Soil Microorganisms and Preventive Fungicide Programs—What are the Interactions?

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Soil is far more influencial in turfgrass management than its most obvious function as a root anchoring medium. Soils often appear to be an inactive mass because the greatest proportion of the inhabiting organisms are too small to be seen with the naked eye. The actual amount of growth that occurs from the vast array of soil organisms (Table 1) is staggering. The greatest portion of the soil organisms are members of the plant kingdom.

Under fertile soil conditions normally associated with the growth of turfgrasses, bacteria may account for one ton or more of live weight in the active root zone. The combined live weight of fungi and actinomycetes is about half that of the bacteria.

More extensive populations of microorganisms are observed in turfgrass soils, than where soil is cultivated for crops. The greater populations have been attributed to the much larger root mass under sod conditions. A strong association and interdependence exists between higher plants and microorganisms. For the most part these organisms are in the immediate vicinity of the plant roots, a zone that is often referred to as the rhizosphere.

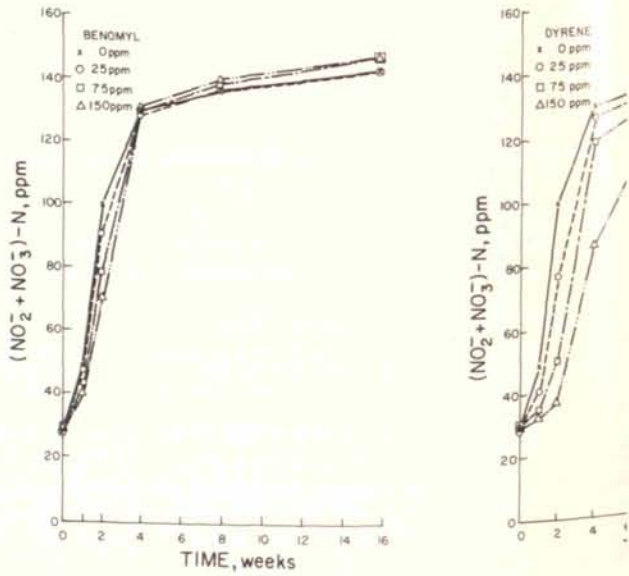
When the word microorganism is used, most think first of the no-see-ums that caused last winter's Hong Kong flu or the *pythium blight* on the ninth green. However, the vast majority of the microorganisms that turf managers deal with are not of the pathogenic or disease-producing type. In general most of these organisms play an important role in decomposition of organic matter residues, improvement of soil physical properties, and increased nutrient availability.

Decomposition of organic residues directly influences soil physical properties and nutrient availability as well as limiting the accumulation of organic debris called thatch. In the undisturbed soil system the breakdown of organic matter often includes the activities of several groups of soil inhabiting plants as well as animals. The rate of decomposition is dependent on the chemical

Table 1. Organisms Commonly Present in Soils.

PLANTS	Bacteria	**ANIMALS**	micro: Protozoa, Rotifers, Nematodes
	Actinomycetes		
	Fungi		macro: Mammals, Insects, Earthworms, Slugs and snails, Mites, Spiders, Millipedes and centipedes
	Algae		
	Roots of higher plants		

Figure 2. Effect of various rates of application of benomyl, Dyrene, and maneb and time on NO_3 concentrations in soil; laboratory application.



nature of the organic substance and climatic factors. Materials which have high percentages of lignin will require primary digestion into smaller sized particles by soil animals such as earthworms. The smaller molecules can then be more rapidly decomposed by actinomycetes, fungi, and bacteria. Where pesticide applications have suppressed or destroyed the activities of one or more of the members of the system, thatch accumulation has often been a persistant problem.

The breakdown products of organic matter decomposition provide the sticky materials and humus that improve aggregation and soil physical properties. These reactions also result in a release of normally unavailable nutrients such as phosphous which is often held in organic combinations or insoluble forms. Organic complexities that form during the decomposition processes also keep metals like iron and manganese available for plant growth.

Controlled release fertilizers which release nitrogen as NH_4^+ rather than NO_3^- are commonly used on turfgrasses. As NO_3^- is the predominate source of nitrogen for turfgrass growth. Any interference in the transformation of NH_4^+ to NO_3^- (Figure 1) has a detrimental effect on turfgrass nutrition. Since the nitrifying organisms have shown a marked sensitivity to several turfgrass fungicides, studies were initiated to investigate the effect of repeated applications of the commonly used fungicides Benomyl, Dyrene and Maneb on these organisms.

Maneb when incubated in soil under laboratory conditions had a pronounced effect on nitrification and essentially blocked the conversion of NH_4^+ to NO_3^- in soil for extended periods particularly at higher concentrations (Figure 2). Dyrene had some inhibitory effects on nitrification that were dissipated almost completely with time (Figure 2). As can be observed in Figure 2, Benomyl had very little influence on the rates at which NO_3^- accumulated in soil samples.

When 14 weekly applications of these fungicides at rates of 3 ounces per 1,000 square feet were applied to Penncross creeping bentgrass field plots, none of the previously observed inhibitory influences were noted (Figure 3). In fact all of the fungicide treated soils generally showed greater accumulations of NO_3^- and an enhancement of mineralization. The greater amounts of mineralized nitrogen observed in treated soils were attributed to the fungicide molecules as Benomyl, Dyrene and Maneb contain 19.3, 20.2 and 10.5% nitrogen respectively. Unlike laboratory incubations, the fungicides were rapidly degraded under field conditions, which accounts for the additional NO_3^- that was observed. The weekly application of fungicides did not accumulate to toxic levels and even appeared to result in an increase in the organisms involved in the degradation of the fungicides. In summary, these fungicides did not appear to have any adverse effect on the soil nitrogen system of golf putting greens when employed for extended periods in preventive spray programs.

Figure 1. Mineralization of Soil Organic Matter

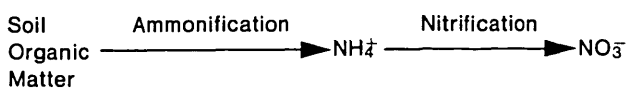


Figure 3. Effect of benomyl, Dyrene, and maneb and time on NO_3 in soil; field application.