A3565

Growing Apples in Wisconsin

Malus x domestica

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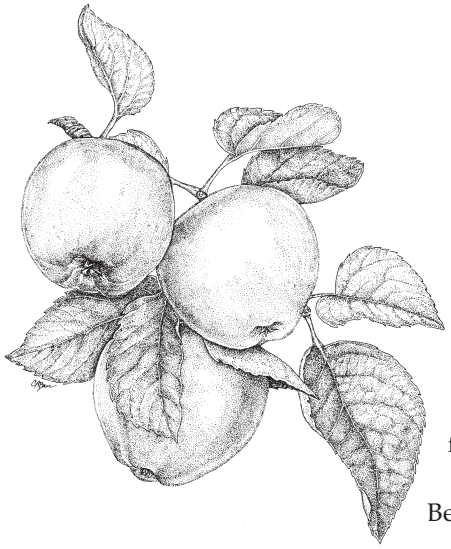
Apples in Wisconsin



Apples are the most widely planted tree fruit in Wisconsin. Apples occur in a wide variety of colors, sizes, flavors, and textures and can be used in many different ways. Trees range in size from very small "super dwarfs" to large standard trees. Besides providing fruit, apples can be a pleasing addition to the home landscape.

Before purchasing and planting apple trees, consider whether you have the space, time, and expertise needed to grow and care for them. This bulletin outlines the basics of apple production. For more information, contact your county Extension office.

The Apple Tree

Cultivated apple trees generally consist of two components—the rootstock, the below-ground part that controls tree size, and the scion, the above-ground part that produces fruit. These two parts are joined by grafting and are equally important.

Apple flowers and fruit are always produced at the end of branches. If a fruiting branch continues to elongate, it is from a side (or bourse) shoot. Apple trees may be spur types where fruit are borne on short shoots called spurs, standard types where fruit are borne on longer shoots, or intermediates. Spur-type trees are about 25% smaller than standard types.

Apples have two types of buds—vegetative and mixed. Vegetative buds produce only leaves and shoots, while mixed buds produce both leafy shoots and flowers. Each flower bud will produce five flowers. The first to open is the terminal or king flower. The side flowers open later, usually within 48 hours of the king flower. The king flower produces the largest fruit.

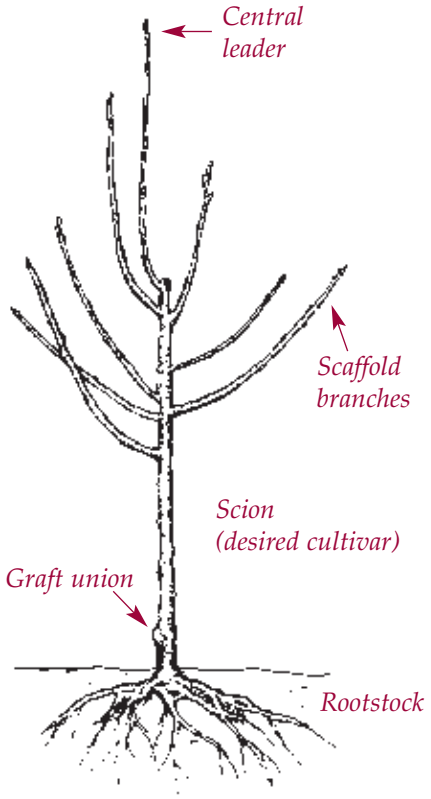


Figure 1. Important parts of a young apple tree. The graft union shows where the rootstock and the scion were joined.

Apple flowers are self-unfruitful. That is, pollen produced by a flower from one cultivar cannot pollinate flowers from the same cultivar. Pollen must come from flowers from a different cultivar. Insects, usually honey bees, carry pollen from one tree to another.

The trunk and branches of an apple tree need to be trained and pruned to support the weight of fruit. Typically, apple trees are pruned to leave a main trunk (central leader) and numerous side branches (scaffolds). Selecting scaffold limbs with wide angles from the trunk gives the branches maximum strength.

Training apple trees does more than strengthen limbs, it also improves fruit quality and production by ensuring that all leaves receive sunlight. Leaves require sunlight to produce carbohydrates needed for fruit production and tree growth. Leaves that grow in the shade cannot produce the needed sugars for quality fruit.

The root system of apple trees is shallow and well branched. The roots have roughly the same horizontal spread as the branches. Most of the active roots are found in the top 12 inches of soil where there is adequate moisture, oxygen, and nutrients. Roots do not tolerate wet or poorly aerated soils. Under these conditions, trunk crown rot and winter injury are more likely.

Site selection and preparation

Once a fruit tree is planted it is not easy to move it to a more suitable location. Therefore, it is desirable to establish the planting in a well-prepared, suitable site. Site selection and soil preparation should begin the season before planting. Planning ahead allows time to adjust the soil pH, control perennial weeds, and amend the soil.

The first consideration when selecting a site is determining how much space each tree will require. Smaller sized (dwarf) apple trees require the least amount of space. Dwarf apple trees require about 75–100 square feet each and grow 8–10 feet tall. Semi-dwarfs require 125–200 square feet each and grow to 10–20 feet. Standard trees take 300–400 square feet or more and may be over 30 feet tall.

The ideal site for apple trees is on land with a gentle slope so that cold air can settle into adjacent lower areas. The bottoms of valleys are "frost pockets" and may be several degrees colder than nearby hillsides. Hilltops are undesirable as they may be very windy. Apples grow best in fertile sandy loam soils, though they will grow in all but the rockiest or heaviest clay soils. The soil must have good internal water drainage, as apple trees will not grow with "wet feet." The soil should be slightly acidic to neutral, with a pH between 6 and 7. Apple trees require full sun at least three-fourths of the day. Shady locations are not suitable for apple trees.

Once a suitable site has been located, begin soil preparation. Control perennial weeds either by tillage or by using non-residual herbicides. Take a soil test of the location to a depth of 6 inches. Follow soil test recommendations to adjust the soil pH: add lime if the soil is too acidic; add sulfur if the soil is too alkaline. To improve soil tilth, aeration, and water-holding capacity, add organic matter such as manure, leaves, or compost. For information on how to sample soil and where to send samples for testing, see Extension publication *Sampling Lawn and Garden Soils for Soil Testing* (A2166).

Cultivar selection

Many apple cultivars grow well in Wisconsin. When choosing a cultivar, consider intended use (fresh eating, baking, processing), flavor, color, and texture. In addition, the cultivar must be winter hardy in your area and must ripen by mid-October. Rome Beauty and Jonathan are not typically grown in Wisconsin because they can't survive Wisconsin's cold winters. Fuji and Granny Smith require about 180 days between bloom and harvest and will not fully mature in Wisconsin.

Another factor to consider is disease resistance. Some apple cultivars are resistant to apple scab, the most serious disease problem of apples in Wisconsin. Such trees will not have to be sprayed with fungicides to control the disease and are highly recommended for home gardens in Wisconsin. More information on cultivar selection can be found in Extension publications *Apple Cultivars for Wisconsin* (A2105), *Home Fruit Cultivars for Northern Wisconsin* (A2488), and *Home Fruit Cultivars for Southern Wisconsin* (A2582).

Since apple trees are self-unfruitful, there must be a second apple cultivar planted close by to provide pollen for good fruit set. Many flowering crabapples also can be adequate pollen sources for fruit set in apples. You should assure that the two cultivars bloom at the same time so they can provide pollen to each other. Some apple cultivars are triploid (have three sets of each chromosome rather than the normal two sets) and do not produce viable pollen. Examples of triploid apples are Jonagold, Gravenstein, Rhode Island Greening, Winesap, and Mutsu (Crispin). If you plant a triploid apple, a second cultivar not in this group must be planted to provide adequate pollen. Most suburban residential areas have sufficient apple and crabapple trees to provide adequate pollination without planting two trees. Pollinizer trees should be within 200 yards of each other.

Rootstock Selection

Apple trees available at commercial nurseries consist of two parts: a rootstock (the below-ground portion) and a scion (the desirable commercial cultivar). Such trees are made by grafting or budding a desirable scion to a rootstock with desirable characteristics.

Rootstocks control tree size in apples. Trees on dwarfing rootstocks such as (Malling) M.9 and M.26 are best for home gardens. It is best to order trees from nurseries or garden centers that allow you to select the rootstock. Small trees take up less space, are easier to spray for pest control, and are easier to prune. Most operations can be done from the ground, eliminating the need for ladders. Dwarf apple trees bear fruit earlier; you can expect a few fruit in the third year after planting dwarf trees. Standard trees won't bear fruit for 5–7 years after planting. Additionally, planting several dwarf apple trees will yield more fruit over a longer season than one large standard tree. For more information on apple rootstocks, see Extension publication *Rootstocks for Fruit Trees in Wisconsin* (A3561).

Planting

Apple trees must be planted correctly. Failure to do so may mean losing the dwarfing characteristics of the rootstock. The procedure for planting bare-root and potted trees is similar.

Bare-root. If trees arrive from the nursery before they can be planted in your area, keep them in a cool place but don't allow them to freeze. Open the container and make sure the roots are still moist. If not, add a small amount of water to moisten the roots, but don't saturate them. You may soak the tree roots in a bucket of water for 4–8 hours before planting.

Potted. Potted trees may be kept for 2–3 weeks in the container. Potted trees will need regular watering, but don't overwater. The soil should dry slightly between waterings. Remove the tree from the pot before planting and spread the roots. If the roots circle the inside of the container, make several vertical cuts through the roots and spread them out away from the trunk.

When you are ready to plant the tree, dig a hole large enough to accommodate the roots without bending or cutting them. If one root is very long it can be shortened, but in general don't prune the roots. The hole should be deep enough so the entire root system will be in the ground with the graft union 2–3 inches above the final soil level. The scion must not be in contact with soil or it may produce roots and the dwarfing influence of the rootstock will be lost! Don't add fertilizer or fresh manure to the hole. Fill using the soil

removed from the hole and gently pack it in with your foot to ensure good contact of the soil with the roots. Water the tree immediately.

Stake trees on dwarfing rootstocks immediately after planting. Suitable staking materials include ¾-inch metal electrical conduit, pressure-treated 2 x 2 lumber or a 2-inch-diameter round stake. Stakes should be 10 feet long. Place the stake 3–4 inches from the tree and drive it 2 feet into the ground. Using light rope, tape, or fabric strips, tie the tree loosely to the stake in a figure 8 pattern where the tie crosses between the stake and the tree. This will hold the tree away from the stake allowing branches to grow on the stake-side of the tree. Tape may need to be replaced periodically. The stake should be left in place for the life of the tree.

Irrigation

Young trees benefit from regular watering. During the first year an apple tree should receive 1–2 inches (3–5 gallons) of water weekly. As trees get older their roots explore a larger volume of soil and irrigation becomes less critical. Don't wait for trees to wilt or show other signs of water shortage before watering. Regular watering throughout the season from planting and bud break to leaf-fall will be most beneficial.

Mineral nutrition

Like all plants, apple trees require some essential mineral elements in order to grow. Have your garden soil tested the year before planting apple trees and till in all recommended nutrients. Micronutrients such as zinc, boron, and copper are not required in great amounts and fertilizing with these nutrients is usually not needed in Wisconsin.

Nutrients can be applied as liquids, granules, or manures. Granular fertilizer is usually the least expensive form. Incorporate granular fertilizer by tilling the soil or watering within 24 hours of applications to get the fertilizer into the soil. Liquids can be applied with a hose-end applicator or watering can. Dilute liquid fertilizers according to package directions. Manures are typically low in mineral content and should be aged before shallowly incorporating them.

Several weeks after planting, a light application of a nitrogen-containing fertilizer can be made. Apply the fertilizer evenly around the drip line of the tree (the ground area under the canopy). The rule of thumb is to apply 1 ounce of actual nitrogen to each tree per year of tree age, but not to exceed ½ pound of actual nitrogen per tree annually. Be sure to include any fertilizer applied to lawns under trees in the total annual amount.

To calculate the amount of fertilizer to apply, divide the actual nitrogen needed by the percentage of nitrogen in the fertilizer. For example, a 3-year-old tree should receive 3 ounces of actual nitrogen. To calculate how much ammonium sulfate (which is 21% nitrogen) to apply, divide 3 ounces by 0.21 for a total application of 14 ounces of fertilizer.

You may need to adjust the standard nitrogen application based on the tree's growth. Shoots on young apple trees typically grow 15–20 inches each year while shoots on bearing trees grow 8–12 inches annually. If growth is less than normal, apply 25% more fertilizer. If growth is more than normal, don't apply any nitrogen for a year.

Weed management

Management of the soil around the trunk of the tree affects tree performance. Do not allow grass or other vegetation to grow within 18 inches of the trunk of the tree. A vegetation-free area of 2–3 feet is even better. Vegetation competes with trees for water and nutrients. Grass growing up to tree trunks also makes it difficult to mow without damaging the tree trunk.

Prevent weed growth around tree trunks by mulching, cultivating, or applying herbicides. Cultivate shallowly (no deeper than 1–2 inches) to avoid damaging tree roots. Organic and inorganic mulches will prevent weed growth. Mulch

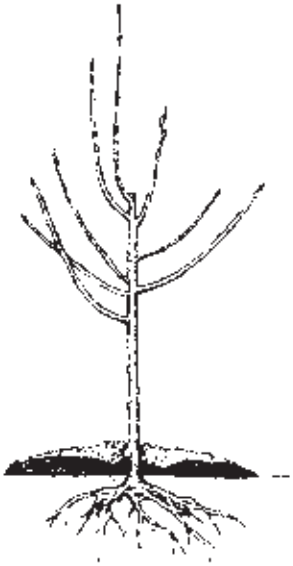


FIGURE 2. Spread organic mulch in a donut shape around the base of the tree. Don't heap mulch against the trunk because this can contribute to fungal rots or attract rodents.

is ideal because it prevents weed growth and conserves soil moisture. Apply 3–4 inches of an organic mulch such as shredded bark, bark chips, or wood chips. Spread the mulch in a donut fashion around tree trunks. Avoid heaping mulch around tree trunks. This can lead to fungal rots on the trunk and attract rodents that gnaw on the bark.

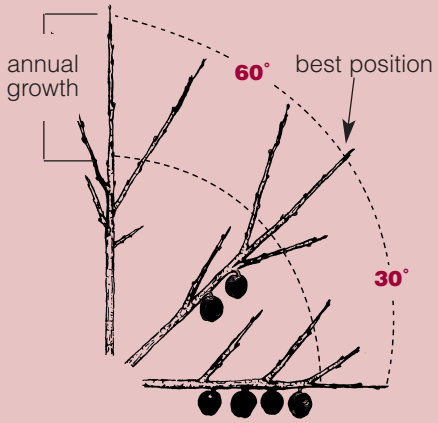
Glyphosate (Roundup or Kleenup) is the easiest herbicide to use to prevent weed growth around tree trunks. For young trees, wrap the trunk with aluminum foil or plastic wrap before applying herbicide. Apply glyphosate according to label directions and avoid getting spray on the trunk or leaves (or you!). Spray only on calm days.

TRAINING AND PRUNING

Annual training and pruning is essential to the production of high-quality apples and to maintain the health and longevity of trees. Proper training and pruning allows light throughout the tree canopy and is required for producing quality fruit. Pruning is always vegetatively invigorating near the cuts and may delay fruiting.

Remove all dead or broken branches annually, also suckers, water sprouts, and branches forming narrow angles that cannot be spread. Remove the weakest of crossing or closely parallel-growing branches. Remove downward-growing branches and spurs. Thin out dense areas, particularly in the top of the tree. Thinning cuts (removing an entire branch to its point of origin) are better than heading cuts (removing a portion of a branch) in making trees less dense.

PROMOTING FRUITFULNESS



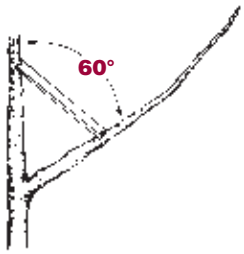
Studies have shown that the angle a branch grows at determines the amount of fruit it can produce. Branches that grow straight up will produce mostly vegetative growth and very little fruit. By contrast, branches that grow straight out from the tree are very fruitful, but will produce little new vegetative growth. The ideal limb position is about 30° above horizontal, creating a 60° crotch angle. This maximizes fruit production while still promoting growth of new wood for future fruiting. The easiest time to adjust limb position is when branches are only 3–6 inches long with very soft wood.

Adapted from Oberhofer, H. 1990. Pruning the Slender Spindle. BC Ministry of Agriculture and Fisheries, Victoria, BC Canada

Do not leave stubs when pruning. Make cuts close to the trunk but do not remove the collar. These cuts will heal most quickly. Do not use pruning-wound paints or coatings as they keep the wound moist, allowing diseases and insects to invade the tree. It is best to allow the wood to dry naturally. The tree will produce growth that will eventually cover the cut.

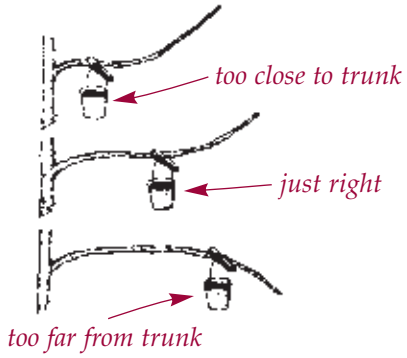
The best time to do major pruning is in late spring while the trees are still dormant (March and April). Prune between late July and early August to remove water sprouts and to allow light into thick canopies. Do not prune after early August as it can delay dormancy and predispose trees to more winter injury.

Limb Positioning Techniques

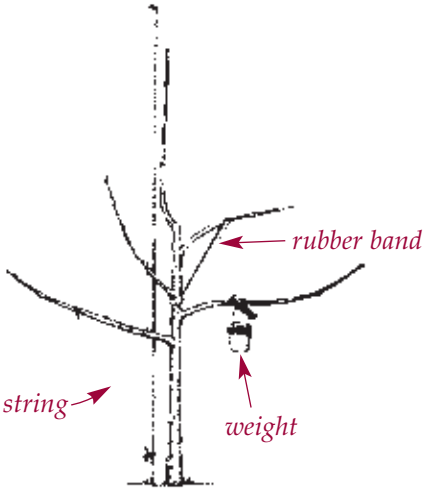


Wooden spreader. For use on branches longer than 6 inches. Notch the ends or, for larger stock, drive small nails into each end of the spreader, then cut off the heads of the nails using heavy pliers to create a sharp surface that will hold in the tender bark.

Toothpick and clothespin spreaders. Use when branches are 3–6 inches long. If using toothpicks, gently push them into the soft bark of the limb and trunk to hold them in place.



Positioning weights on a branch. Avoid placing the weight so far from the trunk that the branch bends down in an arc; too much bend may mean the crotch angle is wider than you'd intended. The position may need to be adjusted periodically.



Various methods of tying and weighting. You can use twine, string, fiberglass tape, long rubber bands, or other material. Take care to not tie material tightly around branches. Use in late June when young branches are at least 8 inches long.

Training young trees

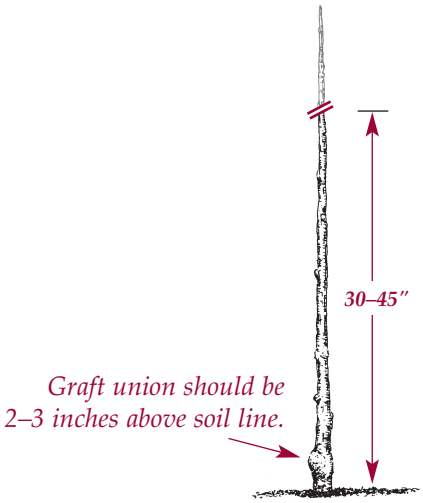
The objective in training a young tree is to develop a structure that will provide a strong framework to support fruit production. The top of the tree should be smaller and narrower than the bottom of the tree. This shape prevents the top of the tree from shading the bottom of the tree. The central leader system (illustrated below) produces a vertical central leader or main stem and strong, properly spaced scaffold limbs. This system is easy to prune and provides optimum production potential.

Over the years, you will train two to three tiers of scaffold branches. These branches will form the central framework of the tree and should grow at a wide angle from the leader.

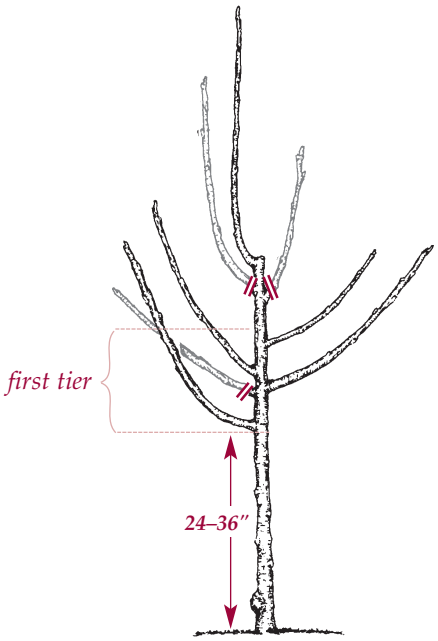
At planting. If you plant an unbranched whip tree, cut off the top leaving the tree 30–45 inches tall. Side branches will grow from the whip the first year. New branches will grow just below this cut. You control the location (height) of the new limbs by the height of the cut. If you've purchased branched trees, remove only broken, damaged, or poorly positioned limbs.

First year spring. Choose four or five good branches for the lowest tier of scaffolds. The lowest scaffold limb should be at least 24 inches above ground and can be as high as 36 inches in a landscape where flowers or bushes under the trees are desired. Limbs growing closer to the ground make it difficult to work around the tree. Select well-spaced branches growing within about 18 inches of the lowest branch that are growing neither exactly opposite nor directly above one another. Remove weak or poorly positioned limbs that will not become scaffolds.

Second and third year spring. After two or three years, select a second tier of scaffold limbs. Again, choose or create branches with wide crotch angles. The lowest branch of the second tier should be at least 24 inches above the top branch of the lower tier. This 24-inch gap allows light to penetrate into the canopy and to strike the lower tier of branches. The upper branches must be kept shorter than the lower branches to



At planting



First year spring

keep them from being shaded. This will create a "Christmas tree" shape. For dwarf trees, two tiers will be sufficient; for semi-dwarf trees, repeat the process to create a third set of scaffolds near the top of the tree.

Yearly maintenance. The central leader must remain the tallest part of the tree. The highest point in the tree is dominant and most vigorous. If a side branch is becoming nearly as tall as the leader, bend it lower (see limb positioning) or prune it back into 2-year-old or older wood.

Once the central leader reaches the height you want (usually 8–10 feet high for dwarf or 12–16 feet high for semi-dwarf) you can adjust the vigor in one of two ways (figure 3). Take the top, supple part of the leader, bend it in an arc and tie it to the support post or the stronger part of the tree. As new branches begin to grow on the arc, remove the ties and allow the leader to return to the vertical position. Alternatively, cut off the leader just above a weak side branch. Both techniques reduce the vigor of the top of the central leader. To maintain tree height, follow one of these techniques every year for the life of the tree.

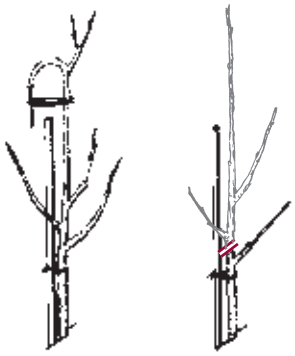
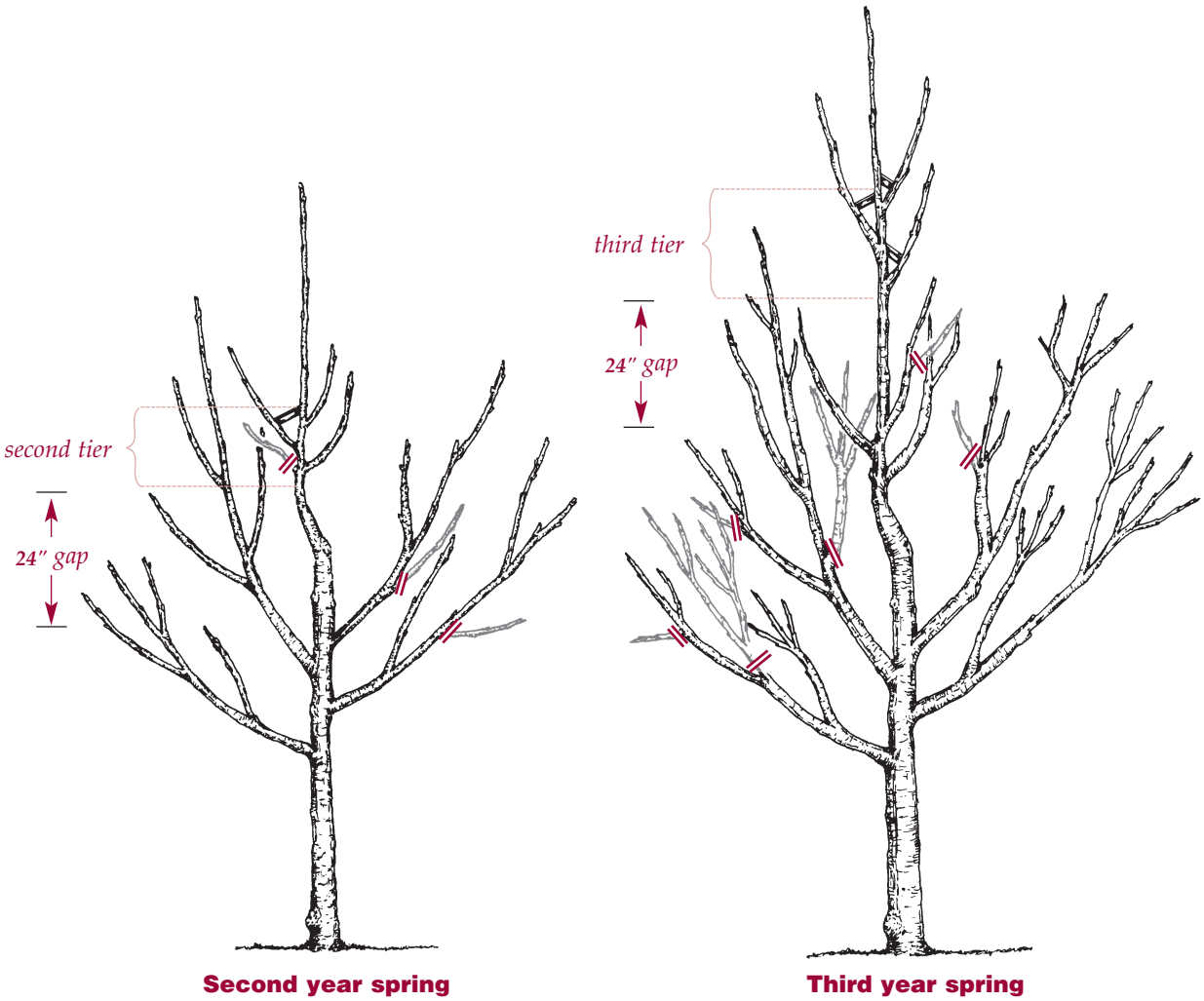


FIGURE 3. Techniques for maintaining trees at a specific height.



Second year spring **Third year spring**

Remove all dead and broken branches annually, as well as suckers, water sprouts, and branches forming narrow angles. By the fifth year, trees should be well established with two tiers of scaffolds. Spurs should be developing throughout the tree to provide annual fruiting.

Pruning bearing trees

The objective of pruning bearing trees is to maintain maximum production of high quality fruit on a continuing basis. Properly trained trees require little pruning but must still be pruned annually. Limit pruning of bearing apple trees to removal of weak, unproductive branches to improve light penetration and distribution, reduce tree height, and improve spray coverage.

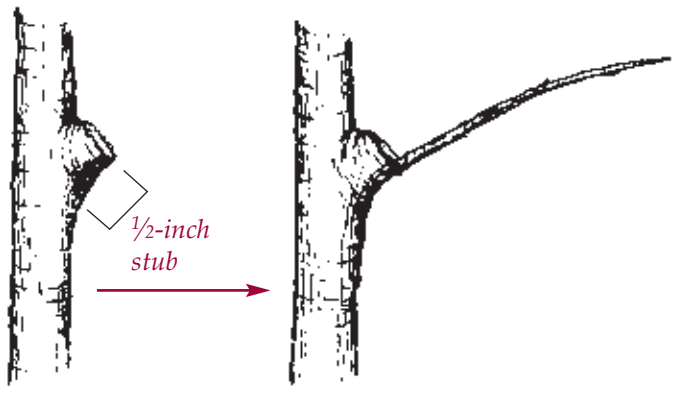
As trees grow older, you may need to make more thinning cuts. Don't let the upper branches grow longer than the lower branches. Long upper branches shade lower branches and reduce productivity. If necessary, prune upper branches into 2-year-old or older wood to keep them shorter than lower branches. Thin out weak, unproductive branches, and keep the tree "open" for good light penetration. In the top of the tree, branches can be cut back to the trunk leaving a short stub (about ½-inch long) on the bottom of the cut (figure 4). A new branch will often grow from the base of the stub.

If an older tree is too tall for convenient spraying and harvesting, more drastic steps must be taken. To lower the height of a tree, completely remove one or two of the tallest growing limbs. Make the cut where the limb joins the trunk. When you prune drastically, you must greatly reduce other pruning in the tree that year. Over-pruning will stimulate too much growth and lower fruit production. Spread out extensive renovation pruning over 2–3 years.

HARVEST

Apples ripen over about a 3-month period in the fall ranging from early August to late October. Harvest apples before they are fully ripe, but after they are mature. Maturing apples undergo changes in skin color, seed color, flavor, and firmness. As apples mature, they lose the bright green skin color of immature apples. Red apples begin to turn red on the exposed side of the fruit; yellow apples first turn pale green then yellow; and green apples change from bright green to pale green. Seeds change from cream to tan to dark brown. Immature apples have a very starchy taste and little apple aroma. As the fruit matures, the starch changes to sugar and the aroma and flavor develop. Immature apples are hard to the touch and are very hard and crisp when cut. Mature fruit should be firm but not hard. Different apple cultivars vary in their firmness at maturity.

FIGURE 4. Pruning to promote new growth.

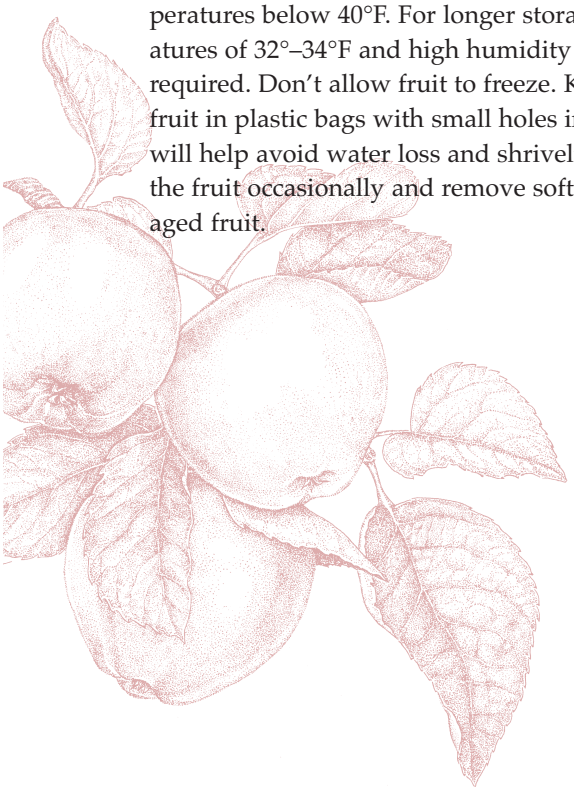


To harvest fruit, hold the apple in the palm of your hand and twist it slightly while pulling. Gripping apples using only your fingertips will bruise the fruit. Avoid pulling spurs or branches from the tree—these structures contain fruit buds for next year's crop. Gently place fruit into a picking bag or basket. Never throw or drop fruit as this will bruise the fruit. Empty the container carefully into boxes or bins to prevent bruising fruit.

Storage

Once harvested, many apples will keep for several months if stored properly. Summer apples, which ripen before Labor Day, generally do not store well and can be kept only a few days to 2 weeks. Fall- or winter-ripening apples, which ripen in September and October, will store well for 1–5 months. If you plan to store the apples, harvest them before the peak of maturity while they are still firm. Discard or use any blemished, diseased, or damaged fruit. Store only the best fruit. Overripe or bruised apples will not only store poorly, but the ethylene gas they produce will shorten the storage life of sound fruit.

Cool apples promptly and keep them constantly cold. For short-term storage, refrigerate at temperatures below 40°F. For longer storage, temperatures of 32°–34°F and high humidity are required. Don't allow fruit to freeze. Keeping fruit in plastic bags with small holes in the bags will help avoid water loss and shriveling. Check the fruit occasionally and remove soft or damaged fruit.



Insect pests

Over 50 types of insects attack apple trees, foliage, or fruit in Wisconsin. Of these, about a dozen are fairly common, but not all occur at damaging levels every year or in every location.

There are two approaches to apple insect management: a **preventive approach** where insecticides are applied routinely regardless of actual insect damage, and a **curative approach** where controls are applied only when pests are present and capable of causing significant damage.

The preventive approach is used by apple growers who are unable to do routine pest monitoring or who are uncomfortable trying to identify pests and damage.

A minimal preventive program uses three to four insecticide sprays per year, timed at petal fall, 2 weeks after the first spray, mid-July, and early August. This spray program usually protects a substantial proportion of fruit. Where the best possible fruit quality is desired, or where insect numbers are high, a more thorough insecticide program may be necessary, with applications at 10- to 14-day intervals starting at petal fall and extending through August or early September.

The best approach to insect pest management is the curative approach. This involves learning to recognize common pests and the types of injury caused, monitoring pest activity routinely (weekly throughout the growing season), and applying insecticides only when necessary.

The chart (table 1) will help you determine when to monitor for the most serious insect pests. It summarizes when insects are likely to be present, and the best times to apply controls. Use the chart together with the detailed insect information to know when controls are appropriate.

Several methods can be used to monitor insect activity, including sticky traps, pheromone traps, and visual inspection. Not all methods work on all insects. Specific monitoring information is given for each pest.

Pheromone traps are sticky traps with a synthesized attractant that mimics the natural odor or pheromone produced by female moths for attracting males for mating. The traps catch males and help identify when mating occurs. Traps can be purchased at better garden centers and through mail-order catalogs. For best results, follow manufacturer's directions.

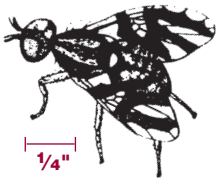
Do not use insecticides during the blossom period. Apples are pollinated by honey bees and other insects. Broad-spectrum insecticides applied during flowering will kill these beneficial insects and interfere with pollination.

The following descriptions are of the most serious apple insects in Wisconsin. More thorough and inclusive descriptions can be found in Extension publication *Common Tree Fruit Pests* (NCR063). For additional information on specific pests and pesticides, see also the list of publications at the end of this book.

Fruit-damaging insects

The most serious insect pests of apples are those that directly damage the fruit. These include apple maggot (railroad worm), various types of caterpillars such as leafrollers, fruitworms, and codling moth, plum curculio, and rosy apple aphid.

Apple maggot (railroad worm)



The adult apple maggot is a type of fly that lays eggs in fruit. The larvae tunnel throughout the fruit, causing it to deteriorate and drop. Apple maggot is a summer pest, causing injury from early July until harvest. If uncontrolled, it is the most serious insect pest of apples in Wisconsin.

Type of damage. The adult apple maggot fly lays eggs under the skin of apple fruit. Several eggs may be laid in a single fruit. The fruit decomposes around the site of the sting, causing a small, darkened depression. The eggs hatch into tiny, transparent larvae that tunnel through the fruit, leaving slender, brown trails. Fruit start to deteriorate and eventually fall from the tree.

Apple maggots also attack pear, cherry, and plum, as well as native hawthorn.

Description. The apple maggot fly is about two-thirds the size of a common house fly. Its body and wings are marked with black and white bands and spots. The larvae are headless, legless cream-colored maggots about ⅓-inch long when fully grown. Young larvae are very tiny and virtually transparent, making them difficult to find within apple fruit, even with the aid of a microscope.

Monitoring. Hang sticky traps during the last week in June and continue trapping until the first frost. There are two types of apple maggot traps: yellow sticky boards and red sticky spheres. Yellow traps are less efficient, but pick up insects before they start to lay eggs. The red sphere trap is efficient for monitoring reproductively mature flies. An "apple volatile" lure, available for hanging with the red sphere, greatly increases the attractancy of this type of trap.

Apple maggot traps are not as selective as pheromone traps; many different types of insects can be caught on apple maggot traps. For this reason, it is important to be able to recognize the apple maggot fly and differentiate it from other, similar insects. Two types of cherry fruit flies occur in Wisconsin and are easily mistaken for the apple maggot fly. They can be distinguished based on differences in wing pattern (see illustration).

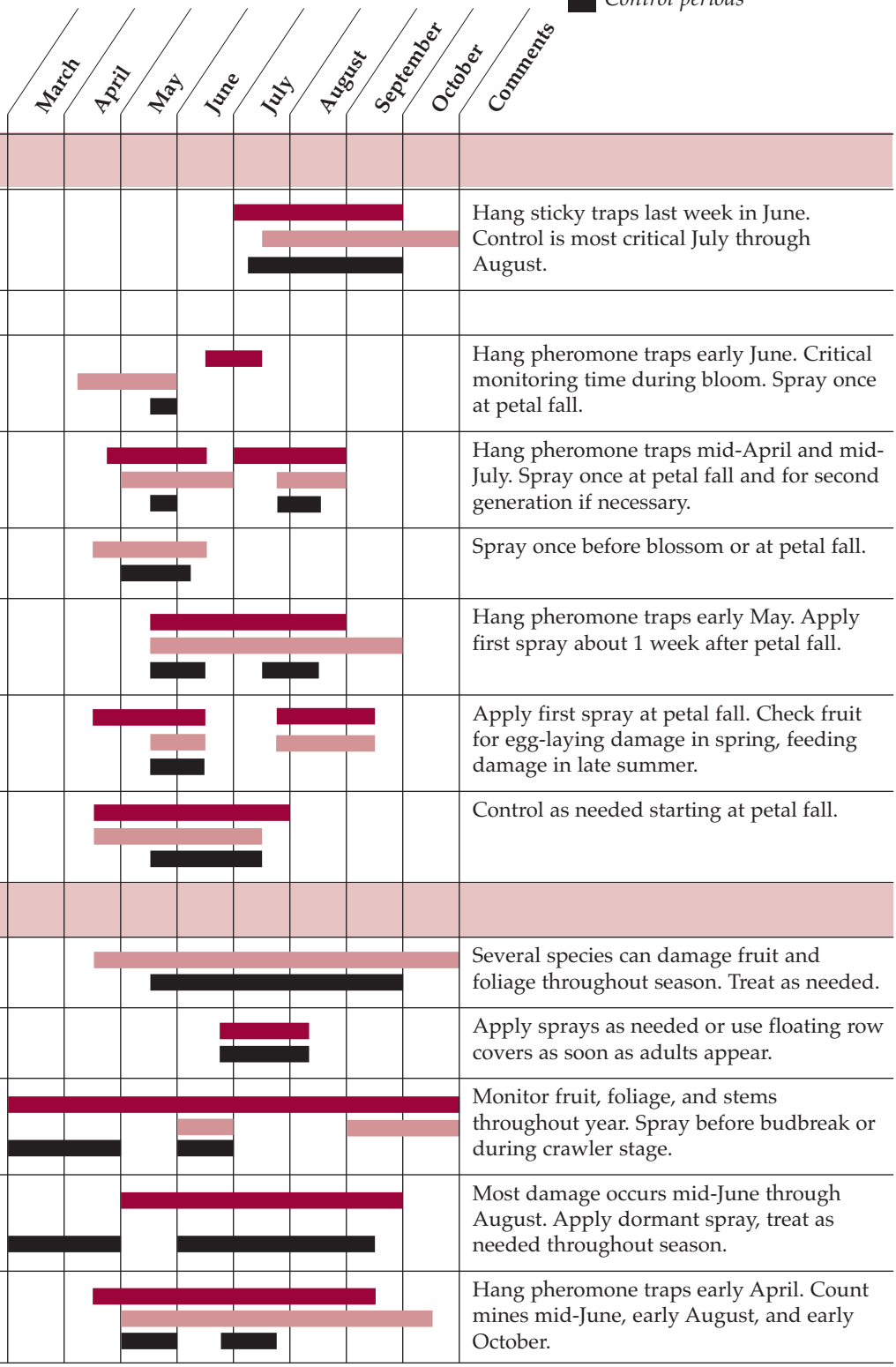
Wing banding pattern of fruit flies

Apple maggot

Black cherry fruit fly

Cherry fruit fly

TABLE 1. Approximate dates for monitoring and controlling insect pests. Dates will vary depending on weather and location in state. Do not apply insecticides during blossom period.



Fruit-damaging insects	
Apple maggot	Hang sticky traps last week in June. Control is most critical July through August.
Caterpillars	
Fruittree leafroller	Hang pheromone traps early June. Critical monitoring time during bloom. Spray once at petal fall.
Redbanded leafroller	Hang pheromone traps mid-April and mid-July. Spray once at petal fall and for second generation if necessary.
Green fruitworm	Spray once before blossom or at petal fall.
Codling moth	Hang pheromone traps early May. Apply first spray about 1 week after petal fall.
Plum curculio	Apply first spray at petal fall. Check fruit for egg-laying damage in spring, feeding damage in late summer.
Rosy apple aphid	Control as needed starting at petal fall.
Plant-damaging insects	
Caterpillars	Several species can damage fruit and foliage throughout season. Treat as needed.
Japanese beetles	Apply sprays as needed or use floating row covers as soon as adults appear.
Scale insects	Monitor fruit, foliage, and stems throughout year. Spray before budbreak or during crawler stage.
Spider mites	Most damage occurs mid-June through August. Apply dormant spray, treat as needed throughout season.
Spotted tentiform leafminer	Hang pheromone traps early April. Count mines mid-June, early August, and early October.

Check fruit for damage beginning mid-July and continuing until harvest. Infested fruit can be detected by the shrunken, discolored dimples. When cut into, the normally white flesh will be crossed with the pale brown trails of the young maggots.

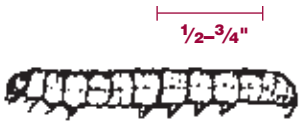
Prevention and control. Use, destroy, or bury infested fruit as soon as they fall from the tree. Do not compost these fruit because larvae may survive.

Apple maggots can be controlled by trapping. Use the round red spheres along with the commercial apple volatile bait. Research shows that one trap per 100 apples will catch most flies and will minimize fruit injury. In larger plantings, place a ring of traps around the planting by hanging traps every 50 feet on the outside of the perimeter trees.

Apple maggots can be controlled with insecticides. In lightly infested areas, spray in early July and repeat once or twice at 2- to 3-week intervals. Reduce the time between sprays in heavily infested areas. Sprays can be timed by using traps to monitor for adult fly activity; spray when the first flies are caught, and again after subsequent catches, but no more frequently than every 2 weeks.

Caterpillars—leafrollers, fruitworms, and others

The larvae (caterpillars or "worms") of several types of moths feed on apple foliage and fruit. Leafrollers (especially redbanded leafrollers and fruittree leafrollers) and green fruitworms are the most common, but others include inchworms, cankerworms, and webworms. Most of these are early-season pests, causing damage shortly after the blossom period, although a few cause damage in midsummer.



Type of damage. The larvae feed on both leaves and fruit. Young larvae feed on leaves during the blossom period, causing minimal damage to the tree. Leafrollers use silken webbing to roll leaves or tie two or more leaves together, creating a refuge in which they live and feed. Leaves are often tied around clusters of young developing fruit, and the larvae feed on the fruit surface, causing superficial smooth or corky brown scars. Such damage caused early in fruit development heals naturally, and, although the fruit is scarred, the flesh is usable and does not rot. In contrast, green fruitworms do not tie leaves together and they feed deeper into the young fruit. Feeding damage from green fruitworms may cause the fruit to abort and drop from the tree. More mature fruit in summer are not able to heal feeding wounds, and usually fall from the tree and rot. Leafrollers, green fruitworms, and similar caterpillars do not tunnel into fruit, but feed only from the surface.

Leafrollers, green fruitworms, and similar caterpillars feed on many types of broadleaf trees and shrubs, often in wooded areas adjacent to where apples are planted. Some types also readily feed on other cultivated fruit plants, including pear, apricot, plum, and even berries.

Description. Leafroller larvae are pale yellow to pale brown, and have a yellowish, brown, or black head, depending on species. They grow from ⅛-inch long at hatching to about ¾-inch long. Green fruitworms are much larger and robust, growing to over 1-inch long. They are green and may have small white spots or pale lines which run the length of the body.

Monitoring. Check during the blossom period for signs of larval feeding, which may appear as tattered leaves or leaves with holes chewed in them. Also check for leaves that appear stuck together; carefully separate these to determine if leafroller larvae can be found.

Pheromone traps are available for redbanded and fruittree leafrollers. These will help determine flight periods and therefore when eggs are being laid. Trap for redbanded leafroller mid-April through mid-June and again from mid-July through August. Trap for fruittree leafroller adults from mid-June through mid-July.

Prevention and control. Insect populations vary from year to year, in part depending on numbers in nearby forests, wood lots, or abandoned fruit trees. In some years they may be essentially nonexistent, whereas in other years, severe defoliation or fruit injury may occur if the trees are not protected.

Insecticide sprays applied at petal fall (the very end of bloom, when 75% of the flowers have fallen) will control most types of caterpillars. Traditional insecticides may be used. Also, microbial insecticides containing the active ingredient *Bacillus thuringiensis* will usually provide satisfactory control as long as they are applied when the larvae are very young.

Codling moth

Codling moth larvae are caterpillars that feed entirely within the fruit. This is one of the insect pests that cause "wormy" apples. Codling moth is not native to North America; its original home is Asia. It now occurs throughout the world, and is considered to be the single most important insect pest of apples worldwide.

Type of damage. Tiny codling moth larvae bore into the fruit and tunnel to the core. They feed on the developing seeds and adjacent tissues. Their feeding leaves black residues and rots the center of the fruit. One or more noticeable tunnels lead directly to the outside, and insect waste (frass) can pile up on the skin of the fruit. Damaged fruit fall from the tree and decompose. If harvested, damaged fruit rot rapidly, even if refrigerated.

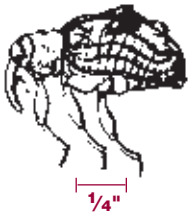
Description. Codling moth larvae are less than ⅛-inch long when they first hatch, eventually growing to over ½ inch. Older larvae have a brown or black head and a body that is creamy white to slightly pinkish in color. Larvae have three pairs of conspicuous legs near the head and a series of fleshy legs along the body. Adult codling moths have wings with slender bands of alternating gray and tan; the tips of the front wings are shiny golden-brown. The wings are held tent-like over the body.

Monitoring. Pheromone traps are available for codling moth. Hang traps at the beginning of bloom and maintain them through mid-August. Replace the lures in early July in preparation for the second flight of adult moths. Check traps weekly.

Damage by larvae is easily observed because of the piles of frass on the outside of the fruit. For positive confirmation, cut open a suspect apple and check for feeding injury and rot in the core.

Prevention and control. If possible, eliminate wild hosts (apple, pear, hawthorn) growing within 100 yards of cultivated apple trees. Remove windfall fruit, which are usually insect infested. If these fruit are not utilized, bury at least 2 feet deep. Larvae can complete development if fruit are merely composted. Spraying once about 1 week after petal fall and again about 10 days later gives the most control. If numerous wild host plants grow nearby, apple trees will need an additional one to two sprays to control the summer generation. Time the sprays based on noticeable increases in pheromone trap catches, usually from mid-July to early August. Microbial insecticides containing *Bacillus thuringiensis* are not particularly effective against this insect.

Plum curculio



Plum curculio is a native species of weevil, a type of beetle. As its name suggests, its preferred host is plum but it attacks other stone fruits as well as apple and pear. Plum curculio is common throughout Wisconsin and is one of the most damaging apple insects.

Type of damage. Plum curculios damage apples in three ways: egg laying, larvae feeding within the fruit, and adults feeding at the fruit surface. The adult female scars the fruit surface at egg laying by cutting small crescent-shaped flaps in the skin of young fruit. This damage occurs when the fruit are smaller than 1½ inches in diameter. As the fruit grows, it becomes very misshapen, with lumps and dimples. Many eggs and young larvae do not survive in the hard tissue of young apples. If they do, the larvae tunnel through the fruit, causing considerable deterioration and eventual fruit drop. Adults feed on the fruit surface, causing small, shallow irregular holes. The surrounding areas decay and rot.

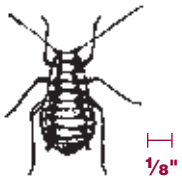
scars caused by egg laying

Description. Adult weevils are less than ¼-inch long and are gray-brown to dark brown. The plum curculio has three pairs of bumps on the back, and a long curved snout on the front of the head. The larvae are pale and grub-like, with a distinct pale brown head but no legs. Fully grown larvae are about ¼-inch long.

Monitoring. Monitor for adult weevils from mid-April through mid-June and again from late July through mid-September. To monitor, spread a white sheet beneath a tree, then sharply tap the branches with a stick. Adults will fall to the sheet, pretending to be dead. Check fruit for 4 weeks beginning shortly after petal fall; look for the characteristic crescent-shaped scars.

Prevention and control. Collect and bury windfalls as soon as they fall. As the weevils can easily tunnel through soil, bury fruit at least 2–3 feet deep. If possible, remove vegetation from fence rows and eliminate other sites where beetles may overwinter. Chickens readily feed on migrating beetles and may provide some benefit. ***Do not allow chickens to forage in areas treated with pesticides or where there may be pesticide drift or runoff.*** Appropriate insecticides applied at petal fall and 10–14 days later will provide excellent control.

Rosy apple aphid



There are several types of aphids that feed on apple trees. Of these, rosy apple aphid is the only type that injures the fruit.

Type of damage. Aphids feed by sucking plant sap from leaves and small succulent stems. During feeding, they inject saliva into the plant to aid in feeding and digestion. Aphid saliva is often toxic to the plant. When rosy apple aphids feed near young fruit, the injected saliva is moved by the plant into the fruit, resulting in small, hard, misshapen apples.

Description. These aphids are about ⅛-inch long and are generally found in large colonies. They vary in color from a pale rose to dark purple and are partially covered by a whitish, dusty material. Occasionally, black, winged individuals can be seen in the colony.

Monitoring. Check leaves near flower clusters from the end of the blossom period through June. Infested leaves will be curled, with the aphids feeding on the lower leaf surfaces. The clusters of small aphids are easily seen. Do not confuse rosy apple aphid with other aphids which are not as damaging.

Prevention and control. Elimination of broadleaf weeds from the vicinity of the apple trees may help reduce local populations by requiring the winged aphids to fly further to find their required alternate summer host plant, narrow-leafed plantain.

Native natural enemies, such as lady beetles and lacewings help control all aphids attacking apples. Lacewing eggs can be purchased commercially and released into the trees during the blossom period to augment native natural enemies; we do not recommend purchasing lady beetles because they disperse too rapidly after release.

An appropriate insecticide applied at petal fall will control aphids. Insecticidal soap will provide some control if coverage is thorough.

Plant-damaging insects

Insects and mites that feed on foliage or branches weaken trees. Severe infestations can cause trees to grow poorly, resulting in reduced bloom and fruit set, and small, low-quality fruit. This group of pests includes aphids, caterpillars, scale insects, spider mites, and leafminers.

Aphids

Several types of aphids feed on apple foliage and young stems throughout the growing season. Feeding damage often causes newly developing leaves to twist and curl. Other than rosy apple aphid, aphids are generally of minor consequence to apple trees. For information on prevention and control, see rosy apple aphids.

Caterpillars

Various caterpillar species are important defoliators of apple trees. Some feed on fruit as well as leaves. Eastern tent caterpillar and fall webworm are common problems. Both caterpillars are relatively large and hairy. Eastern tent caterpillars spin densely webbed "tents" in early spring, soon after the first leaves have formed. The larvae first feed in groups, outside of their tents, and several colonies can completely defoliate a tree. They return to their tents when not feeding. Fall webworms produce large loose tents which surround the colonies of feeding larvae; there are two generations, spring and late summer. For a discussion of control, see the previous section on caterpillars in "Fruit-Damaging Insects."

Japanese beetle

The Japanese beetle is a relatively recent invader of Wisconsin. It is most serious in the southern part of the state, but extends into central Wisconsin, and will likely continue to be an increasing problem.

Type of damage. They feed on many types of trees and shrubs. The USDA lists apples as one of the beetle's top 10 favorite food plants. Beetles prefer apple foliage and usually will not feed directly on the fruit. Populations can build to very large numbers, resulting in substantial defoliation of the trees.

Description. The ⅓ inch beetles are reddish brown and metallic green, with a series of white tufts of hair around the edge of the wing covers. The larvae are white grubs that feed on plant roots and organic matter in the soil, especially under turfgrass.

Monitoring. Japanese beetles are strong fliers and can invade from considerable distances from outside the immediate garden area. Watch for them from late June through early August. Modest defoliation (10–15%) will not affect mature fruit trees or yield, but higher levels of damage will stress trees and reduce crop yield and quality. Substantial defoliation to young trees will delay their establishment.

Prevention and control. Many insecticides registered for use on apples will kill Japanese beetle adults, but others may soon fly in from adjacent untreated areas. Japanese beetle traps are available and can catch thousands of beetles, but, because they can attract more beetles than they catch, research has shown that the use of traps can actually increase damage to small gardens. If you use traps, they should be placed at least 50 feet away from plants you wish to protect. If you have just a few small fruit trees, you may find success using the woven fabric "floating row covers" that are available to protect garden plants from flying insects.

Scale insects

Scales are tiny insects that feed by sucking sap from branches, leaves, or fruit. During most of their lives, scale insects are motionless and covered by a hard waxy coating. The shape and size of the coating varies with species. Two scale insects occasionally occur on Wisconsin apple trees, San Jose scale and oystershell scale.

Type of damage. Young scale crawlers can settle on fruit. Their feeding leaves small (⅛–¼ inch in diameter) red halos on green or yellow fruit. In addition to fruit injury, heavy infestations can stress trees and result in die-back of stems and branches.

Description. San Jose scale is very tiny, only about 1/16 inch when fully grown. The covering is circular, in the shape of a flattened cone. They overwinter as partially grown scales on the tree. They mature and produce young, called crawlers, by mid-June. Crawlers seek appropriate places to settle and start to feed. A second generation occurs in summer. Because of their tiny size and brown color, San Jose scales are difficult to see on branches or trunk; they are usually first noticed when they start to infest fruit. By this time, the tree is usually heavily infested.

Oystershell scale is less common than San Jose scale, but causes similar damage. It is slightly larger and elongate, in the shape of a mussel shell. It overwinters in the egg stage under the scale covering of the mother. Eggs hatch 2–3 weeks after apple blossom and crawlers move about until they find an appropriate place to settle on the stems or branches of the tree; occasionally they will settle on young fruit. The scales grow slowly throughout the year, and there is only a single generation per year.

San Jose scale

Oystershell scale

Monitoring. Because of their small size, scale insects are often overlooked unless they are abundant. If the characteristic fruit damage is seen, carefully examine the tree trunk and branches for scale colonies.

Prevention and control. Lime sulfur sprays or superior oil applied during dormancy controls both types of scale. Crawlers can be controlled with one to two applications of a conventional insecticide, timed 2–4 weeks after petal fall.

Spider mites

size of a period. 1/50"

Spider mites are very tiny creatures that are more closely related to scorpions, spiders, and ticks than they are to insects. There are many different types of spider mites, all of which are plant feeders. Two types, European red mite and twospotted spider mite, commonly attack apples.

Type of damage. Mites suck sap and nutrients from leaves. Their feeding damages leaf surfaces, causes moisture loss, and reduces the plant's capacity to produce energy for growth and fruiting. Damaged leaves first become slightly yellow, then take on a purplish or bronze coloration.

Description. Both species of spider mite are very tiny, being only about 1/50-inch long when fully grown. Twospotted spider mites are pale yellow, with a large dark spot on either side of the body. These mites produce very fine silken webbing along the leaf edges and veins, which becomes quite noticeable when population numbers are high. European red mites are dark reddish brown and do not produce silken webbing. Both types of mites have many generations each year and can build to very high levels. They reproduce rapidly in warm, dry weather and can average more than 100 per leaf.

Monitoring. Because of their very small size, it is helpful to have a 10- or 15-power magnifying glass when checking for mites. If you see leaf discoloration and suspect mites, check 10 randomly selected leaves from each tree. Most mites will be on the lower leaf surfaces. When smashed

between thumb and forefinger, or against a piece of white paper, mites will leave a small brownish stain. In early spring, check stems near buds for eggs of European red mites. If eggs are present, a dormant spray will control them.

Prevention and control. Natural controls are important in regulating spider mites. Heavy rains wash many from leaves, especially on smaller or well-pruned trees. Many beneficial predators occur naturally; these include tiny predatory mites as well as lady beetles, lacewings, and other insects that feed on mites.

A dormant superior oil spray applied at the time of "tight cluster" (when the flower buds first become noticeable) will kill overwintering eggs of European red mite. However, this treatment is ineffective against twospotted spider mites, which do not overwinter on the tree.

Insecticidal soap and certain types of conventional insecticides will suppress mites during the growing season, but may not provide complete control. If numbers are high, two applications 5–7 days apart may be needed. Commercial growers have access to several miticides that are more effective than homeowner products.

Spotted tentiform leafminer

These tiny insects feed within the leaf tissue, leaving blister-like leaf mines. Heavy infestations greatly reduce the tree's ability to produce energy for growth and fruiting. Spotted tentiform leafminers are rarely a problem in home orchards, but the mines are noticeable and can be confused with other problems such as apple scab disease.

Type of damage. A fully developed leaf mine is about ¾-inch long and ½-inch wide. It is raised tent-like on the upper leaf surface, and is speckled with small silvery spots caused by the larva feeding within the mine (hence the name spotted tentiform leafminer). The mined portion of the leaf dies, and the tree loses that portion of its photosynthetic ability. Heavy infestations cause some cultivars to drop their fruit prematurely and other cultivars to drop their leaves early. Apple is the primary host of this leafminer, although some crabapple cultivars may be heavily attacked. Other common types of leafminers, such as birch leafminer, are unrelated to spotted tentiform leafminer.

Description. The adult is a tiny moth, about 3/16-inch long, with wings that are banded with golden brown and white. The larvae are tiny caterpillars, pale yellow in color, and only about 1/5-inch long when fully grown. The pupa is golden brown and about the same size as the fully grown larva. There are three generations per year.

Monitoring. Pheromone traps are available for monitoring flight periods. Hang traps just before bud break and maintain them throughout the year; change lures according to manufacturer's instructions. Monitor for mines starting at petal fall. Each month, count all the mines on 50 randomly selected leaves per tree on at least five trees in each area of planting, and calculate the average number of mines per leaf. An accumulated average of at least five mines per leaf at harvest will likely result in sufficient stress to affect the health of the tree and the size, quality, and storage life of the fruit and may require control the following year.

Prevention and control. The leafminers are naturally controlled by tiny, stingless wasps which parasitize and kill the larvae. These wasps are usually highly effective in trees that are not heavily sprayed with broad-spectrum insecticides. If leafminers become a serious problem on home apple trees, it usually indicates excessive insecticide use. In these situations, limit insecticides to allow the parasites to build up. Adequate natural control will return within one to two growing seasons.

Rake and destroy leaves as soon as they drop in autumn to help reduce the overwintering population.

Several types of insecticides are available for controlling this insect in commercial orchards. This insect has developed resistance to most commonly used sprays. For home orchards, use an approved insecticide that has an active ingredient that is in the synthetic pyrethroid class.

DISEASES

Many disease-causing pathogens (fungi, bacteria, viruses, and nematodes) attack apple trees. Diseases may damage the fruit directly, making it unattractive or inedible. They can also weaken the tree by injuring the leaves, trunk, and branches. Damage to the tree reduces productivity and increases susceptibility to winter injury or attack by additional pests. Pathogens must be managed to consistently produce high-quality fruit. For specific chemical and nonchemical recommendations, see Extension publication *Apple Pest Management for Home Gardeners* (A2179) or *Commercial Tree Fruit Spray Guide* (A3314).

Apple scab

Apple scab is caused by a fungus and is the most serious disease affecting apples in Wisconsin. The disease damages leaves and fruit and is a problem almost every year. Like many diseases, development of scab is favored by wet weather especially during April, May, and early June.

Symptoms of the disease are olive-green to black lesions on leaves, fruit, or both. Scab lesions make the fruit unattractive, misshapen, and in extreme cases cracked and inedible. If the apples are not cracked or severely affected, lesions can be cut out, leaving the remaining fruit unaffected and edible.

Tissues are especially susceptible to infection from early spring through June. After that, leaves and fruit can still become infected, but the risk is lower. It is important to prevent infections early in the season to have "clean" fruit later on. Severe disease can defoliate trees prematurely and cause complete destruction of fruit.

Prevention and control. The most effective method for controlling scab is to plant scab-resistant cultivars. Another practice to help limit scab development is to remove and destroy (e.g., compost or burn) apple leaves in the fall. The fungus overwinters in apple leaves and initial spores in the spring come from the previous season's leaves. Fungicides are available for protecting susceptible cultivars and are most effective if applied in the spring *before* symptoms are noticed.

Cedar-apple rust

Cedar-apple rust is also caused by a fungus. It causes small, circular, yellow to orange lesions on leaves and fruit. Lesions on fruit usually become raised and distorted. Eastern red cedar (*Juniperus virginiana*) is the alternate host for the fungus and must be present for the disease to occur. Air currents can carry spores several hundred yards between cedar and apple trees.

Prevention and control. If possible, remove nearby eastern red cedars to help reduce spore levels. Many of the scab-resistant apple cultivars are also resistant to cedar-apple rust. Alternatively, fungicide applications during spring will help control this disease. For more information, see Extension publication *Cedar-Rust Complex* (A2598).

Fire blight

Fire blight is caused by a bacterium and can develop quickly following warm, wet weather during bloom. Diseased flowers become blighted, young branch tips "crook" over, and leaves turn brown to black giving the appearance of having been burned. Severe disease can kill branches of mature trees and entire young trees within a single growing season. The disease is spread by splashing rain droplets and possibly by insects. Apple cultivars vary in susceptibility to fire blight. Some rootstocks such as M.9 and M.26 are very susceptible to fire blight.

Prevention and control. Adequate fire blight control is usually obtained with good overall management. Choose resistant cultivars and rootstocks. Do not overfertilize with nitrogen as this encourages lush growth which is very susceptible to infection. Prune out diseased shoots by cutting at least 12 inches below the lowest visible symptoms. Disinfest pruning shears for at least 30 seconds in a mixture of 1 part household bleach plus 9 parts water between each cut to

avoid spreading the bacteria. Destroy prunings. During late winter, prune out any affected branches that were missed earlier. For more information, see Extension publication *Fire Blight* (A1616).

Canker diseases

Several different fungi can cause cankers on branches and trunks. If severe, canker diseases can disfigure or kill trees. Canker pathogens often infect through wounds created by improper pruning, broken limbs, and "southwest" injury. Southwest injury occurs when trunks expand after exposure to intense sunlight on winter days, and then quickly contract as the temperature falls at sunset. Trees that are further weakened during the growing season by environmental stresses such as drought or disease and insect pests are especially susceptible to canker development.

Prevention and control. See the section on training and pruning (page 6). Train properly so trees are structurally strong and less prone to mechanical damage. Prune properly so wounds heal quickly. Irrigating during dry periods will bolster the tree's defense mechanisms and reduce canker development. Do not apply nitrogen after August 1 as this will delay winter hardiness. Applying white latex paint to the southwest side of trunks will help reflect sunlight during winter and minimize cracking due to rapid expansion and contraction.

Physiological disorders

Bitter pit

Bitter pit appears as small brown lesions that are typically ¼–⅜ inch in diameter. Lesions may be flush with the surface or sunken. The flesh immediately below the skin is browned. Bitter pit is a calcium-related disorder, not a disease. The most susceptible trees are those that are growing rapidly, such as young trees, over-fertilized trees, and heavily pruned trees. Other candidates for bitter pit include large-fruited cultivars and drought-stressed trees.

There is no "cure" for bitter pit. However, the following practices may reduce the severity and incidence of the disorder:

- Irrigate during dry periods—don't let the soil around trees dry out.
- Don't over-prune or over-fertilize trees as this leads to vegetative vigor.
- On cultivars that have bitter pit every year, consider spraying fruit with calcium chloride. Apply 1 oz/gallon beginning with the first cover spray (after petal fall). Make three additional treatments at 2-week intervals. Calcium chloride is corrosive, so be sure to clean equipment well after spraying.

For more information, see *Bittter Pit and Cork Spot* (Wisconsin Garden Facts, X1055).

Watercore

Watercore is characterized by watersoaked or "shiny" areas in the flesh of an apple. This disorder is most common when fall weather is warm and sunny and on later-maturing cultivars. Watercore is thought to occur when sugars are delivered to the fruit faster than the tissues can use them. As a result, the excess fluid fills the spaces between the cells.

Apples that have watercore can still be eaten and used for cooking, although affected areas may have an off flavor and odor. This fruit will not store well. Unfortunately, there is no way to determine from the outside if an apple has watercore. To reduce the incidence, harvest fruit when mature, but not at the peak of ripeness. For more information, see Extension publication *Watercore of Apple*.

PROBLEM SOLVING

Why apple trees fail to bear

There are many reasons why apple trees fail to bear fruit—spring frosts, poor pollination, age of trees, too much pruning, and too little training. This section describes the most common problems and how to avoid them.

Cold injury. Perhaps the most common problem is spring frosts. Temperatures below 30°F during bloom will kill flowers. When spring frosts damage flowers, no fruit are formed. Flower buds may also be killed by extremely cold winter temperatures. This is a serious problem on marginally hardy cultivars (e.g., Jonathan, Golden Delicious) and in northern Wisconsin. Cold injury can often be avoided by choosing good sites and planting recommended hardy cultivars.

Pollination problems. Poor pollination may be due to poor weather conditions during flowering. If the weather is cold, cloudy, windy, or rainy, bees do not forage well. Insects are required for pollinating apple flowers. Without insects to transfer pollen, no fruit results. Apple trees may also fail to bear due to lack of compatible pollen. Apples require pollen from another apple cultivar to set fruit. Pollinizer trees must be within 200 yards of each other.

Tree age. Apple trees must first mature before they will produce fruit. The number of years before trees begin producing fruit depends on the rootstock: trees on dwarfing rootstocks bear fruit 3–4 years after planting, while those on seedling rootstocks take 5–7 years.

Heavy pruning. Too much pruning, particularly heading cuts into one-year-old wood, will cause trees to produce strong vegetative growth. Trees that are vegetatively invigorated produce few flower buds. Heavy pruning can also remove flower buds once they have formed. Prune trees only as needed to train the tree to the desired shape and to allow light into the canopy. Don't prune trees with hedge shears or similar tools.

Poor training. Trees that have strongly vertical limbs will produce few, if any, fruit. Branches should grow at an angle of 60° from vertical. Training branches to grow out rather than up will increase their fruitfulness. See "Training and Pruning" for advice on correcting this problem.

Too much fertilizer. Trees that receive too much nitrogen fertilizer produce excessive vegetative growth. This growth comes at the expense of fruit production.

Poor fruit quality

In some instances apple trees produce fruit but the apples are small and of poor quality. A variety of factors can lead to poor fruit quality.

Fruit from rootstock. Most apple trees are "two-piece trees" composed of a rootstock and a scion. If the scion (which produces fruit of a specific type) is killed but the rootstock continues to grow, the rootstock can produce fruit. This fruit is typically inferior in size, taste, and quality. Occasionally nurseries miss removing a tree when the scion budding or grafting was unsuccessful. If an apple tree is girdled or is killed back to the ground, it is better to replace the tree than to risk having the rootstock produce fruit.

Neglected plantings. Fruit quality suffers when trees are not properly trained, pruned, and fertilized, and when diseases and insect pests are not kept in check.

Poor growing conditions. Trees planted in poor sites will likely produce small, poor quality fruit. Strong shade prevents trees from manufacturing sufficient carbohydrates to produce quality fruit. Carefully consider site selection before planting.

Inferior cultivars. Inferior cultivars will produce inferior fruit. Also, chance seedlings will likely produce poor quality fruit. For the best chance of success, choose cultivars recommended in Extension publications *Apple Cultivars for Wisconsin* (A2105), *Home Fruit Cultivars for Northern Wisconsin* (A2488), and *Home Fruit Cultivars for Southern Wisconsin* (A2582).

Why plantings fail

Plant death is usually caused by a number of interacting factors rather than by a single identifiable cause. One injury may provide sufficient stress to allow other problems to eventually kill the tree. Several common reasons for tree death are described below.

Winter injury. Although apples are generally cold hardy in Wisconsin, extremely cold weather will damage the scion or the rootstock or both. Winter-injured trees generally leaf out normally in the spring and may even flower. The leaves are typically small and narrow and if the damage is severe the tree may die within 4–6 weeks. The layer beneath the bark (cambium) is normally cream colored but turns reddish brown when damaged. Even modest winter injury may weaken trees making them more susceptible to insect and disease damage. To minimize winter injury, select only cultivars that are hardy in your area, plant trees in appropriate sites, control insect and disease pests, and allow trees to "harden off" by not fertilizing after August 1 and not pruning after August 15.

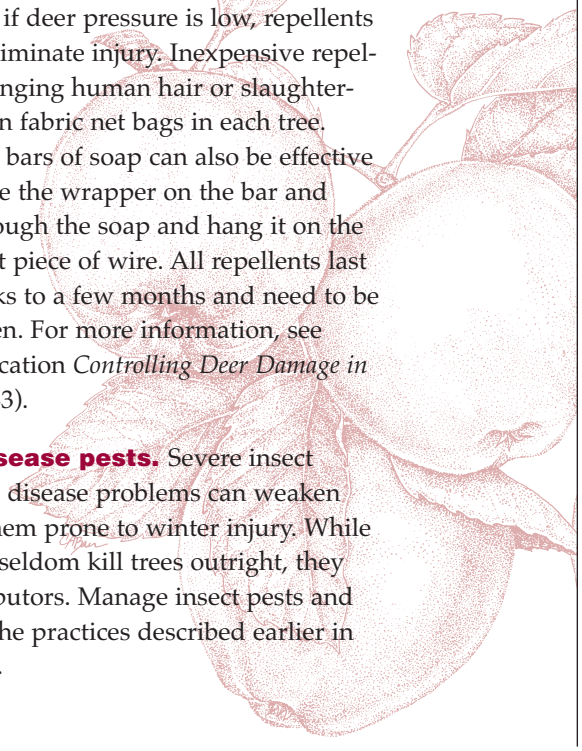
Too much water. Apple trees will not tolerate "wet feet." Poor soil drainage is common in soils with a high clay content or in low areas. Standing water lasting more than 1–2 days during the growing season will likely damage the roots. Water fills the pores in the soil, depriving the roots of oxygen. Prolonged periods of standing water create ideal conditions for crown and root rot, a disease that can kill the tree. Avoid these problems by choosing sites with good soil drainage.

Too little water. Young apple trees are especially susceptible to drought. When water is in short supply, roots cannot supply enough water to replace that lost by the leaves through transpiration. Sandy soils hold little water and are particularly drought-prone. Prevent drought stress by watering regularly. Young trees should receive 3–5 gallons of water per week. Irrigation also benefits older, bearing trees. Grass growing within 18 inches of the trunk of the tree will take up most of the available water. Remove grass and place mulch around the trunk to conserve water.

Physical damage. Damage to the bark can be caused by small animals feeding in the winter and by lawnmowers and string trimmers. If a large portion of the bark has been removed, the tree will be weakened but may survive. If a complete ring of bark is removed so that the tree is girdled, the tree will die shortly after growth begins in the spring. To prevent physical damage, keep the area around the tree trunk free of grass and weeds. Don't pile mulch up against the trunk. This will prevent rodents and rabbits from nesting and make the trees less attractive as a food source. Keep vegetation around the planting mowed short, particularly in the fall. Tree trunks can also be wrapped with wire trunk guards made from an 18-inch square of ¼- or ½-inch mesh hardware cloth. For more information about rodent control, see Extension publication *Meadow Mouse Control* (A2148).

Deer will also feed on apple trees. Deer tend to eat the tips of the shoots in late winter or early spring. When deer browse trees heavily it is more difficult to train and prune trees correctly. Deer may also rub against young trees, scraping off the bark and killing the tree. If deer pressure is heavy, only fencing will keep deer away from trees. However, if deer pressure is low, repellents can reduce or eliminate injury. Inexpensive repellents include hanging human hair or slaughterhouse tankage in fabric net bags in each tree. Small hotel-size bars of soap can also be effective repellents. Leave the wrapper on the bar and poke a hole through the soap and hang it on the tree with a short piece of wire. All repellents last only a few weeks to a few months and need to be replenished often. For more information, see Extension publication *Controlling Deer Damage in Wisconsin* (G3083).

Insect and disease pests. Severe insect infestations and disease problems can weaken trees, making them prone to winter injury. While these problems seldom kill trees outright, they are often contributors. Manage insect pests and diseases using the practices described earlier in this publication.



RELATED PUBLICATIONS

For more information on many of the subjects discussed in this publication, see the resources listed below. These publications are available from your county Extension office or from Cooperative Extension Publishing, 877-947-7827 or learningstore.uwex.edu.

Cultural information

Apple Cultivars for Wisconsin (A2105)

Fruit Crop Pollination (A3742)

Home Fruit Cultivars for Northern Wisconsin (A2488)

Home Fruit Cultivars for Southern Wisconsin (A2582)

Rootstocks for Fruit Trees in Wisconsin (A3561)

Sampling Lawn and Garden Soils for Soil Testing (A2166)

Training and Pruning Apple Trees (A1959)

When are Apples Ripe? (A3743)

Pest management

Apple Pest Management for Home Gardeners (A2179)

Cedar-Rust Complex (A2598)

Commercial Tree Fruit Spray Guide (A3314)

Common Tree Fruit Pests (NCR063)

Controlling Deer Damage in Wisconsin (G3083)

Diseases of Tree Fruits in the East (NCR045)

Eastern Tent Caterpillar (A2933)

Fire Blight (A1616)

Meadow Mouse Control (A2148)

Sooty Blotch and Flyspeck (A3173)

Tree Fruits: Insect and Disease Management for Backyard Growers in the Midwest (AIDEA3)

Watercore of Apple (A3280)

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