Testing Diversified Orchard Ecosystems

Cover crops, mixed trees encourage beneficial insects.

American farmers work steadily to increase production and protect crops against natural hazards such as climate, pests, and diseases. But as agriculture has advanced, new hazards have been created—manmade hazards resulting from extended use of chemicals to maintain crop protection and production.

Because of possible health and environmental concerns, many pesticides have been banned, and others are likely to follow suit. It has even been suggested that we could eventually come to a system of prescriptive farming, meaning that growers would only be able to use those chemicals that had been prescribed for certain crops by licensed practitioners.

To remain competitive in global markets, the current administration is committed to helping farmers reduce chemical use by instituting integrated pest management (IPM) practices on 75 percent of total U.S. crop acreage by the year 2000. While this doesn't preclude the use of chemicals, it is intended to cut the amount used, to better meet tolerances set by importing nations.

"This means that growers may soon be forced to radically change the way they produce our food and fiber," says ARS entomologist Mark Brown. "We think that for fruit growers, diversifying an orchard's ecosystem—which is a form of IPM—would enhance pest control and cut down on the use of chemicals."

For several years at the ARS Appalachian Fruit Research Station in Kearneysville, West Virginia, Brown and colleagues have been using two diversification techniques to bring in beneficial insects to control pests in orchards: They plant cover crops under the trees, and they interplant peach trees with apple trees. The idea has been working for several years—not only at Kearneysville, but on a larger scale in Europe as well.

In 1992, Brown planted a 2-acre apple orchard with Golden Delicious and Empire varieties. In alternate rows under the trees, he initially planted rye and clover, leaving only about 1.5 feet of open space around the tree trunks.

MARK BROWN

Four-year-old apple orchard managed under IPM practices using selective pesticides and ground-covers shows rape (far left), buckwheat (center), and dill just emerging from soil (right).

Orchardists commonly keep an 8- to 10-foot strip of bare soil under the trees, with the idea that the trees should have no competition for nutrients and water. But once the new trees began to bear fruit, Brown planted strips of rape, buckwheat, dill, and dwarf sorghum between tree rows. He is evaluating each crop's effect on pest activity and fruit yields.

Rape is a crop that Penn State researchers have found to be toxic to nematodes, which would discourage any activity from that microscopic pest. Buckwheat flowers produce nectar and pollen throughout the summer to feed beneficial insects. One of these is a parasite that feeds on the codling moth, a serious pest of apples. Dill also produces flowers that harbor beneficial parasites. And dwarf sorghum attracts aphids that become the food source for other beneficial insects that would otherwise leave the orchard in search of food. "We planted this diversified orchard with 2-year-old trees, so we harvested the first fruit under this system this year," Brown explains. "We got less fruit from trees with the ground covers. We think that may be largely because of competition for water and nutrients.

"However, the quality of the fruit we harvested under this IPM approach was as good as what we get with conventional pest controls," he says.

"We did spray the experimental orchards several times with selective pesticides for apple scab, plant bugs, and leaf rollers. But the ground covers gave beneficial insects a place to hide, and the sprays killed the pests,"

MICHAEL GLENN

Technician Frank Adams notes erosion that can occur when soil is left unprotected in an apple orchard.

Brown explains.

He controlled codling moth by disrupting the mating cycle of the pest. This was done by tying sex pheromone dispensers on trees to flood the air with synthetic female moth scent, making it difficult for male moths to find potential mates. [See "IPM Goes Areawide, *Agricultural Research,* July 1995, pp. 4-8.]

Compared to conventionally managed orchards with repeated pesticide sprays and herbicide-treated soil, those planted with cover crops produced far more biological control organisms, Brown says.

"We found that the cover crops allowed more diverse habitats for beneficial insects to rest and mate in. This is a holistic approach to orchard management," says Brown.

Usually, when orchards are managed with chemicals, he adds, pests rebound more rapidly than beneficials.

"The few pests that survive seem to have a higher reproductive potential than the beneficials. Not only do they colonize and reproduce more rapidly, they also disperse more easily."

In fact, after an effective pesticide is applied, Brown says a pest can return to the orchard in about a month, whereas it will take about 6 weeks for the beneficials to return. A pest can do a lot of damage with that 2-week lead.

Not only do cover crops protect the beneficial insects, they also protect the soil from erosion, according to D. Michael Glenn, who is an ARS soil scientist at Kearneysville.

Furthermore, these crops help increase the microorganism population in the soil, he says. "They send out roots into the soil that continually die and regenerate, thereby becoming a carbon-based food supply for soil microorganisms." The organisms help degrade pesticides before they get into groundwater.

There's also a beneficial horticultural aspect.

"Ground covers limit vegetative growth of the trees. Unless the trees are pruned, excessive shoot growth can decrease fruit yield by shading, which decreases the amount of bloom," he says. The cover crops become a good, or managed, competition for the trees.

Brown has replicated his experimental orchards using ground covers in Central Europe. In Romania, Poland, Hungary, and the Czech Republic, scientists have planted ground covers on orchards that cover from 2 to 10 acres.

"We met with our European collaborators in Poland in March 1995 and found that aphid and mite predators were abundant in their IPM orchards. Fruit quality and productivity equaled that of conventional systems," Brown reports.

Brown has a 3-year research grant to further study the use of ground covers in Poland. Several Polish grower groups use a system called Integrated Fruit Production, in which they can use only certain chemicals. This program doesn't cost growers less, but it means that they can sell their crops more readily.

However, simply interplanting peach trees with apple trees has also been found to curb pests.

"When pests have to look for another host, they expend precious energy," says Brown. "If an apple pest is forced into the next tree and that is a peach, the pest will have problems."

Peach trees have special nectar-secreting glands called extrafloral nectaries that provide an excellent additional sugar source for beneficial insects. If the peach trees weren't there, the beneficials would leave the orchard.

Costwise, at the outset, neither orchard interplanting nor establishing ground covers would be less expensive for U.S. growers.

MICHAEL GLENN

Dill cover crop thrives next to apple trees.

"But it is becoming more difficult for growers to manage orchards because of fewer choices of chemicals and fewer times that they can spray those chemicals," says Brown.

"Growers can expect to lose many of the pesticides now available. Our research shows that orchard pest management by diversity is a viable option."—By **Doris Stanley**, ARS.

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