# A behind the scenes look at pesticide use in organic orchards, vineyards and fresh produce

*This is part three of a four-part series attempting to separate fact from fiction regarding pesticide use on organic farms. In the first installment, we looked at the common claim that organic farms actually use more pesticides and more dangerous pesticides than convention farms through the lens of a few simple observations and talking to actual organic farmers. In the second installment, we looked at the factoids that have been taken out of context and twisted into a dishonest narrative. In this installment, we look at the special cases of pest control in organic orchards and vineyards. Finally, in part four, we take a critical look at a widely circulated article purportedly busting myths about organic farming that managed to create a few myths.*

In part one of this series, I kicked the tires of the all too common trope that organic farmers are using more pesticides and more dangerous pesticides compared to conventional farmers in ways that consumers and environmentalists should find alarming (or at least concerning). One of the ways I kicked the tires was an informal survey of organic farmers in a Facebook group I founded. Among the takeaways from their answers about their own pesticide use was that it's not uncommon for organic farmers to forego pesticides completely. However, those were farmers growing mostly row crops in Canada and the upper Midwest. The crops are hardier and the pest pressures are lower. It's easier to get away with zero pesticide use in a cooler climate, with crop rotations and cold winters to break up pest cycles. (A cold winter is a helluva natural pesticide.)

What the survey did not give us any insight into the types of farms I was most interested in: the large corporate produce farms in California's Central Valley, organic vineyards, and organic orchards, which I will cover in some detail in this post.

As I was researching for this series, Civil Eats published an interesting piece by an organic farmer in California's Sacramento Valley going over, line by line, the "Profit and Loss from Farming" form he fills out for his IRS tax return. Mike Madison operates a 21-acre farm, the majority of which is planted to orchards, mainly olive trees. He also grows fresh fruit, vegetables, and flowers. He markets his products locally, mainly at farmer's markets. Owing to my focus at the time, I was struck to see that on Line 11: Chemicals he entered a goose egg. This was before I'd done my survey, so I was surprised to see that. At the time, I really hadn't realized how common zero pesticides was.

tax return

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This farm is an example of more pest vulnerable crops, grown in a warmer California climate, but this is a small farm with a farmer committed by his values to zero pesticide use, selling into a market that gladly compensates him for that.

I still wanted to know more about the industrial organic producers selling into the mass grocery chain produce market with razor-thin profit margins and zero ideological commitment to absolutely parsimonious pesticide use. The big growers have organic and conventional operations and are making pest control

decisions solely on what's best for their financial bottom line. Selling into the grocery market means that the produce must be absolutely perfect, uniform, free from blemishes or any sign of pest damage.

So I called Grimmway Farms (Cal-Organic Farms, Bunny-Luv, and Bunny-Luv Organic) with over 57,000 acres, Earthbound Farms over 50,000 solely organic acres Nunes/Foxy Fresh Produce with 20,000 acres, Mission Acres – 15,000 acres, and American Farms – 7,000 acres. I called them all two or three times and left messages. Nobody got back to me.

I ended up talking with a friend who advises in that sector and was willing to speak on background, but couldn't go on the record for professional reasons. We spoke for a while in pretty fine detail until I'd run out of questions.

Some of the main things I wanted to understand:

- Does having deeper pockets and longer planning horizons allow for greater integrated pest management (IPM)?
- How deep is the commitment to robust IPM?
- How much are stuff like traps, beneficial predator insects, and new biologicals being used in both systems?
- To what degree could the more complete pest control in the surrounding conventional acres provide a "halo effect" by reducing local pest pressures on the organic acres?

How would you characterize the difference in organic and conventional pest control programs within these companies? There were very few clear takeaways. There is a lot of overlap, more than you might think. The traps, beneficials, and new biologicals are used in both, but my impression was that the traps and biologicals were somewhat marginal, but beneficial insects were more important than I'd expected. The ability to do robust IPM is greater on these big corporate farms than on smaller, owner-operator farms, but selling fresh produce to grocery chains with a zero tolerance for any cosmetic defect means the commitment to IPM is strong until it's not. Or rather, what are called *economic thresholds* are just wildly different. Economic threshold refers to a level of presence and damage from a pest you can absorb until spending money on fuel, labor, and pesticide is worth expending to stop the pest. In soybeans, you can tolerate a lot more aphids eating the leaves than you can in lettuce because you aren't selling the soybean leaves. So, when you have a crop worth hundreds of thousands of dollars and it's under attack, you spray twice a week until you get it out of the ground if necessary. That's true for both the organic and conventional parts of these operations. The use of *softer* chemicals in the organic parts generally meant more frequent applications. On the question of "halo" or refuge effects, their "Yes and No" answer surprised me. If not quite surprised, I found it really interesting. Here are some snippets:

> Clearly if organic was a larger percentage of the acreage then spraying such a large amount of crops with such a limited rotation of effective materials would speed up the process of resistance.
>
> But often the problem is the reverse. For instance with organic berries I see more problems

with mites if they are planted near conventional fields that are struggling to control their mite problems. Or the conventional grower finishes the season with heavy populations of a pest like mites or lygus with low predator populations due to spraying conventional materials. So the pest moves in with huge numbers and there is no immediate spray or biocontrol to knock it down.

One strategy organic berry growers use is to try and get isolated fields on the other side of the county mixed in between the avocado and lemon orchards. This way they do not inherit the pest problems of their conventional neighbors since orchard pests are not typically berry pests.

Another example is having organic spring plantings of spinach, beets, celery or another crop that is a magnet for leafminer next to conventional celery. A conventional celery grower or growers may have something like 500 acres near their field in successive plantings. As the conventional grower harvests proceed, the population of leafminer explodes in this time of year naturally, and blows up in the harvested areas in the untreated crop residues left behind. And so there is a huge movement of these leafminer adults into the organic fields where they sting up the leaves and lay their eggs.

Sadly, the late season leafminer sprays conventionally are often the same spinosyn family of chemicals as are used organically as Entrust, so you can develop resistance issues that are passed on to the organic fields. Entrust is an incredible organic pesticide that the entire organic industry relies on heavily. If we ever lose it to resistance issues, life in organic production is going to be tough. It controls worms, thrips, leafminer and fruit flies. Using it on the organic and the conventional on the same population is bad.

Another really interesting insight was the idea that it would be even harder to tabulate head to head comparisons on pesticide use, because organic production uses a number of different products for pest control that well known as pesticides and aren't tracked by the National Agricultural Statistics Service in the same databases, most notably new biocides for insect, fungus, and mildew control.

What really surprised me was a comment about feeling more comfortable walking in organic fields. After decades in the industry, they feel a little niggling sense of unease in the conventional fields, not alarm, but that sense of chemicals getting on your pants, and knowing the increased risks of cancer and other health issues is non-zero. On the other hand, the worry about residues and long-term chronic exposure to the Bt, the Spinosad, and horticultural oils didn't trigger those worries. And this is not someone prone to chemophobia. A few years back in a conversation where I was in support of the Obama administration's move to ban chlorpyrifos, this person pushed back, saying that chlorpyrifos was already tightly regulated and a crucial, if parsimoniously used, mode of action where no other good options exist.

## Vineyards

Here I started with a call to an organic wine vineyard in Oregon. Bill Holloran of Holloran Vineyards, a producer of small batch natural wines was generous enough to take my call. They have 47 acres of vineyards on a 130-acre property, with cows and sheep grazing the rest of the land. They produce 3,000 –

4,000 cases a year of pinot noir.

Bill pointed out right away that he's advantaged over his colleagues in California in terms of pest pressures. The colder climate in the Willamette Valley compared to Napa or Sonoma means he can get away with using less insecticide. He stressed right away that IPM is the order of the day and they work hard to change up modes of action. To control weeds they use mechanical cultivation with an implement that gets in between the vines as it works the rows. The main pest pressures are mites and mildew. Sulfur, stylet oil, and a range of biological controls are used, with one to two sprays a year around the wooly bud break stage of the fruit's development. Stylet oil is a horticultural oil that is used to control both mildew and a number of insects. It degrades mostly into water and $CO_2$.

## Pest management in California vineyards

For more of a view from 20,000 feet, I turned to Steve Savage, a plant pathologist and agricultural consultant who has been working in California agriculture, with a focus on grapes, for decades. This is what he told me.

Both organic and conventional growers use a great deal of sulfur and paraffinic oils, but organic growers are more dependent on those for mildew and mite control. The conventional growers can use several families of synthetic fungicides for mildew – triazoles, strobilurins, SDHI inhibitors. Those are used at ounces per acre versus the 6-8 pounds per acre for sulfur. They also don't have to spray as often, while sulfur applications have to be every 7-10 days. The synthetics can be applied at intervals of two weeks to even three weeks.

Sulfur dust is the cheapest alternative because it is cheap, it controls fungus, mildew, and insects – something that you can't get from a single synthetic product, which is why conventional growers like it too. It's also valuable as a rotational alternative to prevent resistance development to the more potent synthetics. The synthetic fungicides inhibit pathways that don't even occur in animals so they have very low mammalian toxicity. A dust rig can travel through the vineyard much faster, saving on labor costs. In California, you can't use any dusts anywhere close to a school or daycare, so they would have to use the wettable sulfurs which is slower going, thus more expensive.

Vineyard workers

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Vineyard workers using copper sulfate in 1920s Hungary.

Sulfur isn’t toxic for ingestion, but it is the most common cause of complaints of skin and eye irritation for those who have to work in treated vineyards. For other fungi that cause bunch rot or leaf diseases in the East, the organic grower really only has the copper options (various salts). A conventional grower might use a bit of copper for resistance management but has many synthetic options that are much lower rate (coppers are in the several pounds per acre range) and again with virtually no mammalian toxicity. Copper can accumulate in soil and if it gets into water it’s very toxic to invertebrate species. Copper sulfate is fairly toxic to people and has been linked to cancer for workers in the European vineyards where it has historically been used extensively. The mineral oils have very low toxicity but are used at very high rates.

He also sent me a spreadsheet of application rates (Google spreadsheet) for pesticides in California with 2015 data.

## Pest management in orchards

For a 20,000 foot overview of pest management in conventional and organic orchards, I turned to

professor Terence Bradshaw director of the UVM Apple and Grape Program and Horticulture Research and Education Center at the University of Vermont. Bradshaw has a career working in vegetable, vineyard, and mainly orchards on both conventional and organic farms going back over two decades, and is someone I know to be a straight shooter without any particular ax to grind.

This is what he told me about pest management in orchards.

**THE MAIN PESTS** that drive pesticide use in orchards are the diseases apple scab (hands down, #1), fire blight, and a handful of other less insidious but occasionally serious diseases. The main insect pressure comes from the codling moth, plum curculio, apple maggot, and a handful of other second-tier critters that can be serious in the right orchard and the right year. Whether organic or not, these critters are all here and need to be managed.

Vermont and the northeastern U.S., in general, have a very low percentage of certified organic apple acreage, something on the order of 1% or less of the total. That's because you can't rotate crops to break up disease and insect pressure in perennial crops like apples, peaches, or grapes. Certain diseases and pests are ubiquitous every year, meaning input-replacement organic systems are less sustainable than a well-managed IPM (Integrated Pest Management) system.

Copper is commonly used as the first spray of the season in both organic and conventional orchards. In fact, I always get one of the OMRI-approved coppers just so I don't have to manage separate inventories and so I can use the same sprayer in both orchards if necessary. This is targeted mainly at reducing overwintering inoculum of fire blight bacteria, but also provides some protection against apple scab. Specific type varies: copper sulfate, hydroxide, octanoate. For all intents and purposes for this spray, they're pretty similar, as long as the copper ion concentration is kept constant. This is applied at delayed-dormant bud stage. If too much tissue has opened, we run the risk of foliar damage or fruit finish damage (russeting) that makes fruit unmarketable. After this spray and for that reason, copper is usually put away until next year. One shot per year, ~2-6 pounds actual copper per acre (remember an acre of soil 6" deep is ~2 million pounds), and I've not seen an increase in soil copper content.

Early spring until all overwintering fungal spores in leaf litter have discharged, growers maintain fungicide coverage to prevent apple scab. If we prevent it early in the season, we're done.  If it gets established, we fight secondary infections all season, right into harvest. Non-organic, we use a wide range of materials, depending on certain characteristics and our resistance management strategy. Sprays are applied every 7-10 days from mid to late April until mid-June.

We time the release and maturity using development models which we've been running in real-time in many orchards through a collaboration with colleagues at Cornell. Total, six to eight fungicides against scab if we nip it in the bud, maybe another two in summer against other diseases. Retail and pick-your-own growers with greater tolerance for cosmetic issues tend to skip those summer fungicides unless it's very wet.

When it comes to organic scab management: get used to the stink of sulfur. Elemental sulfur is applied every 5-7 days during that same window, as it washes off more easily and isn't as effective as the

synthetics. If you miss a period of coverage and get infection, you can ‘burn out’ with lime sulfur, which is the filthiest material I’ve ever used and I’ve used most everything available in the past twenty years. Most organic growers using this input replacement strategy make 8-12 applications, and sometimes many more applications in a season. One large organic grower told me he sprayed 30 times against scab a few years ago in a wet summer.

Sulfur and lime sulfur have substantial phytotoxic effects – they directly burn leaf and fruit tissue; kill beneficials, especially predacious mites; and suppress photosynthesis. That last one is critical, sulfur-treated trees tend to have smaller crops of smaller fruit. Lime sulfur is so bad in this regard that it’s used (off-label) as a thinner to remove excess fruit. I’ve not seen a sulfur-sprayed organic orchard in the Northeast that is anywhere near as productive as an IPM-managed one, and usually, the scab breaks through anyway. My current organic orchard consists of all Vf-gene scab-resistant cultivars, which gets away from the scab issue but still require management for other pests and diseases. I have a couple of papers worth of data to write up on that work, but it’s not like the industry is pounding down my door to get it. Fungicides (non-organic) are cheap, effective, sustainable, and our industry prefers them to replanting entire orchards to unproven cultivars.

As far as insects are concerned, there’s a fair number of options available to organic growers, but they all cost through the nose. IPM insect management is getting more expensive too, as the old organophosphates that covered most target pests cheaply are largely gone, and we’re using much more selective chemistries and needing to use more careful resistance management strategies. I’ve never known an organic grower to use rotenone in my time; a predecessor of mine here at UVM was doing an organic project assessing it against phosmet (and organophosphate) in the late 80s but that was a lifetime ago – pre-NOP. Most organic growers use kaolin clay between bloom and late June, it deters plum curculio oviposition as well as imidan but costs a lot and is a bitch to work with. Summer insecticides include Entrust, Bt, codling moth granulosis virus (a biocide that kills codling moth), and spot-sprays of pyrethrum. There are others, but these are the main ones. Aside from kaolin, which requires frequent reapplication, I wouldn’t say organic requires any more sprays than non-organic to manage insects. Then again, you also have to plan to tolerate substantially more pest damage as the organic controls aren’t as effective as non-organic. You can see the general guidelines for New England Tree Fruit here.

As for the ‘organic island’ orchards, where a large organic block is managed within the center of a non-organic orchard, I have seen that before, and I understand it’s not uncommon in Washington. The idea is to create a protective zone around the organic orchard that makes management easier. But the scale to make that happen is pretty big, especially factoring in the necessary buffers. Also, that strategy only affects the pests that come in from outside of the orchard. Is something gets established in the orchard, like apple scab, codling moth, even a local apple maggot population, then management outside the organic zone won’t affect that endemic population. Talking to the grower that I know who used this strategy for a while, he said the organic premium wasn’t worth the management hassle.

In vegetables, I’d say that pesticide use is far lower in both organic and non-organic compared to apples. Most organic vegetable growers in Vermont farm at smaller scales where crop rotation and cultural controls are enough to manage pests. Some copper is used against late blight, and Bt and Entrust are the main insecticides. But I would never suggest that organic crops are dripping in copper sulfate, and even

then, it's really just tomatoes and potatoes that get the bulk of that and only in wet years when the disease models predict infection.

## Putting it all together

In researching and putting this series together there were a number of things that surprised me and a few things that confirmed what I'd long suspected.

As I've said, I was pleasantly surprised that, while organic growers DO use pesticides – despite the popular perception that they don't, cynically encouraged by marketers and not a few farmers themselves, many organic farmers actually DON'T use any pesticides. If that works for them, more power to them, I think that's great.

I expected to be slightly horrified by organic pest management in vineyards and orchards. Instead, I was surprised to find out how much coppers and sulfurs were used in conventional farming. Don't get me wrong. I find it incredibly frustrating that the organic marketing premium incentivizes growers to farm in ways that are often less sustainable than their conventional neighbors. But I can't say that pest management in organic vineyards and orchards strikes me as an ecological disaster.

As I said at the beginning of the series, I don't consider pesticide use to be one of the most important environmental impacts in agriculture. But I do consider it a serious worker's safety issue. What I learned in putting this together confirmed what I'd long suspected. If I was a farm worker in California, I'd rather work on organic fresh produce farms than conventional vegetable farms and I'd rather work in convention vineyards than organic vineyards.

One thing that we haven't discussed that I think is important to touch on, is the trade-offs organic farmers make in avoiding synthetic pesticides. Nowhere is the trade-off bigger than in avoiding herbicides. As we observed at the beginning, weeds are the most common, most widespread pest competing for resources with the crop. While when you remove herbicides from the equation, that drastically cuts pesticide use in organic production relative to conventional. But organic farmers still need to deal with weeds, and the ways they do are not particularly environmentally friendly. The main tool is tillage, and while plenty of conventional farmers use full tillage, organic farmers have to lean on it to a greater degree. That results in substantial emissions of $CO_2$into the atmosphere. It's one of the reasons why organics fare more poorly in comparisons on eutrophication and acidification risk.

Another not so sustainable method of weed control is plastic "mulches", where long strips of black plastic are used to cover acres and acres of field so that weeds can't grow. How anyone can think that is more sustainable than spraying a pound or so of glyphosate on an acre boggles the mind – whether it's biodegradable plastic or not.

In the overall scheme of things, the amount of organic acreage is so small, it's essentially a rounding error, so you can't get that worked up about the environmental excesses. The larger problem is the monopoly the organic label has on the concept of sustainable farming.

That wraps up this installment. We'll close out tomorrow looking at the article that is patient zero for the myth that organic farming uses MORE!!! and MORE DANGEROUS!!! pesticides.

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