

Tree Fruit Production with Organic Farming Methods

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Organic crop production methods are determined to a significant extent by the organic certification standards. In general, the standards allow use of natural methods and products and disallow use of synthetic methods and products. Thus the organic grower's toolbox is greatly restricted relative to what a conventional grower has. This is especially true with regard to pest management, where tools for dealing with pest outbreaks are limited or non-existent, necessitating an emphasis on prevention. Natural fertility sources such as manures, organic amendments, and mineral powders can require changes in fertility management strategies. Many horticultural practices are similar. However, growers who have entered organic farming often describe a mental change that is necessary because of the need to understand natural processes and how to enhance those beneficial to the crop within the ecosystem of the farm.

This paper will focus on some general areas of concern for growers adopting organic tree fruit management and will provide examples of organic practices for soils and pests.

1. Major Changes in Moving to Organic Production

Growers considering a move to organic production should consider the following issues that can pose challenges. Many growers have started with a small acreage to experiment with for several years. Over time, they convert more acres as market opportunities warrant. This helps reduce risk and allows for the necessary learning of new techniques.

Approved Materials

The first obvious change for the grower is the restriction on what products can be used. While most all synthetic pesticides and fertilizers are not allowed, there are various natural materials available. In the past, organic orchardists relied heavily on botanical insecticides such as rotenone and pyrethrum. However, some certification programs no longer allow these. Other materials such as sulfur that are routinely used in conventional orchards are generally allowed in organic production. A grower must check the status of any material in advance to ensure compliance. Use of a disallowed material can lead to decertification.

Some organic certifiers are now moving towards brand name lists of approved materials to minimize confusion to growers. This is a major change from past practice, when generic lists of materials were used. For example, a generic list might approve the use of B.t. (*Bacillus thuringiensis*) products. However, a brand name list might only allow certain B.t. formulations, based on inert ingredients. A new organization, the Organic Materials Review Institute, is proposing to perform evaluation of all production and processing materials. A uniform national list is a probable outcome. While this will lessen confusion, it will likely decrease the number of products available for use.

The issue of approved materials cannot be overstated. This is where the regulatory focus is aimed, much more so than at management practices and desired environmental

or safety outcomes. Shipments of organic pears from Washington State to Europe have been rejected on the basis of the use of Mycoshield, an antibiotic used to control fireblight. This material is approved by the state organic program but not by most European programs.

Certification

Virtually all volume markets require that product claiming “organic “ be certified by a third party body. For the grower, there may be several choices in certification agencies. Agencies can vary substantially in their fee structures, reporting requirements, and other aspects, so growers should evaluate these carefully. Also, not all certification agencies have the same status. Some are IFOAM accredited, which helps for international trade. Certain end markets may prefer product certified by a specific agency, based on the agency’s reputation in that market area.

Certification requires careful and extensive recordkeeping that may add to the grower’s administrative workload. Any product claiming organic status must be backed up by a full audit trail. This includes records of all production practices on a given field, receipts of all materials purchased, tracking of lot numbers for storage and handling, and proper indication of organic status on the product label. Growers may need to find new packing, processing, or wholesale partners if the current ones are not also certified to deal with organic product.

Most certification fee structures are based on a percent of sales. Thus, as volume grows, so does the cost of staying in the organic business. Also, growers will need to provide confidential information on sales. Certification is generally done on an annual basis, so fees are due every year. There may be additional fees for the initial application. And there are fees for evaluation of products to be approved for use on organic farms. Overall, certification does add to the cost of operation both in terms of fees and added administration of records.

Labor

One of the criticisms of alternative agriculture systems is their requirement for more labor in a world where fewer people want to work on farms. Organic tree fruit production does require more labor than conventional systems. However, tree fruit is already a labor-intensive crop. Organic farming may provide an opportunity to create more year-round work. However, increases in peak labor needs, especially for blossom and fruit thinning, could prove problematic if large acreages in an area were all competing for a small available labor pool. Organic orchards use different management strategies and thus the increase in labor requirement varies from farm to farm. The areas of increased labor reported by organic growers include thinning, weed control, fertilization, and spraying, in order of importance.

Without traditional chemical thinners, organic apple growers in Washington State report that blossom and fruit thinning represents the largest increase in labor cost. Some growers report that labor costs increase by 15% over conventional systems where chemical thinning and hand thinning are used. Others report cost increases of 50-100%. Thinning can account for 10-20% of the total labor budget.

Weed control, particularly in the tree row, is also more labor intensive in organic orchards. Some growers report twice as much labor for weed control than in conventional systems, while other only require slightly more. The greatest increase

comes with mechanical tillage in the tree row, especially with young trees. Fertilization increases labor costs due to the need to spread bulkier, low analysis organic fertilizers. Some growers have purchased mechanical spreaders, but loading and spreading are still more time consuming than with commercial fertilizers. Also, pest outbreaks may require multiple sprays with approved materials that have low residual activity. For example, one apple grower reported applying 30 sprays of ryania to control codling moth in the early 1990s, prior to the use of mating disruption.

One benefit of organic production on labor is preferential availability. Organic growers often have a waiting list of workers who want to work in an “unsprayed” orchard. In tight labor markets, this positive worker safety aspect could help organic growers find the help they need.

Storage and packing

Since organic fruit must maintain its status from the field to the consumer, storage and packing operations must meet organic standards. In the past, when organic fruit volume was small, organic lots were stored with conventional fruit in Controlled Atmosphere (CA) rooms for late-season markets. The organic fruit cannot be treated with post-harvest chemicals, while much conventional fruit is. There have been numerous cases where the post-harvest chemical DPA has volatilized from the conventional fruit and contaminated the organic fruit such that it could not be marketed as organic. This problem occurs even when CA rooms are filled only with organic fruit.

Since organic fruit cannot be exposed to chemicals used on the packing line, most packers arrange to run organic fruit at the beginning of the week, just after the line has been cleaned and filled with fresh water. Also, certain types of cleaners are not allowed. Thus, a packer must be willing to take on the additional management required to handle organic fruit.

Horticultural Aspects

Many aspects of tree fruit production are similar in organic and conventional systems. However, three areas in particular can pose challenges. These are weed control, fruit thinning, and fertility management. Proper handling of the latter two is important to avoid alternate bearing, which has been a problem for some organic growers. More details on these management issues are provided later.

In addition, virtually all farms switching from conventional to organic management experience a “transition period” which is biological in nature. For example, campylocoma can be a serious pest during the first year of transition to organic, as there are no effective approved controls. But it quickly becomes a minor pest or non-pest as natural biocontrols get established. Pests such as tentiform leafminer, pest mites, and leafhoppers will decline under organic management, while powdery mildew, scab, rodents, and peach tree borers tend to require more attention. Soil nutrient cycling changes as organic fertility sources are used and organic matter increases. Thus fertilization strategies will need to change over time as the soil changes. Nitrogen deficiencies are common in the first years of organic management.

The transition to organic also increases risks and costs. Growers must learn new skills, and have fewer rescue tools to rely on. Production costs will go up. Over time, however, many growers find that organic orchards become more stable biologically.

Some costs will also decline as organic fertility regimes are established and effective management approaches are refined.

2. Soil Management

A healthy soil is one of the fundamental goals of organic farming. Early organic farming advocates such as Sir Albert Howard and J.I. Rodale made a connection between healthy soils, healthy plants, and healthy people. Also, many organic advocates believe that plants grown on healthy soils can better resist pest attacks. Thus, soil fertility receives much attention on most organic farms. Organic certification programs are also beginning to address this by requiring soil-building plans as part of the certification process. The goal is to eliminate organic farming “by neglect”, where a grower uses no disallowed materials but essentially mines the soil without providing proper organic fertility sources.

Soil Organic Matter

Organic growers consider soil organic matter (SOM) as the foundation for their farms. SOM provides a reservoir of nutrients, which are released slowly over time through mineralization. SOM can be a major contributor to the cation exchange capacity of a soil. SOM also provides the food base for soil organisms, both micro and macro. Soil physical properties, such as structure, aggregate stability, and water holding capacity, all improve with increasing SOM. Taken together, these attributes are the basis for the healthy soils desired by organic growers.

All organic growers add organic matter to the soil as part of their fertility program. This can be in the form of animal manures, composts, green manures, food processing wastes, and other organic by-products. These materials also supply a large portion of the nutrient inputs. Organic orchardists in Washington State monitor changes in soil organic matter as an indicator of their management. It is difficult to increase organic matter levels in semi-arid climates and in coarse soils. However, growers have achieved SOM levels as high as 4-5% after years of organic management. One grower has records showing SOM levels of 0.8-1.5% under conventional management and 2.3-3.6% after 10-15 years of organic management in the same orchard.

Tillage is a major destroyer of SOM and a few growers have measured declines in SOM in the tree row where they use repeated tillage to control weeds. Alternative weed management strategies are badly needed to address this problem.

Fertility and Plant Nutrition

Nitrogen (N) is often the nutrient of most concern in Pacific Northwest organic orchards. Soils tend to have adequate phosphorus (P) and potassium (K). Calcium (Ca), zinc (Zn), and boron (B) are other nutrients that are often in short supply. Growers typically provide a large nutrient input with a fall application of animal manure (often composted). Chicken manure compost is a widely used product due to its relatively high N content and lower cost per pound of N. A comparison of N sources and costs is provided in Table 1.

The products differ in their N release characteristics and in their spreading requirements and costs. For example, compost is often spread by hand at a cost of \$20-30 per acre,

whereas the Bio-Gro product is prilled and can be spread easily with available equipment.

Table 1. Organic N Sources and Costs.

<u>Source</u>	<u>% N (dry)</u>	<u>Cost (\$)</u>	<u>Cost per lb N (\$)</u>
Chilean nitrate*	16	560	1.75
Bloodmeal	13	792	3.05
Feathermeal	12	690	2.87
Bio-Gro fish by-product	9	650	3.61
Canola meal	6	395	3.29
Chicken manure compost	4	80	1.33
Alfalfa meal	3	278	4.63

*Chilean nitrate is restricted or not allowed by most organic programs.

The organic N sources provide a combination of readily available N (ammonium and nitrate) and slow-release organic N. Over time, the annual application rate can decrease as N released from materials applied in previous years starts to accumulate. This often takes five to eight years.

Growers strive to balance the need for enough N to provide adequate tree vigor and annual bearing while keeping N levels and vigor low enough to discourage pests such as aphid and problems such as fireblight. If N levels appear low during the growing season, foliar fish fertilizers can be sprayed on. Some growers monitor leaf N; however, experience in other crops indicates that the sufficiency levels developed for conventional fertilizer programs often do not apply to organic management. One Washington State orchardist uses leaf analysis and aims to keep N levels 10% below the University recommendation.

For Ca, Zn, and B, there are a number of commercial products available that are approved for organic farms. These include zinc sulfate, Solubor, gypsum, lime, and chelated nutrients. Seaweed extracts are another source of micronutrients. Rock phosphate and other ground minerals can be used as well.

Bitterpit of apple is a nutritional problem reported by a number of organic growers. Thus, they monitor Ca levels and especially the ratio of Ca to N. Some growers subscribe to the cation balance theory, where they want to achieve a base saturation of 65-70% Ca, 10-15% Mg, and 2-5% K. This concept is controversial among soils researchers, and little work has been done on tree fruits. Most organic growers rely on tree growth and fruit yield and quality as the best integrators of soil fertility and plant nutrition.

The cost of organic fertility inputs can be substantially higher than conventional fertilizers. This is especially true during the first years of transition to organic, when N cycling goes through significant changes. One grower estimates that increased fertility costs can reach several hundred dollars per acre, but this only amounts to \$0.20 per packed 40-lb. box of apples.

A potential problem with organic fertility programs is accumulation of late season N that would delay dormancy and reduce winterhardiness. Organic orchardists do not report a problem with this. They propose that the slow-release nature of the fertilizers prevents accumulation of enough N. Few studies have been done looking at leaching losses of N under organic management. Proper irrigation water management is the most important practice in preventing this.

Ground Covers

Virtually all orchards in the Pacific Northwest grow a perennial ground cover between the tree rows once the orchard is established. This is typically a stand of perennial grass with shallow roots that do not compete with the trees. Most conventional orchards use herbicides to keep a 4 to 6 foot weed-free strip in the tree row. In new organic plantings, maintaining this weed-free strip to allow for maximum growth can be a challenge. Most growers use mechanical tillage with tools such as a Weed Badger or Rinieri. Multiple tillages are required and damage to tree trunks and roots is possible. Some growers have avoided planting a grass cover in the alleys as they have had problems with it creeping into the tree row. A few growers prefer to start a new planting with conventional management and then switch to organic management after the first or second year to help with weed control.

While the grass alleys are generally considered to have minimal influence on orchard function, organic growers are examining ways to increase orchard biodiversity through manipulation of the ground cover. Growers are interested in the potential to achieve multiple benefits from ground cover, including enhanced biocontrol through beneficial insect habitat, biological nitrogen fixation from legumes, weed suppression, and organic matter additions.

Perennial legumes such as white clover and alfalfa are used in a few orchards. The white clover provides excellent weed control, is low growing, and is shallow rooted. It provides continual bloom throughout the season. One drawback is the lack of traction on steeper slopes. Alfalfa provides much more biomass and N production and requires mowing. It is being used in one orchard as a source of mulch for the tree row as well as a source of N. Alternate rows are cut with a sickle-bar mower and swept to the tree row where they form a thick mulch. Potential pests such as lygus bug remain on the ground in the uncut portions. The mulch controls weeds during the season, provides N, conserves moisture, and is then mechanically removed in the fall to break up rodent habitat. In addition, research is underway to evaluate alfalfa as a source of non-pest leafrollers that will host an established leafroller natural enemy that can be induced to move into the fruit trees at the appropriate time.

Interest in such multi-purpose cover crop systems is increasing, and California grape and almond growers have extensive experience in applying these systems to large acreages. In tree fruit, experience is limited and the few existing studies indicate difficulties in getting the natural enemies into the trees where they are needed. Researchers are currently examining the potential of cover crops to assist in biocontrol of apple replant disease. Initial studies with wheat show promise in its ability to shift the rhizosphere microbial community such that apple seedlings grow as well in replant soil as in pasteurized soil. In the future, ground cover management in organic orchards may include several vegetation zones with different functions, and these zones may change over time with the age of the orchard. For example, a weed-free zone is desired during

the first several years and perhaps a cover crop to suppress replant disease would be grown several years prior to orchard removal.

3. Weed Management

With the prohibition of herbicide use, organic growers use a variety of strategies to control unwanted vegetation in orchards. Competition from vegetation is most damaging to young trees during the first two years. Researchers have shown that a 2 to 3 foot radius weed free zone maximizes tree growth. Weed control in the early season (June) is much more critical than late season. Dwarf trees are more negatively affected by competition than full-sized trees.

Mowing is the most common vegetation management strategy. In addition to standard orchard mowers for the alleys, trim mowers with a trip-mount are available that can mow between trees in row. Most organic growers use some form of tillage to keep a weed-free strip in the tree row during the first few years after planting. Some continue this practice for the life of the orchard. However, this can have detrimental effects on soil organic matter. Mulching the tree row is another strategy. It is labor intensive, does not give complete control, and can lead to rodent problems. Growers have tried hay, straw, wood chips, and landscape fabric as mulches. Researchers are examining shredded paper mulches that can be mechanically applied. Mulches add organic matter and buffer moisture and temperature extremes in the soil in addition to controlling weeds.

Cover crops such as white clover can be used to smother weeds. Some growers keep a weed-free strip for young trees and then let a perennial non-grass cover grow into the tree row. The alfalfa mulch system described under Ground Covers above represents an integrated strategy with multiple benefits. Cover crop growth can be used to regulate nutrient competition and control tree vigor if excessive.

Thermal weed control tools have been developed, using either a propane flame or hot water. These are more effective on young annual weeds than perennials. Tree trunks would need adequate protection from scorching if this type of system were to be used. No relevant biocontrols or microbial herbicides are presently available. A fatty-acid based herbicide is available but not allowed by most organic programs.

4. Insect Pest Management

Codling moth (CM) has been the traditional key pest of apple orchards in the Pacific Northwest. It was difficult to control in organic orchards prior to the advent of pheromone mating disruption (MD). MD has allowed for successful and more cost-effective organic production and is perhaps the single new tool that has allowed for greatly expanded organic apple acreage. However, most growers use MD in conjunction with a number of other preventive and suppressive strategies, as a powerful knockdown tool for codling moth is not available. In the past, ryania, a botanical pesticide, was the primary CM control. It was sprayed as many as 20-30 times per season, and cullage still might exceed 20%. Growers tried codling moth granulosis virus (CMGV), but it had limited effectiveness. New formulations may improve this highly specific biocontrol that holds great promise. B.t. does not provide CM control due to the insect larva's feeding habits.

Other CM controls include: orchard sanitation (picking off infested fruit and removing from orchard); banding trees with corrugated cardboard (remove and destroy larvae and eggs in band); black light traps (effective for some growers); repellents (pepper spray, garlic spray); overhead watering at night (to disrupt moth flight); fish oil and other summer oils (mixed results, potential phytotoxicity). Examples of insect control practices and their perceived efficacy by organic growers are presented in Table 2. No organic orchardist is able to achieve acceptable CM control by relying on natural predation.

Table 2. Insect Control in Organic Apple Orchards. North Central Washington Grower Survey, 1995.

<u>Insect Control</u>	<u>Effectiveness of Control</u>		
	<u>Major</u>	<u>Contributing</u>	<u>Negligible</u>
Mating disruption (CM)	14	0	0
Dormant oil	9	2	1
B.t.	7	2	4
Cover crops	5	0	1
Sanitation	4	5	0
Pheromone traps	4	1	0
Summer oil	3	1	1
Ryania	2	7	1
Fertility management	2	1	0
CM Granulosis Virus	1	3	3
Soap	1	1	4
Lacewings	1	1	0
Black light traps	0	2	0
Trichogramma wasp	0	1	4
Diatomaceous earth	0	0	3

Few other pests are consistent problems on apples. Leafrollers can generally be controlled with a dormant oil and B.t. sprays. Vigor control prevents aphid problems. Feeding stimulants appear to improve control with B.t.

Psylla is the most common pest in organic pears in the Pacific Northwest. Many orchards have low populations due to natural predation. Dormant oil is an important practice for psylla. During the growing season, growers can use insecticidal soap, Pyrellin (a pyrethrum product), rotenone, or detergent soap.

New insect control products such as Neemix are becoming available, but often do not perform very well. Established products such as rotenone are losing their pesticide registration. Thus, organic and conventional growers both face an ever-changing mix of tools.

Organic growers vary in their approach to monitoring. Some have very formal programs using degree-day models for insect development and extensive trapping. Others, particularly smaller growers, have faith that the system will self-regulate to a large degree. They know their key pests and visually monitor for them while in the orchard.

In a survey of organic orchardists in Washington State, six out of 14 were using ten or more insect pest management strategies. Seven used five to nine strategies, and only one used less than five. Since no powerful interventions are possible, organic growers need a broad approach to pest management that is based on prevention.

5. Disease Management

Diseases are generally not a severe limiting factor to organic tree fruit production in the Pacific Northwest. In other more humid regions, organic production may be impossible due to disease that cannot be controlled adequately to produce a marketable product.

On apple, scab and powdery mildew are the two most frequent disease problems for organic growers. Mildew is becoming more prominent as growers switch to more mildew susceptible varieties such as Gala. Dormant and early season sulfur and lime sulfur are primary controls. Pruning to improve air movement is a cultural control. Other effective controls reported by growers include moderate N levels, Ca sprays, kelp, and soap.

Growers attempt to prevent disease through a balanced soil fertility program. Composts show some promise for controlling certain soil-borne diseases, including *Phytophthora*. Copper sprays, water management, N management, (e.g. for fireblight), and sanitation are other disease control strategies available. More biological disease control materials are being developed, but some are prohibited for organic production.

6. Rodent Control

Some aspects of organic production (e.g. weeds, cover crops, mulches) can enhance rodent habitat. One rodent poison available to organic growers is Quintox, a vitamin D₃ based product that is not toxic to animals that might eat rodents. Other rodent control strategies include tree guards, trapping, and encouragement of predators such as owls, coyotes, and snakes. A few growers do some early pruning in the fall to leave branches on the ground that act as preferential food for rodents under the snow.

7. Summary

More tree fruit growers are using organic farming practices on some or all of their acreage due to favorable economics, improved management options, and potential loss of pesticides. Shifting to organic production entails more than merely substituting organically approved products for conventional fertilizers and pesticides. Organic growers must be more aware of the entire agroecosystem and employ a range of strategies to achieve a particular goal. Rescue treatments are seldom an option and preventive strategies are critical. Increasingly, agricultural supply companies are introducing products for conventional growers that have great potential for organic production as well. The best example is pheromone mating disruption, which has enabled organic growers to successfully control codling moth and produce high quality fruit comparable to conventional systems.

8. References

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