Organic Pecan PRODUCTION

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EXTENSION

Organic food production is one of the fastest-growing sectors of the American food marketplace and is driven largely by personal health preferences and environmental ethics. Organic food sales in the U.S. rose from $13 billion in 2005 to $35 billion in 2014. Organic farmers are required to follow an ecological soil management program and are restricted in their use of chemicals. In order for a crop to be marketed as organic, it must obtain organic certification and maintain records of the production practices in use on the farm. The U.S. Department of Agriculture's organic certification information is available at https://www.usda.gov/topics/organic. A three-year transition period is required before a crop can be sold as "organic" with the USDA-certified organic seal. Pecan production generates unique challenges to organic production methods in the humid Southeastern U.S. because it is an environment conducive to heavy pressure from insects, diseases, and weeds. Therefore, the foundation of any organic pecan production program in the Southeast will be based on selecting pest-resistant cultivars.

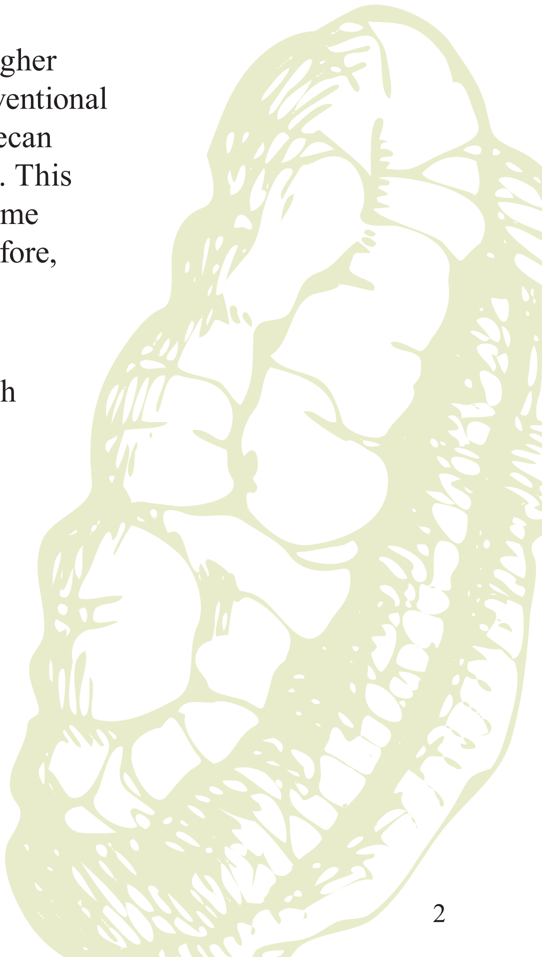
The market for organic pecans

Depending upon the marketing strategy used, there may not be any significant economic advantage to organic pecan production. Yields for conventionally grown, standard cultivars such as 'Stuart', 'Schley', 'Desirable', and 'Pawnee' grown in the Southeast will almost certainly be lower in an organic system as a result of both the significant disease and insect pressures that occur in a humid environment and the lack of effective organic control options. Productive, disease-resistant cultivars offer the best opportunity for success from a production standpoint, but these cultivars often bring a lower price in the conventional pecan market as a result of the smaller nut size, and in many cases, the lower percent kernel of the nut. Organic production systems often require more labor than those for conventional production. Growers should be aware that increased labor costs can potentially impact profit margins.

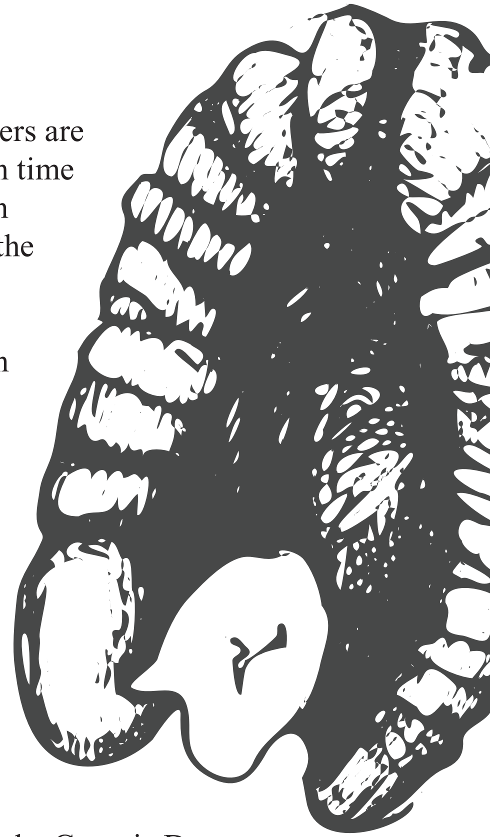
Organic pecan brokers use a sliding scale to determine pricing. Typically, a higher percentage price premium relative to conventional prices is offered when conventional prices are low, and a smaller percentage when conventional prices are high. Pecan prices increased in 2010 as a result of the expanding export market for pecans. This reduces the opportunities for price premiums for organic pecans. However, some consumers are still willing to pay price premiums for organic products. Therefore, organic producers should seek out specialized marketing opportunities.

Organic producers should use an established organic marketer or develop personalized local, regional, or national contacts. Local sales are initially much easier to develop until a higher volume of nuts is produced. Sales to large chains often require a large volume and may be difficult to arrange, as those companies often have pre-existing contracts.

Particularly for the smaller grower, initial sales are usually more successful at established farmers markets. Direct sales to consumers via internet or mail-order often provide a good opportunity and can help build a customer base. Direct sales to retail grocery outlets and restaurants also offer potential markets. Regardless of the market, a consistent supply of pecans is necessary to develop a reliable customer base.



Organic certification



Organic farming is based largely on the development of soil organic matter. Growers are required to monitor soil organic matter level annually until it reaches 2%, at which time it must be monitored every five years. Organic matter levels in Southeastern pecan orchard (conventional and organic) soils tend to be higher on average than that of the adjacent soils found in row crop fields. The higher levels are a result of the year-round vegetated cover found in orchards and the abundance of organic matter that reaches the orchard floor in the normal course of production. In this respect, pecan orchards are essentially meadows containing interplanted trees, and they largely mimic hardwood forest systems. Organic matter may be further enhanced by planting legume cover crops such as clover between tree rows.

In terms of labeling, the "organic" classification is owned by the USDA and certification is governed by the USDA's National Organic Program (NOP). Regulations can be found at https://www.ams.usda.gov/rules-regulations/organic. Growers must supply an organic farm plan to outline its programs for soil improvement and crop management. Organic production restricts the materials used to fertilize crops and control pests, as governed by the Organic Materials Review Institute (OMRI) and Federal Organic Standards (FOS). In Georgia, organic certification can be obtained from any state or private certifier accredited through the NOP and registered with the Georgia Department of Agriculture. A list of materials cleared for organic use is available from the OMRI website at www.omri.org. The NOP outlines important steps to the organic certification process at https://www.usda.gov/media/blog/2012/10/10/organic-101-five-steps-organic-certification.

Pecans sold as organic must also be cleaned and processed separately from conventionally grown pecans. This means that they cannot be cleaned at most commercial pecan cleaning plants.

Conversion from conventional to organic pecan production

In most cases, converting old, established pecan orchards from conventional to organic production is not practical simply because most of the older existing orchards in Georgia are comprised of disease-susceptible cultivars like 'Stuart', 'Schley', 'Desirable', and various others. Older cultivars that potentially offer enough scab resistance to produce a crop without the use of conventional fungicides in most areas include 'Elliot' and 'Moneymaker'. It is best to establish an organic pecan orchard with low-input cultivars that do not require fungicide application.

For the crop to be certified "organic," the NOP requires a three-year period of organic management without the use of synthetic chemicals. Growers who meet all of the provisions for organic certification except passage of the chemical-free time period may market their crop using the words "in transition" once one full year has elapsed since the last application of synthetic chemicals.

The prolonged time to production following planting of pecan trees offers an advantage in the establishment of a pecan orchard through conventional means, which may then be converted to organic management before the trees begin to bear pecans. Pecan tree establishment is often quite difficult in the humid Southeast because weed control is of critical importance in the early tree establishment phase and numerous insect pests attack young pecan trees. Thus, conventional management for the first four to five years gives the trees the best opportunity for optimal growth and establishment.

During the transition period, crimson clover can be grown between tree rows to provide organic matter and supplemental nitrogen. Using integrated pest management (IPM) to minimize impacts on beneficial insects during transition will help ease the move into organic production as well.

Cultivar selection

The foundation for the success of organic pecan production in the Southeast is cultivar selection. The extreme disease pressure generated by the humid climate favors development of pecan scab to varying levels on most commercial pecan cultivars, highly limiting their use for organic production. As a result, organic producers should choose disease-resistant cultivars that can be grown without the use of synthetic fungicides. Table 1 includes pecan cultivars that are suitable for organic production in Georgia. It should be noted that pecan scab resistance is a dynamic mechanism that may change over time based on disease pressure and the disease organism's ability to overcome the plant's defenses. Further details on the characteristics of these and other pecan cultivars can be found in University of Georgia Cooperative Extension Circular 898, "Pecan Varieties for Georgia Orchards" and at UGA's pecan breeding website, www.caes.uga.edu/extension-outreach/commodities/pecan-breeding.html. Since most commercial pecan nurseries may not carry all of the cultivars listed, growers interested in planting these cultivars should contact nurseries at least one year in advance of orchard planting.

Cultivar	Parentage	Dichogamy[2]	Nuts per Pound[3]	Percent Kernel[3]	Scab[4]	Nut Maturity[3]	I[5]
'Amling'	Seedling	I	57	55	1	Oct. 17	UK
'Elliott'	Seedling	II	77	51	1	Oct. 12	UK
'Excel'	Seedling	II	44	49	1	Oct. 13	UK
'Gafford'	Seedling	I	48	50	1	Oct. 16	UK
'Lakota'	Mahan x Major	II	59	62	1	?	UK
'McMillan'	Seedling	II	51	50	1	Oct. 12	UK

[1] Cultivars in the top of the table are generally recommended; those recommended for trial have looked good so far, but they are new and data is limited; and those at the bottom are recommended for special situations. All pecan cultivars have strengths and weaknesses and growers should consult other experienced growers, Extension agents, and specialists when determining which cultivar to plant.

[2] Type I = protandrous (pollen shed first); Type II = protogynous (stigma receptive first)

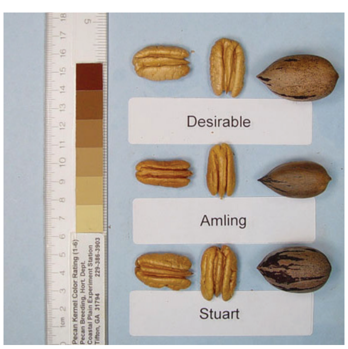
[3] Average from Tifton, Georgia, cultivar trials

[4] 1 = excellent resistance; 2 = good resistance; 3 = mediocre resistance; 4 = poor resistance

[5] I = Alternate bearing index. Ranges are from 0 to 1, with 0 = no alternation and 1 = complete alternation, which would be no yield every other year

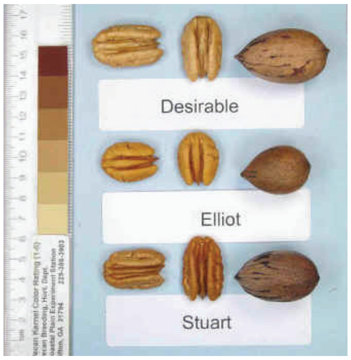
UK = Unknown

'Amling'



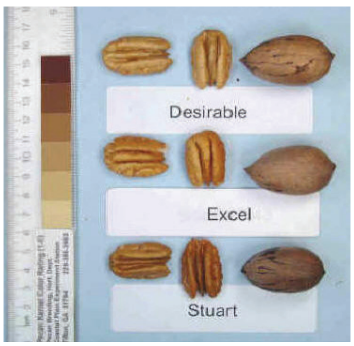
'Amling' has full, dark green foliage and excellent resistance to pecan scab and most pests. The small to medium sized nuts have a high-quality kernel and are easy to shell. 'Amling' is a type I (protandrous) cultivar. It would be pollinated by 'Excel', 'Gafford', 'Kanza', 'Lakota', and 'McMillan' in an organic system. It should also be a good pollinator for 'McMillan' and 'Elliott'. While offering a small nut, 'Amling' is one of the most pest-resistant cultivars available.

‘Elliott’



’Elliott’ is widely planted in Georgia. Due to its resistance to scab and excellent-quality nuts, the Georgia Extension Service started recommending it for orchard planting in the early 1960s. We still recommend it for growers looking for a cultivar that needs little or no scab protection. ‘Elliott’ has a small, teardrop-shaped nut of extremely high quality. Growers should receive a premium price for a small nut because of its plump, perfect halves. Percentage fill and specific gravity are high. It bears alternately, meaning that this variety tends to produce a large crop one year and a much smaller crop the next, but nut quality remains superior in high-production years. Growers should seek those specialty markets that are aware of the merits of this cultivar, otherwise it might bring seedling prices. High scab resistance makes it a good choice for home orchard plantings. ‘Elliott’ is susceptible to late spring freezes and should not be planted in north Georgia or in low spots. For these areas,’Kanza’ is the better choice. Yellow aphids can be a problem with ‘Elliott’, and young trees are slow to come into production.

‘Excel’



‘Excel’ was discovered as a seedling tree on a pecan farm near Blackshear, Georgia. We have never observed scab on this cultivar in our orchard, and it has excellent resistance. However, it was reported to have minimal scab at its home orchard in the excessively wet year of 2013.

Trees are slow to break buds in the spring and are among the last to flower. ‘Excel’ is not a precocious cultivar, but it yields well when it comes into bearing. It does begin to bear alternately at a fairly young age. Nut size is large, similar to ‘Desirable’. The shell is thick and this limits percent kernel to about 50-51% on a very well-filled nut. The kernel has a bright, golden color with an attractive shape. Kernel color holds very well in storage.

‘Excel’ is a type II (protogynous) cultivar, which has very late bud break and flowering. ‘Excel’ would be pollinated by ‘Amling’, ‘Elliott’, ‘Gafford’, ‘Kanza’, ‘Lakota’, and ‘McMillan’.

‘Excel’ is large in cluster size and nut size, suggesting that nut thinning may be necessary in mature trees. However, tree limbs are relatively thin, producing a willowy growth that may make it difficult to mechanically thin the crop. Many acres of this cultivar have been planted throughout Georgia.

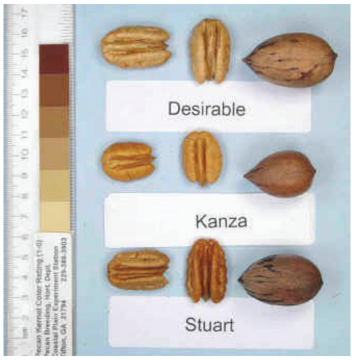
We recommend this cultivar for low input and organic plantings because it is one of the few cultivars with large nut size and high resistance to scab. It also appears to have good resistance to both black and yellow aphids.

‘Gafford’

We have not seen scab on ‘Gafford’ in our trials. It produces a good sized nut with average quality. Harvest date is late October. ‘Gafford’ has a very thick shell, which prevent its percent kernel from ever going above about 50%. We have often noted some fuzz on its kernels and saw some spotting on the kernels in 2010.

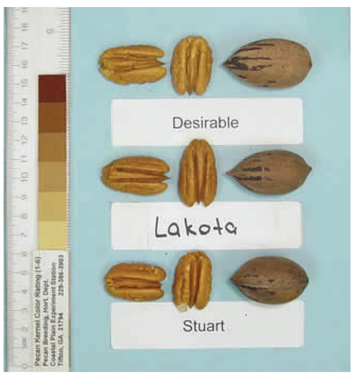
This tree was selected for low-input plantings and will likely only be useful to growers who need excellent pest resistance. While ‘Gafford’ is slightly bigger than ‘McMillan’ (48 vs. 51 nuts/lb), ‘McMillan appears to be more productive and earlier than ‘Gafford’. ‘McMillan’ also doesn’t seem to have the spotting and kernel fuzz problems of ‘Gafford’. However, scab resistance in ‘Gafford’ may be slightly superior to ‘McMillan’.

‘Kanza’



‘Kanza’ was released by the USDA for its superior productivity, quality, disease resistance, and cold tolerance. ‘Kanza’ has good productivity as a mature tree. Alternate bearing has been a problem with ‘Kanza’, but nut quality in high-production years is good. Harvest date is early, averaging around October 8th, and often occurs at the end of September. ‘Kanza’ produces a small, very attractive, round kernel. The nuts are so similar to ‘Elliott’ that they are hard to differentiate. ‘Kanza’ was primarily released for use in the northern pecan growing regions due to its excellent cold hardiness. Its early maturity and small size makes it susceptible to predator damage when only a few trees are planted. So far, ‘Kanza’ appears to have excellent resistance to scab, but it has not been widely grown in southern orchards, so it is unknown how this resistance will hold up in the long run. We recommend ‘Kanza’ as a replacement for ‘Elliott’ in northern areas where ‘Elliott’ would be damaged by late spring freezes.

‘Lakota’

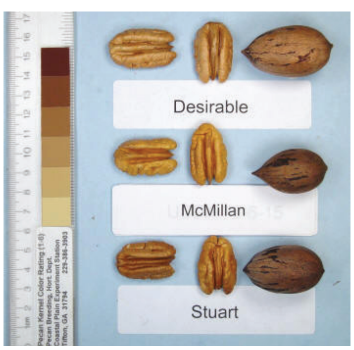


‘Lakota’ was selected for its high nut quality, high yield potential, early nut maturity, and excellent tree strength. ‘Lakota’ is a type II cultivar and is promising because of its high levels of scab resistance and early harvest date (about 2 weeks after ‘Pawnee’).

We have not seen scab on unsprayed trees, even amid abundant rainfall in 2013. In 2012, black aphid damage was very noticeable and organic growers should be vigilant for this pest. Early observations indicate that ‘Lakota’ is a vigorous tree with dark-green leaves. Early results give a nut size of about 54 nuts per pound and 58% kernel. Nut size is somewhat variable, even within the same cluster.

Young trees are setting a crop ahead of the other cultivars planted at the same time and the cluster size is large, indicating that this is likely a precocious cultivar. Observations are minimal at this point, but this cultivar shows great promise for organic production. This is one the few early harvest cultivars with large nut size, and it has excellent scab resistance so far.

‘McMillan’



‘McMillan’ has a reputation for having high, sustained levels of production and excellent pest resistance. It has been a high yielding and precocious cultivar, and early yields were approximately double those of ‘Desirable’. ‘McMillan’ does exhibit an alternate bearing mode, but it produces a decent crop even in light years. We have not crop-thinned ‘McMillan’, but it would likely benefit from some thinning in high-production years. Trees grow vigorously and have a fairly wide canopy.

‘McMillan’ has average nut quality, with a thick shell reducing percent kernel to about 50% and a darker kernel color. ‘McMillan’ is comparable to a high-quality ‘Stuart’ nut. ‘McMillan’ will fill better than ‘Stuart’ and seldom has the packing material (fuzz) sticking to its kernel like ‘Stuart’. It is, however, slightly smaller than ‘Stuart’ and the kernel color is not as bright. The nut shucks have a distinctively rough appearance. The productiveness and scab resistance of this cultivar suggest that it would be a good choice for low-input plantings. Aphid damage has not been a problem. ‘McMillan’ has what we call “good” resistance, meaning that it will develop slight scab in wet years without sprays but remains clean in most years.

In general, ‘McMillan’ is a good choice for organic plantings and low-input plantings. Standard commercial growers will probably want a higher quality nut that will bring a higher price. ‘McMillan’ is a protogynous cultivar with early receptivity and middle to late pollen shed. It would be pollinated by ‘Amling’, ‘Elliott’, ‘Gafford’, and ‘Kanza’.

Fertilization, soil, and orchard floor management

Pecans, whether grown conventionally or organically, require 14 essential mineral nutrients: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), zinc (Zn), iron (Fe), boron (B), manganese (Mn), molybdenum (Mb), copper (Cu), chlorine (Cl), and nickel (Ni). While all of these nutrients are important to pecan production, only a few are commonly limiting in Georgia pecan orchards. The nutritional status of the trees should be assessed annually using both tissue and soil analysis.

Leaf sampling procedures:

1. Sample trees between July 7 and August 7. Sampling can be extended into mid-August without affecting the results.
2. Collect 50 to 100 middle-pair leaflets from the middle leaf of this year's growth (Figure 1). Use terminal shoots exposed to the sun. Avoid twigs from the interior of the tree. Collect leaflets from all sides of the tree. Avoid leaflets damaged by insects and diseases. Place leaf samples in a paper bag or bag supplied by a testing laboratory.
3. Abnormal trees or trees not representative of the area should be sampled separately. A complete and accurate description of abnormalities should accompany such samples.
4. Sample trees of the predominant variety in a given block. If 'Elliott' is the main variety, sample 'Elliott'; if 'Lakota' is the main variety, sample 'Lakota', etc.
5. Upon collection, immediately wipe the leaves (entire surface, both top and bottom) with a damp cellulose sponge or cheese cloth to remove dust and spray residue. Do not allow the leaves to come into contact with rubber or galvanized containers. Partially air dry and place in the large envelope of the mailing kit.
6. Contact a soil testing laboratory and provide any necessary information to be sent along with the sample. By sampling the same trees each year, growers can more readily see the results of any changes to their nutritional programs.

Figure 1. A middle pair of leaflets chosen for leaf sampling.

Soil sampling procedures:

1. Soil samples may be conveniently taken when leaf samples are pulled. Soil sample bags are available from your county Extension agent. They should be used for submitting samples to the laboratory. Supply all the information asked for on the soil sample bags.
2. Use a spade, trowel, soil sampling tube, auger, or other tool which can take a thin, vertical slice of soil to a depth of 8 to 12 inches.
3. Take at least 12 or 15 cores or thin slices at random over the area to be sampled. In general, one composite sample consisting of 12 to 15 cores should be taken for each block of trees. If possible, sample under the predominant variety (e.g., 'Stuart'). Place samples in a clean plastic bucket or other non-metal container and mix well. Fill the soil sample bag at least three-quarters full. Do not use a galvanized bucket if the soil is to be analyzed for zinc or other micronutrients.
4. Cores should be pulled within the drip line, not between rows. The area included in one sample should have been uniformly fertilized and limed in the past. When collecting the sample, avoid high or low spots, eroded areas, and areas along roads and fences. Sample problem areas within an orchard separately.

Nitrogen is the element that most commonly limits pecan growth and, ultimately, orchard profitability. It provides better tree growth, a higher percent kernel, and a healthier tree. When properly maintained, nitrogen helps to ensure optimal year-to-year production. Nitrogen deficiencies result in poor growth and poor tree health. Excessive nitrogen stimulates excess foliage, shading, and, in some instances, reduced yield. The key to nitrogen management is to balance timely availability with tree demand.

Nitrogen uptake in the pecan tree is driven by demand. There are two critical periods of nitrogen (N) demand during the season: 1) early foliage growth, and 2) kernel filling. The early spring foliage flush is nourished primarily from reserves held within the tree, while the nitrogen demand during the kernel fill stage is usually satisfied from soil uptake. If N is limited at kernel filling, then the tree will mobilize N from the foliage to the kernels.

Organic pecan production presents certain challenges to N management. Pecan trees require 100 to 150 lbs of actual N per acre annually. Conventional pecan orchards are often fertilized with synthetic fertilizers, which allow growers to more precisely control the rate and timing of N application, as these materials have a consistent, known, readily available content of N.

Manure can be an excellent source of N and other nutrients. The use of raw (noncomposted) animal manures in pecan orchards carries the risk of nut contamination. However, to minimize this risk, noncomposted manures should be incorporated no later than 120 days before harvest as required by the National Organic Program (NOP) rules. There are currently no federal regulations on manure use in pecan orchards, but it is recommended that growers take the precautions described here to minimize the chance of contamination.

Composted manures do not pose the same risk and may be applied at any time, but must be composted following the rules set forth in the Organic Standards 205.203, which can be found at https://www.ams.usda.gov/sites/default/files/media/Manure%20in%20Organic%20Production%20Systems_FINAL.pdf. All manure and compost should be tested by a qualified analytical laboratory prior to application to determine the amount of available nutrients present in the material. NOP guidelines state that compost must have an initial C:N ratio between 25:1 and 40:1. This is important because soil N is tied up and left unavailable to the trees as the C:N ratio increases.

Feather meal or pelletized poultry litter can be used to provide N. A nutrient analysis of the product should be attained prior to use and applied at a rate that will provide 100 to 125 lbs N per acre for mature trees. Nonbearing trees up to eight years old may use a 50 -75 lbs per acre rate. These applications should be timed so that the N is available primarily within two weeks after budbreak. Feather meal and pelletized poultry litter release just over 60% and 25% of available N, respectively, within 40 days after incorporation into the soil. However, incorporating materials into orchard soil has the potential to disturb roots and spread crown gall disease, so incorporation is not recommended. Research with raw poultry litter suggests that a large percentage of N is released within 60 to 120 days following application on non-disturbed orchard soils.

Trees in agroforestry systems are capable of recycling soil nutrients that leach downward in the soil profile, thereby reducing groundwater contamination and increasing nutrient use efficiency in the system. Pecan tree roots reduce N leaching, partially as a result of tree water uptake, which reduces soil water drainage. Thus, pecan orchard systems may be less susceptible to N leaching than are other cropping systems.

Applying litter or composted materials can lead to high soil P and K levels. Excess soil P accumulation is often a serious concern with poultry litter application as a result of the potential for surface runoff and pollution. Although always a concern, there would likely be a reduced potential for P runoff in a pecan orchard system managed in the Southeast compared with other cropping systems because the orchard floor is maintained with grass alleyways between the tree rows. Although P is relatively immobile in the soil environment, as mentioned previously, deep-rooted orchard crops like pecan can play a significant role as a safety net in the alleviation of excessive nutrient loss. Where P is concerned, pecan roots may also help to stabilize soil, minimizing soil erosion and P runoff into streams. The addition of clover to this system would further reduce the likelihood of surface runoff, because clover is actively growing at the time of poultry litter application and uses some of the P and other nutrients from the litter.

Other nonsynthetic fertilizer N sources are available for organic growers. However, growers should consult NOP rules to determine the suitability of any product used in organic production if there is any uncertainty. The word "organic" on a fertilizer label does not always mean the fertilizer is suitable for organic production. Allowable N sources include blood meal, feather meal, fish meal, cottonseed meal, and soybean meal (from non-GMO plants).

Chilean nitrate (sodium nitrate) is a mined source of highly soluble nitrogen, which is comparable to conventional fertilizers in their benefits but allowable in organic agriculture as long as it accounts for no more than 20% of the orchard's total annual N requirement. Its use must be addressed and justified in the organic system plan. Concerns remain regarding the excessive buildup of salt and/or water quality with the use of Chilean nitrate.

Figure 2. Symptoms of zinc deficiency presenting in pecan.

Zinc has a major influence on the economic returns of a pecan operation due to its effect on flowering, fruit size, leaf efficiency, and nut yield. It is particularly important to leaf expansion and shoot elongation. As a result, zinc must be available to the tree at these specific times during the growing season. The most familiar characteristic of zinc deficiency is a curling of young leaves, resulting in a wavy leaf margin (Figure 2). Additional symptoms may be a rosette pattern, narrow leaves, and terminal die-back.

Even with adequate soil levels, the availability of zinc in the soil depends upon soil pH, nitrogen, and phosphorous application. Zinc is most available at a pH of 6.5 or less and moves slowly in the soil, requiring two or more years for most surface applications to become effective. Poultry litter typically contains around 0.6 pounds of zinc per ton and would likely provide some of the required zinc as long as soil pH is managed appropriately. Foliar zinc applications are the most rapid means of correcting the problem when deficiencies occur. Three applications per season are normally recommended in conventional orchards, applying the first spray about two weeks after budbreak. Sprays should be applied at two-week intervals over the period of shoot elongation. Although zinc sulfate and zinc oxide are considered synthetic, these chemicals are permitted by the NOP for use in organic pecan orchards if there is a demonstrated deficiency.

Weed management, orchard floor management, and legume use in pecan orchards

Pecan orchards in the Southeast typically have grass sod growing between the tree rows. In conventional orchards, the area immediately surrounding the trees is kept weed-free with herbicide application in a 12-to-15-foot band centered on the tree and running the length of the tree row. In organic orchards, a 10-by-10-foot weed-free area can be maintained with mulch.

The warm, humid climate of the Southeast provides a perfect environment for weed growth, which can be a significant impediment to organic pecan production. Weed growth below the orchard canopy can be a benefit to orchard soils in many ways and may provide additional cover for beneficial insects. However, weeds also interfere with normal orchard operations and compete with pecan trees for water and nutrients. Maintaining a weed-free area of 7 to 10 feet around young trees during the establishment phase is critically important for growth and has a large influence on early yields.

Organic mulches (leaves, pine nuggets, pine straw, grass clippings, and chipped limbs) applied at a depth of about 8 to 12 inches in a 7 to 10 foot area around young pecan trees serve as an effective method of minimizing weed competition, and mulching significantly enhances tree growth and early production. In most cases, mulching must be coupled with hand cultivation to completely eliminate weed competition.

Cultivation (disking, hand-hoeing) of weeds can be used as long as care is taken not to damage tree trunks and the roots of young trees; however, this practice carries with it the risk of spreading a bacterial disease called crown gall, which can affect production and tree health. Flaming with a propane torch is a simple and effective method of maintaining weed-free areas around pecan trees but also carries the risk of damage to trees and irrigation lines. Most of these nonchemical approaches to weed management are highly labor intensive and are usually only practical in small orchard operations. Matran is a contact herbicide derived from clove leaf oil and is currently labeled for use in organic pecan orchards.

As mentioned earlier, because elimination of weed competition is so critical to the growth and establishment of young pecan trees, growers may choose to manage weeds with herbicides during the establishment phase, switching to organic methods after the fourth year following transplanting into the orchard (prior to nut production).

Figure 3. Crimson clover growing between pecan tree rows.

Multiple species of cover crops may be used in organic systems for a variety of reasons. An excellent reference to cover crop use in orchard and other systems may be found at https://www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops/Cover-Crops-Selection-and-Management. Considerable research on cover crops in pecan orchards has been conducted. Much of this work has centered around the use of cool season legumes, especially clover and vetch. These plants possess a variety of characteristics that make them compatible with pecan production (Figure 3). Cool season legumes are not especially competitive with trees for soil moisture until middle to late spring. They also serve as an effective source of organically bound nitrogen (N). In addition, cool season legumes stimulate an early increase in beneficial insect populations. The environmental benefits of cool season legumes make their use an especially attractive practice. In addition to the benefits mentioned above, legumes can reduce weed competition, aid in the cycling of nutrients, build soil organic matter, prevent soil erosion and runoff, and serve as an effective source of food and habitat for a variety of beneficial insects.

All legumes, including clover, use soil-dwelling bacteria that convert nitrogen from the air into a form that can be used by plants. This is called "nitrogen fixation." Only particular strains of bacteria provide optimum N production for each group of legumes. When the roots of a leguminous plant come into contact with the appropriate bacteria, the root hairs encircle the bacteria to create a nodule which houses the bacteria. These lumps on the root surface may be as large as a kernel of corn.

Perennial legumes "fix" N during any time of active growth, usually peaking at flowering. With seed formation, N fixation stops and the nodules slough from the roots. While they are alive, legumes release little to no N from the soil. As they die and are decomposed by soil microorganisms, the N in the roots, stalks, leaves, and seeds are converted to a form available to other plants. Because the residue from a grass/legume mix has a higher C:N ratio than the legume alone, the release of N is slow and not as vulnerable to loss.

Previous research indicates a time lag between legume establishment and the response of the pecan tree. In most cases, annual applications of N in another form will be needed for two to three years following legume establishment.

Supplemental N should only be applied to orchards using legumes to supply N after N fixation has ceased (following full bloom). It is important to recognize that the ability of the legume plant to fix nitrogen is limited by the presence of readily available N in the soil. Little to no fixation occurs when available soil N is present, and legumes will use it in preference to fixing atmospheric N. Fertilizing orchards with legumes at the wrong time can also lead to the aggressive growth of grasses and other competitive species, which can lead to the legume crop being shaded out.

The blossoms of clover attract various species of bees, which feed readily on the abundant nectar. In addition, blooms may harbor beneficial insects such as the minute pirate bug. Pea aphids and blue alfalfa aphids are commonly associated with crimson clover. Although these species are not pests of pecan, they serve as alternative food sources for beneficial predators such as lady beetles, green lacewings, soldier beetles, predaceous stink bugs, damsel bugs, and hover flies. As the clover declines with the onset of warm weather in June, these beneficial insects move into the trees to feed on pecan aphids and other insect pests, reducing the need for insecticide application.

As clover grows and is later mowed, it forms a thick mulch. This helps to smother and shade out more troublesome, competitive weed species. White clover has a creeping growth habit and spreads with rhizomes or “runners.” This helps to fill voids in the orchard and is a very effective means of reducing competition from weeds.

Legumes can improve orchard soils in a number of ways. The most obvious benefit is protection against erosion, but providing organic matter is an equally important and more long-term goal. Clover can provide habitat and/or food source for important soil organisms, break up compacted soil layers, and help dry out wet soils.

Cool season legumes can reduce the impact of rainfall on bare ground, slow the action of moving water, increase the soil’s ability to absorb and hold water, and help stabilize soil particles. Crimson clover produces more dry matter (5600 to 6000 pounds per acre) than many other legumes and is recommended for soil erosion control because of its high early autumn dry matter production. Grass/clover mixtures combine fibrous surface roots with long tap roots and have been observed to reduce herbicide runoff by 94 to 100%. See UGA Extension Bulletin 1360, “Clover Management in Pecan Orchards,” for more details on the use of legumes in pecan orchards.

Disease Management

Diseases of pecan are a limiting factor in the Southeast due to the warm, humid climate and the amount of rainfall. When establishing or transitioning to an organic production system, strong consideration needs to be given to potential losses due to diseases. Without the fungicides used in conventional production, producing pecans in the Southeast is challenging.

Pecan scab (Figure 4) is by far the most widespread and overall destructive disease of pecan. Powdery mildew and anthracnose are also fungal diseases affecting both foliage and fruit, but these diseases are not as common or damaging. Other diseases of foliage include downy spot, zonate leaf spot, and bacterial leaf scorch. There are other diseases that are of minor importance, including bunch disease, crown gall, mistletoe, nematodes, and numerous minor foliar diseases.

Figure 4. Scab infection of pecan nuts.

Cultivar resistance, cultural practices, fertilization, irrigation, and chemical control can all play a role in overall tree health and disease development.

- **Cultivar selection:** The most important decision for organic production will be cultivar selection, with resistant cultivars being the most economical and practical control measure. State universities and USDA breeding programs ratings are available, but keep in mind that there will be variability between locations.
  Cultivar diversity within an orchard provides two advantages. One, the diversity helps reduce the scab potential. *Fusicladium effusum*, the causal agent for pecan scab, is genetically diverse and has numerous races. Since races are only pathogenic on certain cultivars, diversity within an orchard helps suppress the development of major epidemics. Two, cultivar susceptibility to scab is likely to change over time and

overreliance on one cultivar is risky. Over the last 100 years, a number of cultivars that were once considered resistant are now highly susceptible to scab. Knowing that this is likely to occur with some of the currently resistant cultivars, diversity would allow the removal and transition to new cultivars without losing a majority of production.

Converting an established orchard from conventional to organic production offers serious challenges for disease management. An understanding of the cultivars in an orchard is critical. Most orchards in the Southeast contain susceptible cultivars that will need to be replaced in order for organic production to be successful long-term. A few older cultivars ('Elliot' and 'Moneymaker'), along with a number of more newly released cultivars, are already used in production and would be suitable. If converting an orchard to certified organic, take advantage of the required period of three years of organic management without use of synthetic chemicals to plant new cultivars.

- **Cultural practices to avoid overcrowding:** Improving water status, sunlight exposure, and air movement can also potentially diminish damage from many diseases. Avoid allowing orchards to become overcrowded. Overcrowding causes reduced air flow and a lack of sunlight reaching into the canopy. Leaves will remain wet longer, increasing the chances for disease to develop. In addition to reduced sunlight, poor air movement, and water competition, obtaining adequate fungicide coverage is also a complication associated with overcrowded orchards. Site selection, tree spacing, pruning, and orchard thinning will all be important in establishing a suitable environment.
- **Fertility and irrigation:** Plant health and nutrition affects both the growth and development of the plant and contributes to the plant's natural defense against pathogens and disease development. Researchers have discovered a number of relationships between the levels of particular nutrients and susceptibility to diseases. Macronutrients (e.g., nitrogen, potassium, phosphorus) and micronutrients (e.g., boron, nickel, molybdenum) have both proven to be important in plant health and have a role in the plant's defense mechanisms against pathogens. Consult the OMRI-approved products list for approved sources of these nutrients. Applications of these nutrients are most useful when timed for the prepollination period. Recent studies have provided evidence that this holds true for pecan and scab. While attention to macro- or micronutrient nutrition will not eliminate disease, optimal nutrition during the development of foliage and fruit greatly improves the chances for genetic resistance within the tree.
- **Chemical control of pecan diseases**: In conventional pecan production, the application of preventative fungicides is the most practiced disease control measure. Effective chemical options for organic production are limited. Products that have provided reasonable efficacy in research trials include Nordox (copper fungicide), Serenade (*Bacillus subtilis*), LifeGard WG (*Bacillus mycoides*), Regalia (which has inconsistent efficacy), and Bordeaux mixture. Bear in mind that these materials have not been as effective as conventional fungicides in research trials but do provide some level of disease suppression.

  Fungicides must be applied on a regular basis to maintain a protective barrier over the foliage and fruit. The standard disease prevention program calls for applications on a 10-to-14-day interval from budbreak until pollination and a 14-to-21-day interval from pollination until shell hardening. Use the shorter protection intervals during periods of frequent rain events.

  A list of materials cleared for organic use is available from OMRI at www.omri.org.

Arthropod management in organic pecan production

The potential pests of pecan can be grouped according to whether they feed on the pecan tree's foliage or its nuts, and the timing of their appearance in the orchard is fairly consistent and predictable. Foliage feeders include three species of aphids, pecan leaf scorch mites, and a variety of caterpillars. Nut feeders include two caterpillars, two weevils, and a variety of true bugs generally referred to as stink bugs. Determining injury levels and treatment thresholds for nut feeders is relatively easy because they cause losses to the current year's crop. Foliage feeders, on the other hand, may affect the quality of the current crop, but they are more likely to cause a reduction in the following season's crop. Pecans are alternate bearing by nature, and determining the real impact of the pests against a background of considerable variation in yield year-to-year has been difficult at best. Here we will discuss the two groups separately and in order of appearance in the orchard each year, covering biology and life cycles for each pest, techniques for scouting or monitoring population development, and management options for organic producers. The Southeastern Pecan Growers' Handbook, produced by the UGA College of Agricultural and Environmental Sciences, provides detailed information and photos of pests and beneficial arthropods found in pecan orchards.

Foliage feeders

Aphids. There are three species of aphids that feed on pecan (and closely related hickories). The yellow pecan aphid (*Monelliopsis pecanis*) and the blackmargined aphid (*Monellia caryella*) are usually grouped together and referred to as "yellow aphids." Their biology and damage are similar and treatment thresholds are considered in aggregate. The black pecan aphid (*Melanocallis caryaefoliae*) causes different damage symptoms and should be considered separately for scouting and management purposes. All three aphid species spend the winter as eggs in bark crevices on the trees. The eggs hatch into female stem mother nymphs in early spring, when they move to the new growth and begin feeding. These stem mothers mature in six or seven days (yellow aphids) or eight to nine days (black aphids). They then begin giving birth to female progeny, which, once mature, will have wings and be able to fly to other parts of the orchard. As day length shortens in October and November, male and female aphids are produced, and young aphids mate to produce the overwintering eggs. Each species can have up to 32 generations per year with a reproductive potential that can double the population in less than two days.

Yellow aphids damage pecan trees by feeding on a high-volume diet of sap extracted from the veins of the leaves. This deprives the tree of large amounts of water and photosynthates, or sugars made by photosynthesis, and damages the network of veins in the leaves. They also excrete large amounts of sugary "honeydew" that coats the leaves below and provides a substrate for the growth of sooty mold, which blocks sunlight from striking the leaf surface and reduces photosynthesis. Heavy populations have been shown to reduce shoot and root growth, flower set, and return bloom the next season.

The feeding of black aphids causes necrosis of the tissue between the small veins (Figure 5). This damage appears to be necessary to "condition" the leaf and improve small nymphs' chances of survival. Typically, winged migrants and stem mothers from within the orchard cause an accumulation of feeding damage beginning early in the season, but they do not succeed in colonizing the leaves. Eventually, the level of damage reaches the point that the leaves are favorable for nymphs to survive, and the population grows quickly. The necrosis will eventually turn brown and, if extensive enough, cause the leaflet to fall. Heavy populations can cause defoliation in late season, affecting the quality of the crop and reducing return bloom.

Figure 5. Black pecan aphids and feeding damage on tree leaves.

Control: The list of beneficial insects that feed on aphids is long and includes lady beetles, lacewings, syrphid fly larvae, and several parasitoid wasps. If left alone (or encouraged), they will usually provide enough suppression of the aphids to prevent populations from reaching damaging levels. There are also organic certified repellents that keep ants from tending and protecting aphids in the trees, and those have been demonstrated to improve the control provided by natural enemies. Some biopesticides, both fungal preparations and bacterial fermentation byproducts, have shown promise in laboratory studies but need more study.
Planting crepe myrtles in the orchard can attract Asian lady beetles, an effective predator of pecan aphids. The crepe myrtle aphid serves as an excellent alternative prey for the lady beetle, since their populations often peak on crepe myrtle plants about two weeks before pecan aphids increase in the pecan trees.

Mites. There are more than 20 species of mites commonly found on pecan leaves. Of these, only one, the pecan leaf scorch mite (PLSM, *Eotetranychus hicoriae*), is regularly associated with leaf damage. Outbreaks of PLSM are rare unless certain insecticides are used in the orchard, and organic producers would not use those products.

Control: Organic producers should not need to control PLSM, but several predatory mites are very effective and can persist for several years after release. The western predatory mite (*Galandromus occidentalis*) has been very effective and persists well in south Georgia orchards. Another predatory mite, *Phytoseiulus persimilis*, has also been very effective.

Foliage feeding caterpillars. Several caterpillars occasionally appear in large numbers in pecan orchards, although defoliation seldom reaches the point where treatment is necessary. Populations of fall webworm, *Hyphantia cunea*, and walnut caterpillar, *Datana integerrima*, are most likely to reach damaging levels. Both species feed gregariously. Fall webworm caterpillars construct a silk web that covers the foliage and feed inside the web. Walnut caterpillars feed on the foliage at night and then gather together on the trunk during the day. The pecan bud moth, *Gretchina bolliana*, is a native insect that is present in virtually every orchard. They seldom damage mature trees but can be devastating to newly planted trees. The caterpillar feeds on new leaves and then bores into the developing buds, killing the terminal. There are several bud moth generations per year.

Control: Destroying webs is often all that is necessary to reduce caterpillar numbers significantly, as there are many natural enemies that will attack the webworms once exposed. These include birds as well as predatory and parasitoid insects. The resting aggregations of walnut caterpillars are easy to find and destroy. If treatment is necessary for any of the caterpillar pests, products containing spinosad are very effective. Small caterpillars can be controlled with *Bacillus thuriengis* (Bt) products.

Nut Pests

Nut feeding caterpillars. The pecan nut casebearer, *Acrobasis nuxvorella*, is a very serious caterpillar pest of pecan in Texas, Oklahoma, and Louisiana but seldom causes economic damage in Georgia. Hickory shuckworm, on the other hand, can cause serious losses in the state. The adult is a small, mottled-brown moth that emerges from the pupa in early spring. Eggs of the first generation are laid on new foliage, on the shucks of early fruiting hickories, or on the galls of pecan *phylloxera*. Caterpillars hatching from eggs laid on foliage generally do not survive. Hickory shucks and *phylloxera* galls are suitable food for the caterpillars, however, and produce the second generation moths that emerge in June and July and lay eggs on developing pecan nuts. A third generation begins emerging in mid-August and attacks nuts in late season. Attacks on developing nuts in early and midseason cause the nuts to fall, and late-season attacks affect only the shuck, causing the shuck to cling to the shell rather than releasing cleanly. This requires an extra step in the cleaning process, which reduces the price buyers will pay for the crop.

Control: The materials recommended for foliage-feeding caterpillars will also control nut pests. Timing is important because the caterpillars are only vulnerable while they are feeding on or tunneling into the shuck. Early-season damage may actually help to thin the crop in years with a heavy nut set, but late-season attacks reduce the number of nuts harvested. If shuckworm damage is significant in July, treatment in mid-August is recommended, followed by a second application two weeks later.

Nut curculio. The nut curculio, *Conotrachelus hicoriae* (Schoof), attacks developing pecan and hickory nuts in midseason. There is one generation per year, with adults emerging from overwintering sites in wooded areas to fly into the orchard beginning in late June through late July. Curculio females make shallow punctures in the shuck of small nutlets into which they lay eggs. The puncture and larval feeding cause a brown, liquid ooze at the point of larval entry, and the small nuts fall from the tree. Larvae feed in the nuts for about two weeks before emerging through a round hole and burrowing into the ground to pupate. Adults emerge about four weeks later and spend the winter in protected places and leaf litter, often in woods adjacent to the orchard.

Control: There is no effective organic-certified control option, although foliar sprays with materials under study for pecan weevil may also be effective for nut curculio.

Pecan weevil. Pecan weevil, *Curculio caryae*, is a key pest of pecan (Figure 6). The weevils emerge from the soil in late summer and attack the nuts after they are full-sized and beginning to mature, so every damaged nut is one the producer could have harvested and sold.

Control: Soil treatment with pathogens or entomopathogenic nematodes has shown promise, but effective control has been demonstrated only with trunk treatments and foliar sprays. Trunk treatments include fungal pathogens and sticky bands, either applied directly to the trunk or on burlap banding around the tree. This takes advantage of the weevil preference for walking over ground and crawling up the tree rather than flying directly into the canopy. At least one certified-organic product has shown promise as a foliar spray, but research is ongoing to refine timing and rate recommendations in hopes of bringing the cost down. Burlap banding provides a hiding place for the weevils and also can be treated with either a fungal pathogen (e.g., *Beauveria bassiana*) or sticky material to trap the weevils as they crawl up the tree. The burlap band should have several folds and completely encircle the tree. For the trunk treatments to be most effective, it is important to have a clean orchard floor with no understory. If the weevils crawl up something that is not a pecan tree, they will fly up into the canopy instead of crawling back down and walking.

Figure 6. Pecan weevil feeding on pecan.

Properly timing foliar sprays is critical to successful weevil control. Weevils emerge from the soil over a long window of time, from late July through September and sometimes into October, and no treatment is available that will last for the entire emergence period without reapplication. This is usually a dry time in Georgia, and the ground becomes so hard that the insects cannot dig their way out. Emergence from dry soil is sporadic and dependent on rain events that soften the ground, allowing the weevils to make their way to the surface. Traps are used to monitor this activity. The most popular type called a “circle trap,” which attaches to the tree trunk and captures weevils as they crawl up. There is no threshold number that triggers a treatment; the traps just alert the grower that weevils are active. The decision to treat is based on previous history of weevil damage—if you have weevils this year, you should be prepared to treat next year.

Stink bugs. There are no effective organic controls for stink bugs in pecan orchards.

Summary

Organic pecan production in the Southeastern U.S. presents unique challenges to the grower. The foundation of organic pecan systems should be based on cultivar selection, soil management, and adherence to the USDA’s NOP standards. Regardless of whether pecans are grown organically or conventionally, successful, consistent nut production requires attention to detail and a significant amount of time spent in the orchard.

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Further reading:

USDA Organics: https://www.usda.gov/topics/organic

Organic Materials Review Institute: www.omri.org

National Organic Program's Five Steps to Organic Certification:
https://www.usda.gov/media/blog/2012/10/10/organic-101-five-steps-organic-certification

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