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Department of Agronomy

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EFFECT OF FERTILIZER SALTS ON CROP PRODUCTION

V. P. Evangelou

Soil consists largely of mineral and organic matter, air, and water. Plants obtain nutrients from mineral and organic matter, oxygen from air, and they use water as a carrier of nutrients from the soil into the root and to the above ground portion of plants.

Since soil water functions as a carrier of nutrients from solid fractions of soil into and through plants, it plays a very important role in plant nutrition. Because of this importance, correct chemical balance of the soil solution is necessary for best crop performance. This means that pH of the solution should be in the range 6.0 to 6.6 and the solution should not contain high concentrations of dissolved solid materials (salts).

Excessive fertilization with very soluble forms of fertilizer can sometimes increase the total concentration of dissolved solids in the soil solution, thereby adversely affecting plant growth and development. However, soluble fertilizers differ in the degree to which they contribute to increasing salt content of the soil solution. The following materials are shown, ranked from those which can cause the greatest salt problems, progressively to those which are less of a problem: sodium chloride > potassium chloride > ammonium nitrate > potassium nitrate > ammonium sulfate > calcium nitrate > potassium sulfate > anhydrous ammonia.

When does a salt problem occur

A salt problem can occur under high fertility programs when large amounts of soluble fertilizers are added during seeding. If rainfall is insufficient to leach some of these soluble fertilizers from the rooting zone of the newly developing seedlings, plant damage due to salt toxicities will take place, or plants will be severely stunted.

Another type of salt problem that may take place is accumulation of salts at the soil surface as a result of surface evaporation of soil moisture. Also, salts can accumulate at the surface from surface disposal of salt brines from oil wells. The latter two types of salt problems have been observed in some fields in western Kentucky.

What type of soils are most sensitive to salts

Soils react to salts differently, depending on their chemistry and texture. For example, a large application of potassium chloride to a clay soil will not have as much of a salt effect as if applied to a sandy soil. The reason is that the sandy soil has less fertilizer adsorption capacity and less water holding capacity. The end result is a greater salt concentration in solution in the sandy soil.

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How are salts measured

Salts in soil solution are measured by the "Saturation Extract Test". The test consists of taking a small amount of soil and slowly adding water until a paste is formed. The water is extracted by vacuum and is then tested for its electrical conductance (EC). The EC is a measure of the ability of the soil solution to conduct electrical current. This is directly related to the amount of salt in the soil solution. (The more salt, the higher the electrical conductivity). The units used to measure EC are millimhos/cm.

Kentucky soils normally test around 0.5 millimhos/cm following normal rates of fertilizer applications. With heavy applications of nitrogen and potassium (greater than 200 lbs/Acre of N and 200 lbs/Acre of K_2O), values may exceed 2 millimhos/cm. If, under normal fertilizer applications, values still exceed 2 millimhos/cm, there is likelihood of natural contamination, and the contaminant will most likely be sodium. This has been observed in river bottoms of western Kentucky.

Under normal soil conditions in Kentucky the crop most likely to incur salinity problems is tobacco, due to large amounts of fertilizer added just ahead of transplanting. For example, rates such as 800 lbs of NH_4NO_3 and 400 lbs of K_2O per acre may cause a salinity problem, especially if rainfall is limited during transplanting. Such rates of fertilizer additions may cause EC values in the upper 3 inches of the soil to vary anywhere from 4 millimhos/cm to 7 millimhos/cm, depending on soil texture and chemistry. These values of electrical conductance are well within the range at which salts affect plant growth. Fertilizer salt problems in tobacco have been observed, but detailed measurements have not yet been made. Salt problems and their effect on agricultural crops are highly dependent on the source of salt and crop being grown. The following table shows the relationship between salt concentration (expressed as EC) and reduction of crop yields.

Table 1. Salinity tolerance levels for different crops.

Crop	Expected Yield Reduction			
	0%	10%	25%	50%
Barley	8.0	10	13	18
Wheat	6.0	7.4	9.5	13
Soybean	5.0	5.5	6.2	7.5
Clovers: Alsike, Ladino, Red	1.5	2.3	3.6	5.7
Corn	1.7	2.5	3.8	5.9
Tall Fescue	3.9	5.8	8.6	13.3
Alfalfa	2.0	3.4	5.4	8.8
Vetch	3.0	3.9	5.3	7.6