The State of the Art of Organic Fruit Research

Researched & Written
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Russell Cothren, University of Arkansas

One of OFRF's former board members, Iowa farmer Rick Hartmann, can be a funny guy. Some time back, when we were talking about doing a survey of the "state of the art" of organic fruit research, his comment was, "Hey, you know who conducted the first organic fruit research?"

"Who?" we wondered.

"Sir Isaac Newton," he told us, cracking a smile.

We laughed.

Thinking about that exchange now, we see there was something telling in Rick's comment that connects with organic research – it is the importance of trusting intuition but verifying through careful observation. That is, after all, the foundation of many monumental discoveries. We talked with nine organic fruit farmers and researchers to prepare our report. We repeatedly heard these well-credentialed scientists and equally well-credentialed organic farmers tell us: It is not enough to take on the challenges of organic food production one problem at a time; we have to think of these farms as systems and build our research accordingly.

To be fair, the so-called "reductionist" research model -- where we identify a problem, study it and devise a solution -- has provided many valuable contributions to the challenge of giving organic farmers the tools they need to succeed as food producers. More and more, however, the folks working in the field as farmers and researchers are applying their intuition to the multi-faceted challenges they face, and coming to the same conclusion: farming with nature and natural inputs is a complex endeavor that will not be fully understood until we start addressing the "Big Picture," as Arkansas researcher Curt Rom puts it.

We need to test the whole system. We need to increase our understanding of how steps taken to improve soil fertility can affect tree health, weed and pest control, nutritional content of fruit, fuel use, water quality, farm viability and even, in the case of carbon sequestration, long-term climate change. We need to better understand the soil as a living organism that can unleash destructive nematodes and devastating bacterial diseases yet deliver symbiotic mycorrhizal relationships enabling plant roots to better absorb necessary nutrients. Colorado apple grower Steve Ela, himself a soil scientist, says soil science today is a "black hole," where very little in the way of understanding is emitted. Where a conventional grower might simply tackle a problem with increased doses of nitrogen or a synthetic pest killer, organic producers must work with nature in all its complexity, and therein lies one of the greatest challenges faced by organic food producers and the researchers who labor on their behalf.

In our survey, we talked with researchers and farmers working on apple, cherry, peach, raspberry, blackberry, strawberry, orange and wine grape production. We heard about a myriad of management challenges including soil fertility, weed outbreaks, insect infestations, root and leaf diseases, and more. We heard, as well, about innovative ways to address these challenges including insect trapping systems, rootstock development programs, orchard floor management approaches, mechanical systems like high tunnels, and integrated pest management regimes. Almost unfailingly, we heard that fruit production is different because it most often involves perennial crops, many of which will remain in the ground for several decades.

The long-lived nature of fruit producing plants complicates research. Most significantly, it increases the time needed to acquire reliable data and evaluate it. A decade-long research project studying an apple orchard or a vineyard is not uncommon. That time challenge plays a significant role in yet another issue confronting organic fruit researchers today, the difficulty in obtaining research dollars to conduct long-term studies.

On the bright side, many we talked with said they saw a tremendous surge in understanding among students, consumers, other researchers, and farmers that organic production is a key element of a healthful and healthy food production system. If that is true, and there are strong indications in the marketplace, on farms and in research institutions that it is, perhaps there is a new opportunity emerging to fortify the move toward a systems approach to research in organic fruit production and beyond.

Russell Cothren, University of Arkansas

Dr. Curt Rom, University of Arkansas

Researcher links fruit studies, food systems

Curt Rom, University of Arkansas

Dr. Curt Rom holds a doctorate in horticulture crop physiology from Ohio State University and has dedicated 25 years to fruit production research, the last seven of those focused on organic. Rom is a research professor in the Horticulture Department at the University of Arkansas, Fayetteville. He does research on tree and small fruits, including apples, peaches, blackberries, raspberries, and blueberries. Dr. Rom is an OFRF grant recipient.

Curt Rom says he is in the process of redefining himself in his academic role. In just the past few years, his students seem to be shifting away from analysis of production techniques toward a discussion of the broader implications of food production.

"They don't talk about fruits and vegetables the way I used to. They are interested in quality food and nutrition, food grown with minimal environmental impact, and food systems," Rom explains. "So, in my own thinking now, I am reluctant to even talk about just fruit production, I'm more interested in food production, something that people are going to eat."

As a researcher, Rom says, this redefinition involves broadening knowledge and experience of production across many crops and trying to understand the farm as an integrated system. Rom considers this readjustment in thinking around organic agriculture to be one of the academic community's highest priorities.

"Now, we're trying to look at system interactions, so part of my priority is to understand the interaction of horticulture, entomology, soil science, weed science, economics and marketing: all of these. We can't separate those individual disciplines in organic research. Our priority has to be seeing the connections," says Rom.

"In conventional agriculture, we typically look for a simple answer to a simple question. It's reductionist. What I'm enjoying about organic is the idea that we have to think 'big picture.' The challenges to me are: everything relates to everything else," Rom explains.

There are numerous problems associated with growing tree fruit and small fruit in the South. Season extension efforts in small fruits led Rom to study high tunnels for blackberries as a way to keep moisture off the fruit and eliminate the need for fungicides. While the technique appears to work, cane borers and crown borers have also thrived, so now Rom and his research associates are working on ways to screen the borers out of the tunnels.

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>
> —*Curt Rom*

In apples, the South has numerous pest and disease challenges, including codling moth and Oriental fruit moth. In one of his projects, says Rom, mating disruption and trapping of these two pests was successful but it also revealed plum curculio as an unexpected pest. Conventional orchards were eliminating plum curculio as a collateral effect of controlling other pests, so without insecticides in the organic system, the curculio resurfaced. Rom says entomologists are now challenged to figure out how to control the pest in organic production.

Rom says one of the biggest challenges in organic fruit production is weed control, a problem he describes as "unwanted competitive vegetation."

"There is some vegetation that we want. That's one of the issues that we're trying to sort out. What is our tolerance to vegetation, and what's the kind of vegetation we don't want," says Rom.

Understanding fertility in organic orchards remains a challenge, and, Rom says many, many basic questions about plant function remain.

"When during the year does the apple root system grow, and when during the season does it take up nutrients? When during the season do we see nutrients manifest themselves in the foliage, so we can sample that and make recommendations for fertilizers," Rom asks. Rom says field trials are aimed at discovering whether orchard soil fertility will stabilize over time, but he says it may take five to seven years of research to draw any conclusions.

Rom recently looked at lime sulfur as a crop thinner in organic apples. The study showed it was an effective organic treatment and it is now also being adopted by conventional growers.

"One of the wonderful consequences of doing work on organics is anything that we discover as a useful technological tool in organics can be applied to conventional orchards. … Finding a tool for an organic grower means we've won the battle. Finding a tool that can be used across the world is winning the war," Rom says.

Natural organisms, Push/Pull system show promise as pest management tools

Mark Whalon, Michigan State University

Dr. Mark Whalon is a professor of entomology at Michigan State University in East Lansing where he directs the Pesticide Alternatives Laboratory. He holds a doctorate from Pennsylvania State University. Whalon grew up on a farm in Oregon and today operates a 16-acre farm in Mason, Michigan.

With 30 years of agricultural research behind him, Dr. Mark Whalon dedicates roughly half of his research time to the study of apple, peach and cherry production issues with a focus on integrated pest management techniques and biopesticide development. Fruit tree borers, cherry fruit fly, plum curculio and mites are the insect pests most interesting to the entomologist, who has developed a number of innovative approaches to pest control that tap into naturally occurring biological control agents.

"Right now, we work with a lot on fungi and nematodes and also on the microclimate modification of orchards to accommodate biopesticides. We're looking at cycling in the soil of beneficial microorganisms that would reduce the populations of key pests as they live underneath the tree through the fall and into early spring," says Whalon.

"A lot of these biopesticides actually occur in the soil already, especially in organic orchards with a high level of humus. In organic orchards, we've isolated a number of strains of fungi. They're quite active on these beetles, on cherry fruit fly, and on apple maggot."

> "A lot of these biopesticides actually occur in the soil already, especially in organic orchards with a high level of humus." —*Mark Whalon*

Whalon says slight changes to management of the orchard floor can have a major impact on encouraging naturally occurring pest control. One line of inquiry led his team to conclude that replacing drip irrigation systems with micro-sprinklers not only encourages more consistent tree growth, it provides a more efficient means of delivering various fungal and nematode biopesticide inoculants to the soil. Whalon is also monitoring the impact of these soil fungi and nematodes on other beneficial insects living in the soil. He has learned that earwigs, while bad for stone fruits, can be natural scavengers or predators to pests that attack cherries and apples.

Another pest control approach developed at MSU that is gaining acceptance among fruit producers is what Whalon calls the "Push/Pull Strategy." Push/Pull involves physically pushing pests out of orchards with repellent materials like kaolin clay and pulling those same pests to the orchard fringe where they can be trapped or exposed to biopesticides in an economical way. For instance, Whalon uses a commercially available pest attractant called Plum Essence to draw plum curculio out of orchards and into the Whalon Lab Pyramid Trap.

"In cherries, we've done enough of these Push/Pull systems that we've experimentally shown that you can decimate plum curculio populations inside that orchard. In organic orchards, it is an ongoing battle to continuously move the pest out of the center of the orchard to the perimeter where growers can tolerate some damage. What you do is move your traps to the perimeter of the orchard and outside the orchard across a road or into a buffer. You bait and trap out there, and we've gone as long as five years after an intense effort to reduce populations inside the orchard with no more than 9 or 10 percent injury in those orchards," says Whalon.

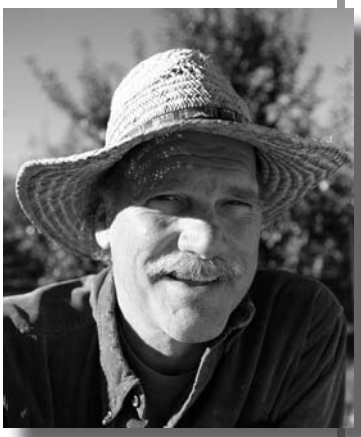
Whalon is also looking at orchard floor ground cloth impregnated with insecticidal fungi like *Beauvaria bassiana*, which attack pest larvae as they leave fallen fruit. He says the technique shows promise, but he does not yet have grant funds available to extend the research.

Pomologist tackles apple replant disease through rootstock breeding

Ian Merwin, Cornell University

Dr. Ian Merwin holds a doctorate in pomology, plant pathology and ecology from Cornell University, where he now divides his time between teaching and research. Apples and winegrapes are his research focus. Long term, he has worked to identify biological methods to control apple replant disease (a growth-stunting malady that occurs in new orchards planted where older orchards once stood) and to enhance orchard and vineyard floor management.

A desire to replace fumigation as a means to control apple replant disease prompted Dr. Merwin to delve into pre-plant cover crops in some of his initial research. He found some success with several cover crops (marigolds, certain oilseed brassicas, and Sudan grass), but he says results were inconsistent because replant disease acts differently in different soils and in different



Ian Merwin, Cornell University

parts of the country. About ten years ago, says Merwin, he began looking for genetic resistance to the disease in rootstocks. He says several new rootstocks developed through the Cornell Breeding Program seem to hold promise.

"They're tolerant but not resistant, in the sense that they don't actually suppress the pathogens, but they just aren't affected by them. Replant disease doesn't stunt the trees on these rootstocks at all," says Merwin. He says these rootstocks are also resistant to fire blight, a bacterial infection that destroys apple and pear tree foliage and can kill trees. The researcher says he is now trying to learn more about the biological mechanisms of their rootstock's replant-disease resistance trait. Preliminary research suggests that these new rootstocks encourage growth of disease suppressing fungi and bacteria around the tree roots.

"The next question we want to ask is: 'Exactly how does that happen?' Do the roots exude something that promotes beneficial microbes in the soil, or is it some kind of gene-to-gene signaling mechanism between roots and beneficial microbes?" says Merwin.

Pursuit of better understanding of tree root physiology, nutrient uptake and leaching, soil quality and general tree performance has led Merwin to study orchard floor management. He's engaged in a long-term field trial involving a two-acre orchard planted in 1992 above an elaborate drainage system that enables sampling and quantification of leaching and runoff flows. The arrangement enables researchers to carefully track and measure nearly everything that leaches through or runs off in field scale replicates of four different ground cover management systems. Early work at this site showed greater runoff of fungicides, and more nitrogen leaching in herbicide treated plots compared with grass or mulch covered plots.

"One of our other hypotheses was that the different soil management systems would influence the efficiency of nitrogen use in the trees, and they did, in a really big way," says Merwin. Use of stable isotope (N-15) fertilizers as tracers showed that these trees were much more efficient in using nitrogen than those in other studies. Merwin says the same orchard system has enabled long-term study of ground cover applications.

"The long-term effects in this study were especially interesting. The bark mulch treatment actually doubled the organic matter content of that soil after 16 years. The mulched soil has gone from 4.5 percent to 9 percent, which is a huge increase," says Merwin. Soil organic matter also increased in the grass strips, but decreased in the two herbicide treatments. RNA fingerprint studies of tree-row soil from each management system showed substantially different microbial community composition in each of these orchard floor systems after 15 years.

But the scientist worries that simply accumulating soil response data does not provide a complete picture in relation to fruit production. Soil health indices, he says, would say the high organic matter content made the soil very healthy, but if orchard soil is too fertile, that can be detrimental to fruit production. "You just get too much vigor. The trees are harder to prune. … A moderate amount of stress is actually a good thing for most tree fruit, or winegrape crops. The trick is to keep it moderate. So I think it's going to be a different set of indices that tells you something is a healthy soil for a vineyard or an orchard," Merwin says.

Colorado apple producer plies research for on-farm solutions

Steve Ela, Silver Spruce Orchards, Hotchkiss, CO

Steve Ela, a 4th generation family farmer, has owned and operated a 100-acre fruit farm in Hotchkiss, Colorado, since 1990. The operation has been 100 percent certified organic since 2003. Ela raises apples, peaches, pears, sweet cherries, raspberries, blackberries, and heirloom tomatoes. The farm also has a commercial kitchen where fruits are dried or processed into jams, fruit butters, cider, and slices. Ela markets product through farmers markets and wholesales to major food retailers in the Rocky Mountain region. A long-time Organic Farming Research Foundation board member, Ela is also a trained soil scientist.

Daunting production challenges are inherent in an organic fruit production operation.

Among the most pressing challenges facing Steve Ela's farm today are codling moth, soil fertility management, labor costs, and early spring frost. Ela has made a practice of staying up to date on current research in each of these areas. Like many farmers, he closely monitors changes on his farm and regularly conducts informal research in his orchards to devise more effective ways to improve production. He regularly searches periodicals for research updates, confers directly with organic fruit researchers, and shares ideas with other growers and researchers through field day workshops. He also attends grower and research conferences.

Steve Ela, Silver Spruce Orchards

"We've gone to great lengths to cultivate friendships with many researchers so we can ask them questions. … And every year we tweak our insect control program based on what we're seeing from those researchers," Ela explains.

Ela says despite a growing base of knowledge about organic fruit production, there are still tremendous gaps in understanding that point to the need for ongoing research across a broad spectrum of production issues. Chief among them is a need to understand the orchard as a perennial system that has specific needs. "A perennial system is a different beast than an annual system. … That's part of the research challenge."

As a soil scientist, Ela says soil dynamics loom large on his list of research needs. He calls the whole area of soil dynamics a huge black hole.

"Soils. What's happening there? What's happening in the systems with the bacteria and fungi and worms and the like? What are the soil dynamics we are working with?"

Pest management is another area demanding attention. Even though pheromone mating disruption has been effectively

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used for decades, it sometimes fails to work and it is not clear why, says Ela. Research to determine the reasons for failure will improve its use as a production tool, he adds.

Means to maintain soil fertility in an organic orchard are particularly challenging, says Ela. Orchardists avoid cultivation because it damages tree roots, but that practice encourages weed growth and compounds cover crop management issues. To Ela, these multiple challenges point to the need to focus on whole systems in organic research.

"We're all worried about weeds, but I think weeds are less important if you think about them as a cover crop and fertility. I'm trying to quit looking at single point factors alone and thinking of them as working within a system--how we can make the system more robust and productive," says Ela.

As an organic fruit grower, Ela says the most satisfying aspect of his effort is the smiling faces that emerge when they receive a great piece of fruit.

"That consumer side of things is very gratifying. Knowing that we're trying to put in place systems that can do that in an environmentally sensitive manner; that we can produce great fruit and feed people without leaving a debris trail behind us. We're not there yet. We still have lots of issues we need to work on," he says.

Orchard floor management practices steadily evolve

David Granatstein, Washington State University

Dr. David Granatstein's interest in organic research began in Washington State in 1978 when, as an organic farmer, he saw a tremendous void in available research on organic production. With an education in environmental and soil science, Granatstein has focused for the past 14 years on sustainable agriculture, including soil quality, composting, and orchard floor management in organic systems at the Washington State University Tree Fruit Research and Extension Center in Wenatchee. Granatstein received an early OFRF grant to survey organic apple producers.

David Granatstein sees weed control, soil fertility, and crop load management as primary areas of interest for organic fruit researchers. He notes that fire blight, a bacterial disease that can kill apple and pear trees if not controlled, is another area of concern to orchardists, whether organic or conventional. He says biocontrols and other alternatives to the current antibiotic treatments are needed to control the disease and that current research is testing some promising ideas. Replant disease is another challenge where research is close to delivering practical alternatives to the standard soil fumigation— often still used by organic growers when replanting an orchard block, forcing them to start transition to organic again.

Granatstein has focused much of his research on orchard floor management, including soil fertility, compost use, mulches, and cover crops. "Rodents, especially voles, end up being the Achilles Heel of a lot of the promising orchard floor management systems that many people have been looking at," says Granatstein. "That is one reason for keeping a bare ground strip under the trees, along with controlling weeds. But filling that niche with something beneficial would be ideal." One project now underway is testing legumes to see how much of the nitrogen requirement of the apples the legumes can supply. Another project is comparing tillage for weed control to wood chip mulching and flaming/organic herbicides.

Ground cover management trial at WSU orchard.

"In all the trials we have done, the wood chip mulch trees grew the best. Tillage is simpler and less costly, but we and others have seen negative impacts on tree growth and fruit size, along with declines in soil quality. And maintaining soil quality is required by the organic standards," says Granatstein.

Overuse of tillage in orchards is a big concern, says Granatstein, because it tends to drive fruit size down.

"I really want to find some alternatives to tillage for these organic systems. The living mulch (in the tree row) is very attractive conceptually because it could be self-maintaining. It can provide multiple benefits like fixing nitrogen, improving soil, excluding weeds, and hosting beneficial insects. But the voles are the deal breaker. We have not come up with a good solution yet," says Granatstein.

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Granatstein offers this advice to growers: avoid tillage – go as shallow as possible and as little as possible – try wood chip mulches, and if you are cover cropping with legumes, pay particular attention to when nitrogen is being delivered to the tree. Fabric mulches may be more practical than wood chips (which are hard to source in quantity and expensive to spread). The fabrics don't always improve soil quality and can harbor voles but have led to good tree response.

"For fruit trees the timing of nitrogen is really important. There are times when you do not want the nitrogen available in any significant amount because it will interfere with fruit quality. And then you want low nitrogen at the end of the season when the tree is going dormant, which will affect winter hardiness," says Granatstein.

Looking to the future, Granatstein says additional research is needed to identify the best legumes to fit into an orchard floor system. Mixes of legumes and other cover crops can be designed to harbor specific natural enemies linked to specific pests. Sweet alyssum has been a successful cover crop and research is now underway to see how it can host a natural enemy of woolly apple aphid. Granatstein says he plans to study fabric mulches compared to wood chip mulches and look more closely at the connection between soil quality and fruit quality.

"Growers really want to know if there's a clear connection between soil management and fruit quality. Are there practices or systems that lead to consistently higher fruit quality and/or nutritional content? If so, this would be highly desirable to implement," says Granatstein.

Young cherry orchard at Oregon State University.

Climate prompts holistic tack on cherries

Anita Azarenko, Oregon State University

Dr. Anita Azarenko has headed the Oregon State University (OSU) Department of Horticulture for the past six years. Her principal research focus is organic and integrated management systems for sweet cherries. She has conducted organic fruit production research at OSU for the past eight years. As an organic fruit producer in the Willamette Valley herself, she has done informal on-farm trials since 1993. Azarenko is an OFRF grant recipient.

Oregon's Willamette Valley features a wet and mild Mediterranean climate that presents unique challenges for cherry growers. The moisture and moderate temperatures open the door to a damaging bacterial canker, *Pseudomonas syringae*. Dr. Anita Azarenko says the disease's challenges have helped shape her approach to fruit production research. Today, she factors whole systems thinking into her projects and tries to look holistically at precipitation levels, basic climatic conditions, and pest management. She is working with high tunnels as potential season extenders and disease management vehicles.

"To be able to grow cherries here requires looking at it systemically and integrating all those things, not just doing a 'plug and chug' of systems that are designed for dry land areas," says Azarenko. Most of the nation's cherries are grown in the dryer dales of Central Washington and Oregon and much of the cherry production research addresses grower's needs under those conditions.

"What I've been spending a lot of time on is identifying varieties, rootstocks, and training systems that are appropriate for the wetter districts in Oregon and Washington. The work really has broader application across the world because many of the areas where sweet cherries are grown are wetter and milder than these typically dry regions," says Azarenko.

The research is applicable in both conventional and organic systems, Azarenko explains, "because there is no good control for bacterial canker whether you are conventional or organic."

Another production challenge is presented by the black cherry aphid, where control is difficult. Azarenko says in some of her field tests involving insectary hedges around high tunnels an unanticipated development occurred: soldier

beetles from the hedges invaded the tunnels and began eating the aphids.

"It's one of the exciting things that I'm uncovering that we need to have more work done on: how these biological hedgerows can actually encourage the appropriate insects to help control black cherry aphid," says Azarenko.

Another line of inquiry evolved around high tunnel experiments when powdery and black cherry mildew were detected. An entomological survey revealed a large population of mildew-eating lady beetles associated with the outbreak. That prompted Azarenko to ask,"Are there other insect pests that could be released in these tunnels that are part of an integrated system that could help us reduce the incidence of disease and the insect pressure?" Once again, additional research is needed, as is study into an organically approved means to repel birds in organic cherry production.

While organic and conventional orchardists regularly wrestle with issues around soil fertility, organic producers

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> —*Anita Azarenko*

are particularly concerned with appropriate means of weed control. Azarenko's research has touched on numerous approaches to both issues, including use of mulches, cover crops, and synthetic landscape cloth. She says the studies have produced mixed results. Landscape cloth appears to contribute to reduced organic matter in the soil and reduction in available nitrogen, while organic mulches present challenges around availability and cost in medium-to-large-scale orchards.

Azarenko's research regularly crosses into conventional cherry production systems. She says she is seeing stronger and stronger interchange between farmers in organic and those in conventional production.

"What's interesting is to see the continuum of farmers who are coming together on certain practices. Many of the conventional farmers have actually implemented soil management strategies to increase their organic matter. Then the organic farmers are learning a little bit more about varieties and rootstocks from the conventional farmers, so it's a really cool time to be doing research," says Azarenko. Among the most pressing needs in her discipline, says Azarenko, is funding for a national, 10-to-20-year study of ecological practices in perennial fruit crops.

"That's probably my biggest frustration, that we're not as coordinated as I'd like us to be, and there's really no money to sustain a twenty-year trial in fruit crops," says Azarenko.

Organic citrus in Florida tests growers

Matt & Ben McLean, Uncle Matt's Organic

Matt McLean is CEO of Uncle Matt's Organic in Clermont, Florida where he manages 1,000 acres of organic citrus. He farms with his father Ben Jr.; his brother-in-law, Alex Howell; and his brother Ben III, who holds a masters in Horticultural Sciences with an emphasis on fruit crops from the University of Florida. Ben heads Uncle Matt's Research and Development Department.

The McLean brothers' transition to organic production in 1999 was the natural complement to a production system pioneered by their father and grandfather that reduced off-farm inputs and limited pesticide use. The emerging organic market opportunities created by adoption of national organic standards helped persuade them to certify their operation, enabling the McLeans to find a market niche and manage their own brand.

Ben McLean, Jr./Uncle Matt's

Ben McLean III of Uncle Matt's Organic

Growing citrus in Florida carries with it a particular set of challenges, many shared by conventional and organic growers. Citrus canker is a century old problem in the region and every grower struggles with fertility management, in particular the appropriate levels of nitrogen to apply in Florida's sandy soils. The recent emergence of the greening disease (a bacteria transmitted by the Asian citrus psyllid, which damages a tree's circulatory system and causes irregular fruit ripening) is also worrying growers in Florida and elsewhere. Organic fruit growers face particular challenges around weed control, simply because they do not have access to the synthetic herbicides available to conventional growers.

"We really don't have economically viable, commercially available herbicide programs yet. So most of the weeds that we remove are either through mechanical cultivation or hand crews, and that's just really expensive to do," explains Ben McLean.

Like many small and medium sized farm operations, the McLeans conduct informal research on their acreage. At present they are focused on cover cropping the weeds that thrive in their groves.

"Let the weeds grow up. Do not mow frequently. Let them grow up tall. Then lightly till them into the soil. Lightly, and yes, they are building organic matter and helping us with nitrogen," says Ben McLean.

The McLeans say there is little, if any, formal organic citrus production research underway in their region. They are working to interest researchers at the University of Florida and the USDA's Agricultural Research Service in studying the role of sulfur as a nutrient to help fruit trees resist pests. They are also hoping to advance research into the multiple environmental benefits provided by organic production methods. Another possible area of study involves seeking organically certified materials that can be applied to citrus post harvest to extend shelf life in the marketplace. Ben McLean says, so far, none of these projects have received funding. He says the research universities and federal research programs have been cooperative in helping him implement his own research and to analyze data he has collected in his studies, but there is a gap when it comes to researchers initiating projects.

"Organic is so small in Florida that they don't have the funding or the time or support behind them today to justify engaging an organic grower and trying to initiate a research project," says Ben McLean.

There needs to be a strong, long-term focus on evaluating organic weed control methods with a similar approach needed on soil nutrients, says McLean.

"Those things have been done in the conventional industry, and they have them down to a science. The industry, the extension personnel, the ARS personnel, they can tell you how much you'll spend per acre and what materials you need to have available. There are dozens of peer reviewed, published papers on timing and application methods and returns on investment. We are way behind on those two. That's what we need," Ben McLean says.

Integrated Pest Management grows stronger in strawberries, apples

Sean Swezey, University of California-Santa Cruz

Dr. Sean Swezey is an entomologist and lecturer affiliated with the Agroecology Center at the University of California-Santa Cruz. He began researching organic fruit crop production 22 years ago with pioneering work in strawberries. He remains focused on strawberry and apple production and his research as an entomologist looks at the practical use of integrated pest management as a production tool. Swezey is an OFRF grant recipient.

Apples and strawberries are the two biggest organic cash crops produced on the central California coast. However, in 1987, when Sean Swezey began his research, organic production was virtually non-existent. An early affiliation with legendary strawberry producer Jim Cochran and a later connection with Corralitos apple grower Jim Ryder cemented his interest in integrated pest management research on what were then emergent crops.

Swezey says his field work indicates there are key pests which absolutely must be controlled. Other insects seem to be problems created by conventional production systems.

"Once we started working under organic conditions, we found that it was a relatively small number of arthropods that were really challenging growers and that needed new control techniques," Swezey says.

In strawberries, lygus and spider mites are two insect pests that cannot be ignored. Lygus bugs cause distorted, unmarketable fruit and spider mites compromise photosynthesis, which can kill plants. Swezey says when the organic industry was just emerging, there were no organically approved control techniques available. He says his research helped growers develop effective controls.

> "We don't believe in inventing the research questions and just using the farms as a place to do the work. We really want farmers' opinions."
>
> —*Sean Swezey*

Organic apple growers have seen significant progress on pest control as well. Even the much publicized light brown apple moth can be controlled with pheromones or parasitoids, says Swezey. Bt (*Bacillus thuringiensis*) is also available in organic systems to control leafrollers (the larval stage in moth development), says the researcher.

Swezey's research today is centered on using parasitoids to control insect pests such as lygus. He has done extensive tests to intercrop strawberries and alfalfa. The alfalfa is a trap crop that houses the parasitoid and attracts the lygus in a complex interaction that Swezey says is not fully understood.

"My fruit research is really about understanding this food web, the relationship between the alfalfa and the strawberries in terms of the efficacy of the parasitoid. The parasitoid was imported from Spain and is doing very, very well. We want to understand how to make it do the best possible," Swezey explains.

A relatively new technique involves marking insect pests with protein sprays which enables researchers to track pest movement through a field.

"Our theory now with trap crops is that a couple of trap crops per acre is adequate to cover the potential flight behavior of an adult, but we don't know that for sure. We're trying to get some basic information about how they fly around in the field, if every fiftieth row, they are encountering alfalfa," says Swezey. The researcher says similar studies are aimed at fine-tuning spider mite control.

Though tracking the flight of the lygus bug may not sound entirely farmer-like, Swezey says working directly with organic farmers has always played a central role in crafting research plans.

"We don't believe in inventing the research questions and just using the farms as a place to do the work. We really want farmers' opinions. We want to plan with them first, then decide how to set up the research," says Swezey.

Sizing up on-going challenges facing organic researchers, Swezey says obtaining funding and recognition are tremendous hurdles.

"The recognition of how important this is, what an important part of the food system organic production is, and getting the proper share of funding to make an impact, it's going to require a lot more mainstream agricultural research funding," Swezey says.

Long-lived vineyards breed pest, research obstacles

Glenn McGourty Mendocino County Extension

Glenn McGourty is the wine growing and plant science advisor for the University of California County Extension in Mendocino County, California. He works primarily with wine grapes and focuses on Mediterranean varieties, evaluating rootstocks and clones. He has been involved in fruit crop research for 30 years and for the past 20 years has focused on sustainable, organic, and biodynamic production.

Glenn McGourty is one of the first California farm advisors hired to work specifically on sustainable and organic agriculture. That happened in 1987. With a long-term interest in environmental studies, the opportunity to apply his knowledge to environmentally friendly farming practices was a natural fit. High on his list of research priorities is the impact irrigation used for frost control has on endangered species such as salmon. He also lists long-term research needs associated with nematode and spider mite control as well as interest in developing trellising systems to enable mechanized grape harvest.

Concerns over water use generally have intensified along the Russian River in Mendocino County, where salmon fry can be endangered by low water flows. Large acreages of wine grapes growing in the region demand heavy water use when frost threatens, so McGourty says developing a set of "best management practices" for the growers is crucial to their economic survival. If water for agricultural use is severely restricted or banned, grape growers would be pushed out of production, says McGourty.

> "We have to start convincing people that it's to their benefit to have organic farmland because we can help solve some of the environmental issues that we're facing." —*Glenn McGourty*

Nematode control is also crucial for grape growers, whose vineyards often remain viable for 30 to 35 years. In a conventional system, soil fumigation is a nematode control, but McGourty says it's not really effective because the pest migrates deep into the soil to avoid the pesticide, then returns after the fumigant dissipates.

"We have probably four or five different nematode species that gradually sort of wear your root system out. We're trying to come up with some strategies to keep root systems healthy because impaired root systems result in lower yields and plant nutrition problems," says McGourty. McGourty says nematode resistant root stocks seem to hold promise, but more breeding and research is needed to find the best stocks.

Tom Liden/Dark Horse Vineyard

Paul Dolan's Dark Horse Vineyard in Mendocino County is one of McGourty's test vineyards.

One great challenge in researching wine grape production issues is the long-term nature of the studies. McGourty says it can take up to ten years to get a good understanding of how an experimental approach has affected production. McGourty says he works almost exclusively with grower cooperators in their vineyards to conduct his research, and those growers have to make long-term commitments to the projects to make them work. Without the growers, he says, there would be no research.

Spider mite control in organic vineyards is another key concern. Conventional growers simply apply a miticide to destroy the pest, but organic producers have a more complex equation to run. Sulfur dust is an organically approved fungicide regularly applied to control powdery mildew, but it can also discourage beneficial insects that prey on the spider mite. McGourty says his research over several seasons is pointing to an approach that may work.

"We're trying to reduce the amount of sulfur dust that goes on, then we're augmenting the insect population with a beneficial mite. We do releases and track effectiveness, and we're convinced we have a good program for people to follow," says McGourty.

Looking to the future, McGourty says it is time for organic producers to be more specific about the ecological services that organic farmland provides.

"We have to start convincing people that it's to their benefit to have organic farmland because we can help solve some of the environmental issues that we're facing. We can sequester carbon, and provide habitat for biodiversity while producing food and beverages. This is how we need to frame organic farming in the future," says McGourty. ■