Manure Produces Poor Aeration

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The use of organic matter, particularly manure, is very likely the direct cause of troubles encountered on heavily watered soils. Some growers have had excellent results with automatic watering methods while others have had a succession of poor crops using the same methods.

The explanations of these differences have usually centered around the soil type used. Many growers felt that sand was best while others advocated clay. Excellent results have been obtained on all soil types by various growers, so this explanation must be ruled out. The adjustment of the water table in the soil has been picked out by some growers as a source of trouble. Undoubtedly, this is a factor in explaining the variable results achieved with constant water level watering methods, but it is not the complete answer.

To get at the whole story it is necessary to review some previous soil practices and see the factors which have changed.

Most crops were formerly grown on the "dry-side," or dried considerably between waterings, in the belief that plants were thus forced to flower earlier. Roses were even "dried off" or dug and refrigerated. In addition to a semi-dry soil, the average grower made use of manure, both mixed with soil and as a mulch. This added organic matter increased the water holding capacity of the soil, prevented rapid evaporation of water from the soil surface and protected the soil from the force of hose watering. Organic matter thus tended to minimize any injury to the plants caused by infrequent watering. In addition, manure built up an active soil bacterial population which improved or preserved the aggregation of the soil allowing free water movement through it.

In the soil described, poor aeration would rarely limit root growth since many soil pores were filled with air in the absence of large amounts of water.

If large quantities of water are added, most of the soil pores are filled with water. Air movement into the soil is restricted by films of water connecting adjacent soil particles.

The soil bacteria derive their energy by decomposing the organic materials present. The added water has dissolved more food and this multiplication rate increases. With an increasing bacterial population this demand for oxygen increases and they quickly deplete the already limited supply of oxygen in the soil and rapidly utilize any that may diffuse in from the soil surface.

As oxygen becomes limiting, the kinds of bacteria shift from those using oxygen (aerobic) to those existing without oxygen (anaerobic). These anaerobic forms of bacteria obtain energy by reducing chemical elements to lower valence forms. Thus ferric iron is reduced to more soluble ferrous iron, manganic ions are reduced to manganous ions, nitrates are reduced to ammonia while carbon compounds are reduced to methane, or marsh gas, and various aldehydes. These reduced elements are in themselves toxic to plant roots.

The addition of large amounts of water to soils containing quantities of organic matter may, therefore, cause injury to growing plants because:

(1) The water excludes air from the soil.
(2) The bacteria are stimulated to more rapid growth and utilize more oxygen.
(3) The soil bacteria, when deficient in oxygen, will reduce various elements in the soil to more toxic forms.

The above discussion paints a rather dismal picture of conditions in the soil but is, of course, an extreme case. Probably in practice this occurs to varying lesser degrees depending on the method of water application and the rates. In many cases, the oxygen is only limited for a short time and reduction of soil elements has not gone to completion, yet it is entirely possible that some injury has occurred to plant roots. There may be no obvious symptoms yet growth may be reduced with time or a light chlorosis appear due to unhealthy root conditions.

The conditions described can be largely eliminated if a few simple rules are followed.

(1) Avoid organic fertilizers and easily decomposed mulches. This will prevent the growth of a large bacterial population due to the shortage of energy yielding material.

(2) Keep the pH down. A low pH, about 5, will tend to repress the bacterial growth. Most crops will grow well at this pH if the soil does not contain excessive iron or manganese.

Soil porosity can be maintained by incorporation of acid peat with the soil while an acid peat mulch will protect the soil from rapid evaporation, aggregate dispersion, and rapid salt accumulation at the surface.

We cannot combine the features of two methods of soil management and expect to get good results. Manure mulches were excellent when the soils were run dry. Most growers now apply plenty of water in order to get long stem roses, high quality mums, and eliminate leaf drop of poinsettias and blasting of lilies. When manure is combined with heavy watering, a decrease in soil aeration is sure to follow with subsequent root injury and decrease in yield.

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