Growing media can be formulated from a variety of components. These include peat, perlite, vermiculite, pine bark and others. Generally speaking these materials do not contain excessive quantities of soluble salts. However it is important to monitor the quality of media components carefully.

How To Treat a High Soil Soluble Salts Problem

1. The excess "soil salts" must be leached (washed) from the root zone. This can be done by overhead irrigation with three to four inches of water. For slight "salt" problems, maintain good, uniform soil moisture and avoid drought conditions by irrigation to supplement rainfall; this will gradually eliminate the problem as plants assimilate nutrient portions of the salts.
2. In some cases, banded fertilizers can be dispersed by shallow cultivation.

Leaching Sodium with Lime (Calcium)

There has been great success in Florida on golf course turf using 5 - 10 # per acre of hydrated lime to alleviate the sodium-tissue drying effects of salt water intrusion. The calcium has 2 positive charges. Sodium only has one. One calcium can leach out two sodium ions bound on exchange sites in the soil. In Florida, they are finding great improvement in quality of the turf due to both leaching of the sodium and the plant utilization of the calcium. This technique can be used in other situations where the salt index is high.