Reducing the amount of pesticides used in food production has become a major objective of agricultural policy. Following a report by the National Academy of Sciences that stressed dangers of pesticide residues on vegetables and fruits to children, federal agencies announced a coordinated effort to reduce chemical applications and develop safer alternatives. Compost could well play a significant role in fulfilling these goals.

Scientific research in Ohio, Florida, Pennsylvania, Alabama and elsewhere is providing "almost unbelievable" but undeniable evidence that compost can effectively replace part or in some cases all of the fumigants and fungicides used on some food crops. "In one of our more startling experiments, compost all but eliminated a fungal disease, macrophomina, from a crop of gourmet beans highly susceptible to it while in nearby untreated plots the disease was severe," says Dr. Herbert Bryan at The University of Florida Research Center in Homestead. "It really was hard to believe."

The science of implementing the potential of compost to suppress plant diseases is hardly 20 years old, with the first practical proven results achieved by Dr. Harry Hoitink, professor of plant pathology at Ohio State University in the late 1970s and early 1980s. Working at the Ohio Agricultural Research and Development Center of the Ohio State University in Wooster, he discovered that when compost was used in potting mixes it all but eliminated damping off and root rot diseases caused by soilborne plant pathogens. Fungicidal drenches of potting mixtures were all but eliminated. This discovery led to a breakthrough in the greenhouse industry (see BioCycle, January 1990). "Those truckloads of fumigants such as methyl bromide that nurserymen used to have to buy are all behind us now," says Hoitink. "Not only are there significant savings in using compost to replace them and peat, but the environment is a lot safer for those who work there."

A few dedicated scientists, working without fanfare, are now busily trying to work out the right techniques to make disease suppression induced by compost as practical and predictable in field crops as it is in greenhouse culture. Although the work is only in its infancy, researchers say the results are promising enough to justify continuing efforts.

Here are some of the highlights of research in compost disease suppression now in progress:

Woods End Research Laboratory, a soil and compost consulting service headquartered in Mt. Vernon, Maine, has been experimenting with compost's disease suppressive attributes in field crops (above) and in the greenhouse.

Ohio State's Fritz Schmitthenner (left), Sally Miller (middle) and Harry Hoitink (right), have been experimenting with compost's disease suppressive attributes in field crops (above) and in the greenhouse.

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Agriculture must pay closer attention to the myriad life of the soil — the unnumbered masses of microorganisms which can provide a healthy repository of soil for food production. To ignore the vast potential involved is an “environmental insult.”

post would have in solving the problem. After four years of applying high quality compost to declining alfalfa fields, we doubled the thickness of the stand and therefore the yield of roughage. What’s more, the compost acted indirectly as an herbicide because the increased vigor of the alfalfa root and stem growth crowded out the weeds. We believe it was more than just a matter of shading. With compost applications, the alfalfa roots become vigorous and the weed roots decline.”

**OHIO STATE RESEARCH**

Using compost at 40 tons per acre, Dr. A.F. (Fritz) Schmitthenner at Ohio State, has controlled Phytophthora rot in soybeans. Schmitthenner, one of the world’s foremost authorities on the plant disease, became interested in compost after experience led him to believe that “pure chemical control was not going to work on Phytophthora and the new no-tillage methods coming into vogue only increased its incidences in heavy clay soils.” He doubts, however, whether compost alone would solve the problem even if enough compost became available to treat all affected soybean acreage. “What we will probably end up with is a combination of controls: plant resistance, soil management techniques, compost, maybe some fungicides,” says Schmitthenner. “One thing’s for sure: Phytophthora is a very serious and vicious disease in some of its strains. The one that attacks pumpkin can reduce a fully grown fruit to a little lump in short order.”

A combination of Phytophthora control methods is what Dr. Sally Miller, a colleague of Schmitthenner and Hoitink, is studying in her experimental pepper plots at the Ohio State University Muck Farm Branch near Willard, Ohio. The Phytophthora strain that attacks pepper plants can kill them in a day or two. She is comparing yard waste compost at 40 ton per acre rates to the cultural practice of hilling the plant rows, along with or without the use of a fungicide, Ridomil, to see which one-practice or combination of practices is most effective. “It’s too early to tell much yet,” she said in early July when BioCycle visited the plots. “The pepper plants grown in a commercial compost mix (originally formulated by Hoitink) were certainly more vigorous than the others when we set them out over a month ago but that difference is not as apparent now. Phytophthora is just beginning to appear in the plots. We’ll know more after harvest. My feeling at this point is that hilling the plants along with composting will be better than either practice alone.”

Hilling prevents water from standing on the soil surface around the plant. “A tiny puddle makes a great swimming hole for Phytophthora zoospores,” says Schmitthenner. “If the puddle lasts only 15 minutes, that’s enough for a many-fold increase in the organisms. Then they can migrate to the plant roots and infect them within an hour.”

“The compost could help at least physically by increasing soil porosity which in turn would eliminate standing water faster,” says Miller. “Also with hilling, we can mechanically concentrate the compost right into the plant area where it’s most needed. The microflora in compost supports Phytophthora as well.”

**COMPOST MULCH STUDIES ON FLORIDA FARM**

“We experienced a really horrible Phytophthora outbreak this year,” says Nancy Roe of the University of Florida who has been working with Ted Winsberg on his pepper farm near Boynton Beach, Florida. “But survival rates were definitely better in peppers on a MSW compost mulch (45 percent), or on an aged wood chip mulch (46 percent), than on white polyethylene (8 percent).”

Roe had previously experienced another interesting response to MSW compost in a similar experiment with squash plants attacked by gummy stem blight and damping off diseases. Thirty six days after seeding, 69 percent of the squash stand remained on the compost mulch, 49 percent on the aged wood chip mulch, 24 percent on the dried sewage sludge mulch, and only 8 percent on the polyethylene. “It’s important to stress that this was an experiment with mulches,” cautions Roe. “The compost was not worked into the soil. It is still to be determined how much of the disease reduction is due to protective effects of the compost and how much is related to differences in the environment created by the mulches. The temperature, moisture, etc. around and under polyethylene may be more conducive to development of these diseases.”

**INCREASED PLANT VIGOR**

Dr. Herbert Bryan at the University of Florida (Homestead) has been studying compost and vegetable diseases for several years. “I always believed that healthy plants should have built-in resistance to disease and my initial curiosity about compost was to see if it would increase overall plant vigor to this end,” says Bryan, “In 1990, we conducted our first field tests with sludge compost at five, 10 and 15 tons per acre rates. The first thing we learned was that with compost we could cut fertilizer rates in half and still get the same yields. But the seedlings where compost was applied did not grow as fast at first. It appeared that the
compost seedlings were developing a bigger cluster of roots however and, after flowering, the plants stayed a rich green while the plants in noncompost plots paled as they customarily do. This delayed action held true right on through harvest: at the first harvest, the noncompost plots yielded better, but in the second and third harvests the composted plots outyielded the controls. The grower was not too impressed with the compost performance however because the first harvest is the one that brings the best price.”

But what caught Bryan’s eye was the absence of bacterial spot lesions on the composted plants, while the uncomposted showed about a 15 percent infection. “That fed my curiosity to try more controlled and focused experiments.”

In his next experiment, Bryan worked with beans and peas using compost application rates of from 36 to 72 tons per acre. On the “LaBel” MSW compost plots, beans which are particularly susceptible, he achieved almost complete control of *macrophomina* in the beans as mentioned above. The disease was only slightly reduced where sludge had been applied. “Yield in the composted plots was almost twice that of the untreated plots,” says Bryan. “The sludge treated plots were comparable to the untreated plots.”

After the bean crop, Bryan planted blackeye peas (California Blackeye No. 5) which made better stands, greener foliage, taller height and more than twice the yield in the MSW compost plots compared to either the sludge treated or untreated plots, says Bryan. “Rhizoctonia severely affected roots in untreated and sludge treated areas,” he says, “but disease was reduced 80 percent in the areas where the highest rates of compost were applied and 40 percent where the intermediate rates were applied. The control plots yielded 75 bushels per acre, the compost plots 200 bushels per acre.”

In your teacher experiment conducted by a graduate student studying plant response to various compost rates at different irrigation rates, an unexpected result occurred. Says Bryan: “Where compost was used even without a fumigant, there was a significant reduction of root knot nematode, something that might have gone unnoticed were it not for the fact that this Ph.D. candidate has a background in nematology.”

**MATURE COMPOST AND TOMATO CROPS**

Dr. Tom Obreza, a soil and water scientist at the Southwest Florida Research and Education Center in Immokalee, says he is encouraged enough by first year results of compost’s disease suppression to continue his experiments. “When we applied dried and partially composted sewage sludge to a tomato field in Dade County, primarily to see if we could get by with less irrigation, early blight disease was significantly less than where no compost was used,” he says. “In a second go around with that experiment, we ran into bacterial leaf spot, but infections were lower in the compost treated plots. So I decided to get serious about experimenting specifically in disease suppression.”

Last October, he grew tomatoes in composts from several different commercial sources and compared them all to control plots treated with the usual fertilizers. At least one of the composts, he later realized, was not mature, the factor that compost scientists increasingly believe is critical to effective results. “Where composts were mature, plant growth just took off from the very beginning. Where it was not, growth was slow and early yields not so good. But the situation completely reversed itself when the plots were planted to a second crop. Then where the immature composts had finally matured, the plants fairly leaped out of the ground. I assume this was partially because the compost was sucking nitrogen away from the plants when it was immature, but after several months all that nitrogen was available for the plants. In general, it appears that compost, and especially mature compost, allows the grower to cut standard fertilizer application rates by at least a third without negatively affecting yields.”

There were no disease problems in any of the plots except for one interesting incident. “We had a little invasion of root knot nematode in one corner of the field. The infection was evident in the plants right up to the compost treated plots and stopped right there. The difference was as plain as night and day. Diseased plants on one side, plants growing vigorously on the other.” Obreza doesn’t know why, but he intends to repeat the experiments again next year. “We can measure the hydrologic benefits of compost — the water conserving properties it provides by increasing soil porosity and water and nutrient absorption — but disease suppression is a new ballgame, at least for me.”

**APPLICATIONS OF MSW COMPOST**

Dean Richardson at Reuter Recycling Inc. in Pembroke Pines, Florida, has supplied compost for some of the Florida experiments and has been conducting his own research as well. “We have gained a reduction in mosaic virus spread by white fly, and in control of crown rot in tomatoes, a real problem in Florida,” he says. “The most dramatic sight I’ve seen was from an airplane over a field infected with *Rhizoctonia* root rot. This disease...
Compost acted indirectly as an herbicide because the increased vigor of the alfalfa root and stem growth crowded out the weeds.

**REDUCTION IN WEED GRASSES**

Dr. Jim Edwards, a USDA soil scientist at the National Soil Lab in Auburn, Alabama, has been experimenting with farmland applications of MSW and composting it "in situ," as he puts it. When he uses mixtures containing newsprint, he gets a noticeable reduction in weed grasses in corn and cotton. In the first year of work, Edwards observed stunting in crop plants as well as reduction in grassy weeds but the stunting did not reappear the following year. "We are not positive yet as to the cause, though it appears to be that the MSW, turning to compost, immobilized the nitrogen available for plant life," says Edwards. "But we increased organic matter content from about one percent to 1.8 percent and in subsequent applications, there was no stunting of crop plants, while reduction of weed grass germination continued. I've duplicated the experiment with the same results. It's no fluke."

He is now conducting various experiments to find out why. "If we can reduce and replace herbicides with a resource we have been prone to calling waste, that would surely be an accomplishment," he says. (See Dr. Edwards' report, "Applying Organics to Agricultural Land," in this issue.)

**AN IMPORTANT FRONTIER**

Hoitink believes compost science, and in fact the whole science of soil microbiology which holds the secrets to compost's action, is barely in its infancy, a frontier which scientists will continue to push back with accomplishments that can scarcely be dreamed of today. "There is some interesting new work being tried using foliar applications of water extracts from compost to control fungal diseases," he says, "a sort of modern scientific application of the traditional use of compost tea by organic gardeners. It appears that such liquids can induce protection but much work needs to be done and potential problems resolved. Obviously if you had a fecal problem in the tea, foliar application would be a great way to spread it. Also, you can't control mycotoxins this way, and (for example, aflatoxin on peanuts) these toxins are more dangerous than fungicide residues."

He is also excited by cultural practices he observed in Brazil last year. "Those who believe composting is not practical for large acreages would find Brazil interesting. I visited a sugar cane farm of some 150,000 acres where the bagasse [stalks left after harvest] was composted and applied back on the land. Every acre got a treatment once every five years with 15 percent increases in yield. Of that increase is apparently due to a suppression of disease organisms. Corn stover is baled, composted in the bale and also returned to the farmland."

Hoitink believes that agriculture in the future must pay closer attention to the myriad life of the soil: the unnumbered masses of microorganisms which, in competition with each other, can provide a healthy repository of soil for food production. "We are learning how to manipulate the populations of these microorganisms to achieve plant protection more or less naturally. To ignore the vast potential involved is an environmental insult."