

Nut Tree Growing in Kentucky

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Kentucky is generally well suited for growing nut trees. Northern pecans, black walnuts, heartnuts, hickory nuts, hardy Persian walnuts (Carpathian strain), American hazelnuts, and Chinese chestnuts all grow well in the state. Most nut trees are grown by hobbyists and backyard gardeners. Several varieties appear to have potential for commercial production, particularly some of the USDA pecan selections and some Chinese chestnut varieties. Nut trees grow best in deep, well-drained soil of medium to good fertility with a soil pH of 6.5 to 6.8. Chinese chestnuts grow best on acidic soils.

Pecan growing in Kentucky should be limited to northern varieties because Kentucky's growing season is usually not long enough for southern pecans to mature, (i.e., for kernels to fill the shell). Nuts of northern pecan varieties will not mature at higher elevations where day and night summer temperatures vary greatly. However, trees do grow well on these sites and make excellent shade trees.

If nuts of a particular variety are planted they will not produce a tree of that variety. Rather, to get a tree of a certain variety, wood from that variety must be grafted onto a rootstock.

All nut trees except filberts become quite large. Because nut trees take many years to fill their allotted space, some growers plant filler trees and remove them later, before branches of adjoining trees meet. Table 1 shows suggested minimum permanent spacing and average years to first harvest when grafted trees are set out.

Table 1. Planting distance and estimated first harvest of various nut trees.

Nut Type	Planting Distance (feet)	First Harvest (years)
Black Walnut	50 x 50	4-7
Butternut	50 x 50	3-4
Persian Walnut	35 x 35	5-6
Chinese Chestnut	40 x 50	4-5
Hazelnut	15 x 15	4-5
Heartnut	35 x 35	3-4
Hican	50 x 50	10-12
Hickory	50 x 50	10-12
Pecan	50 x 50	5-8

Planting Seed

Nut seeds are generally planted about 2 inches deep, soon after harvest in the fall. They do not germinate until late spring. The "Tin Can" planting system helps reduce losses to mice, squirrels, and other wildlife that may eat them. Simply remove the top of a tin can and, with a knife, make two cuts across the bottom, crossing in the center. Push the empty can into the soil over the planted nut until the cut end is flush with the soil surface. In early spring slightly turn up the metal tips at the center of the can so that the seedling can grow through the opening but pests still cannot get it. As the seedling grows, turn the tips back farther.

There is no need to remove the tin can because it usually rusts out, particularly if it has been burned to remove the galvanized coating. However, an aluminum can does not rust and must be cut down one side to permit easy removal before it girdles the young tree.

If you wish to directly plant seeds instead of transplanting, then plant three nuts where the tree is to mature. Position them in a triangular pattern spaced about 1 foot apart and 2 inches

deep. One or two years later, graft or bud the largest of the three seedlings to the desired variety and remove the other two. Exceptions: Chinese chestnuts are not difficult to graft, but rootstock incompatibility may be a problem if the cultivar being grafted is not placed onto a seedling originating from this cultivar. Hardy American or Eastern filberts are difficult to graft and in the past have been propagated by seed. New blight-resistant varieties have been and will continue to be developed and available for purchase. If propagation is not feasible, grafted or budded nursery stock is recommended.

Planting Trees

- Early spring planting of nursery nut trees is better than fall planting because it reduces the chance of winter injury.
- Plant trees as soon as possible after delivery.
- Do not let roots dry out. Tree survival may often be improved by soaking the tree roots in water for 24 hours before planting.
- Prune off broken roots and shorten long ones before planting.
- Dig a deep hole, wide enough so that lateral roots can spread out in their natural positions and deep enough so the tap root (if there is one) will not bend.
- Leave the tap root as long as possible. Trees should be planted as deep as they were in the nursery. Examine tree trunks to find the soil line mark.
- Set the tree in the hole and fill with soil. If the soil is not too wet, firm the soil around the roots with the hands.

- Water trees well after planting to settle the soil around the roots, and then weekly throughout the summer during dry conditions. Watering trees during the first season is extremely important in establishment.
- Backfill around all planted trees with loose soil after rains have settled the soil in the planting holes.

Fertilizing

Take a soil test and, based on its results, adjust soil fertility at least a month before planting. Adjust the pH to 6.5 and bring phosphorus and potassium levels into the high soil test range. Do not fertilize at planting because doing so can injure roots.

After the first year, follow this procedure for fertilization: (1) Determine the trunk diameter 5 inches above ground. (2) For each inch of trunk diameter, apply 1 lb of 10-10-10 fertilizer per tree, but no more than $\frac{1}{3}$ lb of actual nitrogen per inch of trunk diameter per season. (3) Place fertilizer under the tree periphery in late February. (4) Take soil tests annually and apply lime as needed to prevent soil pH from falling below 6.0.

Trace elements are very important in nut production. Zinc is the most critical trace element. When zinc is lacking or present in insufficient quantities, nutlets fail to set and yields are very low. Zinc is best applied as a foliar spray just after pollination at a rate of 1 to 2 lb of zinc sulfate/100 gal of water (1 to 2 tbsp/gal) for young trees and 5 to 10 lb/100 gal for mature trees. Apply two more times at two- to three-week intervals. For soil application, zinc chelate is recommended over zinc sulfate. Zinc chelate 10% can be applied with liquid fertilizers as a broadcast or banded treatment. Use at a maximum rate of 1 part zinc chelate 10% to 50 parts fertilizer in ammonium phosphate solutions, or 1 part zinc chelate 10% to 10 parts fertilizer in nitrogen solutions.

Pruning

Remove about one-third of the top growth at planting. Cut the terminal shoot just above a bud and remove all side branches close to the trunk. This encourages survival and strong regrowth. Prune young trees lightly during the first few years in February or March to select scaffold limbs with wide crotch angles and to maintain a central leader. Branches should be pruned off the trunk to a height of at least 6 feet if you plan to use a metal tree guard to control squirrels. When 10 to 15 good scaffold limbs that are well spaced on the trunk have been developed, cut the central leader back to a lateral limb, and train the tree to a modified central leader shape. For more detailed explanations of pruning, see Cooperative Extension publication, *Growing Fruit at Home in Kentucky* (HO-64). Only limited pruning is needed on bearing trees. Remove dead limbs to a side limb or to the trunk to promote rapid healing and avoid trunk decay. When trees are 20 to 30 years old, thin out some of the top scaffold limbs to allow light into the interior of the trees.

American hazelnuts are grown as a bush and pruning consists of thinning out smaller, weaker shoots by removing them at ground level. Also, remove some of the center shoots to open up the center of the bush, admit light, and prevent bearing only on the bush periphery. A plant should have five to seven main shoots. Grafted hazelnuts are grown as a tree and all suckers need to be removed from the base.

Sunscald and Rodent Protection

Young trees are particularly susceptible to sunscald injury. On bright, cold, sunny days during winter, the bark on the southwest side of the trunk and on top of northeast-growing limbs may warm up considerably. A rapid drop in temperature when the sun sets in the evening may cause vertical splits in the bark and separate bark from the trunk.

Large dead areas on the trunk usually result from this type of injury.

Sunscald may be prevented by painting the lower 30 to 36 inches of trunk and the bases of some scaffold limbs with an interior white latex paint in the fall, by using a white plastic rodent guard, or by wrapping the trunk with aluminum foil. These actions prevent the southwest side of the tree trunk from heating up and help eliminate sunscald injury.

If a white plastic rodent guard is not used around the trunk following planting, place a loose cylinder of $\frac{1}{4}$ -inch hardware cloth at least 18 inches high around the trunk. This will keep rabbits from damaging or killing young trees. Remove mulch from the base of the trees in the fall to prevent vole damage.

Irrigation, Mulching, and Weed Control

Inadequate weed control and lack of water are the two primary reasons for poor nut tree growth, even death, particularly in the first season of growth. Even mowed grass competes heavily with young trees for nutrients and water. Maintain a vegetation-free area beneath the trees to reduce competition from weeds. This area should be 4 to 6 feet in diameter and expanded as the trees get older. Mulching with wood chips, bark, hay, or straw is very beneficial. Lay at least 4 inches of mulch for best results. Mulch should be kept at least 6 inches away from the tree base to avoid injury from mulch heating and to help reduce rodent damage.

During the growing season when soil is dry, irrigation helps promote tree growth and reduce stress, especially in the first year. On bearing trees, irrigation will help produce larger nuts and improve nut fill. Generally, if water is scarce before nut shells form, nut size will be reduced. Lack of water after shell hardening inhibits kernel filling.

Pollination

Pollen of pecan, black walnut, butternut, Persian walnut, heartnut, hickory, filbert, and hican is airborne. It is carried by wind, not insects. While Chinese chestnut pollen is airborne, some may also be carried by insects. Because nut trees depend on wind and gravity to disperse pollen, prolonged rainy periods during pollination remove pollen from the air and may substantially reduce the nut set.

Nut trees have both male and female flowers, located on different parts of the same branch. Male flowers are catkins, which are on 1-year-old branches. Female or nutlet flowers resemble miniature nuts and are situated at the ends of young shoot tips. The stigma is at the tip of the female flower and is receptive when it becomes glossy with stigmatal fluid. Pollination takes place when pollen falls on the stigma. Most nut cultivars and seedling trees are largely self-sterile because the pollen is not ripe or is not shed from catkins when female flowers are receptive. A variety may be either protogynous or protandrous. Protogynous means that the pistillate female flowers are receptive before pollen is shed from male catkins. Protandrous means that the pollen is shed from male catkins before pistillate (female) flowers are receptive.

A mixture of varieties that shed pollen early and late is required for good pollination. However, a mixture of varieties will not automatically assure a steady, season-long pollen supply. Most nut trees, seedlings, or grafted trees require medium to late pollen, some very late pollen. Most nut cultivars shed pollen early, many shed very early. In seasons when large quantities of pollen are shed, some reports indicate that pollen has been carried by wind as far as 1 mile and has effectively pollinated pecan trees.

- Pecans are mostly self-unfruitful, so it is very important to buy or propagate special pollinator trees to successfully set a full crop of nuts. Pecan pollinator cultivars or selec-

tions are listed in Table 2. The pollen of Posey is shed late and will pollinate female flowers of “Major” which become receptive late (see Table 2 on page 8 for more information on pecan blooming periods). Seedlings or native pecan trees can also be used for pollination if they bloom at the right time. A mixture of varieties assures a steady, season-long pollen supply.

- Black walnut varieties are considered self-fruitful, although they perform much better when cross-pollinated.
- Butternuts, such as black walnuts, are self-fruitful but will yield better when cross-pollinated. They also pollinate heartnuts and are pollinated by heartnuts. They do not cross easily with black walnuts.
- Persian walnuts may be either self-fruitful or partially self-fruitful. In the latter case, pollination and nut set are greatly improved by cross-pollination with another cultivar or seedling. Please note cultivar pollination requirements in the cultivar descriptions below.
- Chinese chestnuts are very self-sterile and require other Chinese chestnut trees within 50 to 100 feet. An unpollinated tree will produce burrs, but most will be empty inside. Individual limbs may be grafted to other varieties to provide pollination.
- Hazelnuts or filberts are self-sterile and varieties may be either protogynous or protandrous.
- Heartnuts are self-fruitful, but do better when cross-pollinated.
- Hicans are generally self-sterile. If they are self-sterile, they need to be pollinated by an early shedding pecan such as Major. The Burton and Burlington hican cultivars are self-fertile and very well suited for Kentucky.
- Hickory nuts may be self-fruitful in some cases, but allowing for cross-pollination is better.



Figure 1. Unpollinated chestnut.

Cultivar Recommendations for Kentucky

Many of the cultivars listed in this publication can be purchased through Kentucky nut tree nurseries. If extensive nut tree plantings are planned or new cultivars are desired, individuals may wish to contact the Kentucky Nut Growers Association. Your local county Extension office can help you locate Kentucky nut tree nurseries and put you in contact with the Kentucky Nut Growers Association.

Black Walnuts *Juglans nigra*

Black walnuts begin growth late in the spring, and there is generally little problem with injury and crop loss from late spring freezes. Problems with black walnuts generally relate to poor cracking qualities, disease, and alternate bearing. The number of nuts per pound is related to the cultivar planted. Light crops produce larger nuts, while full or bumper crops produce smaller nuts.



Figure 2. Black walnut.

- **Clermont:** Medium-sized, thin-shelled nut, with 28% kernel. Excellent flavor. Heavy bearer. Resistant to anthracnose disease. Ripens better in the north. Originated in Ohio.
- **Daniels:** Productive variety, with 41% kernel. Relatively small nut, running about 32 nuts/lb. Thin shell, making this an easy variety to crack.
- **Elmer Myers:** Medium-sized, thin-shelled nut. Good cracking quality. Excellent flavor. Upright tree, late to leaf and ripen. Prolific, produces in three to five years. Originated in Ohio.
- **Emma Kay (Emma K):** Medium to large, thin-shelled nut, excellent cracking quality. Excellent flavor. Prolific, bears in three to five years. Nuts average 25 to 30 nuts/lb. Good for the Midwest. Originated in Illinois.
- **Hare:** Large nut. Good shell structure and good cracking qualities. Heavy bearer. The nut is somewhat susceptible to husk maggots. Originated in Illinois.
- **Krouse:** Large nut. Annual crops. Hardy. Very productive. Nut is almost identical to Daniels but has a better shell structure. Originated in Iowa.
- **Leon Pounds II:** Very productive. Thin shell. Nice tasting. Highest crack-out percentage of any variety at 55%. Found by the late Leon Pounds of Gentryville, Indiana. It is believed that Elmer Meyer and a seedling of Thomas are the parents of Pounds II.
- **Neel No. 1:** Thin shell. High crack out. Kernel shaped like a human heart, star at base of nut. Slow to come to bearing. Excellent nut. Considered one of the best.
- **Ridgeway (Rabbit Ridge):** Large nut. Cracks well. Bears heavily. Anthracnose resistant. Two-time Kentucky State Fair winner. Originated in Illinois.
- **Rowher:** Excellent black walnut with 37% kernel. Cracks easily. Kernels have a very light color.
- **Sauber No. 1:** Large nut, averages 20 to 25 nuts/lb with 39% kernel. Outstanding cracking qualities. Very uniform in size. Cracks well in commercial crackers. Nut separates cleanly from the hull. Very productive and an outstanding cultivar.
- **Sauber No. 2:** This is a sister tree to the Sauber No. 1. This tree is not quite as productive as the No. 1. Excellent selection, with 37% kernel. The nut has outstanding cracking qualities.
- **Schrieber:** The largest nuts of any cultivar currently evaluated, with about 15 to 20 nuts/lb with 25% kernel. Similar to Thomas-Meyers variety. Excellent cracking qualities and a very good tasting kernel.
- **Sparrow:** Medium-sized nut, running 25 to 30 nuts/lb. Good to excellent cracking quality. Good, sweet flavor. Prolific, annual bearer. Produces in three to five years. The tree is hardy and tends to retain its foliage later than most other varieties. Originated in Illinois.
- **Surprise:** Nuts crack out in quarters. 26 nuts/lb. Originated in Pennsylvania.
- **Thomas-Myers:** Popular cross of Thomas x Elmer Myers. Large nut, 17 to 24 nuts/lb, with 35 to 40% kernel. Good cracker but not thin shelled. Heavy bearer. Anthracnose resistant. Ripens early. Originated in Missouri. Annual bearer. Begins growth late in the spring, almost two weeks later than other cultivars. One of the least frost-prone black walnut cultivars. One of the best black walnut cultivars for Kentucky. The parent Thomas cultivar is very susceptible to anthracnose disease, alternate bears and nuts do not fill, therefore, Thomas is not recommended for Kentucky.

Other black walnut cultivars reported to have superior characteristics and now being offered in the nursery trade are: Beck, Football 2, and Harney.

Butternuts *Juglans cinerea*

Butternuts are not generally recommended in Kentucky except in the mountains in Eastern Kentucky at high elevations. They are susceptible to bacterial canker in most areas, tend to be short-lived, and rarely survive more than 20 years. Trees are hardier than most walnuts and nuts have a unique flavor similar to that of walnuts. The shells are thick and contain only a small amount of meat. Varieties suggested on good sites are:

- **Ayers:** Medium-sized nut. Better meat-to-nut percentage than most. Upright tree; clean foliage. Late bloomer. Originated in Michigan.
- **Buckley:** Large nut. Vigorous grower. Clean foliage. Originated in Iowa.
- **Chamberlain:** Large nut. Good cracking quality. Very hardy. Originated in New York.
- **Craxey:** Medium-sized nut. Cracks easily. Good producer. Originated in Michigan.
- **Creighton:** Medium-sized nut. Good cracking quality. Vigorous tree. Clean foliage. Well-known variety. Ripens late. Originated in Michigan.
- **Weschcke:** Medium to large nut. Cracks well. Light kernels. Very productive tree. Extremely hardy. Originated in Wisconsin.

Other butternut varieties suggested on good sites are: Beckwith, Coble No. 1, and My Joy.



Figure 3. Butternut.

Hardy Persian, or English, Walnuts *Juglans regia*

One of the greatest problems with Persian, or English, walnuts is that they begin growth fairly early in the spring and the flowers are damaged by late spring frosts. Varieties that bear nuts laterally as opposed to just terminally tend to produce better in frost years.

Poor shell structure is a problem with some varieties where the shell seam does not completely seal, allowing mildew to attack the kernel.

The male flowers, or catkins, begin to develop long before the female nutlet flowers and are often killed by late spring frosts. The Lake variety has harder and slower developing catkins and often survives late spring frosts. This variety should always be planted with most other cultivars that fail to produce pollen in most years. The following varieties are generally recommended.

- **Allegheny:** A new variety from Pennsylvania, which vegetates late, misses frost, and can bear a full crop annually, even after -28°F winters. The tree is self-pollinating and produces a medium-sized nut with a thin shell that has a tight seal and cracks out in whole halves.
- **Bedco 1:** Medium to large nut. Sweet light kernel. Very productive.
- **Broadview:** Heavily productive. Lateral bearing. Medium to large, round, thin-shelled nut with 47% kernel. Kernels are best for culinary purposes. This is a good parent tree for breeding purposes. Broadview seedlings produced from cross-pollination with Hansen have resulted in some superior cultivars.
- **Colby:** Medium-sized, thin-shelled nut with 53% kernel. Plump kernel. good flavor. Ripens early. Hardy. It has self-fruitful flowers. Developed at the Illinois Agricultural Experiment Station.
- **Coble No. 2:** Well-filled, large nut. High quality. Lateral bearer.
- **Greenhaven:** Medium to large nut. Early maturing. Nuts begin to drop about September first. The nuts fill well and have well-sealed shells. This is one of the better cultivars.
- **Hansen:** Small- to medium-, thin-shelled, well-filled nut with 60% kernel. Excellent cracking quality. Sweet, very good flavor. Natural semidwarf. Slow growing. Early bearing; produces in three to five years. Late to leaf out. Reliably self-pollinating; good choice for limited space. Resistant to anthracnose and husk maggot. Ripens early. Originated in Ohio.
- **Kaiser:** Nut has outstanding qualities and is one of the largest. A large nut that fills very well, seals well and tastes good. Early bearer. Kaiser was rated as the most outstanding nut at the 2000 Kentucky State Fair. Originated from a seedling grown by Richard Wilmoth in Kentucky.
- **Lake:** Medium to large, thin-shelled nut. Very good quality and hardy. Cracks easily. Very good flavor and quality. Prolific trees grow 30-feet tall. Bears in three to five years. Self-pollinating but produces better crops when pollinated with Stark Champion or a seedling Carpathian variety. Hardy in zones 5 through 9. Originated in Illinois. This is an important pollinator for most other varieties.
- **Reda:** Medium-sized, thin-shelled nut. Lateral bearing. Blight and anthracnose resistant. May be a good southern variety. Originated in southern Europe.



Figure 4. Hardy Persian, or English, walnut.

- **Somers:** Large nut with 55% kernel. Cracks easily. Annual bearer and early maturing.
- **Utah Giant:** Very large, good-quality nut with a sweet kernel. Very hardy.

Other new introductions reported to have superior characteristics are: Barton, Cascade, Fately, Lightning, McKinister, Orth, and Sigler.

Chinese Chestnuts

Castanea mollissima

The survival rate of grafted chestnut trees, particularly of American X Chinese hybrids, has been less than ideal due to incompatibility between the scion and rootstock. However, by grafting the desired cultivar onto seedlings from this same cultivar, losses from incompatibility can be almost entirely eliminated. All of the following recommended cultivars are resistant to chestnut blight.

- **Armstrong:** Chinese X American hybrid. Large nut, very sweet. Doesn't keep long in storage. The tree bears very well. Originated in Kentucky.
- **AU Leader:** Very sweet, large nut. Excellent flavor raw or roasted. Released by Auburn University.
- **Crane:** Chinese cultivar. Medium to large nut, 25 to 30 nuts/lb. Good cracking quality. Fine flavor. Excellent keeper. Rounded tree grows 40- to 50-feet tall. Precocious; bears in two to three years. Blight resistant. Originated in Georgia.



Figure 5. Chinese chestnut.

- **Eaton River:** Chinese hybrid. One of the sweetest Chinese chestnuts. Large, very sweet nut. Ornamental tree. Ripens early. Originated in Connecticut.
- **Ford's Sweet:** Chinese cultivar. Small, sweet kernel that resembles American chestnut. Heavy bearer. Timber-type growth. Good wildlife food. Originated in Indiana.
- **Ford's Tall:** Chinese cultivar. Medium-sized nuts. Timber-type growth similar to Ford's Sweet. Reaches a height of 70 feet.
- **Mossbarger:** Chinese hybrid. Large nut, 28 to 32 nuts/lb. Sweet nut. Excellent keeper. Very productive. The tree is an annual bearer. Originated in Kentucky.
- **Orrin:** Chinese hybrid. Medium to large nut, 32 nuts/lb. Superior keeping quality. Tree blooms slightly later than other varieties.
- **Qing:** Produces two to four mahogany colored nuts per burr with few singles, of which 90% fall free from burs. Very large nuts, some the size of a half-dollar, 18 to 28 nuts/lb. Very sweet, well-filled with a yellow meat. Pellicle (skin around the meat) separates freely from the nut. Stores very well and considered one of the best cultivars.
- **Sleeping Giant:** Chinese X Japanese X American hybrid. Medium to large, high-quality, easily peeled nuts, 30 to 35 nuts/lb. Timber-type growth. Sweet, attractive light tan colored nut, making it a good market chestnut. Developed in Connecticut.

Additional cultivars now becoming available in the nursery trade are Henry VIII, Wolverine, and many others. Seedling chestnut trees may be planted, but only about 25% will bear nuts of acceptable quality.



Figure 6. Grafting incompatibility in Chinese chestnut.

American Hazelnuts, or Filberts *Corylus americana*

Native American hazelnut, or filbert, *Corylus americana*, and the European hazelnut, *Corylus avellana*, are both plagued by Eastern filbert blight, a fungal disease that eventually kills most hazelnuts grown in Kentucky. The European hazelnut is the species that is generally grown for nut production in Oregon, and Barcelona has been the primary variety grown the past. Over the past 10 years, Eastern filbert blight (EFB) has become a serious problem in the Pacific Northwest, and Oregon State University has recently released Santiam



Figure 7. Hazelnut, or filbert.

with complete resistance to EFB, as well as Willamette, Lewis, and Clark with improved resistance to EFB. Hazelnuts bloom in the winter, and the European hazelnuts often have their flowers killed during the winter in Kentucky.

Breeders have been working to develop hazelnut hybrids that are hardier than the European hazelnut and have resistance to EFB. Hybrid hazelnut cultivar releases with EFB resistance are: Grand Traverse, 89-Lisa, G-22, 88-BS, G-14 by Cecil Farris, Lansing, Michigan; Rush and Winkler from Lancaster, Pennsylvania.; Carlola, Delores, Magdalene by Carl Weschcke, Minnesota; and Laroka, Eastoka, Faroka, and Morrisoka by J.U. Gellatly in Westbank, British Columbia. None of these has been evaluated in Kentucky.

Native American hazelnuts are mostly propagated as seedlings. However, there are some named varieties and hybrids. Hybrids are generally not as hardy and often have their flowers killed during the winter.

Filazel, or Hazelbert, are crosses between American hazelnut and European filbert. Some of the many filazel cultivars available, not widely tested in Kentucky, are:

- **Bid Red:** Large nut with moderately thick shell. Well-filled kernel. Early maturity. Hardy in Zone 4.
- **Gellatly:** Best-quality early filazel. Ripens in September. Hardy in Zone 4.
- **Nut Washer:** Shell is almost as thin as an eggshell, which makes it difficult to crack because it crushes easily. Sweet flavor. Filbert-like in appearance and production. Ripens midseason.

Heartnuts *Juglans ailanthifolia* var. *cordiformis*

A common problem with all heartnuts is that they are subject to blossom loss from late spring frosts. However, their foliage is very attractive and they make good landscape trees. Bunch disease can be a problem, and it is best not to plant heartnuts near black walnut trees.



Figure 8. Heartnut.

- **Canoka:** Large nut. Annual, heavy bearer. Leaf out one to two weeks later than other varieties and is less susceptible to frost injury. Originated in British Columbia.
- **Fodermaier:** Large nut. Cracks well. Good kernel. Produces heavy to very heavy crops. When over-production occurs, a portion of the crop may tend to abort, but remaining nuts will be fully developed. This is an important cultivar and is widely planted. Originated in New York.
- **Frank:** Medium-sized nut. Cracks well. Later to leaf out than other varieties, except for Canoka. A seedling selection named after the late Frank Street of Henderson, Kentucky. An outstanding selection produces a crop almost every year despite late spring frosts. Produces an attractive nut with an excellent kernel. This cultivar is highly recommended.
- **Jewel Box:** Productive tree. Very large nut. Cracks well. Tree begins growth early in the spring and is more prone to late spring frosts.
- **Marvel:** Medium to large nut that cracks well and is of good quality. Bears heavily and is hardier than Fodermaier. Tree begins growth early in the spring. Originated in New York.
- **Mitchell Hybrid:** Butternut X heartnut hybrid. Very productive with a heartnut-shaped nut. Vegetates early.
- **Rhodes:** Large nut. Very good cracking quality. Excellent flavor. Prolific; produces in two to three years. Self-fruitful. Begins growth later in the spring and is more resistant to frost than many other varieties. Originated in Tennessee.

- **Wright:** Medium to large nut. Cracks very well. Has a butternut-type flavor. Heavy bearer. Not resistant to bunch disease. The tree begins growth early and is prone to frost injury. It will pollinate Fodermaier and Marvel. Originated in Pennsylvania.

Hicans

Hicans are crosses between pecan and shellbark, shagbark, or bitternut hickory. These hybrids often have mature nuts earlier than pecans and, consequently, do well in northern areas. Unfortunately, most cultivars are rather poor producers.

- **Burton:** Pecan X shagbark hickory. Medium-sized nut; larger, thinner shell than hickory parent. Excellent cracking quality. Excellent flavor. Prolific tree; produces in five to seven years. Self-pollinating. Best suited for the South and Midwest. Ripens early. Originated on a farm south of Owensboro, Kentucky.
- **Bixby:** Pecan X shellbark hickory. Large nut. Heavy producer. Needs pollination. Developed in Illinois.
- **Burlington:** Pecan X shagbark hickory. Productive cultivar. Does well in the Ohio Valley. Self-pollinating. Originated in Iowa.
- **Country Club:** Pecan X shagbark hickory. Medium-sized nut. Very heavy producer. Originated in Indiana.
- **Hartmann:** Pecan X shagbark hickory. Medium-sized, thin-shelled nut. Good producer. Red tinted buds. Originated in Indiana.



Figure 9. Hican.

- **Hershey:** Pecan X shagbark hickory. Medium-sized nut borne in clusters of three and four. High quality kernels fill well. Originated in Pennsylvania.
- **Jackson:** Pecan X shagbark hickory. Medium-sized nut; tasty kernels. Sets heavy crops when well pollinated. Originated in Kentucky.
- **McAllister:** Pecan X shellbark hickory. Very large nut; seldom well filled. Needs early pollen. Originated in Indiana.
- **T-92:** Large nuts (35 to 40/lb); light kernel with excellent quality; one of the best.

Additional cultivars that do well in Kentucky are: Dooley Burton, Johnson, and Palmer.

Shagbark Hickories *Carya ovata*

- **Bridgewater:** Very large shagbark with 47% kernel. Scab susceptible in the South. Originated in Connecticut.
- **Cook Shag:** Oval flat nut that cracks out in halves. Good flavor. Originated in Kentucky.
- **Grainger:** Large nut. Cracks easily. Tree bears heavily. Ripens late. Originated in Tennessee.
- **Raudabaugh:** Thin-shelled nut. Cracks out well. Seedling originated from Pennsylvania.
- **Silvis 303:** Large, round, thin-shelled nut with 45% kernel. Good quality. Self-fruitful. Good Producer. Developed by Ray Silvis in West Richfield, Ohio.



Figure 10. Shagbark hickory.

- **Wilcox:** Medium-sized nut. Cracks out in halves. Very good flavor. Prolific; bears in five to seven years. Good for the North. Ripens early. Originated in Ohio.
- **Wilmoth:** Large, light-colored, thin-shelled nut. Good taste. Developed by Leslie Wilmoth in Glendale, Kentucky.
- **Wurth:** Large, thin-shelled nut. Cracks out in halves. Strong vegetative growth. Very good producer with good scab resistance.
- **Yoder No. 1:** Nut cracks easily. Excellent flavor. Bears young and heavily. Developed by Emmet Yoder in Smithfield, Ohio.

Additional recommended varieties include: Abundance, Cody Cox, Etter, Neel, Porter, Sauber, and Walters.

Shellbark Hickories *Carya laciniosa*

Shellbark hickory nuts usually have thick shells and large, good-quality kernels. The following varieties are recommended for Kentucky:

- **Daulton:** A very vigorous-growing variety that produces very large nuts.
- **Fayette:** Large, thin-shelled nut with 33% kernel. The kernel has good flavor and cracks out well. The tree bears annually and is one of the few varieties that will self-pollinate. Originated in Pennsylvania.
- **Henning:** A rapid-growing tree that produces a large, very attractive nut.
- **Keystone:** Best cracking shellbark. Kernels fall free from the shell. Developed in Pennsylvania.
- **Lebanon Junction (LJ):** Large smooth nut (38 g or 1.3 oz/nut). Sweet kernel. Cracks out well. Early in season. Originated in Lebanon Junction, Kentucky.
- **Lindauer:** Nuts crack out in whole halves. Healthy foliage. A precocious heavy producer of large nuts with medium shell thickness. Weevil resistant. Originated in Illinois.

- **Selbher:** Heavy bearing, regular producer of thin-shelled, medium-sized (1½ inches long) nuts that crack out very well; will probably self-pollinate.
- **Simpson No. 1:** Medium-sized nut. Very open cavity. Best-flavored, light caramel-colored kernel. Heavy cropping.

Additional varieties recommended for Kentucky are: Big Cypress, Bradley, Bullnut, Chetopa, Henry, Hoagland, Nieman, Preston 7, Scholl, Stauffer, and Totten.



Figure 11. Shellbark hickory.

Hybrid Hickories

(Shellbark X Shagbark)

- **Mitch Russell:** Precocious heavy producer of average flavor that cracks out in half and whole kernels. Annual bearer found in Bloomfield, Kentucky, in 1993.

Pecans (*Northern Cultivars Only*)

Carya illinoensis

Select pecan cultivars that produce large crops of medium-sized, well-filled nuts rather than southern cultivars that produce few large, poorly filled nuts and are more prone to winter injury. Cultivars with resistance to scab disease should also be favored.

Desirable pecan nut characteristics include: less than 80 nuts/lb, greater than 50% kernel, high oil content, kernels that are light straw-colored and lack adherence of shell parts to the kernel.

Pecans normally produce two to three nuts per cluster but have the potential to produce eight nuts per cluster. Consequently, cultivars that produce more than two to three nuts per cluster are of great interest because of possible significant yield increases.

Table 2. Pecan blooming periods.

Cultivars	Period when:	
	Pollen is shed	Flowers are receptive
Giles	early	medium
Gibson	early	late
Pawnee	early	late
Major	early	late to very late
Peruque	early	late
Kentucky	medium	medium
Greenriver	medium	medium
Hirschi	early	late
Colby	late	early
Posey	late	early
Mohawk	medium-late	early to mid
Kanza	late	early
Lattus	late	medium
Hodge	late	very late
Howle	late	late
Kiowa	late	early to mid
Witte	very late	early to medium
Yates 127	medium	late
Yates 68	early	late

For more information on these and other pecan varieties, including photos, go to: <<http://aggie-horticulture.tamu.edu/carya/pecans/pecalph.htm>>.

For more information on these and other pecan varieties, including photos, go to <<http://aggie-horticulture.tamu.edu/carya/pecans/pecalph.htm>>.



Figure 12. Pecan.

- **Colby:** Medium to large nut (55 to 60 nuts/lb). 50% of kernel is meat. Good flavor. Tree quickly reaches a mature height and width of 40 feet. Heavily productive; bears young after seven to eight years. Pollinate with Green River Hirschi, Major, Peruque, or Starking Hardy Giant. Good pollinator for James and Major. Needs 160-day season. Zones 6 to 8. Some scab resistance.
- **Fisher:** Medium-sized nuts. Productive. Matures early and of excellent quality. Very hardy, scab resistant, and bears up into Pennsylvania.
- **Greenriver:** Medium to large, thin-shelled nuts (80 nuts/lb). Very good cracking quality. Plum kernel of fine flavor. Large trees. Prolific and regular bearer. Medium pollen shed. Flowers receptive early. Ripens late. Originated in Henderson County, Kentucky, at the mouth of the Green River.
- **Hirschi (Steuck):** Shells with prominent dark stripes (72 nuts/lb), with 49% kernel. Kernels golden to light brown in color. Initially considered scab resistant, but now quite susceptible.
- **Kanza:** A new highly productive northern pecan cultivar release from the USDA with cold tolerance. High-quality kernel and excellent color. Cracks mostly in halves with no packing material adhering to the dorsal or ventral grooves. Considered to be one of the best northern cultivars. Highly resistant to scab and to fungal leaf scorch and leaf and stem phylloxera. Medium in susceptibility to hickory shuckworm and other pecan insects.

- **Major:** Medium-sized, round nut (60 to 80 nuts/lb). Thin, easy-to-crack shell. Small, plump, sweet, buttery, golden kernels. Excellent flavor. Beautiful, vigorous tree produces heavily. Bears in three to five years. Plant with Colby or Stark Surecrop to ensure proper pollination. Ripens medium-early. Hardy in Zones 6 to 8. Scab resistant and protandrous. Discovered in Henderson County, Kentucky.
- **Mohawk:** Large nut (35 to 50 nuts/lb). Very thin shell. 60% of kernel is meat. Fills well. Cracks easily into fancy halves. Distinctive flavor. Excellent quality. Vigorous, upright tree with diffuse branching and dark green foliage. Very productive. Bears at a young age. Blooms late. Plant with Kanza or Posey. Good choice for home planting. Ripens early. Hardy for zones 6 to 9. Originated in Texas.
- **Pawnee:** Large, soft-shelled nut (57 nuts/lb). Excellent quality. Produces five years after planting. Pollinates well with Posey. High yields, about 2,700 lb/acre when mature. Ripens early. Hardy in Zones 7 to 9. Medium scab resistance. Plant on a site with good air drainage and may need spraying for scab on low, damp sites. Developed in Texas.
- **Posey:** Medium to large nut (72 nuts/lb). Very good cracking quality. Excellent flavor. Bears very well in five to seven years. Ripens medium-early. It does well in all parts of the state. It is scab resistant and protogynous. Originated in Indiana.
- **Yates 127:** An important selection discovered in the nut grove of the late Ed Yates at Chrisney, Indiana. It has 65 to 70 nuts/lb, and 55% of the kernel is meat. Extremely thin shell makes possible to extract the kernels in one piece. Scab resistant.
- **Yates 68:** Another important seedling discovered in the Ed Yates nut grove. It has 60 to 70 nuts/lb and a very thin shell with excellent kernel quality. Yates 68 is about 59% kernel. Scab resistant.

An additional pecan cultivar that shows promise is Lattus.

Squirrel Damage to Nuts

Nut losses to squirrels may be reduced by placing a 4-foot-wide tin or aluminum shield around the trunk, with the lowest portion of the shield at least 4 feet from the ground. The shield keeps squirrels from climbing the trunk. Bolt the shield around the tree before you expect squirrel damage (four to six weeks before harvest) to occur. Unfortunately, if squirrels can jump into your tree from another one, this technique won't work. The following publications are available at your county Extension office.

- *Managing Tree Squirrel Problems in Kentucky* (FOR-45): <<http://www.ca.uky.edu/agc/PUBS/for/for45/for45.htm>>
- *Managing Chipmunk Problems in Kentucky* (FOR-41): <<http://www.ca.uky.edu/agc/PUBS/for/for41/for41.pdf>>
- *Managing Rabbits and Vole Problems in Kentucky Orchards* (FOR-43): <<http://www.ca.uky.edu/agc/PUBS/for/for43/for43.htm>>

Harvesting and Storing Nuts

Except for Chinese chestnuts, all nuts discussed in this publication are high in oil. They store best if nut meats are extracted, placed in an air-tight container, and frozen because oils turn rancid more rapidly at higher temperatures. Frozen nuts may be kept for several years or longer without loss of quality. The next best way to store nuts is to shell them and keep them in air-tight containers in the refrigerator.

Unshelled nuts should be placed in a cool, dry, well-ventilated location such as a garage, shed, or cool root cellar. Put them in mesh bags to promote good air circulation. Properly cured nuts may keep a year or longer in a cool place. See Table 3 for additional curing and storage requirements.

Walnut and hickory nut kernels are easier to remove if they are soaked in water for one to two hours, drained, and then held in a closed container such as a covered bowl or jar for 10 hours.

Table 3. Nut storage.

Type of Nut	Curing Area Requirements	Best Long-Term Storage Technique
Black Walnut	cool, dry	shell & freeze
Butternut	cool, dry	shell & freeze
Persian Walnut	dry at 95-105°F within 24 hr after harvest	shell & freeze
Chinese Chestnut	shady, cool, humid, well ventilated	boil or roast, remove shell & freeze
Hazelnut	shady, well ventilated	shell & freeze
Heartnut	cool, dry	shell & freeze
Hican	cool, dry	shell & freeze
Hickory	cool, dry	shell & freeze
Pecan	cool, dry	shell & freeze

Black walnuts are ready for harvest as soon as enough have fallen to make picking them up worthwhile. Nuts should be hulled quickly because the stain in the hull will penetrate and discolor the nut meats if left on too long. The hull can also impart a strong, disagreeable flavor to the nut meats.

To remove hulls, place the nuts on a hard surface and step on them or hit them with a rubber hammer. If a large number of black walnuts need to be hulled, there are mechanical hullers available. Contact the Kentucky Nut Growers Association for details on mechanical hullers. Wash the hulled nuts by placing them in a flat pan measuring approximately 1 ½ by 2 feet wide and 8 inches high. Fill the pan about half full with nuts and direct a garden hose using high pressure to remove the remaining hull fragments and black stain. Pour off the water once or twice until nuts are clean.

Dry them in shallow layers no more than three nuts deep for two to three weeks in a cool, dry, shady spot with good air circulation. Crack a few nuts to be sure that kernels are good and worth storing.

Butternuts are harvested and stored the same way as black walnuts. However, the surface of the hull is sticky.

Persian walnuts should be dried within 24 hours of harvesting. They are usually dried in the shell but will dry faster if shelled first. Screen-bottomed trays will give good ventilation and encourage drying. The best temperatures for drying are 95 to 105°F. With this procedure Persian walnuts will dry adequately in three to four days.

Walnuts are dry when the divider between the halves of the shell breaks crisply when bent. If it doesn't snap, it isn't dry. If nuts are stored in their shells, they should be in a closed container.

Chinese chestnuts should be gathered as soon as they fall from the burrs. Keep them out of the sun because it will dry out the nuts. Harvesting is easier if the grass under the tree is kept mowed low. The nuts drop over a two-week period and should be collected every two days. Place nuts on a screen in a shady, cool, rather humid, well-ventilated place for several days to cure. Chinese chestnuts have a high starch and water content and a very low oil content. Nuts lack flavor when burrs open and chestnuts fall, but after they dry slowly for one to two weeks in a cool place (50 to 65°F), starches are converted to sugars and flavor improves tremendously.

Chestnuts should be cooked before eating and are often roasted or boiled. To cook them in a microwave oven, puncture all but one chestnut with a knife point and put them in a covered glass casserole dish. They are done when the one not punctured explodes. Boiling nuts for three to four minutes in water will make the shell soft and much easier to peel with a sharp knife when they are to be used for cooking.

Don't let chestnuts get too dry. Nuts should remain nearly as plump as they were at harvest. Chinese chestnuts may be stored by sealing whole nuts in air-tight containers and placing them in the refrigerator at 30 to 45°F or in the freezer. If you store them in the refrigerator, check the nuts occasionally and

eliminate any with mold. Reduce mold in storage by placing the nuts in a hot water bath at 120°F for one hour before storing. See the section on chestnut weevil control on page 16.

Hazelnuts are harvested when they drop to the ground. They should not be exposed to direct sunlight. Separate empty nuts, or "blanks," by floating the nuts in water. Dry them on a screen in a shady area with good air circulation. As hazelnuts are dried, they change texture and color. At harvest they are firm and white, but as they dry they first become spongy, then hard and cream-colored throughout when fully dry. Better varieties have less shaggy wood integument around the nutmeat. Store filberts or hazelnuts the same way as Persian walnuts.

Heartnuts are harvested when they fall from the tree. The thin hull on the nut always remains attached at harvest but falls off after drying. Dry nuts for several weeks in a cool, dry place. Crack a few nuts every couple of days to check their dryness before storing. Heartnuts store well and have a long storage life.

Heartnuts may be eaten raw, but they develop their best flavor when used in candy and baked goods or when toasted in a frying pan with a little butter and salt until they darken. They have a milder flavor than black walnuts.

Hickory nuts vary considerably in size, with the shellbark hickory nut being consistently larger than the shagbark hickory nut. The sweet kernels of these two types place them in high demand by nut consumers everywhere. Unfortunately, most of the supply comes from native trees. The best nuts are generally produced by shagbark hickory trees. The shellbark nuts have thicker shells from which the nutmeats are not always easily extracted; however, improved selections of shellbark hickories produce nuts that compare favorably with the cracking qualities of the best shagbark nuts.

Gather hickory nuts as soon as they fall from the tree. Hull them and place nuts on screens to dry. Crack a couple

of nuts every few days to check for dryness. When kernels are crisp, store nuts in their shells in a mesh bag. A cool, well-ventilated place where squirrels cannot get to them is best.

Hicans are harvested when they fall from the tree. Dry and store them as you do hickory nuts.

Pecans are mature on the tree when the shucks around the nut split and expose the nut. The percentage of nuts recovered can be increased if the grass is mowed and a tarp is spread beneath the tree. After nuts are gathered, growers can reduce losses to birds and squirrels by harvesting four times each season. If pecans are allowed to drop naturally, don't let them remain on the ground long because their quality will be reduced. Store pecans in a well-ventilated area where they can dry without molding and sprouting. They may then be refrigerated or frozen.

Nut Cracking

Table 4 provides information on the best way to crack and store Kentucky-grown nuts. There are a number of nut crackers on the market. The following nut crackers are ones that have been tested and recommended by W. C. Donoho, a member of the Kentucky Nut Growers Association who has an extensive collection of nut crackers.

When nuts are incompletely cracked, a pair of wire snips with the tips ground down to a narrow point are helpful in snipping away portions of the shell to obtain larger nut meat pieces.

- **Texas Native Inertia Nutcracker:** This cracker does a good job on pecans, Persian walnuts, and hazelnuts. It obtains its power from rubber bands, and the nuts are cracked by relaying impact through the force of inertia. It produces primarily whole kernel halves. It costs about \$25 and can be ordered from: Bill Price, P.O. Box 305, Bunn, NC 27508

Table 4. Nut cracking.

Type of Nut	To Shell:
Black Walnut	apply pressure either end-to-end across longest dimension or side-to-side across widest dimension
Butternut	apply pressure either end-to-end across longest dimension or side-to-side across widest dimension
Persian Walnut	apply pressure side-to-side not on suture line after harvest
Chinese Chestnut	peel with a knife
Hazelnut	any way
Heartnut	tap lightly on sharp point with a hammer
Hican	apply pressure on suture, side-to-side across widest dimension
Hickory	apply pressure side-to-side across widest dimension
Pecan	any way

- **Get Crackin' Nutcracker:** This is a good fast cracker for many nut types, including Brazil nuts. It does not do well on black walnuts or very hard-shelled nuts. This cracker does not need to be adjusted for nut size. It costs about \$30 and can be ordered from: Creative Designs, Box 156, Goodman, MO 64843.
- **Mr. Hickory Nut Cracker:** An excellent cracker for hickory, black walnut, and butternuts. Readily adjusts for small and large nuts and does well on other nut types. Made of box tubing and comes in two sizes, one for shagbark and one for shellbark hickories. It costs about \$70 and can be ordered from: Mr. Hickory Nut Cracker, Fred

Blankenship, P.O. Box 1182, Radcliff, KY 40159, 502-624-2712 (work).

- **Wileys Nut Grove Cracker:** This is a good, all-purpose cracker. The large cracking post works well for large nuts and the smaller one works well for small nuts. The long handle provides considerable leverage for cracking hard-shelled nuts. It costs about \$50 and can be ordered from: Wileys Nut Grove, 1116 Hickory Lane, Mansfield, OH 44905.
- **Hunt Black Walnut Cracker:** One of the best black walnut, butternut, and hickory nut crackers. It operates smoothly and allows very precise nut cracking because the piston moves only $\frac{1}{8}$ to $\frac{3}{16}$ of an inch. It is not easy to complete the cracking of uncracked portions of a nut, but nuts rarely need to be cracked again if the cracker is adjusted properly. It costs about \$45 and can be ordered from: Hunt's Black Walnut Cracker, 2465 Cleveland St., Swan, IA 50252, 515-989-3869
- **Potter Walnut Cracker:** This cracker was invented in the 1930s and is very well built and sturdy. It does a good job on all nuts. The Potter Walnut Cracker adjusts quickly to the nut size and the indentations on the top of the jaws work very well to crack small hickory nuts and nuts that need additional cracking. It costs about \$40 to \$80 and can be ordered from: Potter Walnut Cracker Co., Box 930, Sapulpa, OK 74066.



Figure 13. Texas Native Inertia Nutcracker.



Figure 14. Mr. Hickory Nut Cracker.

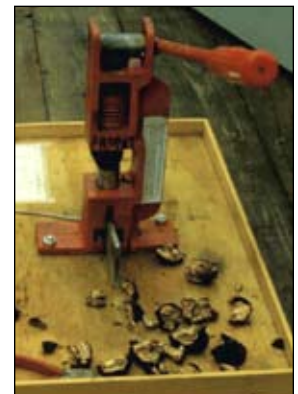


Figure 15. Hunt Black Walnut Cracker.

Table 5. Nut production problems.

Symptoms	Cause
Nuts fail to begin enlarging and drop	1. Spring frosts may injure the flowers or small nuts
	2. Pollination may not be complete; cold, wet weather prevents good wind dispersal of pollen
	3. Cold weather after pollination
Nuts may begin growing, then fall	4. Insect damage: case-bearer, plant bugs, or shuckworms
	5. Poor nutrition
	6. Insufficient moisture, crown gall, or impaired root system
	7. Defoliation by insects or disease
Kernels are shriveled or fail to develop normally	8. Prolonged cool weather during growing season
	9. Trees heavily shaded
	10. Causes 4-7 above
Kernels have dark spots	11. Insect damage
	12. Disease damage

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Major Diseases of Nut Trees in Kentucky

Sometimes, diseases can limit nut production in Kentucky. The following are some diseases most likely to be encountered by nut producers along with specific recommendations for each disease where available.

Chestnut Blight

Chinese chestnuts are generally resistant but not immune to chestnut blight caused by the fungus *Cryphonectria parasitica*. Occasionally, a Chinese chestnut tree will become infected, but this is generally not a major problem. Chestnut blight is a major problem with American chestnuts and these trees often become blighted when they reach the age of 10 years. Chestnut blight can also be a problem with the more susceptible American, Japanese, European, and Chinese hybrid cultivars. This fungus causes swollen, yellow-brown, oval to irregular cankers on young twigs. On branches and tree trunks, cankers are brown, circular to irregular in shape, with slightly raised or depressed margins. Girdling of stems by cankers causes leaves to wilt and die. Dead leaves and burrs cling to diseased branches well after normal leaf fall.

Control

Generally, nothing can save severely infected trees, but the following method may clear up less severe infections where only a few trees are involved in a home planting.

- Prepare a soil compress by mixing soil from the base of the infected tree with enough water to produce mud.
- Tape a piece of plastic over the canker and fill the pocket with muddy soil. Tape the plastic at the top to prevent drying of the soil compress. Be sure that the entire canker is covered with soil. If the canker is large, plastic may need to be wrapped completely around the tree. If the canker is at the base of the tree, mound soil up around the base.
- Keep the soil compress in place for at least two months or, preferably, for an entire growing season. When the compress is removed, the canker should be cured. This treatment will not prevent new infections elsewhere on the tree or prevent re-infection of the "cured" canker. However, if this happens, prepare another soil compress.



Figure 16. An American chestnut stem with a chestnut blight canker (*Castanea dentata* with a *Cryphonectria parasitica* canker). The fungus enters through wounds, such as the broken branch stub on the left, and grows in and under the bark, killing the cambium. Fungus breaks through the lenticels to sporulate. Photo by R. A. Jaynes, courtesy of the Connecticut Agricultural Experiment Station, New Haven, Connecticut.



Figure 17. Dead branch due to infection by chestnut blight canker.



Figure 18. Closeup of a branch stub after chestnut blight canker infection reached the main trunk.

Crown Gall

The bacterium *Agrobacterium tumefaciens*, the cause of crown gall, is widely distributed and can occur in all nut trees commonly grown in Kentucky. Bacterium enters trees through wounds and causes formation of rounded, rough-surfaced galls, up to several inches in diameter. Galls typically occur on roots and crown area, but they may occur on the trunks and limbs as well.

Crown gall is primarily important as a disease of nursery stock, but it may cause losses in large, productive trees. Infected nursery stock usually succumbs to the disease because of the girdling effect of galls on roots and/or main stems of affected trees. Older infected trees show an overall reduction in vigor. Structural decline may also be evident because disintegrating galls often provide entry points for wood-rotting fungi and insects.

Pruning infected stock greatly increases the probability that disease will spread to uninfected stock. Long distance spread of crown gall is primarily through movement of infected nursery stock, infested soil, or infested surface or irrigation water. The crown gall bacterium can survive several years in soil without a host.

Control

- Sanitation is the best way to prevent spread. Thoroughly inspect all incoming nursery stock and destroy infected young trees as soon as you detect the disease.
- Avoid replanting in areas where trees were known to be infected. Fumigation of infested soil is generally not effective unless it is followed by three years of a nonsusceptible crop before replanting with nut trees.
- Avoid unnecessary wounding of stems and roots of healthy trees because crown gall infections occur only at wounds.

A few products help prevent crown gall infection or reduce its activity once infection is evident. They require techniques that are fairly labor intensive and may not control the disease.

Bunch Disease

Bunch disease is a problem in heartnut, Japanese walnuts, and butternut and is endemic, but rarely causes a major problem, in black walnut. It may occasionally be found in Persian walnuts and pecans. Some growers have observed that walnut seed nuts from infected black walnut trees produce a high percentage of bunch disease-infected seedlings; however, this has not been confirmed by research. It is not always possible to detect the existence of bunch disease in black walnut trees. It is best to separate black walnut plantings from heartnuts and butternuts to reduce the chances of infection of the heartnuts and butternuts.

The characteristic symptom of bunch disease is “brooms” of growth formed at terminals and suckers. Brooms develop from diseased branches and form tufted masses of thin, wiry shoots with abnormally short internodes and small, crowded leaves. Dieback may occur with severe infection.

Bunch disease is sometimes confused with zinc deficiency. Leaflets with zinc deficiency, are narrower, thicker, and more brittle than normal. Chlorosis generally develops between veins. In bunch disease leaflets tend to be wider, thinner, and softer than normal. They develop general chlorosis, not confined between veins.

Zinc deficient terminals break dormancy when healthy terminals do. Bunch-diseased terminals, on the other hand, break 10 to 14 days ahead of healthy terminals.

Brooming is a common symptom of zinc-deficient terminals because dominant terminals die and side terminals proliferate. Death of masses of main terminals is not a characteristic of bunch disease. Instead, dieback is general and not confined to terminals.

Bunch disease is thought to be caused by mycoplasma-like organisms that live in the inner bark's food conducting cells. The means of natural spread of this disease has not been determined. No insect vector is known, although graft transmission has been demonstrated.



Figure 19. Crown gall on peach seedlings, caused by the bacterium *Agrobacterium*. Symptoms are similar on pecan. Courtesy of Department of Plant Pathology, North Carolina State University, Raleigh.



Figure 20. Advanced stage of bunch disease. Courtesy of <<http://entopl.okstate.edu/ddd/diseases/bunchdisease.htm>>.

Control

Eradication of the infected tree is the easiest and most foolproof method of control. Although it may seem drastic, diseased trees are poor producers, and the dense broomy growth of trees with bunch rot also presents problems in controlling scab and other foliar diseases. Pruning out diseased branches can be successful if the pruning is done very close to when the infection first takes place. Once the disease becomes systemic in the tree, the only control is tree removal.

Pecan Scab

The pecan scab fungus, *Cladosporium caryigenum*, attacks young, rapidly growing tissue of leaves, leaf petioles, and nut shucks. Infection is first apparent as small, circular, olive to black spots on susceptible tissues.

Greatest damage from scab occurs to leaves, which drop, leading to incomplete nut filling. Infected nuts also drop. As the season progresses and growth of trees is reduced, scab infections become less damaging to both nut yield and quality. Scab overwinters on shucks, leaf petioles, and stems infected the previous season. Infection usually occurs just after bud break. The fungus requires free moisture and moderate temperatures (65 to 85°F) to infect pecans. Very little infection occurs during hot, dry weather. Secondary spore production begins within seven to nine days, after the fungus has colonized host tissue.

Control

The best control is to plant varieties that are scab-resistant. All the pecan varieties recommended in this publication have very good to excellent scab resistance.

During wet years, scab can be extremely damaging on susceptible varieties and cause heavy losses. Consult the spray schedule on page 19 if you need control measures. However, if it doesn't rain much in June and July, the spray schedule can be reduced considerably.

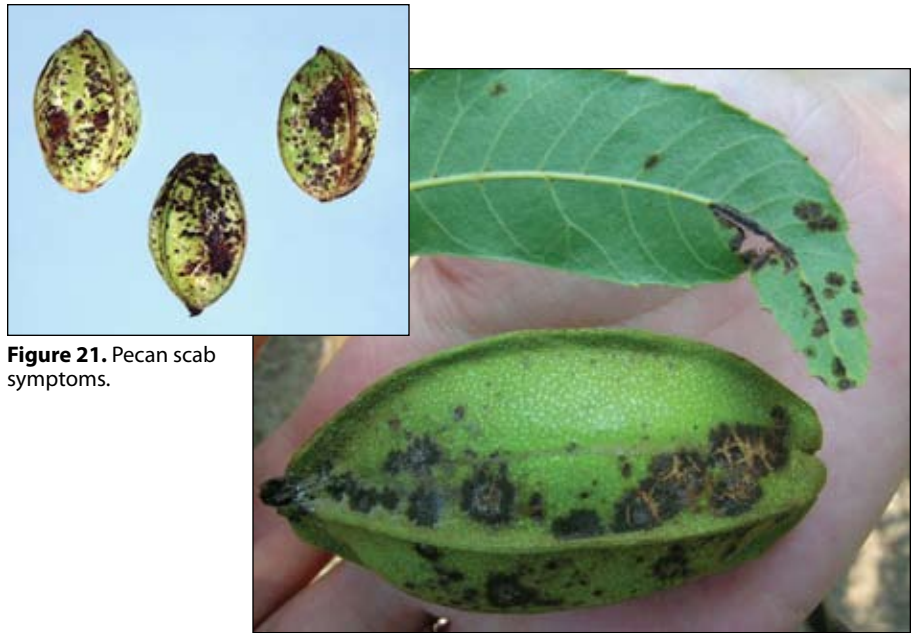


Figure 21. Pecan scab symptoms.

Powdery Mildew

Powdery mildew is a common disease of nearly all nut trees grown in Kentucky. This is not the same pathogen that causes powdery mildew on grape (*Uncinula necator*) or vegetable crops (*Sphaerotheca fuliginea*, *Erysiphe cichoracearum*). The powdery mildew fungi, *Phyllactinia corylea* and *Microsphaera alni*, infect leaves in late summer and early fall, producing patches of white to gray fungal growth on leaf surfaces. Tiny black spore-bearing structures are often found in these patches. These structures remain viable on both living and dead tissue and are the means by which fungi overwinter.

Control

Powdery mildew is seldom serious enough on most nut trees to warrant control measures. Generally, the disease appears so late in the season that tree health and nut yield and quality are little affected.

Shoestring Root Rot

This disease can infect all types of nut trees. Trees infected by the fungus *Armillaria mellea* show a general decline in vigor as well as dieback of limbs in the tree top. Decayed wood develops on lower trunk and root flares of affected trees. When bark is removed from these areas, whitish wefts of the fungus or dark brown, root-like branching structures, called shoestrings, are usually found.

Clumps of brown-yellow mushrooms may be seen growing around the base of affected trees in late fall. Trees are infected through injuries by spores released from these mushrooms. Infection can also occur through contact with shoestring fragments present in surrounding soil.

Shoestring root rot is mostly a problem on trees under considerable stress. However, trees may decline and die without ever becoming infected by the root rot fungus. Many die because they are planted in unsuitable locations. Poor drainage, inadequate moisture holding capacities, low levels of nutrients, insufficient area for root growth, etc., can contribute to a tree's decline and ultimate death.



Figure 22. Shoestring root rot.

Control

To help avoid shoestring root rot, keep trees as healthy as possible with a regular program of fertilization, pruning, and watering during periods of drought. Severely affected trees will not recover and should be removed (including the stump and root flares). Do not replant a tree in the same spot.

Walnut Anthracnose

This disease affects butternut, heartnut, and black, Japanese, and Persian walnuts. The anthracnose fungus, *Gnomonia leptostyla* (*Marssonina juglandis*), causes irregular, dark brown spots on leaflets in early summer. Infection occurs in spring as spores are expelled from dead leaves on the ground. Once infections are established, secondary spread to nearby foliage prevails. In wet years, severe infection causes premature leaf drop and general poor condition of



Figure 23. Anthracnose spots on a black walnut leaf. Courtesy of <http://www.na.fs.fed.us/spfo/pubs/fidls/walnut_anthr/wal_anthr.htm>.



Walnut Blight

The bacterium *Xanthomonas juglandis* attacks leaves, young shoots, and nuts. Persian walnuts are more susceptible to this disease than are black walnuts. Infections start as small, water-soaked spots that eventually turn reddish-brown. Severely affected leaves appear twisted and curled. New shoots are often killed by girdling stem cankers. Diseased nuts exhibit black, sunken lesions on husks. These lesions exude a black, slimy ooze during wet weather. Many infected nuts fall prematurely; others remain attached and reach full size with husks, shells, and kernels blackened and destroyed. Bacteria overwinter in old nuts and in buds.

affected trees. Early defoliation, if it is severe, may also result in incomplete nut fill. If the early part of the season following bud break is dry, the disease may not be significant.

Control

It is best to plant varieties that have a high level of anthracnose resistance because it is difficult to spray large black walnut trees in most situations.

For black walnut, spray with currently labeled fungicides such as 65% dodine (e.g., Syllit) starting when first leaves are half grown, and make three additional applications at 10- to 15-day intervals or as needed, depending upon prevailing conditions. No fungicides are registered for use against anthracnose on other walnuts, butternut, or heartnut.



Figure 24. Walnut blight symptoms on New Zealand grown walnuts. Courtesy of <<http://www.scitech-trust.org.nz/walnut.htm>>.

Control

It is best to plant resistant varieties to avoid this disease. Spray with a fixed copper solution containing at least 50% metallic copper when female flowers appear, again when 50% of the female flowers are in bloom, and again when all female flowers have finished blooming.



Major Insects of Nut Trees in Kentucky

Aphids

These soft-bodied insects infest tree leaves during the summer and early fall and use their piercing-sucking mouthparts to remove plant sap. Black, sooty mold can grow on "honey dew" deposited by aphids as they feed. Heavy infestations may cause extensive leaf drop that can reduce the nut crop in current and succeeding years.

Several species of aphids can be found on nut trees. These black to yellow insects overwinter as eggs in bark crevices on the tree. Eggs hatch in the spring and small aphids begin to feed on the leaves. There are several generations during the year, and winged individuals spread the population over the area.

Usually, aphids do not become abundant enough to cause significant damage until mid- or late summer. Examine tender terminal growth for aphid colonies at regular intervals during the growing season to detect increasing populations. Colonies or clusters of aphids are usually found on the undersides of leaves. Aphid infestations may become severe following use of certain pesticides.

Thorough spray coverage is essential for satisfactory control. Results may be less than satisfactory when aphid numbers are excessively high. Aphids are considered secondary pests and often build to damaging numbers following the use of insecticides.

Borers

Shot hole borers and flathead borers injure stressed or unhealthy trees. Their exit holes may be found riddling limbs and trunks. Adequate fertilization and water will keep trees healthy and allow them to ward off attack by borers.

Remove dead or dying wood that is prone to borer attack and burn it. Young trees may be protected by wrapping trunks with heavy paper or other wrapping material.

Chestnut Weevils

Both the larger and lesser chestnut weevil may be found in Kentucky, but the lesser chestnut weevil appears to be most common. These ¼-inch-long beetles can be identified by their long snout. These weevils breed exclusively in Chinquapin, American, and Chinese chestnuts.

Adults emerge from the ground in June to July, about when chestnuts bloom. Only a few beetles appear early and their population continues to increase during the season. Peak numbers generally occur by the time nuts are maturing in September.

Egg laying begins when nuts begin to form and continues through the season. The first eggs are laid on soft wood around the forming nut. Later eggs are laid just under the inner skin. Most of the eggs are laid after the burr begins to open. Small, grub-like larvae feed in the nut until fully grown (½ inch long). They leave the nut and enter the soil to complete their development.

Although harvested nuts may appear sound when put into storage, some will soon show obvious signs of infestation. These infestations began while the nut was still on the tree. Weevil infestations can be reduced by gathering nuts daily and heating them to 120°F for 20 to 30 minutes to kill larvae in the nuts. A cold treatment, holding nuts at 0°F for four days may be effective, but it may affect the nuts' flavor. Collect and destroy fallen, infested nuts before larvae have a chance to escape and enter the soil. Trees can be jarred similar to monitoring for pecan weevil to determine the presence of adult weevils. Sevin is the only insecticide registered for chestnuts. Maintaining bare ground or closely mowed grass beneath the trees will aid in finding the nuts and reducing weevil populations.

General Leaf Feeders

Several species of caterpillars may feed on nut trees. In addition, the Japanese beetle is very fond of chestnut, and May and June beetles may feed on trees as well. Populations of these insects may vary in significance from year to year. They may be active at different times of the growing season depending on their life cycles.

Large trees can withstand some defoliation, but if insect damage is coupled with droughts or other stresses, the tree may lose vigor or even die. Inspect plantings regularly to detect



Figure 26. Chestnut weevil larvae and the exit hole they make.

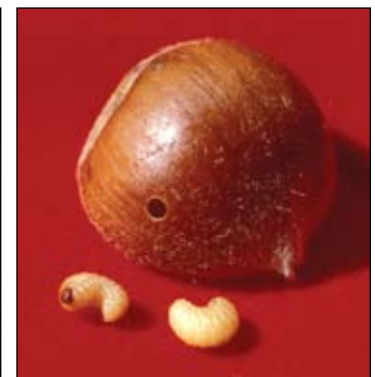


Figure 25. Female chestnut weevil on sweet chestnut leaf. Courtesy of The American Chestnut Foundation at <<http://www.acf.org>>.

beginnings of insect feeding activity and to allow appropriate and well-timed spray applications as necessary.

Unneeded sprays are a waste of money, and frequent applications may produce outbreaks of mites or aphids. Your county Extension agent will be able to help identify insect pests and to help determine the appropriate recommendation.

Leaf-Feeding Caterpillars

- **Walnut caterpillar:** Young larvae are red-brown with narrow yellowish lines extending the length of the body. Full-grown larvae are almost black with two gray lines on the back and two on the sides. Many long, soft gray hairs cover the body. Larvae feed in colonies for about three weeks. There are two generations each year.
- **Fall webworm:** Larvae are pale yellow and spotted with black. Full-grown caterpillars are about 1 inch long and are covered with long black and white hairs. They produce loosely woven dirty white webs on the ends of branches. Infestations are most common in late summer.

Mites

These tiny pests feed on the underside of leaves along midribs and produce irregular brown areas. Leaves may drop from heavily infested trees in late summer or early fall. Mites have a short life cycle and several generations develop each year. Outbreaks may be triggered by certain pesticide applications.

The light green mites are just large enough to be seen with a hand lens. Fine webbing may be seen on leaves if mite populations are very high. Check regularly for mite infestations by carefully examining the undersides of plant leaves with a magnifying glass or by shaking leaves over a piece of white paper. Mites falling off leaves can be seen as tiny moving dots on the paper.



Figure 27. Active feeding by nearly mature caterpillars. Courtesy of Kentucky State University Research and Extension at <http://www.oznet.k-state.edu/hfrr/extensn/POW/2001/June_27.htm>.



Figure 28. Fall webworm netting in a chokecherry. Courtesy of Michael Masiuk (photographer) at <http://woodypests.cas.psu.edu/FactSheets/InsectFactSheets/html/Fall_Webworm.html>.

Pecan Phylloxera

Pecan phylloxera produces galls or bumps on new growth. Leaves, twigs, or nuts may be affected. Galls may range from 1/10 to 1 inch in diameter. They are produced by small, soft-bodied insects closely related to aphids. Phylloxera overwinters as eggs in bark crevices. Tiny nymphs hatch in the spring and move to feed on tender tissue. A substance secreted by these insects causes the plant to grow abnormally, producing galls. Several generations may occur during the growing season and infesta-

tions can continue as long as the tree has fresh, young growth.

Insects are protected within the gall from insecticides. Sprays may reduce continued buildup over the season but will not affect galls that have already developed. Dormant oil spray, as recommended for scales, will help with control if applied thoroughly to the tree trunks. This spray is targeted for overwintering eggs. During the growing season, control should be targeted at the "crawler" stage before the galls form. The crawler stage is active just before or at bud-break.



Figure 29. Damage to foliage by pecan phylloxera (top) and closeup of an opened phylloxera gall (right) showing the insects and larvae.



Pecan Spittlebug

Pecan spittlebugs are small, soft-bodied insects that use their piercing-sucking mouthparts to remove plant sap. They can be found inside foamy white masses on tender shoots and young nuts in spring and early summer. There is a May and a July brood of the insect. They occasionally can damage nuts.



Figure 30. Pecan spittlebug. Courtesy of Clemson University—USDA Cooperative Extension Slide Series, www.forestryimages.org.

Pecan Weevil

The pecan weevil is a late-season pest of pecan and hickory that may sometimes destroy a large part of the crop. The weevil is a brown, $\frac{3}{8}$ -inch-long beetle with its head extended in the form of a snout. It is a serious threat to growers because it feeds directly on the pecan kernel.

The adult, or weevil, appears in late August and early September, about when the nut kernels harden. The female uses her long snout to chew a hole in the shell and deposits her eggs in the nuts. The small white, legless grub hatches from the egg feeds inside the nut during the fall. When mature, about $\frac{3}{8}$ -inch long, the redheaded grub chews a small hole and leaves the nut. It drops to the ground in late fall or early winter and burrows into the soil. Most larvae remain in the soil until the following August, pupate, and emerge as adults. Some remain in the soil for two years before emerging as adults.

Control

Timing of control measures is critical. Insecticide sprays are directed at killing the adult female before she lays her eggs. Once eggs have been deposited in the nut, they are safe from insecticides. The grub, or larva, remains in the nut until full grown so it does not come in contact with the insecticide.

Apply sprays as weevils emerge from the soil and move to trees. They often emerge after the first good rain in mid-to late August. Determine spray timing by “jarring” trees every week starting in early August. Put a large sheet on the ground under a tree and jar the limbs with a padded pole. If any weevils are present, they will fall on the sheet and stay there at least long enough for you to count them. When three or more weevils fall out of a tree, start your spray program. Those not prepared to spray can reduce injury by periodically shaking weevils onto a harvesting sheet. Beetles can easily be collected and destroyed.

Scales

Several species of scale insects can damage nut trees. Scales are often overlooked as pests because they are inactive and blend in with tree bark. Scales suck sap from trees and severe infestations may cause symptoms ranging from leaf drop to dieback of limbs. Trees stressed by scales become more vulnerable to attack by other pests such as wood borers. The scale covering is the visible symptom. This waxy material is secreted by the insect as it feeds and serves as a protective covering. Close examination of twigs and branches is necessary to find scales. Infested twigs may have a roughened or pitted appearance.

Female scales overwinter under their coverings on the tree. They lay eggs in the spring under the scale, and tiny “crawlers” are active for a short time as they move to find a feeding site. After they settle and begin to feed, they start to secrete the covering that will shield them during their life. These insects will not move again.

Insecticide treatments must be applied while the crawler stage is active. Dormant oil applications will help reduce infestations.

Stinkbug

Stinkbugs feed on a wide variety of cultivated crops and weeds. Their feeding with piercing-sucking mouthparts causes discolorations to the kernels. Stinkbugs feed on developing kernels before shell hardening. Although stinkbugs cannot complete their life cycle in nut trees, adult feeding can cause serious losses. Because stinkbug populations usually develop on weeds, effective weed management can reduce stinkbug injury.

Twig Girdler

As the name implies, twig girdlers act as pruning agents on several types of nut trees and persimmon. Symptoms include sudden twig drop in late summer or early fall. Secondary branching may occur on trees and the number of bearing twigs is reduced. Adults are $\frac{1}{2}$ - to $\frac{3}{8}$ -inch-long, gray-brown beetles that have long antennae and a red-brown head. A broad gray band is present over the middle of the wing covers.

Beetles are active in late summer and early fall. The female girdles twigs and lays her eggs beyond the cut. The larva, unable to develop in healthy sapwood, feed for a short time and pass the winter in the twig. They complete their development the following spring and emerge as adults in late summer. There is one generation each year.

Infestations may be reduced with good orchard sanitation. Girdled and fallen twigs should be collected and burned.



Figure 31. Twig girdler.

Table 6. Pecan pest control guide.*

Disease or Insect	Chemical	Rate/100 gal ¹	Rate/gal	Comments
Dormant stage				
Phylloxera, Obscure Scale	Dormant Oil (97%)	3.5 gal	½ cup	Apply when temperature is above 40° F.
Bud break to 3 inches of new growth				
Phylloxera	Asana XL ²	2-5.8 floz	--	21 day PHI
	Brigade WSP ²	4-16 oz	--	7 day PHI
	Centric 40 WDG	1-1¼ oz	--	14 day PHI
	Lorsban 50WP	1 lb	--	28 day preharvest interval (PHI). Limit five applications/season.
	Proaxis 0.5 EC ²	1.28-2.56 floz	--	14 day PHI
	Provado 1.6 F	1.75-3.5 floz	--	7 day PHI
	Malathion 57% EC	0.6 pt	--	Repeat as necessary.
	Sevin 80 S	1.25-3 lb	1¼-3 tbsp	14 day PHI
	Warrior ²	1.28-2.56 floz	--	14 day PHI
	Pecan scab	Syllit 65% WP	1 lb	1 tbsp
Benlate 50% WP		2.7-5.3 oz	1 tsp	
Topsin-M 70% WP		2.1-4.3 oz	1 tsp	
Orbit		1.3-1.8 floz	--	
Abound		3.1-4.1 floz	¼ tsp	
Ziram 76W		2 lb	2 tbsp	
Super-Tin 80W		1.7-2.5 oz	½ tsp	
Enable 2F		2.7 floz	¼ tsp	
1st cover, soon after pollination when tips of nuts turn brown (mid-May to early-June)				
Pecan scab	as above	as above	as above	
2nd cover through shuck split				
Pecan scab	as above	as above	as above	Apply fungicides during periods of frequent rains at 10- to 14-day intervals. Do not apply fungicides after shuck split. Only limited fungicide sprays may be needed during very dry periods.
Early to mid-August following a heavy rain				
Pecan Weevil	Imidan 70 WSP	1 lb	--	14 day PHI
	Asana XL ²	2.0-5.8 floz	--	21 day PHI
	Baythroid ²	1.0-1.2 floz	--	14 day PHI
	Sevin 80 S	1.25-3 lb	1¼-3 tbsp	Do not apply after shuck split. 14 day PHI
	Mustang Max ²	1.28-2.0 floz	--	21 day PHI
	Proaxis 0.5 EC ²	1.28-2.56 floz	--	14 day PHI
	Warrior ²	1.28-2.56 floz	--	14 day PHI
	Apply insecticides for these pests only when they become a problem in the pecan grove			
Aphids	Admire Pro	7-14 oz/acre	--	7 day PHI
		Soil applied, see label		
	Brigade WSP ²	4-16 oz	--	7 day PHI
	Centric 40 WDG	1-1.25 oz	--	14 day PHI
	Dimethoate 4 EC	0.3 pt	--	21 day PHI
	Malathion 57% EC	0.5-1 pt	--	21 day PHI
	Mustang Max ²	1.28-2 oz	--	21 day PHI
	Nexter 75WP	2.6 to 5.33 oz	--	7 day PHI
	Proaxis 0.5 EC ²	1.28-2.56 floz	--	14 day PHI
	Provado 1.6 F	1.75-3.5 floz	--	7 day PHI
	Sevin 80 S	1.25-3 lb	1¼-3 tbsp	14 day PHI
	Thionex 50 WP	1.5 lb	1½ tbsp	For black-margined aphid.
	Warrior ²	1.28-2.56 floz	--	14 day PHI

continued on next page

Weed Control in Nut Trees

Because most available herbicides are selective, there will always be some escapes, which, if not controlled, will become the dominant weeds in the grove. To prevent this, do not depend on herbicides exclusively. Cultivate, hoe, or pull escapes. Rotate herbicides and be sure to use herbicides with differing modes of action in rotational crops.

Mixing two or more herbicides improves the spectrum of weeds controlled, while minimizing required rates. However, do not mix herbicides unless the mixture is approved on at least one label of the products intended for use.

Nut crops can be easily injured if too much herbicide is applied. To prevent this, calibrate the sprayer before each use and adjust nozzle tips to the proper height above soil level. Herbicides should be applied with a boom sprayer. Backpack sprayers are not recommended for commercial orchards because they do not provide uniform application of herbicides. Airblast sprayers should not be used because herbicide tank residue can burn foliage when spraying insecticides or fungicides.

Controlling Weeds Before Planting

Many of the worst weeds are perennials such as quackgrass, Johnsongrass, yellow nutsedge, Canada thistle, and field bindweed. Perennials spread and reproduce mainly by underground rhizomes and are more difficult to control once nut crops are planted. Therefore, eliminate all perennial weeds before establishing a new planting by using a planned program of tillage, rotational crops, and herbicides. After planting, continue to hoe them any time they appear. Time and money spent before planting will eliminate the need for more costly and ongoing weed control methods during the establishment and production years. Without the presence of competing perennial weeds, there will be a greater potential for

Table 6. Pecan pest control guide, continued.

Disease or Insect	Chemical	Rate/100 gal ¹	Rate/gal	Comments
Leaf-feeding caterpillars	Asana XL ²	2-5.8 floz	--	21 day PHI
	Baythroid ²	1.2-1.4 floz	--	7 day PHI
	Brigade WSP ²	4-16 floz	--	7 day PHI
	Confirm 2F	4-8 floz	--	14 day PHI
	Intrepid 2 F	2-4 floz	--	14 day PHI
	Mustang Max ²	1.28-2 floz	--	21 day PHI
	Imidan 70 WSP	1 lb	--	14 day PHI
	Lorsban 50 WP	1-2 lb	--	28 day PHI. Limit 5 applications.
	Malathion 57% EC	0.6 pt	--	21 day PHI
	Proaxis 0.5 EC ²	1.28-2.56 floz	--	14 day PHI
	Sevin 80 S	1.25-3 lb	1¼-3 tbsps	14 day PHI
	Spintor 2 SC	1-2.5 floz	--	14 day PHI
	Thionex 50 WP	1.5-2 lb	1-2 tbsps	21 day PHI
Warrior ²	1.28-2.56 floz	--	14 day PHI	
Pecan spittlebug	Admire Pro	7-14 floz soil applied, see label	--	7 day PHI
	Asana XL ²	2-5.8 floz	--	21 day PHI
	Baythroid ²	1-1.2 floz	--	14 day PHI
	Imidan 70 WSP	1 lb	--	14 day PHI
	Proaxis 0.5 EC ²	1.28-2.56 floz	--	14 day PHI
	Provado 1.6 F	1.75-3.5 floz	--	7 day PHI
	Sevin 80 S	1.25-3 lb	1¼-3 tbsps	14 day PHI
	Warrior ²	1.28-2.56 floz	--	14 day PHI
Mites	Acramite 50 WS	0.375-0.5 lb	--	14 day PHI
	Dimethoate 4 EC	0.3 pt	--	21 day PHI
	Envidor 2 SC	7 - 9 floz	--	7 day PHI
	Malathion 57% EC	0.5-1 pt	--	21 day PHI
	Nexter	2.6-5.33 oz	--	7 day PHI
	Savey 50 DF	1.5-3 oz	--	28 day PHI
Zeal	1-1.5 oz	--	28 day PHI	

When rosette is a problem

Zinc deficiency	Zinc sulfate 25 WP	1 lb	1 tbsps	Apply at bud break and at 1st cover.
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¹ Rates given are dilute rates based on per acre rates using 200 gallons of spray per acre.

² Restricted use pesticide

NOTE: Some products have restrictions concerning the grazing of livestock on orchard floors following treatment. Read the label of all pesticides before purchase and use.

*Always read the pesticide label in full.

Table 7. Pesticides registered for other nut crops.*

Crop	Pesticides Registered	Comments
Walnut	Acramite, Agri-Mek, Apollo, Asana, Baythroid, Brigade, Confirm, Diazinon, Envidor, Esteem, Guthion, Imidan, Intrepid, Kelthane, Lorsban, Malathion, Nexter, Pounce, Proaxis, Savey, Sevin, SpinTor, Thionex, Warrior	
Chestnut	Acramite, Baythroid, Brigade, Confirm, Envidor, Esteem, Imidan, Intrepid, Proaxis, Nexter, Savey, Sevin, SpinTor, Warrior	For the chestnut weevil apply 2.5-3.75 lb/100 gal or 2-3 tbsps/gal. Make 4 applications at weekly intervals. Begin in late July, end before shuck split.

* See the label for specific recommendations.

vigorous, healthy establishment of the nut planting.

Roundup applied directly to the foliage of perennial weeds before plowing is the most effective means of control. Roundup application must be timed correctly and the right rate used for the perennial weeds you are trying to control. Most perennials are best controlled with fall-applied Roundup. Grasses should be at least 8 inches tall when treated. An extended period of drought just before spraying may adversely affect control. Spring applications are effective on grasses but do not provide as good control of broadleaf perennials as fall applications.

Methods of Application

Uniform application is absolutely necessary if herbicides are to provide the desired results. Variations in the spray pattern, speed of the rig, worn nozzle tips, etc., may change the application rate sufficiently to damage the crop or reduce weed control. Devrinol, Karmex, and some formulations of Simazine (Princep) are wettable powders that do not easily dissolve in water. These herbicides form a suspension in water that needs constant agitation in the spray tank. Consequently, you must take several precautions to maintain a uniform application.

Precautions

1. Screens in the line should be no more than 50 mesh to avoid clogging.
2. The material will settle to the bottom of the tank if not constantly agitated. Either continuous mechanical agitation by paddles in the tank or hydraulic agitation by return flow jets (pressure regulator bypass) is necessary.
3. Wettable powders are abrasive; therefore, do not use these herbicides in gear, roller, or impeller pumps. The clearances in these positive displacement pumps are close; they wear quickly when abrasives are pumped.

4. Wettable powders wear nozzles readily, too. Brass nozzles wear sooner than polymer and stainless steel nozzles. Because of wear, the amount of spray being pushed through the nozzle will gradually increase. The spray rig must be properly designed and calibrated often (approximately every 20 hours of use with brass nozzles) if you are to be sure of the amount of material being applied per acre.

Water Volumes and Adjuvants with Roundup/Touchdown (Glyphosate)

Low water volumes of 5 to 10 gallons per acre provide best weed control. If higher water volumes must be used, use the maximum rate of glyphosate for the weed to be controlled. At high water volumes, adding a non-ionic surfactant at 0.5% (1 pint in 25 gal) or ammonium sulfate (2 to 4 lb per acre) to the spray mix will improve control. Always add ammonium sulfate to the water before adding glyphosate. Hard water with more than 500 parts per million of calcium or magnesium will usually reduce glyphosate activity. If hard water must be used, keep the volume low (5 gal per acre) or increase the rate of herbicide. Use clean water. Silt, clay, and organic debris in water will also reduce glyphosate activity.

Herbicide Injury

Crop injury resulting from the use of herbicides is common, particularly on light sandy soils. Most herbicide injury can be traced to using too high a rate on light soils, incorrect timing of sprays, incorrectly calibrated sprayers, sensitive cultivars, and weak plants growing under unfavorable conditions. The grower usually has some control over these factors. Any factor that injures the crop (other pests, winter injury, exposure of root systems as a result of erosion, improper mineral nutrition, wet spots in the field, etc.) will make the crop more susceptible to injury.

Newly planted trees are especially sensitive to herbicides. Crop tolerance increases in late summer and fall. This corresponds to the time when preemergence herbicides can be used to control many winter annual and perennial weeds.

Remember that light, sandy soils require less herbicide than heavier soils for comparable levels of weed control. Nut crops growing on soils low in organic matter are especially prone to herbicide injury. Accordingly, lower rates of herbicide should be used on fields low in organic matter (less than 2%).

To minimize the risk of crop injury, growers must be careful not to exceed maximum recommended annual application rates. Fully understand and follow the instructions on the product labels. Do not expect herbicides to control all weed problems. Understand that hand weeding and cultivation will be required to obtain complete weed control. Weakened plants are more susceptible to herbicide injury. Conversely, healthy plants are most capable of tolerating recommended treatment rates.

Table 8. Herbicides cleared for nut crops.

	Walnut	Butternut	Chestnut	Hazelnut	Heartnut	Hican	Hickory	Pecan
Preemergence								
Chateau 51WDG	x			x				x
Devrinol 50DF	x			x				x
Gallery 75DF	x			x				x
Goal 2XL	x	x	x	x			x	x
Karmex 80DF				x				x
Princep 4L	x			x				x
Prowl 3.3EC	x	x	x					x
Sandea 75DF	x	x	x	x			x	x
Snapshot 2.5TG	x			x				x
Solicam 80DF	x			x				x
Surflan 4AS	x		x	x			x	x
Treflan HFP 4EC	x							x
XL 2G	x			x				x
Postemergence								
Aim 2EC	x	x	x	x			x	x
Amine4	x	x	x	x	x	x	x	x
Gramoxone	x	x	x	x			x	x
MSMA-6 Plus	x	x	x	x	x	x	x	x
Poast 1.5EC	x	x	x	x	x	x	x	x
Recoil 3.2E	x	x	x	x	x	x	x	x
Reglone 2L	x							
Roundup 5.5L	x			x				x
Select 2EC	x	x	x	x				x

Table 9. HRAC code, risk of resistance, signal word, restricted use, and preharvest intervals of herbicides labeled on nut trees.

Trade Name	Common Name	HRAC Code	Risk of Resistance	Signal Word	Restricted Use	Preharvest Interval
Preemergence						
Chateau 51WDG	flumioxazin	E	Medium	Caution	No	60 d
Devrinol 50DF	napropamide	K3	Low	Caution	No	35 d
Gallery 75DF	isoxaben	L	Medium	Caution	No	-
Goal 2XL	oxyfluorfen	E	Medium	Warning	No	-
Karmex 80DF	diuron	C2	Medium	Caution	No	-
Princep 4L	simazine	C1	Medium	Caution	No	-
Prowl 3.3EC	pendimethalin	K1	Low	Caution	No	-
Sandea 75DF	halosulfuron	B	High	Caution	No	-
Snapshot 2.5TG	trifluralin + isoxaben	L,K1	Medium	Caution	No	-
Solicam 80DF	norflurazon	F1	Medium	Caution	No	14 d
Surflan 4AS	oryzalin	K1	Low	Caution	No	-
Treflan HFP 4EC	trifluralin	K1	Low	Caution	No	-
XL 2G	benfen + oryzalin	K1	Low	Caution	No	1 yr
Postemergence						
Aim 2EC	carfentrazone	E	Medium	Caution	No	3 d
Amine4	2,4-D amine	O	Low	Danger	No	14 d
Gramoxone	paraquat	D	Medium	Poison	Yes	-
MSMA-6 Plus	MSMA	Z	Low	Caution	No	1 yr
Poast 1.5EC	sethoxydim	A	High	Warning	No	14 d
Recoil 3.2E	2,4-D + glyphosate	G,O	Low	Danger	No	40 d
Reglone 2L	diquat	D	Medium	Warning	No	-
Roundup 5.5L	glyphosate	G	Low	Caution	No	14 d
Select 2EC	clethodim	A	High	Warning	No	-

Table 10. Herbicide application information for nut trees.*

Material and Rate/A	Weed Problem	Comments and Limitations
Preemergence		
Chateau 51WDG (flumioxazin 51% ai) 6-12 oz/15-75 gal water	Annual broad-leaves, suppression of grasses	Nonbearing trees only: The preferred timing is in the fall to maximize the potential for rain-fall to activate and set the herbicide. Do not apply to trees less than one yr old, or to mature trees after bloom through final harvest, unless with hooded or shielded application. Apply alone preemergence or tank mix with Roundup or Gramoxone postemergence with a crop oil 1% v/v or NIS 0.25% v/v. Do not incorporate. Do not allow drift to contact foliage or green bark. Max. rate is 6 oz per season if trees are less than three years old. Min. 30 days between applications. PHI = 1 year.
Devrinol 50DF (napropamide 50% ai) 8 lb/20 gal (min.) water	Annual grasses and broadleaves	Apply from late fall prior to soil freeze-up to early spring prior to weed emergence. If no rain-fall occurs within 24 hours after treatment, cultivate or irrigate 1 in to activate. Apply alone to weed-free soil or in tank mix with Roundup or Gramoxone. Do not allow spray to contact nuts or foliage. May be applied to newly planted and established crop. Max. one application per season. PHI = 35 days.
Gallery 75DF (isoxaben 75% ai) 0.66-1.33 lb/10 gal (min.) water	Most broad-leaves	Nonbearing trees only: Apply in late summer to early fall; or preemergence in early spring prior to weed germination or immediately after cultivation. Do not apply to new transplants until soil has settled with no cracks present. Rainfall or irrigation 0.5" is needed within 21 days of application. Not effective on germinated weeds. Min. 60 days between applications. Max. rate is 4 lb per acre.
Goal 2XL (oxyfluorfen 2 lb ai/gal) 2-8 pt/40 gal (min.) water	Annual broad-leaves, suppression of grasses	Dormant application only: Effective both preemergence (5-8 pt) and postemergence (2-8 pt) as a directed spray on weeds <4 in. Do not apply from bud swell till harvest completion. Can be mixed with other preemergence herbicides or with Roundup or Gramoxone. Max. rate is 8 pt per year.
Karmex 80DF (diuron 80% ai) 4-9 lb/25-40 gal water	Annual grasses and broadleaves	Make an initial treatment of 4-5 lb in the last fall or early winter after harvest. Repeat annually with 3-4 lb in the fall. Can also apply 2 lb in the fall, followed by 2 lb in the spring. Apply as a directed spray, avoiding contact of foliage with spray or drift. Do not graze livestock in treated groves. Do not replant treated areas to any crop within two years after last application, as injury to subsequent crops may result.
Princep 4L (simazine 4 lb ai/gal) 2-4 qt/40 gal (min.) water	Annual grasses and broadleaves	Apply 2-4 qt in the fall or as a split application of 2 qt in the fall and spring. Apply under trees established at least one year for hazelnut and walnut and two years for pecans. Apply in spring before weeds emerge avoiding contact with nuts, foliage, or stems. Max. one application per year. Do not apply when nuts are on the ground.
Prowl 3.3EC (pendimethalin 3.3 lb ai/gal) 2.4 qt/20 gal (min.) water for short-term control 4.8 qt/20 gal (min.) water for long-term control	Annual grasses and certain broadleaves	Nonbearing trees only: Do not apply if buds have started to swell. May be applied preplant incorporated, preplant surface or preemergence. For best results, rain or irrigation is needed within 21 days of application. Not effective on germinated weeds. Do not allow spray to contact leaves, shoots, or buds. For new plantings, do not apply until soil has settled and no cracks are present.
Sandea 75DF (halosulfuron 75% ai) 0.66-1.33 oz/20 gal water	Annual broad-leaves and yellow nutsedge	Apply as a directed spray to trees established at least 12 months and where the soil has firmly settled around the roots from packing and rainfall or irrigation. Avoid contact with trunk, foliage, roots or stems.
Snapshot 2.5TG (granular) (isoxaben+trifluralin 2.5% ai) 100-200 lb	Annual grasses and certain broadleaves	Nonbearing trees only: Apply preemergence on weed-free clean soil. For best results, 0.5 in rain or irrigation is needed within 3 days of application. Not effective on germinated weeds. Min. 60 days between applications. Max. rate is 600 lb per year.
Solicam 78DF (norflurazon 78.6% ai) 2.5-10 lb/20 gal (min.) water	Annual grasses and broadleaves, suppression of yellow nutsedge	Apply a directed spray to settled and firm soil from fall to early spring before weeds emerge and before shaking or nut drop. Soil should be settled and firm. Rainfall or irrigation 0.5 in is needed within four weeks. Do not contact nuts or foliage.
Surflan 4AS (oryzalin 4 lb ai/gal) 2-6 qt/20-40 gal water	Annual grasses and certain broadleaves	Make a single band or broadcast application to the ground beneath trees before weeds emerge. Apply alone to weed-free soil or postemergence mixed with Roundup or Gramoxone. Rainfall or irrigation 0.5 in is required for activation. Min 2.5 months between applications. Max. rate is 12 qt per year.
Treflan HFP 4EC (trifluralin 4 lb ai/gal) 1.25-4 pt/5-40 gal water	Annual grasses and broadleaves	New plantings: Apply 1.25-2 pt and incorporate before transplanting. Established plantings: apply 2-4 pt and incorporate prior to period of weed germination or after removal of weeds with tillage or herbicides.
XL 2G (granular) (benefin + oryzalin 1 lb ai/50 lb bag) 200-300 lb	Annual grasses and broadleaves	Nonbearing trees only: Apply only to established plantings. Apply preemergence to weed-free soil or immediately after cultivation. A 0.5" rainfall or irrigation is needed within 21 days of application for herbicide activation. Min. 4 months between applications. Max. rate is 900 lb per year.

continued on next page

Table 10. Herbicide application information for nut trees, continued.

Material and Rate/A	Weed Problem	Comments and Limitations
Postemergence		
Aim 2EC (carfentrazone 2 lb ai/gal) 1-2 fl oz/20 gal water	Annual broad-leaves	Apply any time during the season. Always add non-ionic surfactant 0.25% v/v or crop oil 1% v/v. Mix with Roundup or Gramoxone for broader weed control. Max. 7.9 fl oz per year. Min. 14 days between applications. PHI = 3 days. Sucker management: Apply when suckers are green. Do not allow spray to contact nuts, foliage, or green bark.
Amine4 (2,4-D) 3 pt/5-25 gal water	Annual and some perennial broadleaves	Apply as directed spray to annuals 1-2 in high and to perennials up to early bud stage. Do not allow spray to contact leaves, nuts, or limbs of tree. Use coarse spray and low pressure to avoid drift. Nonbearing trees must be established at least one year. On bearing trees. Do not apply during bloom or after before irrigation. Do not apply to bare ground. Max. two applications per year and 75 days between applications. PHI = 60 days.
Chateau 51WDG (flumioxazin 51% ai) 6-12 oz/15-75 gal water	Annual broad-leaves, suppression of grasses	See "Preemergence" section above for details.
Goal 2XL	Annual broad-leaves	See "Preemergence" section above for details.
Gramoxone Inteon 2L (paraquat 2 lb ai/gal) 2.5-4 pt/10 gal (min.) water	Most annual grasses and broadleaves weeds, top kill of perennial weeds	Apply as directed spray to actively growing weeds. Repeat applications are necessary to give sustained control. Apply as a coarse spray. Always add nonionic surfactant 0.25% v/v or crop oil 1% v/v. Do not allow spray to contact leaves, nuts, or green stems. Do not apply when nuts are on the ground. Max. 5 applications per year. Restricted Use Pesticide.
Karmex 80DF	Annual grasses and broadleaves	See "Preemergence" section above for details.
Poast 1.5EC (sethoxydim 1.5 lb ai/gal) 1.5-2.5 pt/25 gal water	Annual and perennial grasses	Apply as a directed spray to actively growing grass before tillering. Always add crop oil 1.25% v/v. Max. rate is 2.5 pt per application and 7.5 pt per season. PHI = 14 days.
Recoil 3.65E (glyphosate + 2,4-D) 1-4 qt/15-100 gal water	Annual and perennial grasses and broadleaves	Use on nonbearing (well established, 1 yr or older) and bearing trees before and after bloom. Max. 2 applications per season. Min. 75 days between treatments. PHI = 14 days. Apply as a directed and shielded spray with flat-fan nozzles and low pressures (20-25 psi). Avoid contact with nuts, foliage, stems, or lower limbs. Apply when soil is moist and do not irrigate for 5-7 days after application.
Roundup WeatherMax 5.5EC (glyphosate 5.5 lb ai/gal) 0.5-3.3 qt/10-40 gal water	Annuals and some perennial grasses and broadleaves	Rate depends on weed species and stage of growth. See label for details. Apply as preplant broadcast application or in fall for control of roots and rhizomes of perennial weeds or as a directed spray or wiper application (20-100% solution) to actively growing weeds in established plantings. Always add AMS 8.5-17 lb/100 gal in hard water or drought conditions. Do not allow spray to contact any part other than mature bark. Does not provide residual control; can be mixed with labeled preemergence herbicides. Allow min. three days between application and transplanting.
MSMA 6 Plus 2.66 pt/50-100 gal water	Annual grasses and broadleaves	Nonbearing trees only: Apply as a postemergence directed spray. Max. three applications per year. Do not allow spray to contact foliage, stem or bark.
Reglone 2L (diquat 2 lb ai/gal) 1.5-2 pt/15 gal (min.) water	Annual grasses and broadleaves	Nonbearing trees only: Apply postemergence as a directed spray using a shield for contact burn of weeds. Complete coverage is essential for good control. Can be used during site preparation and up to 1 year of harvest. Do not allow contact with green stems, foliage or fruits. Do not use for food or feed for one year after application.
Select 2EC (clethodim 2 lb ai/gal) 6-8 fl oz/20-30 gal water	Most annual and perennial grasses	Nonbearing trees only: Apply postemergence as a directed spray to actively growing grasses before tillering. Do not use crop oil. Always add non-ionic surfactant at 0.25% v/v. May be applied as a spot treatment at 0.65-1.3 fl oz per gal. Rainfast in one hr. Max. rate is 32 fl oz per year.

*Consult label for full application instruction before use.

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