AGRONOMY

Managing Saline & Alkaline Soil: Soil Diagnosis

Managing saline and alkaline soil requires monitoring the salinity content in both the irrigation water and soil. In the 'Managing Saline & Alkaline Soil: Irrigation Water Quality' bulletin we discuss the measurements of water quality that impact the soil and crop growth. In this bulletin, we will discuss the analysis of soils as it relates to determining salt concentration and salt type.

Salt Concentration: Total Soluble Salts

As the salt concentration in the soil increases, plants must exert increasingly more effort to extract water from the soil. At some point, the soil will hold onto the water more tightly than the plant roots can extract it. As a result, the soil's ability to supply usable moisture is reduced. If the salt concentration continues to increase, drought conditions will occur.

Total soluble salt is usually reported as electrical conductivity. As the salt load in the soil increases, the value for electrical conductivity will also increase. Typically, AgSource Laboratories performs two different tests. The first test is a fast and simple procedure. A slurry of soil is made using a 1:1 ratio of soil to water. This procedure is best for determining if the soil has a high salt concentration and monitoring its level from one year to the next. It answers the question, "Is the salt concentration increasing or decreasing over time?"

The second test is the saturated-paste method. This involves adding only enough water to saturate the soil. A coarsely textured soil will need less water than a heavy clay. As a result, this method is more "truly" calibrated to the salt concentration encountered by plant roots. Therefore, the saturated-paste method is best for determining potential crop injury.

When looking at interpretations of salt concentrations in the soil, it is important to know which method is being used. Many tables will only state the salt concentration without stipulating the method. As you can see in the table below, the 1:1 Slurry values are less than half of values under Saturation Paste method.

Slurry 1:1 Extract (mmhos/cm)	Saturation Paste ECe (mmhos/cm)	Saline Classification
0.01 to 0.45	0.01 to 2.00	Salt sensitive plants can be grown
0.46 to 1.50	2.01 to 4.00	Sensitive plants can be affected
1.51 to 2.90	4.01 to 8.00	Medium tolerant plants can be affected
2.91 to 8.50	8.01 to 16.00	Most plants will be affected
> 8.50	> 16.00	Severe saline conditions

Salt-concentration tolerances, based on saturated-paste method, for commonly grown crops based on maximum acceptable yield losses are shown below:

Maximum Acceptable Yield Loss

Crop	0%	10%	25%	50%	100%
	Maximum ECe Concentration (mmhos/cm)				
Bermuda grass	6.9	8.5	10.8	14.7	22.5
Barley	8.0	10.0	13.0	18.0	28.0
Alfalfa	2.0	3.4	5.4	8.8	15.5
Corn	1.7	2.5	3.8	5.9	10.0
Soybeans	1.0	1.5	2.3	3.6	6.5
Wheat	6.0	7.4	9.5	13.0	20.0
Oranges	1.7	2.3	3.2	4.8	8.0
Grapes	1.5	2.5	4.1	6.7	12.0

Note: Salt tolerance is much less during germination for many salt-tolerant crops. Salt-tolerant crops require ECe less than 3.0 mmhos/cm during germination.

This table of maximum salt concentrations and corresponding yield losses assumes average soil moisture conditions are maintained throughout the growing season. If soil moisture conditions are higher than average, yield loss will be less than that stated in the table. On the other hand, as soil dries out, salt concentration increases along with salt injury. On average, salt concentration doubles as the soil dries from saturation to field capacity. It doubles again as it dries to wilting point. For example, a saturated-paste salt concentration of 3.0 mmhos/cm would be about 6.0 mmhos/cm at field capacity and 12.0 mmhos/cm at permanent wilting point.

Type of Salt

The three main soil salts are are calcium, magnesium, and sodium in combination with chloride, sulfate, and bicarbonate. The most important salt is sodium because of its potential to destroy soil structure and reduce water infiltration. As the proportion of sodium absorbed in the clay increases, the soil tends to disperse or "run together," bringing about reduced rates of water penetration. However, soil sodium alone provides little information about the potential effect on soil structure and water infiltration. The dangers of soil sodium are best expressed as a ratio to calcium plus magnesium. Based on this concept, the sodium absorption ratio (SAR) was developed to express the soil sodium danger. SAR above 15 is expected to be more of a problem for a heavy textured soil versus a sandy soil because heavy textured soils have low infiltration rates under good conditions.

Soil boron concentrations are rather low in comparison to the other salts, but are important to mention from a toxicity standpoint. Soil boron concentrations below 0.7 ppm are safe for sensitive plants, 0.7 to 1.5 ppm is marginal, and more than 1.5 ppm is toxic to many crops.

Conclusion

Soil salinity and alkalinity are best managed by knowing soil salt concentrations and salt type. Interpretation tables for salt concentration and salt type are based on the saturated-paste extract. Soil salinity ECe values less than 2.0 mmhos/cm are safe for most crops. With ECe values above 2.0 mmhos/cm, yield loss is highly crop specific depending on crop-salt sensitivity. Salts that contain sodium are dangerous to soil structure and water infiltration. The ratio of sodium to calcium plus magnesium (SAR) reflects the true soil-sodium danger. Soil with SAR above 15 is prone to drainage problems.