NEW SENSE OF QUALITY COMES TO COMPOST

MOST PROJECT managers will be more than happy if their finished compost is brown, granular in texture, within safety standards, and doesn't smell too much. But this pragmatic viewpoint will likely be looked back upon in a few tomorrows as only the primitive beginning of what will by then be the artful science of commercial composting. "The composting industry is poised at the beginning of a new era where composts will be evaluated not just for safety, but for quality," says Will Brinton, founder and president of Woods End Research Laboratory, Mt. Vernon, Maine.

What does he mean by quality? "The ultimate value of a finished compost is its effect on plant life," he says. "The ultimate yardstick of quality is how well a compost nourishes plants and does not harm them, and enriches soil while possibly also suppressing soil-borne plant diseases."

For 10 years, Brinton has been defining and refining laboratory and field methods that measure and enhance this kind of compost quality. After Masters degree research comparing benefits of raw vs. composted manure, he spent a few years in Europe comparing organic and conventional farming, and then returned to New England, to found Woods End Laboratory and embark, in partnership with Dr. Robert Parnes, on a rather unique business as a soil consultant to agriculture stressing organic farming methods. In those days, both commercial and university soil labs generally did perfunctory analysis of the nitrogen, phosphorous and potassium in the soil (not necessarily what portion of these nutrients present were actually available to plants) and a pH reading for soil acidity. Their standard advice, even if their tests indicated ample NPK content, was more fertilizer.

In the not-so-distant future, compost making may well be as much an artful science as wine making.

"Despite all the evidence to the wastefulness of that practice, many labs are still doing it," says Brinton. He offered a much more detailed analysis, including organic matter content, its decomposition rate, a nutrient analysis of specific manures and composts applied, crumb structure of the soil, moisture retention capabilities, and other

Compost technician readies sample of disease inoculated potatoes to be inserted in compost windrow and tracked for destruction at Woods End Laboratory.

tests. "In fact what we finally ended up doing and are doing today, is what we call a nutrient budget for farmers rather than simple tests of soil samples from various fields. We try to give the farmer a comprehensive fertility picture that proper management can achieve, and what, if any, additional fertility might be needed to replenish nutrients lost when products are exported from the farm. We use soil tests mostly as a check for ourselves against our nutrient budget analysis. There's still way too much overuse of chemical fertilizers. Nebraska has become the first state to enact fertilizer use regulations, and I would not be surprised if some chemical fertilizers are banned or severely restricted after the turn of the century. We could be using more composted manure and composted urban wastes in place of at least a portion of the chemical fertilizers."

When landfill space became dear a few years ago, the crisis generated a dynamic new business for Brinton's agricultural testing service. The refinements he had perfected in soil testing were precisely what harried waste managers needed to solve problems in composting various carbonaceous wastes so they could be recycled rather than landfilled. As word got around that there was some firm in a little town of Mt. Vernon, Maine, which could compost everything from dead chickens to woolen mill waste, Woods End went into overdrive, acting as both consultants and testing lab to the commercial composting industry. Brinton and his staff (now seven in number) fine-tuned tests that measured stability or maturity of a compost in a way that gave indications as to its probable effect on plants. Information gleaned from testing also became more and more helpful in interpreting and predicting the success of a planned composting program.

TESTS FOR QUALITY COMPOST

Brinton lists the five principle tests he has found of great value in producing a measure of compost quality:

1. An oxidation-reduction test (redox test) is used to assess micro-chemical aeration status and therefore the potential generation of odor. A low redox means more N release by denitrification and more potential odor problem. Stabilization of N as nitrate can't occur when the redox level is low. "Having done thousands of redox tests, we now have established guidelines that tell us at what redox level the compost is more or less stable," says Brinton.

2. A test for ascertaining the rate of decomposition by measuring microbial respiratory activity in combination with redox tests enables Brinton to get an even more complete picture of compost stability. The test is actually a measurement of the percent of carbon dioxide given off in a suitable period of time. "This is different than reporting absolute activity in terms of oxygen consumption or CO_2 release. Relative rates are more indicative of true stability," says Brinton. "Relative rates are also important in ascertaining potential nutrient release from the compost. The higher the respiratory rate, the higher the decomposition rate and hence more release of organic nitrogen."

3. A measurement of organic acid (acetic, butyric, and proprionic acids) activity helps to determine the phytotoxicity of a compost. This is done by bio-assays, usually using sprouted wheat, and quantitavely by ion chromatography. "The higher the organic acid content, the longer the composting period will usually have to be," says Brinton.

4. A measurement of disease suppression capability. Research, especially by Harry Hoitink at the Ohio Research and Development Center in Wooster, has demonstrated bark compost's ability to suppress certain

COMPOST DISEASE SUPPRESSION

Rhizoctonia infected growth media with and without added compost products.

Woods End Research Laboratory Trial

EXTENSIVE research has found a variety of composts may reduce the amount of disease caused by soilborne plant pathogens. The colonization of compost by beneficial microorganisms during the latter stages of composting appears to be responsible for inducing disease suppression. Not all composts exhibit this trait, in fact some composts are disease conducive and their use may actually increase plant disease.

Treatments:

Control	60% *R. solani* inoculated potting mix 40% uninoculated potting mix
Fish Waste Compost	60% *R. solani* inoculated potting mix 40% mature fish waste compost
Sheep Manure Compost	60% *R. solani* inoculated potting mix 40% mature sheep manure compost
Potato Waste Compost	60% *R. solani* inoculated potting mix 40% immature (<60 days) potato waste compost

- Seeds planted immediately after the introduction of compost
- Plants grown for 1 week
- 2 replicates for each treatment

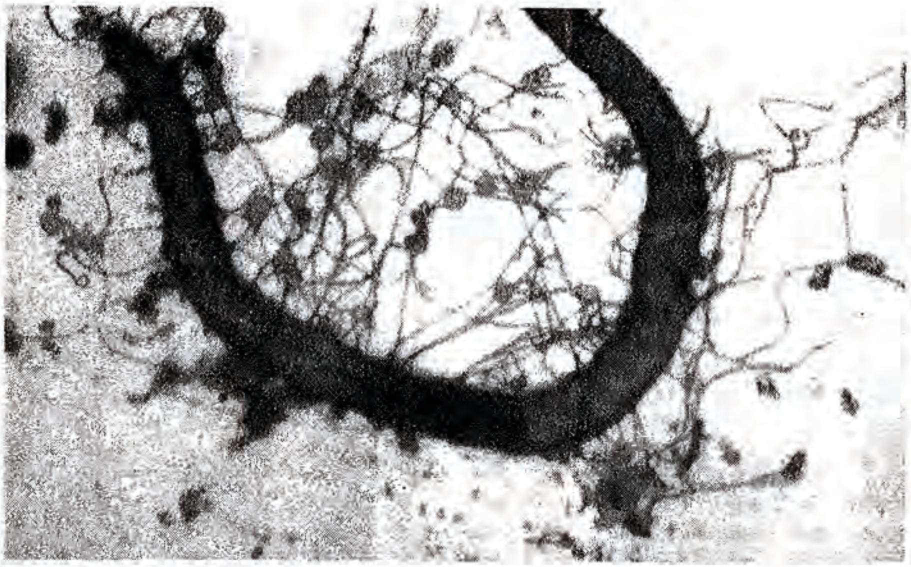
Results:

Treatment	*% Emerged*	*% Diseased*
Control	80a	57a
Fish Waste Compost	90a	20b
Sheep Manure Compost	72ab	19b
Potato Waste Compost	44c	67a

Treatment means followed by the same letter do not differ significantly at $p = 0.05$

CONCLUSIONS

- The addition of sheep manure and fish waste compost to potting mix resulted in disease suppression.
- The addition of immature potato waste compost to potting mix resulted in increased disease.
- Compost maturity appears to affect disease suppressive attributes.
- Reduced emergence in immature potato waste compost indicates phytotoxic conditions which may contribute to increased plant disease.



Fungi from ripe compost attack soil inhabiting nematode, above. (Photo by G. Croteau). Compost phytotoxicity test show plant growth in extract from stable compost at right; unripe compost at left.

soil-borne plant diseases, and Brinton believes there is an enormous potential in pursuing this research for composts in general. "Not all composts exhibit this disease suppressive trait—some seem actually to increase plant disease, especially if the compost is not completely mature. Our experiments have shown that stable fish waste compost and sheep manure compost suppress specific plant pathogens significantly, but immature potato waste compost actually increased disease potential. This may be because the phytoxicity of the immature potato compost weakens the plants and makes them more susceptible to disease. There's very exciting discoveries to be made in this area. We are researching, for example, that chitin from shellfish may be a good suppressant of soil-borne plant pathogens."

5. A more precise measurement of human and plant pathogens in the compost. "There's a lack of good *specific* information about the relationship of pathogen survival to composting method," says Brinton. "We are developing techniques to track the survival of a wide range of pathogens through the composting process so that we can establish the parameters for producing truly safe composts."

Out of these tests, taken together, comes a model of a quality compost: high in redox, low in respiration, low or no phytotoxicity, and high disease-suppressant effect.

BLENDING MATERIALS

Along with testing, Woods End has assembled an exceptional databank of information on blending various kinds of material in composts. "We've been doing this for a number of years and among other things, we now have located quantity sources of different materials that a client may need to mix with his waste to make a good compost," says Brinton. In blending composts, as in testing itself, the more experiments he does, the more background data he has to bring to bear on new problems. Like an alchemist he mixes and matches numerous blends in the lab until he finds one that works for the particular compost problem he is considering. He calls his formulaic blending a kind of "matrix algebra," and says that after enough data is collected, matrix algebra can be computerized. Then computer simulations on theoretical blends can be run and success almost guaranteed. "Yes, it is true that lab tests and small scale models do not necessarily react the way compost does in a large, real-life situation," he says. "Or at least they do not seem to. But we have found that that is mostly a matter of how well you can interpret your lab data. Over a long period of time and many tests, you can learn how to translate your lab findings to the field situation. For example, when we tackled the cull potato wastes in Aroostook County, Bill Seekins of the Maine Department of Agriculture commented on how close our lab predictions came to the field experience."

POTATO AND WOOL WASTE

That project, composting part of the 200,000 tons of cull potatoes and processing potato waste generated near Fort Fairfield, Maine, is a good example of the kind of work Brinton and Woods Ends are doing. The buildup of potato waste becomes acute due to market swings and more recently the closing of the last starch plant where potato wastes used to go. Because of plant disease latent in the cull potatoes, and the high organic acid content in the raw wastes, farmers were reluctant to spread them on fields they intended to crop the next year. Could the potato waste be composted into a safe and hopefully beneficial soil amendment? Brinton took up the challenge. "We knew we had our work cut out for us. The potatoes were chunky, very odorous, and had such a high level of both acetic and proprionic acid that they acted almost like a herbicide on the wheat sprouts in our bioassay tests. At first, try as we might, we could not get the compost windrows to heat up. This is the point where some would have given up. We kept playing around in the lab with alkaline materials to counteract the excessive acidity of the potatoes. Finally, we hit on adding wood ashes at three percent to the mix, and the temperature of the windrows started rising almost immediately. In a matter of days the composting process took off."

Brinton has also achieved success with woolen mill waste, mixing with it wood sawdust and manure, resulting in a quality compost. "The company (Robinson Manufacturing of S. Davis, Maine) is now restructuring its entire waste management system around composting and another woolen mill wants to get started in composting too."

The list of unusual waste materials that Woods End has been involved in composting include fish and shellfish wastes, fruit wastes, poultry and dairy farm wastes, and papermill sludge. The latest project involves crab wastes in Florida. "Some companies have to pay $100 a ton to landfill the waste just because it stinks so much," says Brinton. "We're working on various blends of cypress and pine bark to compost this waste. It should be no more difficult that what we worked out successfully for North Atlantic Products in Rockland, Maine, although the ingredients are different."

Some composters find it hard to believe that Brinton has no odor problems with his open-windrow method. "You must have good lab work beforehand," says Brinton. "The initial mix is very important. You can't just throw stuff together and then try to deal with odor. But with the right mix to begin with and proper adjustments later, you can handle ammonia release and odors in the large-scale windrow. We've been called in on odor problems and have stopped excessive volitalization of ammonia in 24 hours so you couldn't smell it. There's no particular secret to it, just a matter of finding the right way to buffer pH without using too much acid material, which inhibits respiration."

Brinton believes strongly but not exclusively in windrow composting and frequent turnings. (A Wildcat turner is used in most of the projects he is involved in.) "We've had good luck with windrows even in northern Maine. If cold temperatures really do cause a problem, you can usually schedule the composting for the warmer months. At the agricultural level I'm willing to defend windrows against static pile with anyone. It is completely outrageous to be spending $100 to $200 a ton making compost. We have to make compost for perhaps under $10 a ton to be acceptable to our clients."

As all new businesses do, especially in the enviromental field, Woods End has helped generate other small enterprises. One is Sustane in Cannon Falls, Minn., which manufactures and sells a blended compost with an NPK analysis of 5-4-5, a high nutrient level for a compost. "Not high by chemical fertilizer standards, but you get more bang for the buck out of a compost fertilizer," says Brinton. Another new business he has assisted is Roots, Inc. of New Haven, Conn., which is working with Yale to develop a humic acid stimulant for plants. "We are not affiliated with either company, but just do consulting and testing work for them," says Brinton.

Brinton worries about the quality of the compost industry as well as the compost itself. "The industry is in its infancy only, and it being pulled along by public concern to an extreme extent. As a service sector, we are growing rapidly, and I'm afraid, clumsily, as we try to fill the needs of society in a hurry. We can do better and those who go the further route will come out up front."

As for quality compost, Brinton sees its coming as unavoidable. "As the public finds out about ways to bring more precision into the field, they will demand it as part of their gardening and environmental concern. And the marketplace will encourage it. Visualize three composts for sale, one of which has documented proof of suppressing plant diseases or has a high nutrient level. Which of the three is the customer going to buy, even at a higher price?" ■

Reprinted from BioCycle, December, 1989.
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