EFFECTS OF PESTICIDES ON SOIL FERTILITY

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Agriculture is directly dependent upon certain microbiological processes which build and maintain soil fertility. Essential to fertility is nitrogen, which for the most part enters the soil in forms not directly usable by plants. Nitrification, the conversion of nitrogen into nitrates, the nitrogen form preferred by plants, is carried out by only a limited group of soil microorganisms.

In relation to this, addition of new pesticides to soil involves certain risks. Even small changes in the chemical structure of compounds can change their biological effects greatly and unpredictably. An example is the common herbicide 2,4-D, which breaks down quite rapidly in soil as the microbial population utilizes it for nutrition. However, adding only a single additional chlorine molecule, forming the compound 2,4,5-T, results in an herbicide which will resist decomposition in soil for prolonged periods. Similarly, pesticides added to soil may prove to have unexpected resistance to degradation, or have toxic effects on plants or soil microorganisms such as the nitrifying bacteria.

The Department of Bacteriology, in cooperation with the Department of Entomology, has been investigating the effects of the organophosphate group of insecticides on soil nitrification. Also included in the study have been a limited number of carbamate insecticides which have a similar mode of action. These insecticides are widely used in agriculture, where they are replacing the chlorinated hydrocarbon insecticides (e.g., DDT, aldrin, etc.) for many uses. They tend to be less persistent in soils and not as prone to accumulate in animal tissues. Some 15 insecticides have been tested to date.

No important harmful effects on soil nitrification were observed when the insecticides are applied at normal application rates. However, a substantial number of the insecticides inhibited nitrification at 50 ppm, which is somewhat above normal rates of application. Many of the tested insecticides proved extremely toxic to nitrifying bacteria when applied at very high levels of about 500 ppm. The toxic effect also proved persistent for at least 30 days in several instances. It is evident that toxic levels of these insecticides could accumulate through repeated or careless applications. Effects of the more toxic of the insecticides are currently being investigated in more detail and their persistence in the soil determined.

Another aspect of soil fertility in which microorganisms are intimately involved is nitrogen fixation from the atmosphere by leguminous crops. The site of nitrogen fixation is at nodules which are formed on the plant roots in response to infection of the root hairs by the **Rhizobium** bacteria

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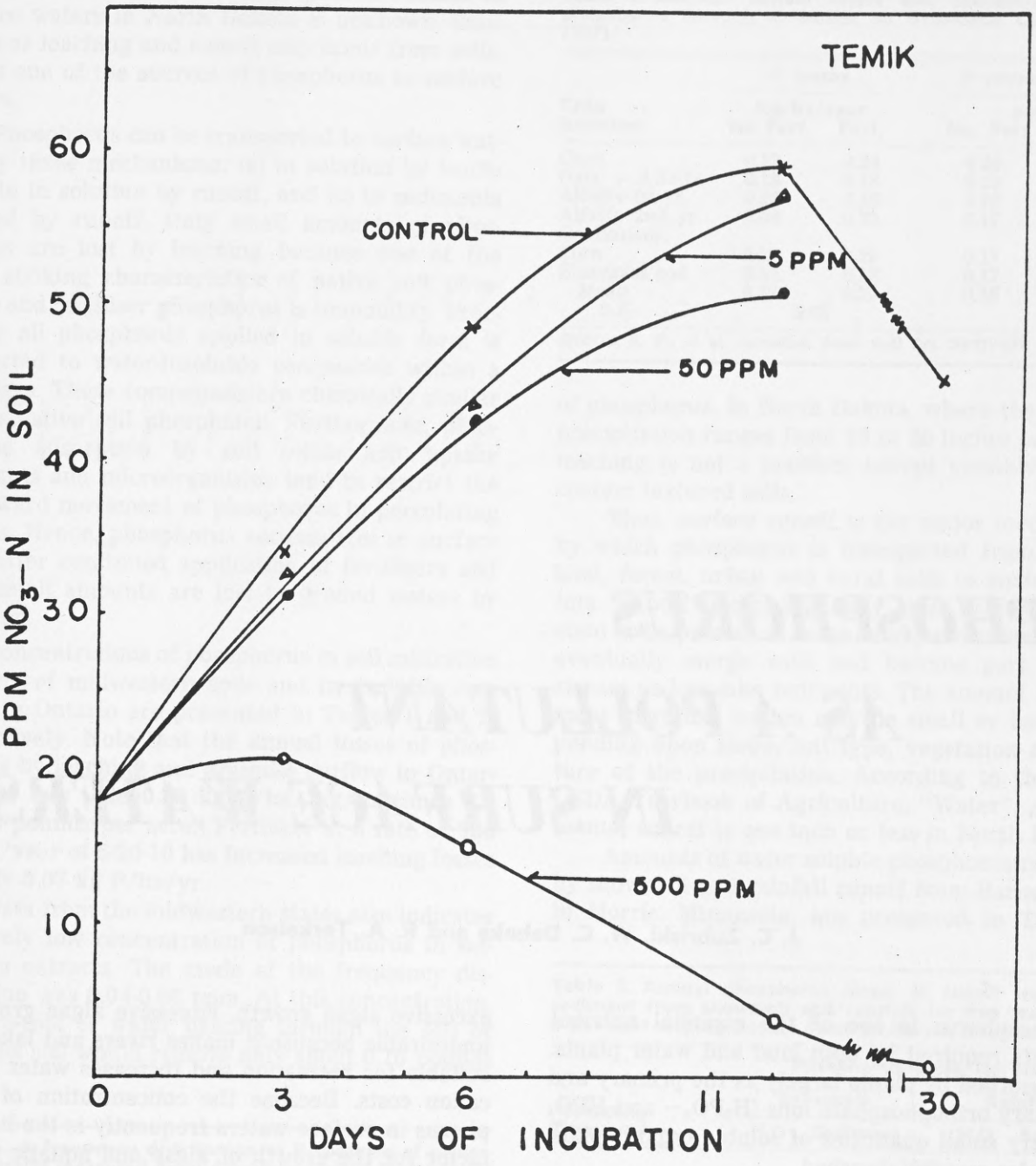

Figure 9. The effect of Temik on nitrification in soil.

of the soil. Toxicity of the insecticides to these bacteria has been tested in pure culture studies. The majority were found to be toxic to these bacteria to some degree.

Greenhouse experiments also were conducted with alfalfa and sweet clover legumes. The investigation centered on the effect of various concentrations of the test insecticides on the nodulation and growth of these plants.

No significant growth or nodulation inhibition was shown at normal field rate applications. Applications at higher rates often resulted in poor plant growth and formation of fewer nodules.

Experiments to date have shown that none of the insecticides tested showed evidence of toxicity at normal field rate applications for nitrification or for legume growth. However, potential toxicity arising from careless application or accumulation is possible. Work is continuing in this area with detailed studies of the more toxic insecticides and further surveys will be made with other insecticides.