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Complexity and Charade in the World of Soil Microbes: A Plea for Balance

Many growers today are discovering a new awareness of microbes in soils and composts. They are putting these new ideas to work in examining compost-microbe relationships and treating composts and plants. I view these developments as generally positive. It is leading to an enhanced appreciation of the role of microorganisms in the environment. However, the way in which many persons are simplifying, popularizing and commercializing this new view raises big questions. For biodynamic growers the new approach poses a dual dilemma: commercializing on an extrapolation of nature's bounty, and reducing and totally materializing agents – the microbes – that largely operate from the periphery – as I will shortly try to explain. How well do we know what we are doing? I am worried that quite possibly, very impractical and costly attempts to manipulate soil or compost microbes are underway, possibly doomed to fail. More than this, the mental and emotional cost of the human effort expended in rushing off to extremes is inestimable.

Studies in my laboratory clearly support the notion that it is a mistake to ignore microbes in soil and composts. This, by the way, is very easy to say. What is very difficult is finding out how to notice (and do something about) microbes. Certainly, I believe that by overlooking the significance of microbes, modern farming and horticulture often excuse practices that are destructive to long-term fertility. In the worst cases, misunderstanding and mishandling of practices that have microbial ramifications can lead to the emergence of dangerous pathogen problems in soils, plants and animals. By the same token, the opposite may not be true: that is, we shouldn't leap at the idea that it is "time to start manipulating microbes"!

One of the first problems is extrapolation; the practice of taking a fact of microbial ecology (usually from a field outside the one in focus) and using it to propose full-scale 'managing' of soils and composts, as in a kind of recipe. This is not just totally experimental and premature, it may be instantly incorrect. Why do I say this? For over ten years, my lab has studied compost extracts for microbial properties. For six years, I managed a joint venture in Germany with AUC-Agrar Umwelt, which included one of Europe's leading compost microbiologists – Dr. Traenkner – one of the original researchers in the field of compost teas. Additionally, with our own staff scientist, Dr. Mary Droffner, a recognized bacteriologist, I have spent six years researching microbial bio-diversity of composts and compost extracts using modern phenotypic characterization methods. It was the sheer wonder in the complexity of the microbial world that kept us going. These and other efforts – many of which we have presented in published form – led to a surprising experience of the ultimate chicken/egg phenomena. We often found we couldn't tell where cause ended and effect began. For example, the ratio of fungi to bacteria in compost and soil changes dramatically over small spatial distances and in short periods of time, depending on moisture, stress and heat. Beware of a simplified scheme to form judgments from this observation, or still more dangerously, to assume it can be interpreted to explain which composts are right for specific situations! I have gone up and down the shelves of scientific literature and spoken with experienced growers, and have found no single published paper or experience that appears to support this approach.

I offer a case in point. Mary Droffner studied the addition of select microbes to a variety of compost systems. In most cases, the only remarkable feature she found was the rapidity with which the introduced species died off. One could start with apparently ideal consortia of organisms, and eight-tenths of them would perish almost immediately after introduction. What seemed clear here was that the pre-existing stability of the microbial system into which we were trying to introduce species was what we needed to appreciate. In another replicated study lasting four months, the longest survival period for a species introduced to active compost was about three days! (In actuality, a few species vanished for several weeks, and then re-appeared later.) Droffner also found along the way that the manner in which we divide organisms into mesophilic and thermophilic groups is unrealistic; each to a certain extent mimics the other, crossing any strict temperature boundaries.

There are, of course, instances of success with microbial inoculation, such as Dr. Harry Hoitink's work at Ohio State University with specific microbe strains added after active composting had ceased. In Belgium, work is underway to see how and to what extent soil amendments can be universally changed to make them more disease suppressive. To date, this effort led by microbiologist Dr. Matthew Krause is revealing how enormously complex – and costly – breakthroughs in this microbial-dynamic arena will be.

The lesson in all this is simple: there are very good – not

bad – reasons that microbes tend to frustrate our efforts. For every soil and compost system, within the context of its constituents, a truly unique set of adapted microbes exists. Their numbers and ratios are virtually an emergent property of the entire system. For the most part we don't understand how individual factors work in setting the stage for microbial events, certainly not well enough to say that one approach will work above others. This is to say nothing about the technical challenges in accurately estimating microbial community size and variability with existing test methods, which Dunbar (2002) recently outlined. Recent papers by European microbiologists Girvan et al. (2003) and Sessitsch (2001) reveal the significance of intrinsic microbial stability very clearly. The UK group under Girvan has demonstrated that the physical soil environment, including its particle distribution and soil typology, exercises an astonishingly dominant role on the microbe community structure. Even when the Austrian group under Sessitsch examined microbial effects of fertilizers, including organic management, over several years, the overwhelming result was that species and diversity variation depended more on soil particle fractions than on organic practices. This is important to appreciate and not to be disappointed about. Perhaps this is the reason why the word *terroir* has such coinage. The landscape and the geological history, including soil formation and type, influence the qualities of the grapes and the wine produced therefrom, enough perhaps to dominate effects for centuries. This and other facts, of course, make it harder to accept stupendous claims regarding temporal methods and microbe brews and what they may do for your soil.

If you look at the big picture about microorganisms, essentially we have only successfully characterized the medically significant microbes on the planet. This is one explanation for the statement we have all heard: namely, that human knowledge about microbes is tiny compared to the vast array of microbes that exist. There's a hidden physical point in the statement. Microbes constitute a tiny, tiny fraction of the earth's biomass. How small? About 99.98% of topsoil is not microbes (and that's only accounting for topsoil). The amount of biomass (microbial tissue) is so tiny in soil and compost that it is measured in parts per million! Dr. Pfeiffer tried to work it out decades ago, and from what I have gathered came up with the estimate that in each acre of soil there is a microbial mass equivalent to the mass of one cow. Pfeiffer by the way stressed very early that we look holistically at the entire soil and urged persons to recognize the natural load capacity of each soil. Regarding this cow per acre of microbes, one may imagine this is very significant, yet consider the actual mass: that is about 1,000 pounds of biomass in 1,000 tons of soil (or about 0.05%). In composts, it could be ten to twenty times higher, or about 0.1% – still a very small amount. The sheer mental challenge required to grasp the smallness of the microbe quantity begs the question of what their dynamic role really is in terms of managing soils, composts and growing crops. This does not mean they do not play a very important role, but microbes cannot deliver the moon. The enormous mass of the physical and chemical matter of soil and compost is their environment. This encompassing, nurturing environment largely shapes and governs their world, as the papers I cite above show. This is to say that the role of microbes is mediated largely by their environment. Instead of inoculating microbes to have an effect, we should be 'inoculating environments.' What this means is that by carefully minding the important physical and chemical features which dominate these soil and compost systems, the microbes will largely fall in line. In fact, I know they do – we have seen it again and again. The opposite is not true: one's compost or soil will surely not fall in line by treating it with microbes. The ludicrous view that one can 'fine-tune' a soil's microbes as though it is a car engine – a popular notion that has shown up in the press recently – will surely soon fall away. What I am proposing is no more surprising than to say that by being a good farmer, and tending the soil, crops and animals properly – staying within the sensorial, observable realm, and exercising restraint in soil fertilizing and physical manipulation – you end up with, presto, a healthy system. This, of course, we knew all along.

References

Droffner, M. and W. Brinton. 1994. Microbial approaches to the characterization of composting process. *Compost Sci. Util.* Vol. 2 (available at <www.woodsend.org>)

Droffner M. and W. Brinton. 1995. Evidence for the prominence of well characterized mesophilic bacteria in Thermophilic Composting Environments. *Biomass & Bioenergy* 8: 191-195.

Dunbar, J. et al. 2002. Empirical and theoretical bacterial diversity in four Arizona soils. *Appl. Env. Microbiol.* 68: 3035–3045.

Girvan, M et al. 2003. Soil type is the primary determinant of the composition of the total and active bacterial communities in arable soils. *Appl. Env. Microbiol.* 69: 1800–1809.

Pfeiffer. E. 1938 *Biodynamic Farming and Gardening.* NY: Anthroposophic Press.

Sessitsch, A. et al. 2001. Microbial population structures in soil particle size fractions of a long term fertilizer field experiment. *Appl. Env. Microbiol.* 67: 4215–4224.

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