SOIL FUMIGATION FOR NEMATODE CONTROL

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In the development of control measures for plant parasitic nematodes the problem has been approached from various directions. Among these are cultural practices (e.g. crop rotation and organic manuring), physical methods (e.g. hot water treatment, steam sterilization, clean fallow, flooding), exclusion (e.g. certification, quarantine, sanitation), biological control (e.g. trapping crops, parasitic organisms, predaceous organisms), host resistance, and chemical control (e.g. root dips and soil fumigation). Selection of the best control measure for any given problem depends on the effectiveness of the method and the amount of reduction of economic loss resulting from its use.

Today, we shall consider soil fumigation as a method for controlling plant parasitic nematodes. Soil fumigation is a costly control measure at best and, to be effective, a fairly strict set of conditions are required. Anyone interested in fumigation should have a clear understanding of the factors affecting movement of fumigants in the soil.

We normally think of soil as being made up of mineral particles (sand, silt and clay), organic matter, organisms, water, and air. If we consider the gaseous phase we find that soil is made up of a large number of interconnecting air spaces which may be represented here as pores. The inner portion of a pore is filled with air, this being surrounded by a film of water which is in contact with the soil particles.

A fumigant, when injected as a liquid into the soil, evaporates and individual molecules of the material move outward through the pores in a random direction. These molecules travel most rapidly through the air spaces. However, many of the molecules are absorbed by the water film. Movement of molecules through the water film occurs at a slower rate than it does through the air spaces.

An equilibrium is reached between the number of molecules in the air space and the number of molecules in the water film, this depending on the kind of fumigant. Thus, a material such as DCP has approximately 15 molecules of material in the soil air per 100 molecules in the soil water. Conversely, methyl bromide has approximately 90 molecules in the soil air per 100 molecules in the soil water. From this relationship it is easy to see why methyl bromide moves through the soil at a faster rate than does DCP.

A number of factors affect the rate of diffusion of a fumigant through the soil, these being soil type, soil moisture, soil temperature, soil compaction and organic matter.

1. Soil type. -- Fumigants move through sandy soils more readily than through clay soils. At first this appears to be a contradiction since the total volume of air space is greater in clay than in sand. However, when

clay soil is moist a large number of the interconnecting passages are plugged with water and this slows the rate of movement of a fumigant through the soil.

2. Soil moisture, -- When soils are dry fumigants diffuse rapidly through the soil and escape before their job is done. Diffusion in soils at approximately field capacity is sufficienty slow so that the chemical reaches concentrations in the soil water which are high enough to kill nematodes and yet the chemical can still diffuse readily throughout the soil. The water content of the soil is high, many of the soil pores become plugged and diffusion is exceedingly slow.

3. Soil temperature, -- Soil fumigants should be applied when soil temperatures range from about 50°F. to 70°F. At temperatures less than 50°F. the tendency for fumigants to vaporize in the soil is decreased and the rate of movement through the soil is decreased. Where temperatures exceed 80°F. the fumigant moves through the soil air so rapidly that the material does not reach killing concentrations in the soil water.

4. Compaction, -- For best results a soil should be loose and friable. Pore spaces in compacted soils are so small that fumigants do not move well through them. Here also the pores tend to become full of water and barriers to passage of the material are formed.

However, compaction of the soil surface following injection of the fumigant tends to hold the material in the soil for longer periods and thus has a beneficial effect.

5. Organic matter, -- Organic matter may affect the efficiency of a fumigant in several ways. Undecomposed roots may harbor endoparasitic nematodes and serve as a barrier to the fumigant. Organic matter may absorb the material, preventing its movement through the soil. Undecomposed straw may provide openings in the soil surface which greatly increase escape of the gaseous material from the soil.

Placement of a fumigant in the soil is also important. The recommended depth of placement for chisel applicators is from 6" to 8". If the material is placed at a depth less than 6" the fumigant will not diffuse deep enough into the soil for adequate control. Should the material be placed at depths exceeding 10" adequate control will not be accomplished in the surface layers of soil.

Width of placement, i.e. distance between chisels, is also important. When chisels are greater than 12" apart horizontal coverage will not be complete.