The Natural Process for Cleansing Soils of Unwanted Entities

Were it not for nature's ability to biodegrade or mineralize unwanted substances in soils, there would be no room left for you and me. And were it not for nature's ability to destroy soilborne plant pathogens, we could grow very little food and fiber except with more chemicals. We have disease-conducive soils and disease-suppressive soils, and only nature seems to know why.

How does nature accomplish this enormous task, that others may enjoy nature's world? Nature has strange ways, some even devious and some very simple, her method for destroying soilborne plant pathogens being an example. During this process, nature also destroys diesel in fuel spills, hazardous chemicals, wood preservatives designed to thwart the wood-rotting fungi, and even the highly chlorinated biphenyls used in industry for the past 30 years.

Back in the early 1940s, J. A. Pinckard and his associate, Oliver Leonard, now deceased, asked themselves how nature controlled soilborne plant pathogens. They published a 3-year replicated randomized field study demonstrating that composted alfalfa hay suppressed the Fusarium wilt–nematode disease of cotton, while other composts failed (1). Their sponsor, Mississippi Agricultural Experiment Station Director Clarence Dorman, suddenly passed away. The incoming director could find no value in their research and, assuming them to be organic extremists, terminated their financial support. Both Pinckard and Leonard found jobs elsewhere. It was years before Pinckard could revive the project, which has been done on his own personal funds, it being a problem that "bugged" him for years.

Now we have learned, for example, that if the common soil microbiota are enriched with a high nitrogen-to-carbon ratio humus, not inorganic plant foods, and not just any compost of yard debris, the microflora of the soil will increase in numbers and kinds by millions of bacteria per gram of substrate. We have learned that this microflora is capable of biodegrading or mineralizing almost anything of an organic nature if given time, moisture, and oxygen. And in many cases, bioremediation of a soil may be accomplished without oxygen (U.S. Patents 5,005,345 issued 9 August 1991, 5,100,455 issued 31 March 1992, and 5,395,535 issued 7 March 1995 to J. A. Pinckard).

If one makes a simple compost of alfalfa hay or of cotton gin trash, which is also high in nitrogen, there is sufficient organic nitrogen in either material to enrich the natural microbiota on the contaminating field soil enough to start a mixed culture growing after it is moistened with water. We have observed that when either material was mixed with water to make a water culture, the first microorganisms to appear were a few bacteria. Within 16 h, very small protozoa began feeding on the bacteria. After 24 to 36 h, the protozoa and bacteria increased in both numbers and kinds. Microscopic observations revealed numerous spores of fungi, some germinating. Many fungi were identifiable by their morphology and opportunistic nature. By planting cottonseed or sugar beets in the composting gin trash (obtained from different gins), several soilborne plant pathogens could be easily isolated; *Rhizoctonia solani, Fusarium,* and *Pythium* being familiar examples. (*R. solani* proved to be a useful test organism.) After a week or two, a few nematodes were observed hatching. The opportunistic fungi were replaced by the more stable Basidiomycetes, *Coprinus* being an example. The bacterial and protozoa counts increased to hundreds of millions per gram of substrate, as did the protozoa.

After 5 to 6 weeks, there were drastic changes in the microflora. Almost all of the protozoa disappeared, while the bacteria, including the Actinomycetes, increased to more than a billion per gram of substrate. The fungi, including *R. solani* and presumably other pathogens, disappeared. *R. solani* could not be reestablished in the high nitrogen-to-carbon ratio substrates for nearly 3 years afterward. While this observation is not unusual in the technical literature of phytopathology, what was unusual were the clean, paper white roots of the sturdy seedlings that could be grown in the high-nitrogen humic soil mixes. Plant roots seemed immune to nature's oxidizing microflora. Also unusual was the biodegradation of toxaphene and DDT present in some of the old cotton field soils contaminating the gin trash. We should emphasize that old cotton field soils contain many residues of previously applied chemicals and that their microbiota have apparently become adapted accordingly and are extremely variable.

In these days of heavy emphasis on soil bioremediation and "environmental protection," we find it surprising that environmental regulators have made so little use of indigenous soil microbiota for soil bioremediation. For example, we are now using the information once spurned and a high nitrogen-to-carbon ratio humic polymer to cleanse soils for small chemical companies that cannot afford to send their contaminated soils and ground drumming shed concrete floors to approved incinerators. Furthermore, soils cleansed by this process may be used in landscaping and horticulture and need not be disposed of in dumps and landfills.

Shortly after the discovery of synthetic fertilizers, composts received a bad name; they not only were competitive to the new synthetic product but also failed to live up to exaggerated claims of controlling diseases. The research director who terminated Pinckard and Leonard's investigation assumed he was only protecting the growers from organic extremists, of which there were many. It was not the compost that was suppressing disease; it was the high-nitrogen enrichment encouraging the soil's microbiota that suppressed disease and biodegraded unwanted entities in soil.

If we are ever to develop a sustainable agriculture or cleanse our soils of unwanted entities, it will be accomplished only with the help of natural processes. Plant pathologists are far more knowledgeable in this field of soil microbial ecology than are the engineers, chemists, and attorneys being employed by environmental regulators.

It seems the above information is not readily known or understood by professionals and the public alike.

LITERATURE CITED

1. Pinckard, J. A., and Leonard, O. A. 1944. Influence of certain soil amendments on the yield of cotton affected by the *Fusarium-Heterodera* complex. J. Am. Soc. Agron. 36:829-843.

J. A. Pinckard
150 Pleasant Creek Road
Rogue River, OR 97537

R. G. Davis
P.O. Box 40
Avon, MS 38723-0040

P. B. Richey
P.O. Box 3246
Sonora, CA 95370-3246

Publication no. D-1996-0708-04O