WALNUT NOTES

Finding Suitable Seed

One reason black walnut plantations may grow poorly or not at all is the use of seed from the wrong places. Planting success and genetic gains in growth depend partially on locating planting stock that both withstands the winter and grows rapidly, traits strongly influenced by geographic origin of the seed. Choice of seed sources can, therefore, affect the economic return from black walnut plantations. Research has shown that 10- to 20-percent gains in height and diameter growth are possible in most locations by using more appropriate sources of seed.

Guidelines for Locating Suitable Seeds

Here are some guidelines for locating suitable seed sources:

1. Collect seed from areas 100 to 200 miles south of your planting site. Trees of southern origin tend to grow faster than local or northern trees.
2. In the northern part of the walnut range where winter hardiness may be a problem, use only seed that originated within 100 miles of your planting site or mix non-local seed with local seed. To avoid loss of potential growth, never plant seed from more northerly sources.
3. Use only seed from western sources in the western part of the black walnut range. In general, seeds of eastern origin have not grown well in the west.
4. In other parts of the range, there seems to be little advantage to using seed from east or west of the planting site. To be safe, plant only seed from within 200 miles east or west of the intended site.

if you do your own collecting in a specific geographic area, be sure to collect seed from several trees in as many stands as possible. If you plan to purchase seed from a specific area, specify that the seed must have been collected from many trees. This will ensure genetic diversity and provide greater opportunities to select and favor fast-growing, high-quality trees and to remove poorly formed, slow-growing trees as the plantation develops.

Whether you collect your own seed or purchase it, keep detailed records on the origin of the seed. You should record latitude, longitude, elevation, legal description, and exact geographic location of the collection area as well as the number of trees included in each collection. This information will be helpful if you should ever want to collect in the same area again or to avoid it because trees from the area have not grown as well as those from other locations.

Knud E.

WALNUT NOTES

Seed Handling

Walnuts are usually collected in the fall or early winter shortly after falling or being shaken from the tree. Because they are a favorite food of squirrels and other rodents, ripe walnuts should be collected as soon as possible to minimize losses. When ripe, walnut husks are yellowish green to dark brown. Once off the tree, walnut seeds must be handled several times before they're ready to be planted. Remember: wear rubber gloves when handling walnuts. The husk material can severely irritate and stain your skin.

1. Husk

Although walnuts may be sown with intact husks, they are easier to handle without husks. If you plan to store walnuts, husk them as soon as possible, while they're still firm. Here are three ways:

- Remove husks with mechanical hullers similar to corn shellers (easiest method but hullers are not always available to small landowners).
- Mix equal volumes of nuts and water in a cement mixer; blades in the cement mixer remove husks when the mixer is turned.
- Drive over walnuts repeatedly with a small car or pickup truck until the husks are crushed.

If husks remain on stored nuts, heat builds up and the nuts become less viable. For this reason, keep unhusked walnuts in porous bags (like burlap sacks) until the husks are removed. With time, the husks dry out and harden, making them even more difficult, if not impossible, to remove.

2. Test for Viability

Within 3 days after husking, immerse walnuts in water to separate filled and empty seeds (fig. 1). Filled seeds sink and will probably germinate; empty seeds float and

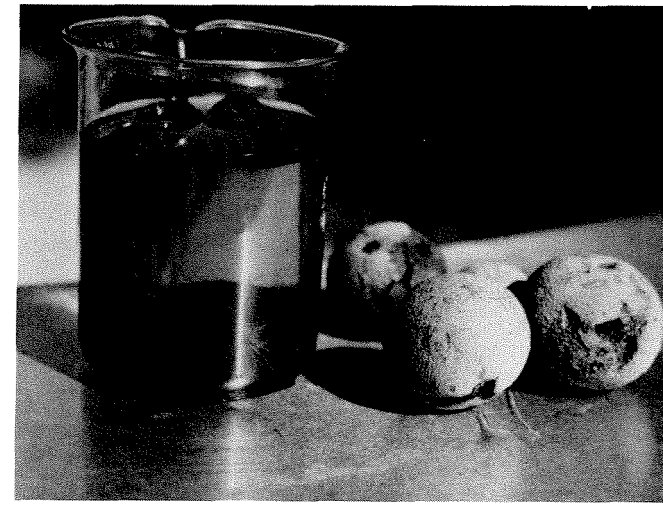

Figure 1.—Freshly husked walnuts can be tested for viability by immersing them in water.

should be discarded. Do not allow walnuts to dry out before testing them-all dry seed will float. Drain filled seeds by placing them on a wire screen for about 15 minutes. They will then contain the proper moisture content (about 30 percent) for either stratification or storage.

3. Stratify

Freshly gathered seeds are dormant and require 3 to 4 months of cold stratification to germinate properly. Note: stratification will not work with seeds that have been allowed to dry out. Seeds of northern origin may require longer periods of cold treatment than those from more southerly sources. Small seedlots are commonly stratified by holding nuts for 90 to 120 days in moist peat or sand at 34° to 41° F (2° to 5° C) in 4-mil plastic bags closed with wire ties. Alternating daily temperatures between 37° and 52° F (3° and 11° C) results in even greater and more uniform germination. Or, nuts may be stratified by storing them in well-drained outdoor pits from December through March (fig. 2). Construct the pits by alternating single layers of nuts and 2-inch layers of sand. Cover with at least 6 inches of soil. Pit depth depends on the number of nuts to be stratified, but most pits are 3 feet deep.

Figure 2.-One way to stratify nuts is to store them between layers of sand in a well-drained outdoor pit.

4. **Store**

Because large nut crops may occur only every 2 to 3 years, some walnut seed has to be stored for sowing during poor seed years. Successful seed storage depends on proper seed moisture content. For example, walnut seed may be stored at subfreezing temperatures for up to 1 year if the seed moisture content is reduced to 17 percent. However, if husked nuts are to be stored at 37° F (3° C), then moisture content should be between 20 and 40 percent. Here's how to determine moisture content:

$$\text{Moisture content} = \left(\frac{\text{Wet weight} - \text{Oven dry weight}}{\text{Wet weight}}\right) \times 100$$

You can use this formula with a sample of only 5 nuts. Obtain ovendry weight by weighing nuts after cracking and leaving shells and nuts in an oven at about 220° F (103° C) for 16 hours.

Walnut seed stored at subfreezing temperatures at reduced moisture content must be soaked to increase the moisture content to approximately 30 percent. It must then be stratified before sowing.

5. sow

Although stratified seed can be sown in the spring, most nurseries sow walnuts in the fall to avoid filling valuable storage space with large bulky seed. Seedbeds containing fall-sown walnut must be mulched and covered with wire cages to minimize predation by rodents. Walnuts are usually sown in the nursery at a depth of 1 to 2 inches at a rate of around 8 sound seeds per square foot (86 sound seeds per square meter). In addition, walnuts may be sown directly in the field, avoiding the nursery altogether (see Note 2.03: Direct Seeding).

George Rink

WALNUT NOTES

Growing Containerized Seedlings

Growing walnut seedlings in containers can give them a better start than planting them as bare-root seedlings or seeds. These benefits include:

1. High-value seedlings can be protected from predation and adverse weather when grown in a greenhouse.
2. Containerized seedlings can be outplanted later in the growing season than bare-root seedlings.
3. Containerized seedlings have an extensive lateral root system that may allow them to adapt to adverse sites more quickly.

This Note is meant to serve as a general guide for the small landowner or nursery operator. For large-scale commercial production of containerized walnut, you should consult texts such as *How to Grow Tree Seedlings in Containers in Greenhouses* by Richard W. Tinus and Stephen E. McDonald (1979, USDA Forest Service General Technical Report RM-60, 256 p.) available from the Rocky Mountain Region of State and Private Forestry, Box 25127, Lakewood, CO 80225.

Facilities

To grow containerized walnut, you will need access to a shadehouse and/or a greenhouse. Shadehouses are bird- and rodent-tight structures that reduce the summer air temperature below what it would be in direct sunlight. Shadehouses are usually covered with a fabric that provides 30- to 50-percent shade, and they are used most frequently to harden-off or over-winter seedlings. Greenhouses, on the other hand, are relatively air-tight structures covered with transparent materials and equipped for controlling supplemental lighting, air circulation, temperature, and watering schedules. Typically, they have rigid frames and are covered with glass, film plastic, or rigid plastics.

When growing containerized seedlings in a greenhouse, you should have the following equipment:

1. A hygrothermograph ($200 to $400) to provide a 24-hour-a-day record of air temperature and relative humidity.
2. A pH meter ($100 to $200) to measure the pH of the watering solution and the solution leaching from the containers.
3. A conductivity meter ($100 to $300) to measure the salt content of the container leachate and indicate when salts from excessive fertilization are accumulating in the growing medium.
4. A programmable repeating timer ($50 to $100) to control the supplemental lighting and photoperiod.
5. Tensiometers ($50 to $100 each) or bimetal moisture probes ($10 to $15 each) to monitor the moisture content of the growing medium. Also, platform scales can be

used to compare the current weight of moist containers with the weight of dry and saturated containers.

Suitable Containers

Container size and shape strongly influence seedling growth. Too small containers result in large tops and small rootballs (a high shoot:root ratio). Plastic pots are usually equal in depth and diameter and are unsuitable containers because they don't have enough space for the developing taproots. Several manufacturers have designed special containers for tree seedlings (table 1). Most of these containers are typically 10 times longer than wide with vertical ribs or grooves to prevent lateral roots from spiralling.

Table *1.-Manufacturers or distributors of containers suitable for growing walnut seedlings*

Supplier	Common name[1] of container	Container material	Container volumes (cm^3)	Biodegradable container
United Asia Trading Co. 3840 Crenshaw Blvd. Los Angeles, CA 90008 (USA distributor)	Paperpot	Special paper	650	Yes
J. M. McConkey Co., Inc. F? 0. Box 309 Sumner, WA 98390	DEEPOT	High density polyethylene	656	No
Spencer-Lemaire Industries, Ltd. 9160 Jasper Ave. Edmonton, Alberta Canada	Rootrainers Super-45's	Polystyrene	738	No
Tree Tech, Inc. P. 0. Box 86 Mason, Ml 48854	Plant bands	Paper with or without polyethylene coating	Any size	Yes

[1]Trade names used in this note are for your convenience and do not constitute an implied or intended endorsement.

Containers can be either biodegradable or rigid. Rigid containers are designed so that the seedling rootball and plug of growth medium can be removed intact. Before rigid containers are reused, they should be washed, surface sterilized in a lo-percent household bleach solution (0.5-percent sodium hypochlorite) for 20 minutes, and thoroughly rinsed.

The size of container you choose depends on the length of time seedlings will be in the containers and the size of seedlings desired. Containers with volumes between 600 and 2,000 cm^3 are suitable for growing succulent seedlings for outplanting in the late spring or early summer. Larger containers are usually required for seedlings that will be overwintered in the containers. Containers larger than 4,000 cm^3 waste materials and valuable bench space, and walnut seedlings in them are unlikely to grow sufficient roots to hold the growth medium together.

Growing Medium

Sphagnum moss peat mixed with 1 to 2 volumes of vermiculite or perlite produces a lightweight growth medium that possesses many ideal characteristics. Sphagnum moss peat gives the medium the desired water holding capacity and fibril strength to hold the medium together. Horticulture grade #1 or "attic fill" vermiculite provides the necessary buffering capacity, is high in ion exchange capacity, and has a high pore volume. Because perlite will not compress when wet, coarse (1- to 3-mm particle size) perlite is a better bulking material than vermiculite; however, perlite has little or no buffering or ion exchange capacity. A shallow layer of perlite over the growth medium protects the germinating seed from the sun, provides a droughty surface to reduce algal and fungal growth, and allows water to penetrate better into the medium.

Homemade growth medium using topsoil, compost, or unsterilized peat should be steam sterilized at 180° F for 30 minutes or chemically sterilized with formaldehyde, chloropicrin, methyl bromide, or Vapam®[1]. Chemical sterilization should only be done by trained individuals. The chemical must be thoroughly dissipated from the medium before use to prevent trapped residual chemical from injuring germinating seed.

Thoroughly mix and moisten the medium before filling the containers. The medium should not be allowed to dry out because peat is difficult to rewet when in the containers. Do not mix water-soluble fertilizers in the medium because they leach out before seedlings are large enough to use them. Slow-release fertilizers can be added if seedlings will be outplanted before the hardening-off stage.

Seedling Growth Stages and Requirements

Germination.-Fully stratified seed (see Note 1.02: Seed Handling) should be pregerminated to minimize the number of empty containers. To pregerminate seed, place 250 to 500 nuts in large 2- to 4-mil black polyethylene bags and set them in a warm shaded area. Check bags every other day for seeds with split sutures and emerging radicles.

Plant pregerminated seed on its side and cover with 1 to 2 inches of growth medium or perlite before moving containers into the greenhouse. Set containers on racks or on painted surfaces containing copper carbonate to "prune-off" emerging taproots and lateral roots. Seedlings should emerge within 7 to 10 days, depending on temperature. During this stage, maintain daytime temperatures around 75° F (65 to 80° F permissible range) and a relative humidity of 70 percent (50 to 90 percent permissible range). Providing 8 to 10 $watt/ft^2$ (450 lux) supplemental incandescent light for 1 minute out of

[1]Mention of trade names does nor constitute endorsement by the USDA forest Service.

every 15 minutes throughout the night is also beneficial. Water containers during the day as needed to minimize the time water droplets stand on the new leaves or growth medium surface.

Juvenile *Growth* Phase.-After the first leaves have expanded, raise the daytime temperature to 83° F (79 to 86° F permissible range) and the night temperature to 72° F (66 to 82° F permissible range), lower the relative humidity to 60 percent (50 to 80 percent permissible range), maintain supplemental lighting, and begin fertilizing with each watering, using a complete, high nitrogen fertilizer. Water to excess and rinse foliage with clear water at each watering to avoid leaf damage and reduce algal growth on containers. Water leaching through containers should have a pH within 0.3 to 0.4 units of the watering solution and a conductivity reading below 1,800 mhos. Begin checking daily for pests. Pest problems start small and grow rapidly. Treat infested areas immediately and begin regular weekly spraying. Rotate use of pesticides to retard development of resistance.

Exponential *Growth* Phase.-At this stage, seedlings will become tall and slender without a visible terminal bud. Maintain the same growing conditions as for the juvenile growth phase. Increase air circulation to prevent air from stagnating in seedling crowns. Check that all seedlings are being uniformly watered and rootball moisture stress levels are between 0.5 and 3.0 bars for maximum height growth. Elevating CO_2 levels between 1,000 and 2,100 ppm during the daytime when the vents are closed will increase height growth of walnut seedlings. The CO_2 level can be raised by using specially designed propane or natural gas burners or by piling *fresh* manure in one corner of the greenhouse. At the end of this phase, seedlings can be outplanted in late spring or early summer on moist, well-prepared sites; however, the succulent stems are easily broken.

Bud Development Stage.-During this stage, seedlings are forced to set a terminal bud while growth in caliber, roots, and buds continues for another 3 to 5 weeks. Water containers heavily to remove excess nitrogen from growth medium, then allow them to dry until seedlings wilt for 12 to 24 hours. After this, fertilize the containers with each watering, using a complete fertilizer high in phosphorus and potassium. Seedlings can now be moved to a shadehouse if night temperatures are well above freezing. If seedlings are left in the greenhouse, discontinue the supplemental lighting and elevated CO_2 levels and gradually reduce the temperatures. Seedlings outplanted at the end of this phase in late summer or early fall when frosts are not expected will not reflush until the following spring.

Co/d Hardening Stage.--During this stage, temperatures are brought close to freezing, and seedlings begin to develop leaf abscission layers. After 2 weeks at low temperature, seedlings can tolerate some frost; and after another 2 to 3 weeks, the stems can remain frozen for weeks at a time if protected from dessicating winds. The rootball should not be allowed to freeze. Place sawdust, straw, or coarse peat along the sides and over the top of the containers to protect rootballs from freezing. Just before outplanting cold-hardened seedlings, thoroughly water the seedlings with a complete, high nitrogen fertilizer.

J. W. Van Sambeek

WALNUT NOTES

Seedling Sources

Black walnut seedlings may be obtained from most State nurseries in areas where walnut is found naturally. Contact your local extension agent or State forester to find out if walnut seedlings are produced in your State, how much they cost, and how to order them. Some State nurseries only sell seeds, not seedlings.

Seeds or seedlings may also be obtained from commercial nurseries. **A** list of commercial nurseries is provided below.

Note: prices differ substantially depending on whether seedlings are grafted varieties selected for fast growth or "run of the woods" seedlings grown from seed.

Commercial Nurseries

Bountiful Ridge Nurseries, Inc.
Box 250
Princess Ann, MD 21853

Burgess Seed & Plant Co.
905 Four Seasons Road
Bloomington, IL 61701

W. Atlee Burpee
300 Park Ave.
Warminster, PA 18974

Cascade Forestry Service, Inc.
Route 1
Cascade, IA 52033

Central Indiana Walnut Growers, Inc.
1818 Arrowhead Drive
West Lafayette, IN 47906

Charley's Nut Tree Nursery
C. A. Richcrick
RD 10, Box 155
York, PA 17404

Krider Nurseries
I? 0. Box 29
Middlebury, IN 46540

Earl May Seed & Nursery Co.
Shenandoah. IA 51603

Mellinger's Inc.
2310 W. South Range Road
North Lima, OH 44452

J. E. Miller Nurseries
Canandaigua, NY 14424

Neosho Nurseries
900 North College
Neosho, MO 64850

The Nolin River Nut Tree Nursery
Route 2, Box 330
Upton, KY 42784

Pennsylvania Nut Nursery
Glenn L. Helms, Propagator
Hellertown, PA 18055

Saginaw Valley Nut Nursery
705 Adam Street
Saginaw, MI 48602

Emlong Nurseries, Inc.
Stevensville, Ml 49127

Environmental Collaborative
P. 0. Box 539
Osseo, MN 55369

Farmer Seed & Nursery Co.
Fairbault, MN 55021

Earl Ferris Nursery
811 4th Street, N.E.
Hampton, IA 50441

Henry Field Seed & Nursery Co.
Shenandoah, IA 51602

Louis Gerardi Nursery
RR 1, Box 144
O'Fallon, IL 62269

Girard Nurseries
I? 0. Box 428
Geneva, OH 44041

W. Greiner & Sons Nursery
I? 0. Box 70
Mulvane, KS 67110

Gurney Seed & Nursery Co.
Yankton, SD 57078

H. G. Hastings, Co.
Box 4274
Atlanta, GA 30302

Inter-State Nurseries, Inc.
Hamberg, IA 51644

Kelly Bros. Nurseries, Inc.
Dansville, NY 14437

Elwood Kerstetter
2743 Boas Street
Harrisburg, PA 17103

Savage Farms Nurseries
P. 0. Box 125, PL-1
McMinnville, TN 37110

St. Lawrence Nursery
Bill Mackently
RD 2
Potsdam, NY 13676

Stark Bro's Nurseries
Box 83457 A
Louisiana, MO 63353

Summer View Nursery
Rt. *2,* Box 210
McMinnville, TN 37110

Vanbourgondien Bros.
Box A 245, Rt. 109
Babylon, NY 11702

Vans Pines, Inc.
West Olive, MI 49460

Warren County Nursery, Inc.
Rt. 2, Box 204
McMinnville. TN 37110

Waynesboro Nurseries
P. 0. Box 987
Waynesboro, VA 22980

Wayside Gardens
Hodges, SC 29695

Leslie H. Wilmoth Nursery
Rt. 2, Box 469
Elizabethtown, KY 42701

Zilke Brothers Nursery
Box 8
Baroda, MI 49101

George Rink

WALNUT NOTES

Grafting

Black walnut is a difficult species to propagate vegetatively. The most successful propagation methods involve grafting-either grafting indoors with containerized rootstock (bench grafting) *or* grafting on established seedlings or trees (topworking).

Materials Required

- A very sharp knife made of high-quality steel that will hold a sharp edge. Grafting success depends on the grower's ability to make long, smooth cuts with a single stroke of the knife.
- Grafting rubber or budding strips for binding the graft union.
- Some semipermeable material such as grafting wax, paraffin, or Parafilm®[1] to cover the graft and keep the scion from drying out.

Bench Grafting

Two types of bench grafting-side and cleft grafting-use dormant scionwood (1-year-old branch tips from the desired cultivars) and actively growing seedling rootstocks. The grafting method you choose depends on your ability to match the cambiums (single layers of cells between the bark and the wood) of the scion and rootstock. For both methods:

1. Collect dormant scionwood in late winter (January to March) when the tissue is not frozen.
2. Bundle together scionwood from the same tree, label it, and then store it dry in labeled plastic bags in a refrigerator until rootstocks are ready for grafting.
3. Select large 1-O seedlings for the rootstocks and plant them in ½- to l-gallon containers using a well-drained potting medium (see Note 1.03: Growing Containerized Walnut).
4. Graft rootstocks when the buds along the stem begin to elongate or a few small leaflets are present.

Cleft (wedge) grafting.-This graft is best used on scionwood and rootstocks of the same diameter (fig. 1).

Side grafting.-With side grafting, you can adjust the depth of cut on the rootstock to fit a variety of smaller scionwood diameters (fig. 2).

Budding

Budding is a form of grafting where a bud and the surrounding bark are slipped from the scionwood and grafted to the rootstock. Budding can be done from the time rootstocks begin to leaf out until new shoots are 12 inches long.

1. Prepare the rootstock by making two parallel cuts about one-half inch apart through the cambium but not into the wood about 4 inches above the ground The cuts should be about 1½ inches long.

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[1]Mention of trade names does not constitute endorsement by the USDA Forest Service.

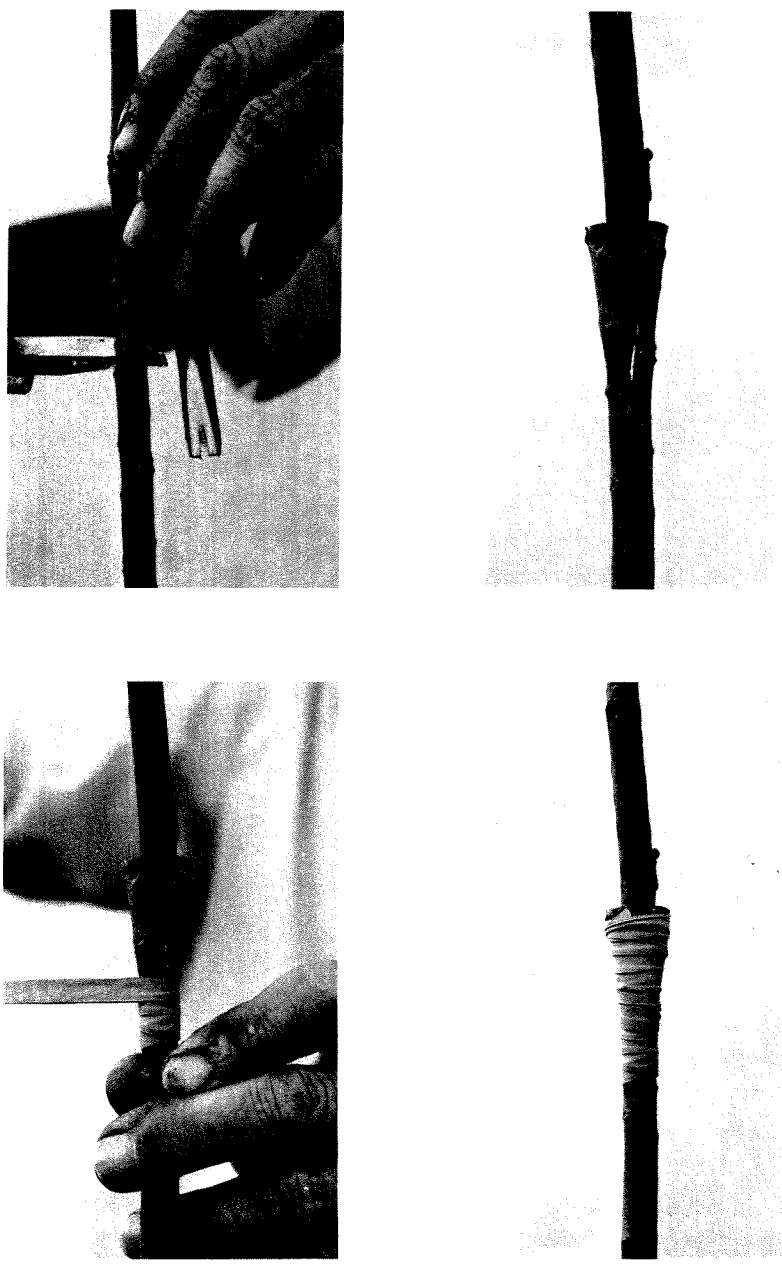

Figure I.-Cleft (wedge) grafting.

1. Prepare the basal end of the scionwood by cutting it evenly on both sides to form a long, uniformly tapered wedge about 2 inches long.
2. Cut off the stem of the rootstock where its diameter is equal to the diameter of the scionwood (upper left).
3. Make a vertical cut down the middle of the stem about 2 inches deep.
4. Insert the scionwood wedge into the cut until the cambiums match on both sides (upper right).
5. Tie the graft with a budding strip around the base of the graft union and wrap overlapping each turn to prevent the tissues from separating as the area calluses over (lower left).
6. Tie budding band off by inserting end through last wrap, then paint entire graft with grafting wax or softened paraffin to prevent the scion from drying out (lower right).
7. Complete the graft by clipping off the scion, leaving two dormant buds.

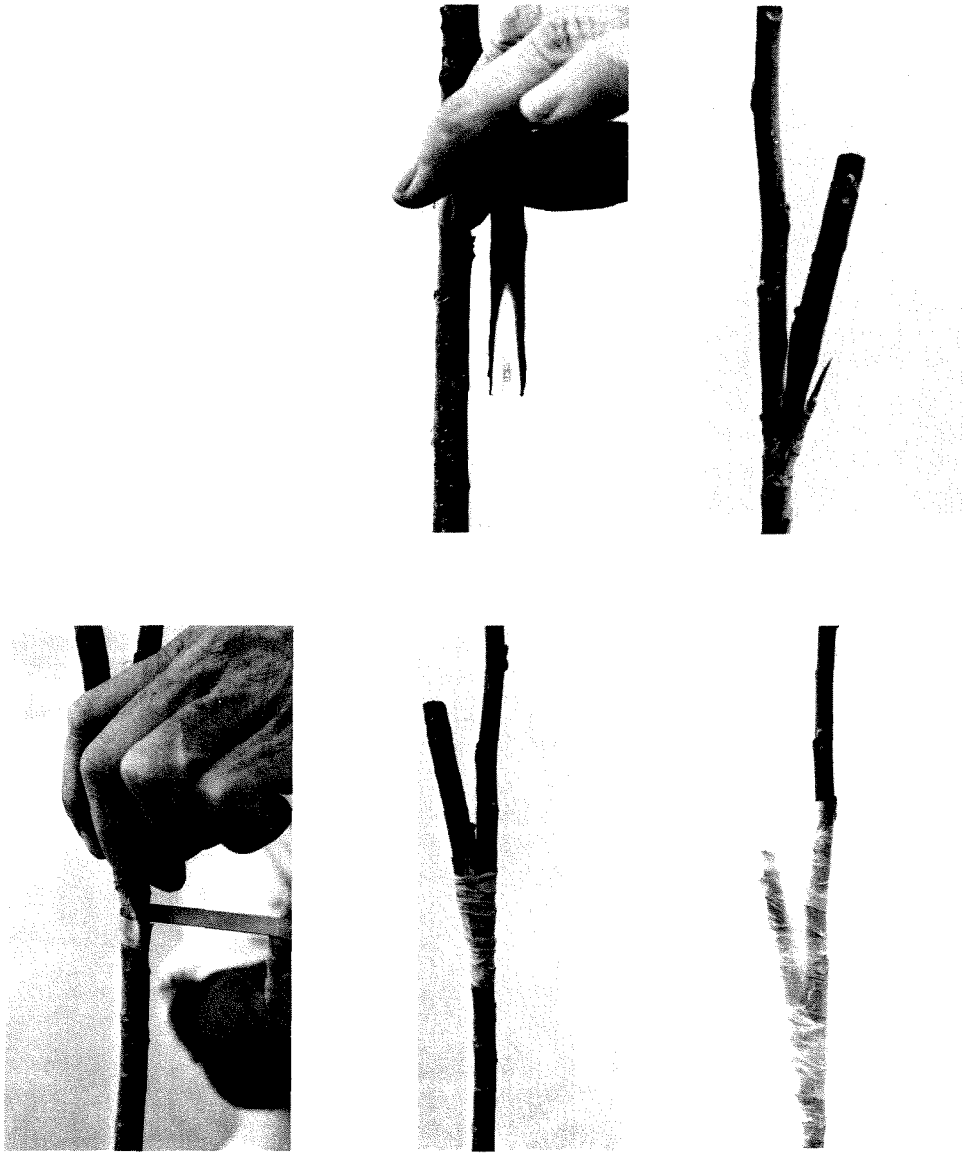

Figure 2. -Side grafting

1. Cut a piece of scionwood off 2 inches below an intact bud.
2. insert the knife into the bark just below the bud and make a long, smooth diagonal cut through the center of the base.
3. Make a similar cut on the opposite side.
4. Prepare the rootstock by making a single diagonal cut' about 1% inches long near the base of the stem so that the width of the cut tissue matches the diameter of the scionwood (upper center).
5. Insert the scionwood into the cut with the bud on the side away from the rootstock (upper right).
6. Tie the graft union with a grafting rubber or budding strip (lower left and lower center) and then cover it with soft paraffin, grafting wax, or Parafilm to prevent the scionwood from drying out (lower right).
7. About 7 to 10 days after grafting, remove the rootstock stem above the scion.

2. Make two perpendicular cuts to remove the entire piece of bark or remove the upper two-thirds of it to create a flap.
3. To prepare the bud, take the dormant scionwood and start a cut about one-half inch above a bud, cutting through the cambium and along the wood until about one-half to three-fourths inch below the bud. The bud chip should be a near duplicate of the cut on the rootstock.
4. Slip the bud chip into the cut on the rootstock or under the flap if it was not removed and align cambiums.
5. Starting below the bottom of the chip, spirally wrap masking tape around the graft, just missing the bud.
6. Repeat the operation starting from above the graft in the opposite direction.
7. Using waxed string, spirally wrap the graft three times below the bud, cross over behind the bud, and spirally wrap three more times to the top of the graft.
8. Repeat the procedure in the opposite direction.
9. If excess bleeding occurs around the graft, drill one or two small holes through the base of the rootstock.
10. In 2 to 3 weeks, cut off the original stem 12 inches above the graft.
11. Perodically rub off all buds on the stub except the grafted bud.
12. When the new growth is 2 to 3 inches long, make a vertical cut through the string and masking tape on the stub opposite the bud.
13. When the new growth is 6 to 8 inches long, tie it to the stub to support it and induce vertical growth.

Bench grafting aftercare.-Keep greenhouse temperatures between 65° F and 90° F to promote rapid callusing and new shoot growth. Twice weekly, all buds sprouting along the rootstock stem must be removed to prevent competition with scion growth. Keep humidity as high as possible without directly misting or sprinkling the graft union. Grafts should be held in the greenhouse until the union calluses over and leaves begin to expand. Outplant grafted seedlings as containerized seedlings after all danger of frost has passed; or move them to a shadehouse and hold them over until the following spring.

Topworking established rootstocks-Topworking refers to grafting onto rootstocks already established in a plantation or nursery bed. Topworking does not require use of a greenhouse. All three methods of grafting can be used to topwork established walnut seedlings and saplings; however, budding usually gives the best results.

Whichever grafting method you use, keep these basic principles in mind:

1. Black walnut cuttings should be grafted to black walnut rootstocks.
2. Long, smooth cuts with a very sharp knife are the secret to successful grafting.
3. The cambiums of the scionwood and of the rootstock must be aligned as closely as possible.
4. Optimum temperatures to promote callusing of the graft union are between 80° and 85° F.
5. The scionwood and graft union must not be allowed to dry out.

J. W. *Van Sambeek*

WALNUT NOTES

Black Walnut Cultivars

Cultivars are the products of vegetative propagation of a clone, of selection of a race, or of controlled breeding worthy of a separate name. More than 400 black walnut cultivars have been named in the past century, most for increased nut yield or quality. Walnut growers interested in producing nuts might achieve better yields by planting cultivar seedlings instead of bed-run nursery seedlings if a cultivar can be found to match their needs. Cultivars for timber, a recent development associated with rising prices for veneer logs, are also described in this Note.

Cultivars for Nuts

The more popular cultivars currently being commercially propagated and grown for nuts are listed below with permission! States and provinces in parentheses indicate the cultivar's place of origin.

BURNS (Ontario), small, thin-shelled nut that has an exceptionally high kernel percent. All kernels can be recovered on the first crack, mostly as halves.

EDRAS (Iowa) has high kernel weight and exceptional total kernel percent. The high percentage of kernels recovered at first crack indicates good cracking quality. Above-average survival in plantings.

EL-TOM (Ohio), a cross between Thomas and Elmer Myers, is characterized by a thin shell, high kernel percent, and light kernel color.

EMMA K (Illinois) has a thin shell and cracks out a high percentage of kernels. This cultivar bears heavily in southern Ontario, but not all the nuts fill well in heavy crop years. Nut flavor is reputed to be excellent, but the cultivar has not yet been extensively tested. The tree has a spreading crown.

GRUNDY (Iowa) ranks high in all kernel traits: total weight, first-crack percentage, and total percentage. Below-average survival in plantings. Poor producer in Kentucky so may not be a good selection in warmer climates.

HARE (Illinois) produces a large smooth nut. The good shell structure allows a high first-crack and total kernel percentage. Easily propagated by budding and seems well adapted to Illinois and Missouri conditions.

[1]*Scionwood of many cultivars can be purchased from the Nebraska Nut Growers Association, Box 4644, Lincoln, Nebraska 68504.*

HARNEY (Kentucky) ranks high in all kernel characteristics, but survival in all plantings has been below average.

HOMELAND (Virginia) matures early, producing large kernels that tend to be slightly shriveled.

MINTLE (Iowa) is a small nut with exceptional total kernel percentage. Reputed to have the best flavor of all black walnuts; can be stored at room temperature for 2 years without becoming rancid. Survives exceptionally well in plantings.

MONTEREY (Pennsylvania) has large kernels and high kernel percent; easily propagated by budding and grafting. Survives well in plantations.

MYERS (Ohio) is a standard cultivar noted for its very thin shell and good cracking qualities. Exceptional total-kernel and first-crack kernel percentages and a high recovery of quarters. Resistant to anthracnose and apparently adapted to southern growing conditions, but needs to be on a good site and well cared for. At more northern locations, kernels tend to be shriveled and bearing is often erratic.

OHIO (Ohio) dates from 1915 and is well known for its fine cracking qualities. Moderately resistant to anthracnose, but highly susceptible to husk maggot.

PINECREST (Pennsylvania) produces large kernels and a high percentage of kernels. Readily propagated by budding and grafting.

SNYDER (New York) has plump, medium-color nuts that have earned good nut evaluation test scores when grown in New York and Ohio.

SPARROW (Illinois) cracks well with exceptional total kernel percent. Excellent nut flavor and good color; very resistant to anthracnose. The nut is small unless the tree is well grown and on a good site.

STAMBAUGH (Illinois) is a large-kerneled cultivar that bears at an early age. Susceptible to anthracnose leaf spot infection.

STABLER (Maryland) cracks exceptionally well. Some of the nuts develop with a single lobe. Very susceptible to husk maggot.

THOMAS (Pennsylvania) has become a well-known black walnut cultivar since its discovery in 1881. Bears at an early age, and the large nuts crack well with large kernels and taste good. After many years of objective testing, Professor MacDaniels (1974) concluded that, " . . . (no) one variety is consistently better than Thomas." But Thomas does not perform consistently from year to year or over a range of locations. Poor selection for the

Midwest. The most frequent criticism is that the nuts do not fill well, especially on trees more than 5 years old. Nuts may develop poorly because of early defoliation induced by anthracnose.

TODD (Ohio) bears a large nut with a smooth shell and good cracking quality. High kernel yield and kernel percent. Does not always fill well in Northern States.

VANDERSLOOT (Pennsylvania) is outstanding for its large nut size, kernel weight, and its good cracking quality. Resistant to anthracnose leaf spot.

VICTORIA (Kentucky) has lower nut evaluation scores than other thin-shelled cultivars. Vigorous tree, resistant to leaf spot.

Cultivars for Timber

In addition, the Purdue Research Foundation of Purdue University has developed the following nine cultivars from selections made for good form, rapid height, and diameter growth, primarily for faster timber production.

PURDUE 1 bears abundant crops each year with nut set on lateral shoots, a rare occurrence in black walnut. Only negative features: some susceptibility to anthracnose and a slightly earlier than normal leafing date.

PURDUE 2 has rapid growth, but below-average straightness. Leafs out a week later than average, a desirable trait. Good choice if a nut crop is not necessary.

PURDUE 3 combines rapid growth and good straightness with very late leafing and good anthracnose resistance. Good all-around tree even though the nut crop is light and erratic from year to year.

KNOX 1 is noted for rapid growth, heavy annual nut crops, and good anthracnose resistance, but is below average in straightness. Susceptible to late spring frosts because it leafs out nearly a week earlier than average.

LAWRENCE 1 has very rapid growth, good straightness, and excellent anthracnose resistance. Its nut crop is abundant but tends toward alternate-year bearing.

LAWRENCE 2 doesn't grow as fast as some of the other patents, but it is uniquely suited to plantation culture. Extremely straight and fairly short with a large diameter and relatively little taper so very firmly anchored and not susceptible to wind damage. Very good anthracnose resistance, outstanding annual nut-bearer.

TIPPECANOE 1 is the fastest growing of all the patented trees. It has good straightness but is somewhat susceptible to anthracnose and produces very few nuts.

FAYETTE 1 is fast-growing, has average straightness, and abundant but alternate-year nut-bearing characteristics. Most outstanding feature: unusually strong anthracnose resistance.

FAYETTE 2 was patented for its nut production. Otherwise, it has a relatively slow growth rate and very poor straightness. It has good anthracnose resistance and is very late to leaf out. Produces nuts in great abundance each year by age 3 or 4; clusters on spur-type lateral shoots contain up to six nuts.

George Rink

Funk, David T. 1979. Black walnuts for nuts and timber. In: Jaynes, R. A., ed. Nut tree culture in North America. Hamden, CT Northern Nut Growers Association, Inc: 51-73.

Beineke, Walter F. 1984. Characteristics of Purdue University's patented black walnut trees. FNR-105. West Lafayette, IN: Purdue University Cooperative Extension Service. 3 p.

WALNUT NOTES

Choosing a Good Walnut Site

One of the black walnut grower's most important decisions is where to plant this valuable, but sensitive hardwood. Black walnut has specific soil-site requirements that must be considered when locating a planting site. It grows well only on land of good quality. Briefly, black walnuts grow best in soil that is:

- medium textured
- deep, well-drained
- not stony
- on lower north- or east-facing slopes (avoid planting on rolling, hilly ground) not compacted.

Landform

Natural stands of black walnut are located most frequently on bottomlands, coves, and lower slopes. In selecting your planting site, consider floodplain sites carefully-you'll need to avoid the many clayey and heavy textured soils that often occupy such sites. On the uplands, the better planting areas are commonly located on the lower uplands, lower north- and east-facing slopes, and stream terraces. Soil moisture and depth may limit growth on upland sites. Avoid: steep or south-facing slopes and narrow ridgetops.

Soil Texture

Soils in the better black walnut sites are deep and medium textured over loose, well-drained subsoils. The best soils for walnut plantings are composed of topsoils of sandy loam, loam, or silt loam over similar subsoil textures, or sandy clay loam or clay loam. Also good are limestone soils with silt loam over clayey subsoils.

Select with caution: soils with gravel layers or bedrock within 3 feet of the surface. Avoid: coarse or heavy-textured soils that are eroded or shallow to a mottled subsoil or bedrock.

Drainage

Black walnut needs an ample supply of moisture but cannot tolerate long periods of high water. The soil must be well aerated to allow air movement in the rooting zone. Soil color is usually a good indicator of soil drainage. Well-drained soils have uniform shades of brown or reddish-brown from the surface to 3 feet deep or more. Avoid soils with streaks of gray, red, or yellow, or an unpleasant odor-they're poorly drained.

Nutrients and pH

Planting in naturally fertile soil is a more reliable way to get black walnut growth than fertilizing poor soils. Nutrients needed by black walnut in the largest amount are available at pH 5 to 8. Avoid soils with acid clayey subsoils.

Other Things to Consider

When choosing a planting site, remember that walnuts grow better when protected from high wind and frost.

Check out the vegetation on a prospective site before planting-it can give you clues to the site's productivity. For example, a sparse cover of weeds and grasses generally indicates low fertility, erosion, or droughty conditions. The composition of the cover can also tell you about the site; sedges, for example, indicate a wet soil.

For other help in selecting suitable black walnut planting sites, consult a soil scientist or State forester who is familiar with the soils in your area.

Reference

Ponder, Felix, Jr. 1982. Some guidelines for selecting planting sites. Northern Nut Growers Association Annual Report 72: 112-117.

Felix Ponder; Jr.

WALNUT NOTES

Site Preparation

Spending a lot of time, effort, and money on preparing a site for black walnut may actually save you money in the long run. The most intensively prepared sites generally require the least weed control after planting.

Site preparation involves removing unwanted vegetation and/or improving the physical and chemical condition of soil on the planting site for tree establishment and growth. Vegetation can be controlled by various mechanical, chemical, or combination mechanical-chemical methods, depending on the density and size of existing cover, topography, soil type, and equipment available.

Mechanical Methods

Mechanical site preparation should be done in the fall, and precautions should be taken to minimize erosion. On brushy clearcuts, remove brush completely with bulldozer and attachments. Then disk to reduce the impact of compaction caused by roads, skid trails, and tractor tracks. Heavy sod areas may be prepared by plowing, disk harrowing, or rototilling several times. In some cases, subsoiling may be useful to destroy plow pan layers on old field sites.

Chemical Methods

Chemical methods of site preparation depend on the species, size, and density of vegetation present. Chemicals are quite specific in the kinds of vegetation they control. A list of commonly used chemicals is included at the end of this Note. Check with your county extension office to find which ones are registered for use in your area. For dense, mixed hardwoods, apply broadcast foliage or stem-foliage spray in early summer after leaves fully develop. Apply enough herbicide to thoroughly cover leaves.

Some herbicides used in chemical site preparation

I. **Grass and herbaceous weeds**

Refer to note on weed control.

II. **Woody vegetation**

	Suggested rate
A. *Soil treatments*	
1. Fenuron	50-l 00 lbs/acre
2. Tordon 10k	60-85 lbs/acre
3. Tordon 101	1-4 gals/acre
B. *Foliage*	
1. 2,4-D	2 qtslacre
2. Glyphosate	2 qts/acre
C. Basal-bark	
1. 24-D	2-3 qtslacre
2. Monosodiummethane arsonate	1 ml/injection
3. Triclopyr[1]	2 qtslacre

'Depending on formulation, triclopyr may be used as a basal spray or as a ground application for less selectivity

Chemicals may also be applied in the cut surface treatments listed below.

Cut stump: Thoroughly wet the surface of the freshly cut stump and the bark with chemical.

Frill-gridle: Cut through the bark around the tree, and girdle the trees by stripping a band of bark away. Spray chemicals over the area.

Tree injector: Make incision through bark and inject chemical.

Soil sterilants may be broadcast or spot applied to control non-selective hardwood brush. Use these chemicals carefully because they may be absorbed by roots or nearby desirable trees. Delay planting 6 to 12 months or longer because some sterilant chemicals persist in the soil. In all cases, follow directions.

In addition to killing competing vegetation, prepare the site chemically to accept the new seedlings. Soil should be analyzed for pH, nitrogen, phosphorus, potassium, calcium, and magnesium. The pH should be between 5 and 8. Some sites may require an application of lime to raise the pH.

The importance of site preparation cannot be overemphasized. Consult your State forester to find out if other methods of site preparation may also be appropriate.

Felix Ponder, Jr.

WALNUT NOTES

Direct Seeding

Should a grower plant black walnut seeds...or black walnut seedlings? There's no one right answer, but planting seeds offers several advantages over planting seedlings:

1. Seedlings from seeds develop normal taproots.
2. Seeds are easier to store and carry to the planting site.
3. Seeds can be planted in the fall or in the spring after stratification.
4. Seeds of selected, high-quality trees can be planted instead of run-of-the-mill seedlings.

However, direct seeding has some drawbacks:

1. Because of unpredictable germination, several seeds must be sown in each seed spot.
2. Seeds must be protected from squirrels and other predators.

If you've decided to direct seed your plantation, here are some guidelines to follow.

Prepare the Site

Before sowing seeds, prepare the planting site to kill competing vegetation (see Note 2.02: Site Preparation). This can be done by cultivation (plowing, disking, or rototilling) or by treatment with a combination of preemergent and postemergent herbicides. Recommended techniques include:

1. Plow and disk the entire planting site if soil erosion will not occur.
2. Spray 4-foot-wide strips, and plant the nuts down the middle of each strip at the desired spacing, or
3. Spray a series of 4-foot-diameter circles at the desired spacing, and plant seeds in the middle of each circle. A properly squared spacing will allow for plantation maintenance by machine in both directions.

Choose Good Seed

Test the viability of freshly husked seeds by placing them in a container of water. Empty seeds will float; filled seeds will sink (see Note 1.02: Seed Handling). Crack open a small sample of nuts (10 to 20) to determine the percentage of sound seed in your seedlot. Viable nuts have white, sound-looking meat; non-viable seeds have beige, shriveled kernels that are watery or give off a foul, rancid odor (fig. 1). The percentage of viable seeds in your sample will determine how many seeds to plant per spot. Use of the following table as a guide will result in only 5- to 20-percent blank spots.

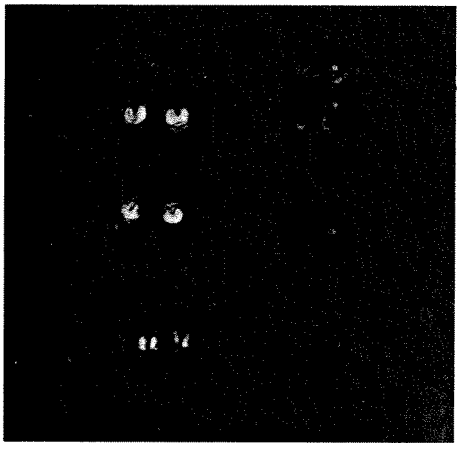

Figure 1.-Viable nuts have white, sound-looking meat.

Sound seed	Seeds per spot
(Percent)	*(Number)*
80-l 00	2
60-80	3
40-60	4
Less than 40	5 or more

Plant the Seeds

Seeds may be planted early in the fall so that the necessary chilling occurs naturally, or they can be planted in the spring if they are fully stratified (see Note 1.02: Seed Handling). Improper stratification or dry soil may delay germination until the second year. Fully stratified seeds can be taken out of cold storage about 1 week before planting to accelerate germination. Make sure they do not dry out. Handle seeds carefully to protect the emerging radicles.

Plant each seed about 2 to 3 inches deep with the nut laying on its side. If more than one seed is planted per seed spot, place them at least 8 inches apart to make it easier to remove excess seedlings at a later date. If you plan to strip spray with herbicides in the future, plant nuts within a seed spot in a single file parallel to the rows. If you plan to spot spray, use a triangular pattern for three seeds or a square pattern for four seeds within each seed spot. Using clustered patterns helps to keep rows straight, minimize size of herbicide circles, and minimize amount of materials needed if you erect mechanical barriers to predation.

Protect seeds from squirrels and other predators by using mechanical barriers or chemical repellents. The cheapest and most effective repellent is a generous portion of *fresh* cow manure over each seed spot (see Note 5.06: Preventing Animal Damage).

Tend the Seedlings

After the first or second growing season, pick out the best seedling in each seed spot and remove the rest. Thrust a sharp spade diagonally under the unwanted seedling, cut off the shoot about 1 inch below the root collar, and pull up the shoot. (You may want to dig up extras and transplant them to empty seed spots.) Use postemergent herbicides on unwanted seedlings with caution because spray may drift onto the desired seedling or be carried through the root system to that seedling. When using a postemergent herbicide like Roundup', apply it when the top growth has slowed and soil moisture is adequate for continued root growth.

J. W. Van Sambeek

'Mention of trade names does not constitute endorsement by the USDA Forest Service.

WALNUT NOTES

Planting Seedlings

Black walnut plantations can be established by either planting seeds (see Note 2.03: Direct Seeding) or by planting seedlings. Most plantations are established using bare-root, nursery-grown seedlings because it's more predictable than planting seeds and because it's cheaper than planting containerized stock (see Note 1.03: Growing Containerized Walnut). If that's what you decide to do, here are the steps to follow.

1. Prepare and Lay Out the Planting Site

For timber production, spacings of 10 or 12 feet square (436 or 302 trees per acre, respectively) are recommended because these spacings allow room for mechanized weed control and allow trees to reach a 5-inch average d.b.h. without thinning. Band or spot-spray herbicides within the tree rows before planting to (1) remove the immediate competition, (2) mulch the soil surface, keeping soil moisture from evaporating, and (3) leave weeds between the rows to provide some shade and wind protection (see Note 2.01: Choosing a Good Walnut Site and Note 2.02: Site Preparation).

2. Order Seedlings

Obtain seedlings from a private nursery or from your State nursery through your State forester or local extension agent (see Note 1.04: Seedling Sources). If you order ungraded seedlings, order extra so you can cull out all seedlings with damaged or diseased roots and the smallest 10 to 20 percent of the seedlings.

3. Prepare the Seedlings

The care you give your seedlings after they arrive from the nursery and during planting will have more bearing on their survival and early growth than how they are planted. Seedlings should be planted as soon as possible after they arrive. Open packages when they arrive and rewet roots if necessary. Bundled seedlings can be stored for several days in a cool, shady place if protected from freezing or stored for 2 to 4 weeks in cold storage (34 to 38° F) without seriously deteriorating. Stack bundles so air can freely circulate around each bundle to prevent "heating" within the seedling bundles.

Seedlings can also be temporarily transplanted into "heeling-in" trenches. Dig a V-shaped trench that is deep enough to cover the entire root system and long enough to spread seedlings out along the sloping side. Pack soil firmly around roots, and water as needed. Trenches should be dug in a shady, somewhat protected area and mulched to give the seedlings additional protection.

Before planting, soak seedling roots in water for 1 to 2 hours; keep seedlings moist when planting by carrying them in planting trays or canvas planting bags packed with moist peat. Before planting, prune the seedling taproot to a length of 8 inches and all lateral roots to a length of 1 to 2 inches. Do not shear lateral roots off because this reduces the number of potential sites for new root growth. Do not plant seedlings when there is snow on the ground, when soils are too wet, or if frost-heaving can still occur.

4. Plant the Seedlings Walnut seedlings can be planted using either the hole or the slit method.

Hole method.-Use a shovel, grub hoe, mattock, or post hole digger to dig a hole deep and wide enough to spread the root system out in all directions. The seedling root collar should be placed about 1 inch below the groundline. Layer soil back into the hole 2 to 3 inches at a time to minimize the size and number of air pockets. If you use a mechanical auger or post hole digger in heavy, wet soils, the sides of the hole can become "plastered" forming a "pot" through which the seedling roots cannot penetrate (fig. 1).

S/it method.-Make **a** lo-inch-deep vertical slit with a planting bar, tile spade, or mechanical tree planter. Insert the seedling taproot to the bottom of the slit and lift it slightly to spread out lateral roots. Firmly tamp soil around the roots at both the top and bottom of the slit. Air pockets, especially those at the bottom of the slit, help to reopen the soil when it dries out and shrinks. If you use a tree planting machine, make sure the slit is deep enough to prevent the seedling from forming L-shaped roots along the bottom of the slit. In addition, you should follow the machine to straighten and tamp soil around each seedling. If the seedling is planted on a slant, a sprout may originate from the root collar and replace the original stem (fig. 2).

Walnut seedlings normally must go through a brief period of transplant shock before they adapt and begin growing new shoots.

J. W. Van Sambeek

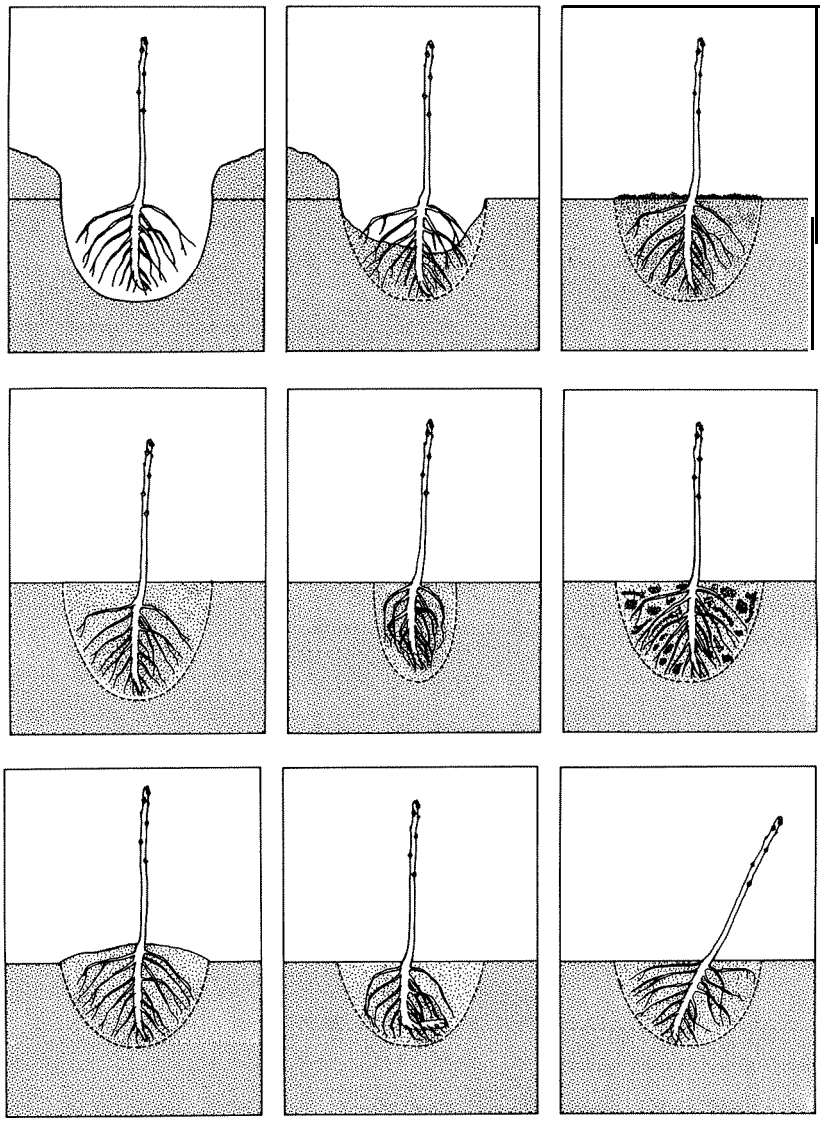

Figure l.-Hole method of planting large or fibrous rooted seedlings.

CORRECT METHOD FOR HOLE PLANTING

A. Dig hole slightly larger than the rootball when spread out.
B. Set seedling root collar slightly deeper than top of hole, partially fill hole, and firm soil
C. Fill hole, firm soil, and add loose soil as mulch.

INCORRECT METHODS FOR HOLE PLANTING

D. Seedling set too deep, hole too large.
E. Compacted rootball, hole too narrow.
F. Duff and debris added to hole which may form air pockets
G. Hole too shallow and will lead to exposed roots.
H. "L"- or "J"-rooted, hole too shallow.
I. Seedling not vertical, hole too shallow.

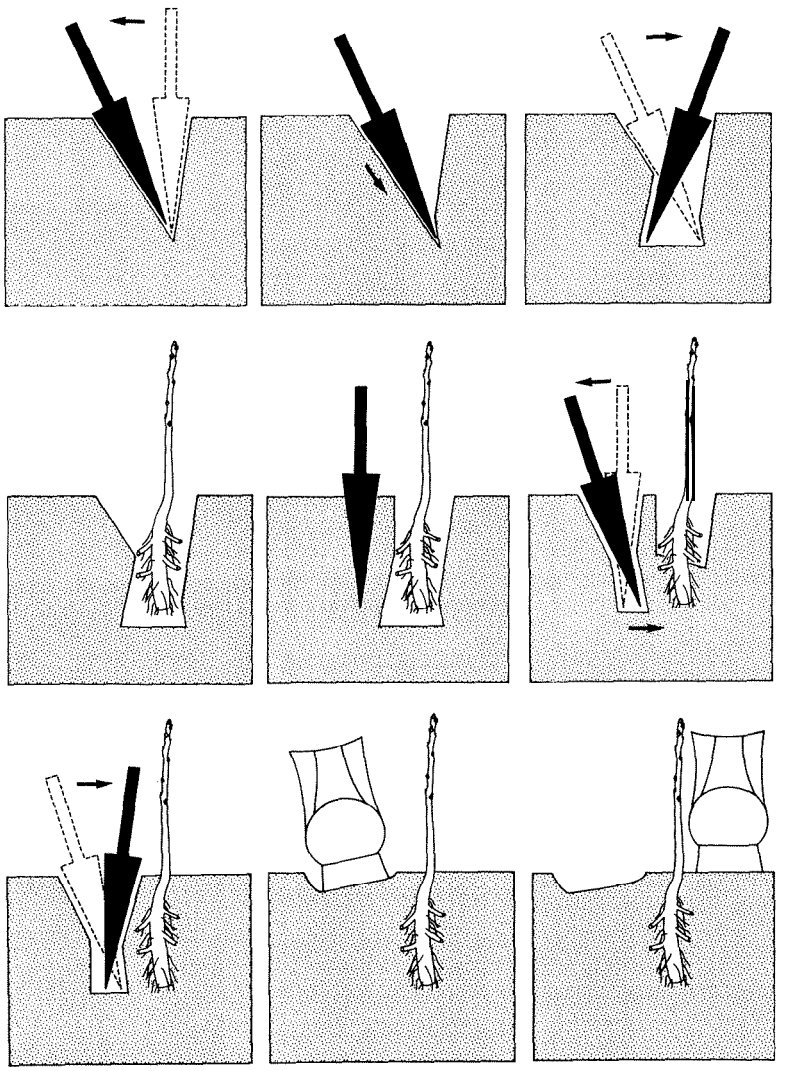

Figure 2.-Slit planting method with planting bar or tile spade.

A. insert bar straight down and pull backward.
B. Push bar down at same angle to get a new bite.
C. Push bar to vertical position.
D. Remove bar and set seedling in hole at correct depth.
E. Insert bar straight down about 2 inches behind first hole.
F. Pull bar back and tightly pack soil around lower roots.
G. Push bar forward and tightly pack soil around upper roots
H. Repeat steps E to G and close new hole with shoe heel.
I. Firm soil around seedling with shoe heel.

WALNUT NOTES

Weed Control

Weeds affect black walnut trees the same way they affect other crops. They rob them of moisture, nutrients, and light. But walnut growers can use a variety of mechanical and chemical methods to protect their trees from weeds.

Mechanical Controls

Cultivation is the most effective mechanical weed control method. You can cultivate thoroughly using a tandem disc, but that may damage feeder roots. Roots will be damaged less if you cultivate shallowly with a rototilling attachment. Begin right after "green up" in the spring, and repeat as often as necessary to keep weeds from getting taller than 6 inches. Time the last cultivation of the season to let vegetation recover enough to provide erosion protection during fall and winter. Take care: as trees get larger, their lateral branches are easily torn off by equipment operated close-by.

Periodic mowing provides plenty of sunlight for young trees by removing the tops of weeds and grasses; but weed roots remain actively in place. Do not substitute mowing for cultivation or herbicides.

Mulching with plastic, sawdust, bark, or wood chips can control weeds, but consumes a lot of time and money. It is practical only in small plantations.

Chemical Controls

Chemical weed control works better and costs less than mechanical control, but must be done with skill and care.

Two general types of chemicals are used in walnut plantings: (1) preemergent herbicides are applied early in the spring before seeds begin to germinate when moisture conditions are favorable; (2) *postemergent* herbicides act upon contact with the foliage and are applied when the vegetation is growing vigorously.

Several chemicals are effective in controlling weeds in black walnut, particularly one preemergent herbicide, simazine, and five postemergent herbicides: atrazine, amitrol, dalapon, glyphosate, and 2,4-D. These are tolerated well by black walnut, generally available, inexpensive, and safe when handled and applied properly. Consult your State forester to find out what other chemicals may work satisfactorily in walnut plantings.

The type of herbicide you need to use depends on the types of weeds you need to control. It may take a combination of herbicides to control the various weeds in a plantation because no single one works best in all situations. For example, a chemical mixture will work better than a single chemical when both grasses and broadleaf plants are present. Dalapon will control the annual and perennial grasses; 2,4-D will

control the broadleaf plants. Applying a combination of postemergent herbicide and simazine is often the most effective way to control weeds. The postemergent herbicide controls initial vegetation, and simazine provides residual weed control.

Applying chemicals-If your land is fairly level and the trees are uniformly spaced, you can use a farm-type sprayer to either broadcast the chemical or spray it in strips. Broadcast spraying covers the entire area and uses the most herbicide. Strip spraying costs less than broadcast spraying and reduces the possibility of soil erosion. Spraying 2-foot strips on each side of walnut seedlings at IO- or 12-foot spacings requires only 30 to 40 percent as much herbicide as broadcast spraying.

Spot spraying 4-foot circles around each tree, using a hand-held backpack sprayer, is the the most versatile and, for smaller areas, probably the easiest and cheapest way to control weeds.

Broadcast spraying generally requires more than 20 gallons of water and chemical to cover an acre. When spot or strip spraying, adjust the amount of solution per acre in proportion to the actual amount of ground sprayed. Monitor agitation, pressure, and calibration carefully to ensure an accurate rate of application.

Herbicides-what, when, how much

Vegetation present. Apply postemergent herbicide in combination with simazine for residual weed control

A. Walnut seedling absent:	
1. Dowpon M (dalapon)	4-15 lbs/acre
2. Dowpon M	4-15 lbs/acre
plus 2,4-D	l-3 lbs/acre
3. Amitrol-T (amitrole)	2-4 lbs or 1-2 gals/acre
4. AAtrex (atrazine)[1]	2½-5 lbs/acre
5. Roundup (glyphosate)	1½-2 qts/acre
B. Walnut seedlings present:	
1. Roundup (glyphosate)	1½-2 qts/acre

[1]*Apply atrazine in the fall preceding the spring when you plan to plant. Usually, an application of atrazine without simazine will provide sufficient weed control.*

Precautions.-Before applying any herbicide, check State and federal regulations concerning its use, follow directions on the label, and take recommended safety precautions. Although the recommended chemicals are not normally considered dangerous, be sure to handle with care.

Felix Jr.

WALNUT NOTES

Ground Cover Management

The ideal ground cover in a black walnut plantation would be similar to that in a dense mature forest or mixed black walnut stand. Unfortunately, when a plantation is established, regardless of the type of site preparation, the walnut seedlings will not be tall or dense enough to shade out the vegetation that competes against them. Most plantations go through a natural succession from annual weeds to perennial weeds and then grasses if trees are widely spaced and free to grow.

Criteria for Choosing a Cover Crop

The type and amount of ground competition can greatly affect black walnut survival and growth. In general, legumes increase tree growth if they persist; and grasses reduce growth. More testing is needed before we can make specific recommendations on ground cover; however, the following is a list of general criteria to consider when selecting a cover crop for your plantation.

1. Ground cover should not compete strongly with your walnut.
   - does most of the vegetative growth occur during periods of walnut growth or when soil moisture is inadequate?
   - does the ground cover produce phytotoxins-chemicals that will limit walnut growth?
2. Ground cover should be easy to establish and maintain on your site.
   - are varieties available that are adapted to your section of the country?
   - is seed readily available at a reasonable cost?
   - will ground cover persist long enough to justify the cost of establishing it?
   - are shade-tolerant varieties available
3. Ground cover should produce adequate biomass to control other weeds.
   - can the ground cover overtop and smother existing herbaceous competition?
   - will the ground cover increase or decrease fire hazard in your plantation?
4. Ground cover should improve soil structure and/or fertility.
   - does the ground cover fix nitrogen and if so, how much annually?
   - will the ground cover result in rapid litter accumulation and increased organic matter in the soil?
5. Ground cover should be relatively free of pests, especially pests that may attack walnut.

Your choice of ground cover is probably limited to those species used for hay, pastures, or green manure cropping. For silvicultural treatments, use half of the seeding rate suggested for agricultural uses unless site preparation is minimal. Contact your local extension agent for more information on how to establish the ground cover and how much of what varieties to plant. The agent knows about the soil types in your area and what other landowners are growing. The following list describes some of the most common ground covers, their principal uses, seeding rate for agricultural use, rate of establishment, pattern of stem growth, longevity, and whether tested as a cover crop with black walnut or other hardwoods.

Species	Principal uses	Seedling rate (lbs/acre)	Rate of establishment	Pattern of stem growth	Longevity	Tested'
Alfalfa	forage pasture	10-20	moderate	erect	perennial	NA
Red clover	forage pasture green manure	8-10	rapid	erect	short-lived perennial	NA
Ladino or White clover	pastures bees	2-4	moderate	prostrate	perennial	NA
Tall fescue	forages pastures	20-35	rapid	upright	perennial	
Timothy	forages pastures	5-10	moderate	upright	perennial	NA
Birdsfoot trefoil	ground cover pasture	5-10	moderate	procumbent	perennial	0
Crownvetch	ground cover forages	15-20	slow	procumbent	perennial	t
Alsike clover	pastures bees	4.5-8	moderate	decumbent	short-lived perennial	NA
Sweet clover	green manure forages bees	10-15	rapid	upright	biennial	+
Bromegrass	forages pasture	15-20	moderate	upright	perennial	NA
Orchardgrass	forage pasture	10-15	moderate	upright	perennial	NA
Sericea lespedeza	ground cover forages	10-18	slow	upright	perennial	t
Annual lespedeza	forage pasture green manure	15-25	rapid	procumbent	annual	
Hairy vetch	green manure	40-45	rapid	vines	annual	t +
Crimson clover	green manure forage bees	15-20	rapid	erect	annual	+ t

(Table continued on next page)

(Table Continued)

Species	Principal uses	Seedling rate	Rate of establishment	Pattern of stem growth	Longevity	Tested[1]
		(lbs/acre)				
Kentucky bluegrass	pasture groundcover	15-25	slow	upright	perennial	NA
Bermuda grass	ground cover pasture forage	7-12	rapid	procumbent	perennial	NA
Soybeans	oils green manure	30-50	rapid	upright	annual	t
Subterranean clover	pasture	20-25	rapid	procumbent	annual	t
lbs/acre	ground cover	60-70	slow	vines	perennial	NA
Arrowleaf clover	forage pasture bees	5-8	rapid	erect	annual	+ t

[1]NA = no data available; + = beneficial to some hardwoods; t + = beneficial to all hardwoods tested; 0 = mixed results with hardwoods; and - = reduced growth on tested hardwoods.

J. W. Van Sambeek

WALNUT NOTES

Fertilization

Fertilization is perhaps the least understood of all the cultural practices associated with managing black walnut trees. Many fertilization studies have been done, but the results have been inconsistent and hard to compare. So we are only able to make general recommendations for fertilizing black walnut. However, first, there are some general points to keep in mind.

Our best advice for ensuring good walnut growth is to locate your plantation on an ideal site. Don't fertilize walnut trees on good sites, especially young trees. Fertilization doesn't seem to help the trees grow; but it does help weeds grow, which then suppress walnut growth.

Fertilizing pole-size and larger trees is likely to provide the best economic return. Chemical analysis of walnut leaves can indicate current nutrient element levels of the trees and suggest probable response to fertilization with nitrogen (N), phosphorus (P), potassium (K), and calcium (Ca) (table 1). Of these elements, N deficiencies are most common; and use of N increases diameter the most. Height growth is seldom increased by fertilization. However, all four elements can be effective in improving growth and nut production.

Table 1 .-*Tentative critical foliar nutrient element levels- for diagnosing nutrient deficiencies in black walnut trees*

Nutrient element	Deficient (will probably respond to fertilization)	Intermediate (may or may not respond to fertilization)	Adequate (will probably not respond to fertilization)
	Percent		
N	Below 2.00	2.00-2.60	Over 2.60
P	Below .10	.10- .25	Over .25
K	Below .75	.75-1.30	Over 1.30
Ca	Below .50	.50-1.10	Over 1.10

'Based on analyses of mature leaves collected about mid-August (Phares and Finn 1971).

Before deciding to fertilize, determine if there are *moisture* or *physical /imitations* that may be affecting tree growth. Remember, fertilizer cannot compensate for these two limiting factors,

If you do decide to fertilize, identify several trees to receive no fertilizers; use these trees to compare the growth of fertilized trees in terms of the amount of growth and

its duration, and to estimate when to refertilize. Do not refertilize if fertilized trees grow no better than trees not fertilized. Refertilize when the satisfactory growth response to fertilizer is no longer evident when compared to trees not fertilized. All fertilized trees should be free to grow or released before fertilizing.

For pole-size and larger trees managed for timber, apply 3 pounds of N per tree. Spread fertilizer evenly around the tree in late spring. Add 5 pounds of triple superphosphate and 8 pounds of muriate of potash if trees are managed for timber and nuts. Except for Ca, treatments may need to be repeated every 3 to 5 years. Frequent fertilization, especially with N, can increase the need to add lime to maintain and raise pH. The pH range for growing black walnut is 5 to 8.

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Felix Ponder, Jr.

WALNUT NOTES

Irrigation

Some sites don't have enough moisture to grow good black walnut trees. This is especially a problem where drainage is excessive or where soil volume suitable for root development is limited by soil depth or impermeable soil layers. Unless other factors are limiting (and this is often the case), irrigating such sites may help to maintain tree growth during periods of inadequate precipitation and/or high evapotranspiration. But keep in mind: it probably won't pay to irrigate just to increase the value of merchantable trees.

The moisture necessary for tree growth can come from rainfall, subsurface moisture, or irrigation. Normally, if well distributed, trees do well without supplemental water in areas where 30 inches or more of rainfall occurs. Of course, the amount and frequency of rainfall required will depend on how much water the soil will hold.

On some sites, lack of available water is less of a problem than elsewhere because of "perched" water tables, where water is restricted from moving downward in the soil layer but, rather, collects in the rooting zone. In such cases, efforts to maintain an adequate supply of available water are overshadowed by the site's poor quality. Aside from texture, which also influences the soil's water holding capacity, both drainage and aeration affect tree growth and irrigation practice. A rise in the water table reduces the amount of oxygen available to roots. Increasing the available water also increases nutrient uptake, diminishing what may already be a limited supply in shallow soils.

Irrigation methods include flood, furrow, border strip, sprinkler, drip, and trickle. Flood, furrow, and border strip methods use soil-constructed diversions and a small amount of hardware to deliver water by gravity to trees. Sprinkler, drip, and trickle irrigation systems require more equipment and hardware to install and maintain.

If you decide to irrigate, you will need to estimate how much water to add. With flood, furrow, border strip, and sprinkler systems (also called surface irrigation methods), it is important to determine the amount of water the soil can hold, to prevent adding too much water and temporarily "waterlogging" the soil. For drip and trickle irrigation, this calculation is less important than for other methods because frequent, low-pressure irrigations continually replace water in the root zone as it is used.

The amount of water to apply during an irrigation can be determined with elaborate equipment. However, as a rule, trees need about 1 to 1½ inches of rain per week. Calibrate your equipment to deliver this amount of water over 1 week. Depending on your system, a watch and/or rain gauge may be all you will need. Dealers and suppliers of irrigation equipment are good sources of advice on determining water needs for your soil. You can also contact the Soil Conservation Service or the State and Private Forestry branch of the Forest Service.

Felix Ponder, Jr. and F. Danny McBride

WALNUT NOTES

Interplantings

Interplanting nurse trees and shrubs with walnut trees can greatly improve walnut growth and quality (fig. 1). In addition, nurse crops have been used for esthetic reasons; for wildlife food or cover; and for intermediate crops like Christmas trees, pulpwood, or fenceposts. But nurse crops should be selected carefully-not all are equally effective on every site.

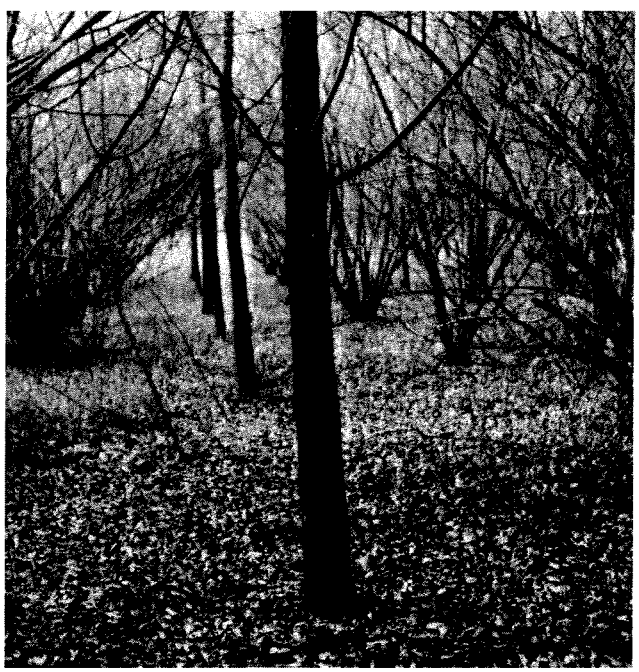

Figure I.-Walnut interplanted with autumn olive. Note the lack of a competing herbaceous understory in these plantings.

Most nurse crops we've tested have been nitrogen-fixers-they take nitrogen from the atmosphere and add it to the soil in a form available to other plants. Walnut trees use a lot of soil nitrogen, but many sites being planted to walnut are low in available nitrogen.

The following nitrogen-fixing species have been tried in walnut interplanting.

Autumn olive, a multiple-stemmed, densely foliated shrub, has stimulated walnut growth on all but the best walnut sites. Unfortunately, the cultivar of autumn olive originally planted as food and cover for wildlife is spread by seeds into uncultivated areas, and several States are discouraging the future planting of autumn olive.

Russian olive, a small, densely foliated tree, is a suitable alternative to autumn olive in the northern part of the walnut range. Russian olive can also spread to uncultivated areas; it is prone to diseases that will limit its growth.

European (Black) alder and *black* locust have stimulated the growth of walnut on some sites, but both can overtop and suppress walnut trees if they are not managed. Fortunately, both species are relatively short-lived because of locust borer damage on black locust and European alder's sensitivity to juglone

Nurse crops can help walnut trees in other ways besides increasing the availability of soil nitrogen. They protect walnut trees from wind, moderate soil and air temperatures, improve soil texture, reduce the incidence and severity of foliar diseases, and reduce competition from the understory. Of these benefits, reduced competition from the understory, especially grasses, may be the most important (see Note 2.06: Ground Cover Management). Walnut trees alone will not produce enough shade to exclude the understory vegetation before tree competition reduces growth (see Notes 3.03: First Thinning and 3.04: Second Thinning). Interplanting other trees or shrubs with walnut apparently helps maintain a high total crown cover without as much tree-to-tree competition as in pure walnut plantations.

Only a few non-nitrogen-fixing trees or shrubs have been tested in walnut interplantings. Amur honeysuckle, a densely foliated shrub, is promising because it has a growth rate and crown structure similar to autumn olive. Eastern white pine has been encouraged because it can be harvested early in the walnut rotation for Christmas trees or later for pulpwood. Hardwood species such as white ash, red oak, and sugar maple that have widespreading branches and dense foliage can provide the necessary shade to suppress the competing understory vegetation.

The following table lists some possible species for interplanting with walnut, their origin, degree of shade tolerance, expected growth rates, mature height, ability to fix nitrogen, and major uses:

Common and scientific name	Shade tolerance[1]	Growth fate*	Mature height	Fixes nitrogen	Major uses[3]
Autumn olive *(Elaeagnus umbellata)*	M	M-R	15-20	**Yes**	W,E
Russian olive (Elaeagnus angustifolia	M-I	M - R	25-30	**Yes**	W,E
European alder *(Alnus glutinosa)*	I	R	40-50	**Yes**	W,E,P
Black locust *(Robinia pseudoacacia)*	I	R	70-80	**Yes**	W,P
Amur honeysuckle (Lonicera maacki)	M	M-R	15-20	**No**	W,E
Eastern white pine (Pinus strobus)	TM	M	80-I 00	**No**	W,E,P,L
Red oak *(Quercus rubra)*	M	M-R	60-80	**No**	W,E,P,L
White ash *(Fraxinus americana)*	M	M-R	70-90	**No**	W,E,P,L
Sugar maple *(Acer saccharum)*	T	S-M	80-100	**No**	W,E,L

[1]T = shade tolerant, M = intermediate tolerance, I = intolerant.

[2]R = exceeds that of walnut, M = similar to walnut, S = slower than walnut.

[3]W = wildlife habitat, E = esthetic or screening, P = pulpwood or posts, L = forest products (lumber, veneer, gunstocks, millworks, etc.).

J. W. Van Sambeek

WALNUT NOTES

Multicropping

Multicropping involves planting crops between wide-spaced rows of planted black walnut. Soybeans, winter wheat, and other crops can provide early financial returns that may help offset the cost of establishing a plantation and provide some income through this phase. An additional advantage for some growers is that more of the land is used, increasing the yield per acre.

Obviously, the walnut grower's first concern should be to produce veneer logs, timber, and possibly nuts. Consider the following points before planting other crops in your walnut plantation:

- Small plantations may not be large enough to economically accommodate multicropping as an alternative to walnut alone.
- An ultimate spacing of 40 x 40 feet is desirable. However, this spacing provides for only 27 trees per acre at the end of the rotation and eliminates the opportunity to select crop trees early in the rotation. Therefore, an initial spacing of 10 feet between trees in the row, with rows 40 feet apart, is a good starting point.
- Multicropping does not eliminate the need for pruning, weed control, and good tree growth (see Notes on these subjects elsewhere). In addition to the usual required pruning, branches may need to be removed to prevent them from interfering with the operation of equipment. Walnut trees also benefit from fertilizer applied for planted crops. Cultivation of the planted crop will help control weeds along the rows of walnuts. Weeds within the row can be controlled by spraying Roundup'

The type of crops you plant will be determined by the growth rate of the trees. Walnut trees will occupy more and more of the plantation area as they develop, decreasing your multicropping options. Because most black walnut sites are also good soybean and wheat sites, these three crops are logical companions. However, shading will probably limit soybean production after 7 years. Winter wheat could possibly be planted over a longer period because black walnut leafs out late. Both soybean and wheat yields will probably be a little smaller than under normal cropping systems.

Planting fescue for hay and grazing livestock could be another use for your plantation towards midrotation. The number of cows or other grazing animals and the amount of hay per acre depend on the site quality, growing conditions, and length of grazing period. It may be necessary to protect the walnut trees from animals.

Multicropped black walnut trees will probably produce commercial nut crops by age 15, and many will produce nuts by age 10. Consistent nut crops could provide income for most of the remaining rotation period.

[1]*Mention of trade names does not constitute endorsement by the USDA Forest Service.*

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Felix Ponder; Jr.

WALNUT NOTES

Corrective Pruning

Young black walnut trees may fork or produce multiple leaders when their terminal shoots are damaged by frost, insects, animals, or humans. Because a walnut tree must develop a single, straight stem for valuable lumber or veneer, corrective pruning is often needed to remove lateral branches that compete with the terminal for dominance. But pruning can also cause a tree to grow more slowly by removing part of its food manufacturing plant, the crown.

Is Pruning Needed?

Before you begin to prune, decide if it is really needed. Sometimes a delay in pruning may eliminate the need for it. About one-third to one-half of the trees that develop form problems will correct themselves within a year or two if they are growing well. Or, if your trees are spaced closely enough, a problem tree might have to be removed anyway in an early thinning. Corrective pruning is most likely to be needed in wide-spaced plantings (spacing of 20 feet x 20 feet or greater), because most of the trees planted will be harvested for sawtimber or veneer.

How to Prune

If you decide to prune, remember that the objective is to produce trees with single, straight stems while minimizing the amount of leaf area removed so that the vigor of the tree is not reduced.

Corrective pruning should normally be considered during the first several years after planting, until the desired log length-generally 9 or 17 feet-has been reached.

If two or more leaders are competing for dominance, remove or cut back all but one so that the selected leader can develop into the main stem. The selected leader need not be perfectly straight and upright at the time of pruning. Removing the competing leaders will allow the selected one to straighten and grow upright after one or more growing seasons.

Coppicing

For trees that appear to be hopelessly deformed, you can use a severe form of corrective pruning called *copping.* In coppicing, the tree is cut completely off near the ground. If trees are grafted seedlings, be sure to cut high enough above the graft union so that new sprouts will be produced from the grafted stem and not from the root stock. Coppicing should be done in the late dormant season or very early spring. Normally several sprouts will grow up from the stump. Identify the best of these by late June or early July of the same year, and then cut off the other sprouts.

High Coppicing

A variation of coppicing, called high coppicing, has also been used for young walnut trees. If a tree has 1 to several feet of straight stem below the hopeless deformity, cut off the tree just below the deformed section, if the diameter of the stem at that point is 2 inches or less. One or more sprouts should develop near the point of cutting. Return to the tree in late June or July to cut off all but the one best sprout.

In pruning, it's not possible to prescribe a standard treatment; each tree must be treated individually. But keep in mind that the least amount of pruning necessary to correct the form problem will produce the best results.

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Richard C. Schlesinger

WALNUT NOTES

Lateral Pruning

One thing that makes some walnut wood valuable is something it doesn't have: defects. But defect-free wood can be produced only after a branch has fallen off the tree or been removed. Black walnut trees do not prune themselves readily. Even small branches tend to leave stubs when they die, and large branches may hang on the tree for many years after they die. So lateral branches must be pruned to produce high-value, knot-free wood.

Pruning can begin once the trees are 10 to 12 feet tall, but should be confined to the lower half of the tree stem. Generally, pruning should leave at least half of the tree stem with branches, and the leaf area should be reduced by no more than 25 percent in any one year.

Prune live branches during the latter part of the dormant season, but before the trees start to grow in the spring. Pruning at this time of year minimizes the time that pruning wounds are open to infection. Dead branches can be pruned at any time, but do not cut into the branch collar that generally forms around dead branches. Doing so will create a fresh wound.

Prune branches when they are small, generally less than 2 inches in diameter because small wounds are more likely to heal over without becoming infected. Also, pruning small branches is much easier than pruning large ones. However, if the tree is growing well, even fairly large wounds of 4 to 5 inches can heal successfully.

Continue to prune periodically until at least the first 9 feet of the tree is clear because veneer logs are normally 8 feet long. If you want a large crowned tree for nut production, stop pruning at 9 feet. If wood production is your primary concern, then continue pruning until at least 17 feet are clear so that two veneer logs can be produced.

Target pruning (fig. 1) is the best way to get the benefits of pruning while avoiding the problems.

Several tools can be used for pruning. Generally, the pruning saw will produce the best results. Long-handled pruners can be used on branches 1 inch in diameter or less. Pruning saws can be used on larger branches. When pruning above 9 feet, work from a ladder or use a pole saw. You can also use lightweight chain saws, but be extremely careful to avoid damaging the tree or yourself.

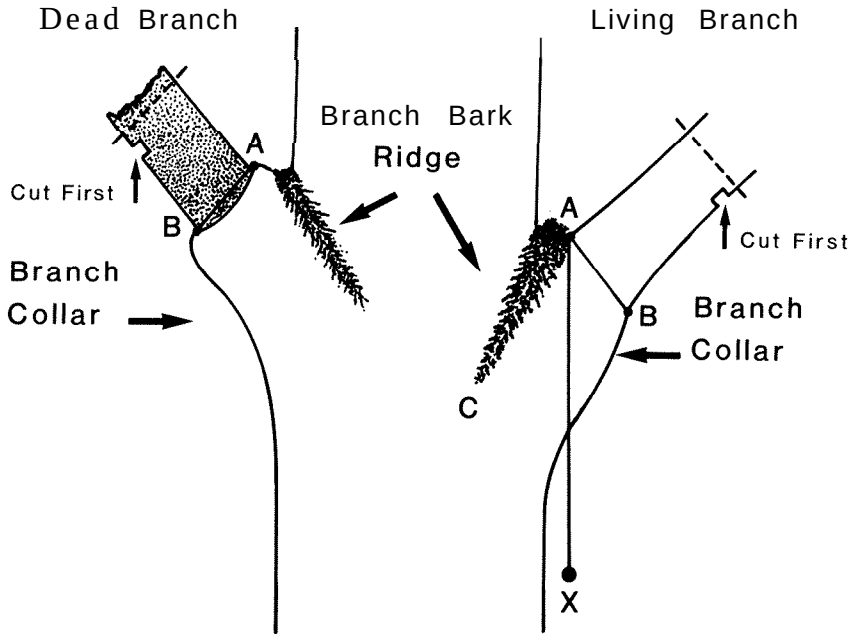

Figure I.-Target pruning steps

1. Begin by locating the branch bark ridge.
2. Find **target** A-outside of the branch bark ridge.
3. Find **target** B-the swelling where the branch meets the branch collar.
4. if B is hard to find-drop a line at AX. The angle XAC is equal to the angle XAB.
5. If the branch to be pruned is large, first make a stub cut a few inches from the branch collar.
6. Make the final cut at line AB.
7. **Caution:** Do not cut behind the branch bark ridge or cut the branch collar, do not leave stubs, do not paint cuts--except for cosmetics, and do not leave flat top when topping.

The time required to prune depends on the number and size of the branches removed and the equipment used. For 3- to 5-inch diameter trees that have never been pruned, it takes about 3 minutes to prune six branches from the first 8 feet using a hand saw. It takes about 9 minutes to remove 13 branches from the first 18 feet of similar trees.

Keep these two general principles in mind when pruning. (1) Removing live branches removes part of the food manufacturing capability of the tree, and thus can reduce tree growth. (2) Disease organisms can enter the tree through pruning wounds or dead branches. You'll need to take special care that wounds are as small as possible, that healing is promoted, and that tree growth is maintained. If done carefully and correctly, pruning can greatly increase the value of the trees. If done carelessly, it can do more harm than good.

Richard C. Schlesinger

WALNUT NOTES

First Thinning

Thinning is one of the most important silvicultural practices available to tree growers. It is particularly important with black walnut because walnut trees differ widely in value, depending on their quality and size. Thinning a walnut stand can greatly increase its value by making all the moisture, nutrients, and light available to a few high-quality trees and by removing the low-quality trees.

Deciding when and how much to thin requires some care. Thinning too late allows between-tree competition to slow the growth of the better trees. Thinning too soon eliminates insurance trees, makes the choice of crop trees less certain, and reduces the potential benefits of limited competition in restricting the growth of lower branches. So, thinning often involves compromises.

1. When to Thin?

A useful measure for evaluating the need for thinning is crown competition factor (CCF). For plantations with a regular square spacing, CCF can be easily determined if the size of the plantation, approximate number of trees, and average d.b.h. in inches are known, using the following equation.

$$CCF = \frac{(\text{total \# trees})(3.14)(0.997\ \text{d.b.h.} + 2.436)^2}{44{,}000\ (\text{\# acres})}$$

The following table gives the average diameter for CCF's of 100 to 150 for several common spacings.

Tree diameter at which to thin
(In inches)

	Original spacing (feet)					
CCF	5x10	8x12	10x10	11x11	12x12	15x15
100	1.6	3.1	3.2	3.8	4.3	6.0
110	1.8	3.4	3.5	4.1	4.7	6.5
120	1.9	3.6	3.7	4.4	5.0	6.9
130	2.1	3.9	4.0	4.7	5.3	7.2
140	2.3	4.1	4.3	4.9	5.6	7.6
150	2.5	4.3	4.5	5.2	5.9	8.0

If you want to maintain maximum growth rate of your crop trees, thin when CCF is 100. For each additional 10 CCF units above 100, expect the growth rate to go down by 4 to 5 percent per year. For example, if the diameter growth rate were 0.4 inches per year at a CCF of 100, it would be 0.3 inches per year at a CCF of 150, a 25-percent reduction.

For plantations with a wider spacing between rows than within rows, thin when the average tree crown width (CW) within a row is 1.5 to 2 times the distance between the trees, using the following equation:

CW(feet) = 1.993 d.b.h.(inches) + 4.873

2. How Much to Thin?

Heavy thinning provides plenty of growing space for the crop trees and delays the next thinning. However, the open stand conditions after thinning may encourage the growth of grasses, weeds, or invading trees. Light thinning may not provide enough additional growing space for each crop tree, but it does allow you to retain more insurance trees. It also provides more side shade that may slow the growth of side branches on the crop trees.

3. Which Trees Should Be Left After Thinning?

Examine small groups of trees within the planting. If the spacing is much closer within the rows than between them, as in a 5- x lo-foot planting, choose the better tree from groups of two trees within the rows. If a tree has died or is missing, the other tree of the "pair" automatically becomes the tree to keep.

In more regularly spaced plantings, such as 10- x lo-foot, examine groups of 16 (if half of the trees are to be left) or 9 (if two-thirds of the trees are to be left). From a square four trees by four trees, select the best eight to leave, again considering any missing or dead trees as part of the group to remove. From the nine-tree group, a square of three trees by three trees, select the best six. Mark the selected trees by tying a colored plastic ribbon around each at eye level.

Once you've marked all the groups, reexamine the entire stand, looking for areas where too many or too few trees will be left. As a general rule, each tree to be left should benefit from the thinning by the removal of at least one of its nearest neighbors. Also, the thinning should not result in large, open areas unoccupied by trees.

Finally, thin carefully to avoid mechanical damage to the trees that are left. Also, avoid chemical thinning (timber stand improvement) or chemical treatment of cut stumps because chemicals may spread from treated trees to the trees that are left.

Reference

Anonymous. 1981. Quick reference for thinning black walnut. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station and Northeastern Area State & Private Forestry. 32 p.

Richard C. Schlesinger

WALNUT NOTES

Second Thinning

Thinning your black walnut stand the second time is much like thinning it the first time except that you face tougher decisions about which trees to keep (see Note 3.03: First Thinning). Most of the poorest trees have already been removed.

Deciding when and how much to thin is still important. Delaying thinning allows between-tree competition to slow the growth of the better trees. The amount of wood produced per year on an acre of land is about the same no matter how many trees there are. So, if there are many trees, each will grow only a little; if there are few trees, each individual tree can grow much more.

The following tables give the average diameter for stocking (crown competition factor) levels of 100 to 150 for several common planting spacings in two stands previously thinned by different amounts.

Table *I.-Tree diameter at which to make a second thinning in a stand previously thinned to two-thirds of its original size*

(In inches)

	Original spacing (feet)					
CCF	5x10	8x12	10x10	11x11	12x12	15x15
100	2.5	4.3	4.5	5.2	5.9	8.0
110	2.7	4.7	4.8	5.6	6.3	8.5
120	2.9	5.0	5.1	5.9	6.7	9.0
130	3.1	5.3	5.4	6.2	7.0	9.4
140	3.4	5.6	5.7	6.6	7.4	9.9
150	3.6	5.9	6.0	6.9	7.7	10.3

Table *2.-Tree diameter at which to make a second thinning in a stand thinned to half its original size*

(In inches)

	Original spacing (feet)					
CCF	**5x10**	**8x12**	**10x10**	**11x11**	**12x12**	**15x15**
100	3.2	5.4	5.6	6.4	7.1	9.6
110	3.5	5.8	5.9	6.8	7.6	10.1
120	3.7	6.1	6.3	7.2	8.1	10.7
130	4.0	6.5	6.7	7.6	8.5	11.2
140	4.3	6.8	7.0	8.0	8.9	11.7
150	4.5	7.2	7.4	8.3	9.3	12.2

For the second thinning, you'll need to make the same three decisions as for the first thinning: when to thin, how much to thin, and which trees to leave (see Note 3.03: First Thinning).

When selecting which trees to keep in the second thinning, be sure to consider the distance between any two crop trees. Generally, the minimum distance between any two crop trees should be 55 percent of the sum of their crown radii. For example, the crown radii of a 7-inch-diameter tree and an 8-inch-diameter tree would be 9.4 feet and 10.4 feet, respectively. To find the crown radius in feet, multiply the diameter in inches times 0.997 and add 2.44 feet. The two trees should be at least 10.9 feet apart (9.4 plus 10.4 times 0.55) if both are to be retained as crop trees.

Once you've marked all the groups, reexamine the entire stand, looking for areas where too many or too few trees will be left. As a general rule, each remaining tree should benefit from the thinning by the removal of at least one of its nearest neighbors. Also, the thinning should not result in large, open areas unoccupied by trees.

Finally, thin carefully to avoid mechanical damage to the trees that are left. This is especially important in the second thinning because the trees removed are larger than in the first thinning, and there are fewer insurance trees. Also, avoid chemical thinning (timber stand improvement) or chemical treatment of cut stumps because chemicals may spread from treated trees to the remaining trees.

Reference

Anonymous. 1981. Quick reference for thinning black walnut. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station and Northeastern Area State & Private Forestry. 32 p.

Richard C. Schlesinger

WALNUT NOTES

Releasing Walnut in Natural Stands

Black walnut trees generally grow singly or in clumps in natural stands. To make the most of their potential value, you'll need to give these trees some "elbow room" from nearby trees and vegetation that compete with them for moisture, nutrients, and growing space. For individual trees in natural stands, release is the most important and worthwhile silvicultural treatment you can apply.

When to Release

Some type of release may be needed in these three cases:

1. Young trees growing in forest openings. Release by controlling weeds (see Note 2.05: Weed Control). Cut or kill any brush or other small trees that overtop the walnuts. If there are many young trees in the opening, so that the area will be managed for walnut, enlarge the opening to at least one-half acre to provide enough light.
2. Vines growing around individual trees. Several types of vines may be present, but wild grapes are the most damaging. The vines can deform the trees and kill them if left alone. Release by severing the vines and treating the cut ends carefully with a herbicide.
3. Trees of all sizes that are competing with other trees for light, moisture, and nutrients. In this situation, release and thinning have the same purpose; but release focuses on an individual tree's need for growing space rather than on the stand of trees.

A walnut tree will grow much more slowly in diameter if it's crowded. You can estimate how seriously crowded an individual tree is by comparing the tree's actual crown width with its potential crown width. An easy way to approximate potential crown width in the field is by estimating (or measuring) the d.b.h., doubling it, and adding 5. Or, use this equation:

Crown width (feet) = 1.993 d.b.h. (inches) + 4.873.

Once you've determined the potential crown width, the next step is to estimate (or measure) the actual crown width. Then express the two widths as a ratio (Actual Crown Width/Predicted Crown Width). For example, a lo-inch-diameter tree might have an actual crown width of 19.8 feet and a predicted crown width of 24.8 feet. The crown width ratio would be 0.8, and the crown area would be 84 percent as large as if the tree were free to grow (table 1). More importantly, the tree's diameter growth would be about 25 percent less than if it were free to grow.

Table *1.-Estimating the effects of crowding*

Crown width ratio	Maximum crown area	Potential growth
	Percent	
1.00	100	*100*
.95	90	*95*
.90	81	*90*
.85	72	84
.80	64	75
.75	56	66
.70	49	53
.65	42	38
.60	36	19
.55	30	0

Although walnut trees are very sensitive to crowding, they respond well to release from crowding. If all the walnuts in a stand are about the same age, the largest trees and those with the largest crowns will respond best. Release is best done when the trees are still young and before they have been crowded too long.

For release, forest trees are often separated into four crown classes: *dominant* (with crowns in the uppermost layers of the canopy), *codominant* (with crowns in the upper canopy, but less free to grow than dominant trees), *intermediate* (with crowns slightly below the upper canopy, but receiving some light from above), and *suppressed* (with crowns below the upper canopy and completely shaded). Even though walnut trees of many sizes, ages, and degrees of crowding have responded well to release, the best candidates for this treatment are from the dominant, codominant, and intermediate classes.

To be effective, release should increase the growing space available to the tree on at least three sides. As a general rule, there should be at least 10 feet between the walnut crown and any adjacent tree crowns after release. Additional treatments will be required periodically as the walnut crown grows out into available space.

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WALNUT NOTES

Revitalizing Stagnating Stands

Has your plantation or natural stand of black walnut trees stopped growing rapidly enough in height and/or diameter to meet your objectives? As a rule of thumb, walnut trees should grow at least 1.5 feet in height each year during the early part of the rotation and 0.3 inches in diameter during the latter part in short-rotation forestry.

Are the leaves of your trees smaller than normal (usually less than 12 inches long)? Do they turn yellow in late June and early July? If so, your stand may be stagnating; and the first step in revitalizing it is to look for the cause.

Why Stands Stagnate

Several factors could be involved:

- The plantation or natural stand could be growing on soil unsuitable for walnut (see Note 2.01: Choosing a Good Walnut Site).
- The trees may be too crowded (see Notes 3.03: First Thinning and 3.04: Second Thinning) or overpruned (see Notes 3.01: Corrective Pruning and 3.02: Lateral Pruning).
- The ground vegetation may be taking away too much of the moisture and nutrients the trees need for growth.

Tree growth depends on light, water, nutrients, carbon dioxide, and oxygen. If the trees are overtopped by other trees or vegetation, they may not get enough sunlight and carbon dioxide. If they're in inadequately aerated soil without enough oxygen, their roots may grow poorly.

Trees may not get enough nutrients and moisture if they have to compete directly with the understory vegetation. They may also have to compete indirectly with other types of vegetation that produce chemicals that reduce the trees' ability to extract moisture and nutrients from the soil. Possible examples of this vegetation are: tall fescue, quack grass, goldenrod, asters, and ferns. Less than optimum walnut sites are more likely to have inadequate supplies of nutrients and moisture for both trees and vegetation.

Three Ways to Revitalize Your Stand

If the ground vegetation seems to be causing the stagnation, here are three ways to put some life back into your stand:

1. Control the vegetation with herbicides or with mechanical cultivation.. Weed control is essential during the first 2 to 3 years after planting (see Note 2.05: Weed Control). However, even after the trees are taller than the weeds, they apparently do not produce dense enough shade to dominate the site. So, chemical or mechanical control of the ground vegetation may also be needed in later years to increase the nutrients and moisture available to the trees.

On some sites, removing the ground vegetation may temporarily stimulate tree growth while nutrients, especially nitrogen, are released from the decaying vegetation. Available nitrogen is often low in stagnating stands. Premature yellowing of the leaves is one sign of this. If foliar nitrogen content is more than 2.5 percent, adequate soil nitrogen is available. If it's less than 2.5 percent, fertilization may be necessary along with continuous weed control (see Notes 2.07: Fertilization and 2.06: Ground Cover Management).

2. Plant nurse or companion trees or shrubs with the walnut trees (see Note 2.09: Interplantings). Autumn olive has been particularly effective in increasing soil nitrogen through fixation, altering the types of understory vegetation, increasing wind protection, and reducing the incidence of leaf diseases. Russian olive, European alder, and black locust (all nitrogen fixers) and white pine (not a nitrogen fixer) also appear to be potential nurse trees.

3. Replace the existing understory vegetation with one that is compatible with walnut trees (see Note 2.06: Ground Cover Management). Hairy vetch (an annual legume), crownvetch, and sericea lespedeza (perennial legumes) appear to be good choices.

Consider the following management questions before attempting to revitalize a stagnating stand. Will the trees continue to grow slowly or just persist and eventually die if nothing is done? If you do remove the understory vegetation, are you likely to improve growth enough to offset the additional costs? If the trees will continue to grow slowly and you decide to do nothing, are you willing to accept the lower quality logs that will be produced in a longer time? Is it time to place less emphasis on timber and more on nuts from your stand? If the trees will eventually die if you do nothing, you must decide between growing and not growing walnut trees. In either case, consider the consequences.

J. W. Van Sambeek and R. C. Schlesinger

WALNUT NOTES

Nut production

Managing walnut trees for both nuts and timber might bring in extra profits, but there's a hitch. Maximizing timber yield conflicts with maximizing nut yields. So, to produce both, growers need to compromise on spacing, thinning, pruning, and managing ground covers.

Spacing

Initial tree spacing for nuts and timber should be 15 to 20 feet square. Planting at the closer spacing of 10- to 12-feet square recommended for timber requires a thinning before you can adequately assess the nut production of individual trees. The crown competition factor (CCF) determines when to thin (see Note 3.03: First Thinning and 3.04: Second Thinning). Significant competition among trees begins with CCF's between 80 and 100; therefore, a CCF between 70 and 90 is usually recommended for nut and timber production.

Pruning

Nut production requires open-grown trees with large crowns; therefore, most growers prune walnut to produce one high-quality veneer log. Begin pruning side branches when the trees are 5 to 10 feet tall; continue pruning off a few additional branches annually until at least 9 feet of clear stemwood is obtained. The clear stem length should never exceed 50 percent of the total tree height. Excessive pruning reduces tree growth, increases internal wood defects, and results in epicormic sprouts.

After a 9-foot clear stem has been produced, continue spot pruning to create a scaffold branching system. Walnut tends to produce a whorl of branches at the base of each year's terminal growth. Within each whorl, select two or three branches that have the widest stem-to-branch angle, are evenly spaced about the central bole, and have branch bark ridges without included bark (see Note 3.01: Corrective Pruning and 3.02: Lateral Pruning). A strong scaffold branching system above the clear bole will mean fewer broken branches and higher nut yields in the long run.

Managing Ground Cover

The amount and type of ground cover can significantly affect walnut growth and nut yields. Cover crops will delay a tree's bud burst and flowering, allowing more of the flowers to escape damage from late spring frosts. Legume cover crops are usually recommended because they can provide part or all of the nitrogen walnut trees need. Do not plant grass cover crops; they are too competitive and can produce chemicals that inhibit walnut growth.

Tending the Trees

Walnut trees should begin producing nuts regularly on a good site when they are 8 to 10 years old or 15 to 25 feet tall. Nut yield tables for plantation-grown trees are not yet available. Many black walnut trees may bear only irregularly or during alternate years, but you can select those trees that regularly bear when you thin the plantation. One way to record nut production each year is by spraying a spot of paint on each tree with a nut crop. Use a different color each year. When thinning the plantation, you can then rapidly evaluate each tree both for its stem size and quality and for its nut production.

Several cultural factors can influence flower production, fruit set, and fruit maturation. Because female flowers are formed within the dormant buds when the current year's nuts are rapidly enlarging and filling, the immature flowers must compete with the nuts for carbohydrates produced by the leaves. Cultural practices such as fertilization or thinning that increase the leaf surface area or sunlight striking the leaves should increase the number of new flowers formed in the buds. To provide the nitrogen needed for good fruit set, walnut plantations should be fertilized according to their cropping potential. For every 100 pounds of freshly husked nuts harvested, approximately 15 pounds of nitrogen must be added either through nitrogen-based fertilizers or legume cover crops.

Moisture stress, especially during July and August when the nuts are rapidly enlarging and filling, will drastically reduce nut production and quality. Be sure that your trees get the moisture they need (see Note 2.08: Irrigation).

Handling the Nuts

Walnut trees generally drop their fruit in four phases:

1. shortly after flowering, because of natural pollination failures.
2. summer, in response to damage by the walnut curculio.
3. late summer, when incompletely filled nuts fall because of foliar diseases or moisture stress.
4. early autumn, mature nuts fall to the ground.

A bushel of freshly collected nuts weighs about 48 pounds and contains about 375 nuts. To keep the nuts from overheating and losing kernel quality, spread freshly collected nuts out in shallow piles until husked. Wear rubber gloves when handling nuts because the hulls contain chemicals that can irritate and blister the skin. Husked nuts can be stored in open mesh bags and allowed to air dry. Nuts to be used for seed must be kept moist and prepared for stratification (see Note 2.03: Direct Seeding). Nuts are usually purchased on a green hulled weight basis by local agri-business firms who are supplied with walnut hullers by walnut processors. After husking, about one-third of a bushel of nuts weighing 18 pounds will remain.

Evaluating the Nuts

When managing a plantation for nuts and timber, you should evaluate the nuts from some of your best trees. Trees that consistently produce nuts with more than 4 grams of kernel, kernel percentages higher than 20 percent with more than 50 percent of kernel extracted as quarters, and fewer than 20 percent blind nuts are worth further evaluation and possible propagation as new cultivars for timber and nut production.

J. W. Van Sambeek

WALNUT NOTES

Walnut Anthracnose

Walnut anthiacnose is the most common leaf disease of black walnut. Caused by a fungus, this disease makes walnut trees lose their leaves prematurely. This premature defoliation slows the trees' growth and reduces the quantity and quality of nut crops. Wet weather in which the foliage is covered with moisture for prolonged periods makes the disease more severe.

Dark spots first appear on the leaf blades and petioles in spring as the leaves approach their mature size (fig. 1). The spots may range from a few mm to around one-half inch in diameter. As the season progresses, more spots appear. Eventually, affected leaflets drop prematurely.

Figure 1.-Walnut anthracnose leaf spots.

Control

Control may not be required where trees are being grown exclusively for timber and where disease does not appear each year. But control measures may be needed where trees are being grown for a nut crop or where the site has a history of annual anthracnose epidemics.

Cultural.-Interplant walnut with autumn-olive or Russian olive. The olives interfere with spread of the disease spores from tree to tree, and olive leaves cover fallen infected walnut leaves on the ground. The olives also fix nitrogen in the soil. This helps create a more favorable nitrogen balance in the walnut leaves that makes them more resistant to infection. Nitrogen fertilization of young plantations also suppresses anthracnose infestations.

Chemical.-Apply the fungicide benomyl as a foliar spray, beginning in mid-June. Repeat every 3 weeks. At least four applications may be required for control.

References

Berry, Frederick H. 1981. Walnut anthracnose. Forest Insect & Disease Leafl. 85. Washington, DC: U.S. Department of Agriculture, Forest Service. 3 p.

Black, W. M.; Neely, Dan; Matteoni, James A. 1977. How to identify and control leaf spot diseases of black walnut. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 6 p.

Kenneth J. Kessler, Jr.

WALNUT NOTES

Mycosphaerella Leaf Spot

Mycosphaerella leaf spot causes premature defoliation of black walnut, which slows the trees' growth and reduces the quantity or quality of nut crops (fig. 1). This disease, caused by a fungus, has been found in North Carolina, Georgia, Illinois, and Iowa. It is especially common in young black walnut plantations. Wet weather in which the foliage is covered with moisture for prolonged periods makes the disease more severe.

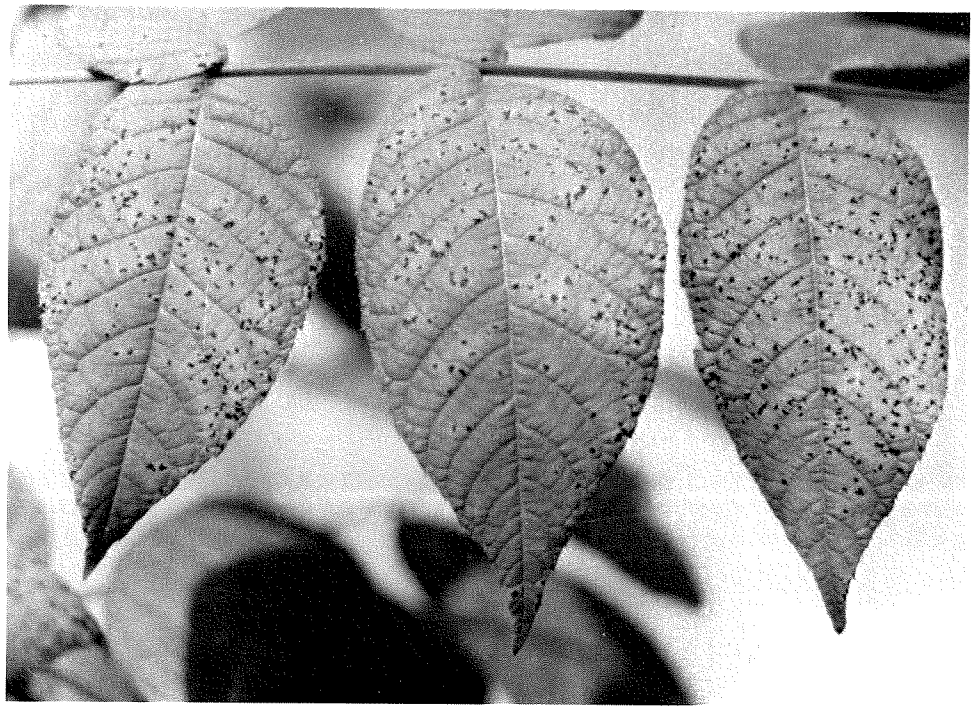

Figure I.-Typical Mycosphaerella leaf spot lesions.

Small, angular-sided dark spots up to 4 mm in diameter first appear on leaf blades in spring as the leaves approach their mature size. As the season progresses, more spots appear-often concentrated at the tips or along the major veins of the leaflets. Eventually, affected leaflets drop prematurely.

Control

Control may not be required where trees are being grown exclusively for timber and where disease does not appear each year. But control measures may be needed where trees are being grown for a nut crop or where the site has a history of annual Mycosphaerella epidemics.

Cultural.-Interplant walnut with autumn-olive or Russian olive. The olives interfere with spread of the disease spores from tree to tree, and olive leaves cover fallen infected walnut leaves on the ground.

Chemical.-Apply the fungicide benomyl as a foliar spray, beginning in mid-June. Repeat every 3 weeks. At least four applications may be required for control.

Reference

Kessler, Kenneth J., Jr.; Swanson, Linda B. H. 1985. How to identify and control black walnut Mycosphaerella leaf spot. HT-65. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 6 p.

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WALNUT NOTES

Canker Disease

Most cankers in black walnut are caused by fungi that enter the tree through unprotected wounds, small injuries, or leaf scars. Cankers may damage trees by allowing decay-causing organisms to enter the tree, by degrading the wood, and by weakening or girdling the stem. They can be either annual or perennial, depending on how long the canker-causing fungus operates.

Annual Cankers

Annual cankers, active for one season only, generally affect young, smooth-barked walnut trees. They often occur near the ground on the stem. The tree may develop basal sprouts below the canker, particularly if one-half or more of the stem has been girdled by the canker (fig. 1). Annual cankers affecting less than one-fourth of the stem often heal, but affected trees may later develop weak seams at the former canker locations.

Figure I.-Girdling annual canker on black walnut. Note basal sprouts.

Figure 2.-Two open-faced perennial Nectria cankers.

Perennial Cankers

Perennial cankers caused by a Nectria fungus, are much more destructive than annual cankers (fig. 2). Nectria cankers may remain active for many years. In response to the Nectria infection, the tree creates folds of callus at the canker site. After a few

years, the canker begins to look like an open, target-like face. Nectria cankers, in addition to creating a wood defect, weaken stems and make them susceptible to wind breakage.

Control

Annual cankers.-If stems are girdled and sprouting occurs, remove girdled stem and all sprouts but the most vigorous one. Burn or remove all dead stems from the area.

Perennial cankers.-Nectria cankers usually develop around old branch stubs on the stem. In areas with a high incidence of Nectria cankers, prune lower branches to remove this source of infection. Encourage vigorous tree growth so that wounds will heal quickly. Release trees as required to prevent stagnation.

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WALNUT NOTES

Walnut Caterpillars and Other Defoliators

Leaf defoliators eat the leaves of trees and other plants, sometimes the leaves of entire trees. Defoliating insects usually do not kill trees by their feeding, but trees may lose their vigor and grow more slowly when attacked by many insects or when defoliated several years in a row. Several types of leaf defoliators strike black walnut.

Walnut caterpillar

The most common one is the walnut caterpillar, which occurs throughout the eastern United States. Walnut caterpillars are often found in masses on the trunk or feeding on the leaves (fig. 1). One colony can quickly defoliate an entire young tree. A very young caterpillar is red and covered with grayish white hairs. A full-grown caterpillar is as long as 2 inches and has a black body with yellow stripes along each side. The entire body is covered with long white hairs.

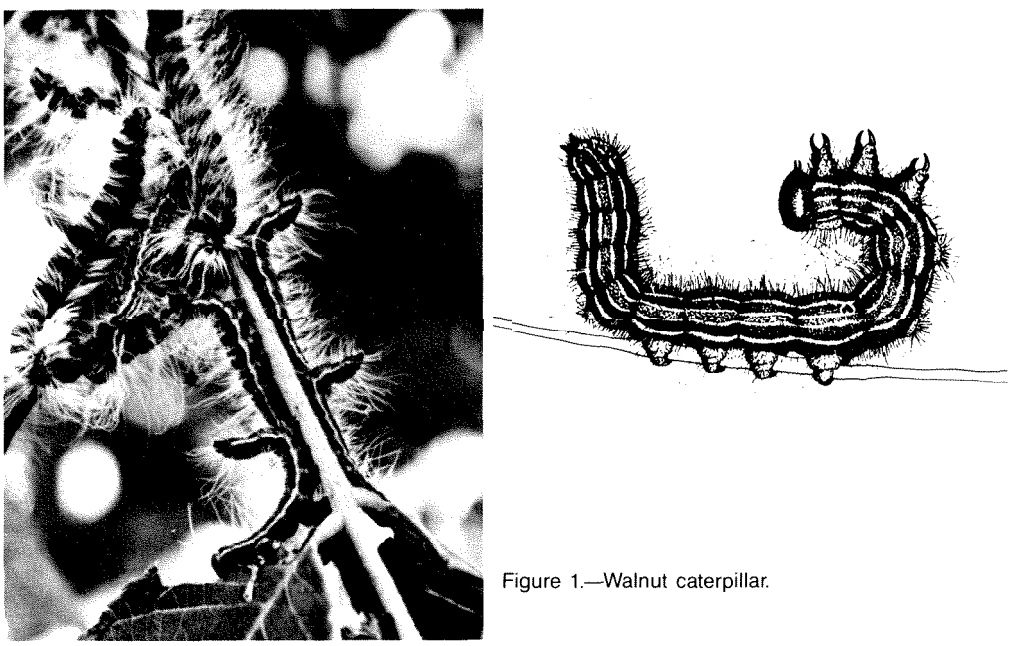

Figure 1.—Walnut caterpillar.

Fall Webworm

The fall webworm is another common and conspicuous defoliator of walnut and other trees throughout the eatern United States. It is easily recognized by its web, which encloses one or more branches of a tree and sometimes an entire small tree (fig. 2). Webs begin appearing on the outer tips of branches about mid-July. As the summer progresses, the webs enlarge and become more noticeable. The larvae live inside the web, sometimes as many as several hundred to a colony. A full-grown larva is usually pale yellow or green with a broad dark stripe down the entire back and a yellow stripe down each side. The body is covered with l-inch-long gray or red hairs.

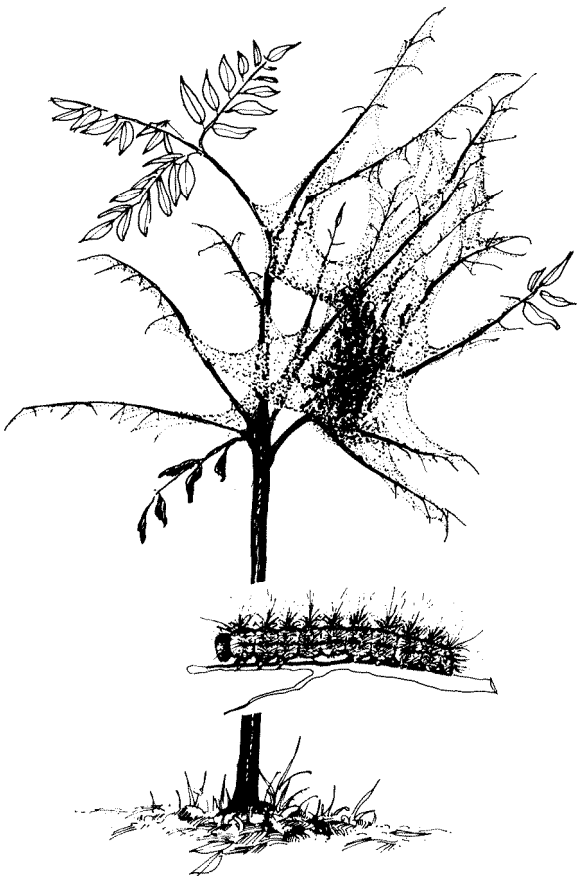

Figure 2.-Fall webworm.

Grasshoppers and May Beetles

Other insects besides caterpillars also feed on and defoliate walnut trees. Two of these include grasshoppers and May beetles. Grasshoppers may become a problem in young walnut plantations next to open fields that are mowed or cut periodically to produce hay. The grasshoppers may move to the walnut trees after the field crop has been cut. May beetles, also known as June bugs, feed on newly expanding buds and leaflets (fig. 3). The beetles also chew holes in already expanded leaves, causing a shot-hole effect in young leaves in early spring.

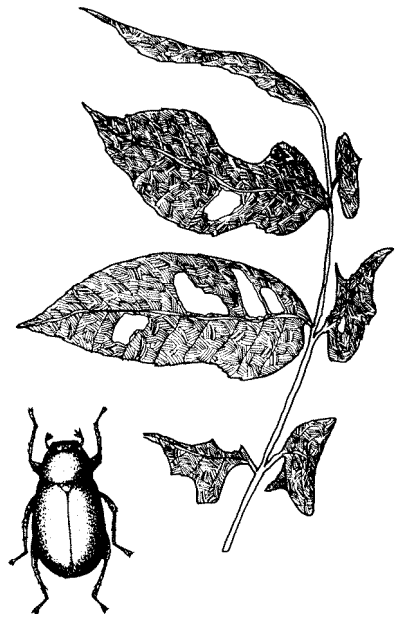

Figure 3.-May beetle.

Control

The simplest control method is to remove webbing and caterpillars by hand when you first notice them. This is less expensive and less environmentally damaging than chemical control methods, particularly when only a few trees are affected. Repeated defoliation over several years, however, may require chemical control. Usually no control is necessary for May beetles. Consult your local extension agent for other recommended controls.

Reference

Farris, Marion; Appleby, James E. 1978. How to identify and control the walnut caterpillar. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 4 p.

Barbara C. Weber

WALNUT NOTES

Twig and Stem Borers

Although many twig- and stem-boring insects can be found in walnut trees, they are generally not a major problem for walnut growers. The two stem-boring insects that cause the most concern and some damage are walnut shoot moths and ambrosia beetles. Both cause multiple forks or crooks in the main stem of young trees, thereby reducing the potential for the mature trees to produce veneer or high quality lumber.

Walnut Shoot Moths

Female walnut shoot moths lay their eggs in late summer on the undersides of leaflets. Newly hatched larvae feed briefly and move to the base of a terminal bud to spin overwintering protective cases. In early spring the larvae leave their overwintering case and begin feeding on expanding buds. A small pile of excrement and webbing can be found on damaged buds as the larvae tunnel into the bud. As the larvae grow, they tunnel down the expanding shoot. The dying shoots frequently look as if they have suffered frost damage. In April or May, the mature larvae emerge, drop to the ground, pupate, and then emerge as adults in late summer to start the cycle over again.

Destruction of the terminal bud results in one or more new terminal shoots from lateral buds below the damaged terminal (fig. 1). Many young walnut trees straighten naturally by producing a single dominant leader from one of these new terminal shoots. However, when such damage occurs annually, the trees may become badly deformed with numerous forks and crooks (fig. 2). The trees may then require both corrective and side-branch pruning to produce straight, high quality stems.

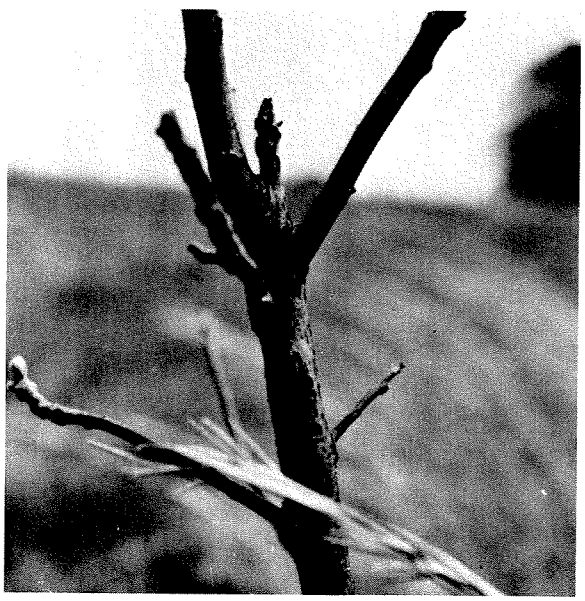

Figure l.-New terminal shoots from lateral buds below the damaged terminal bud.

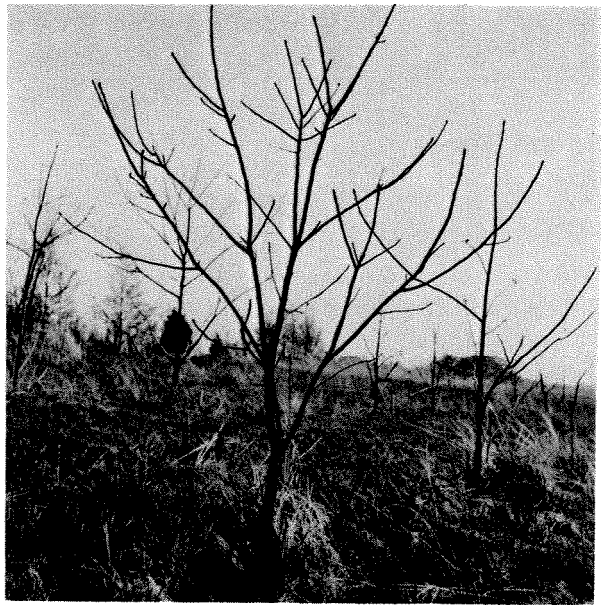

Figure 2.-Walnut trees badly deformed after repeated annual damage by walnut shoot moths.

Shoot moths also feed on older walnut trees. However, after a tree has developed a straight, single stem at least 9, 17, or 25 feet long (depending on your management objectives), forking within the crown will not reduce the tree's value.

Ambrosia Beetles

Adult females emerge in early spring from trees infested the previous year and fly short distances to new host trees to excavate galleries and lay their eggs (fig. 3). The larvae feed on fungi growing in the gallery, pupate, and emerge as adults in about a month to repeat the cycle. Two or more generations may occur each year, but the early spring generation often does the greatest damage.

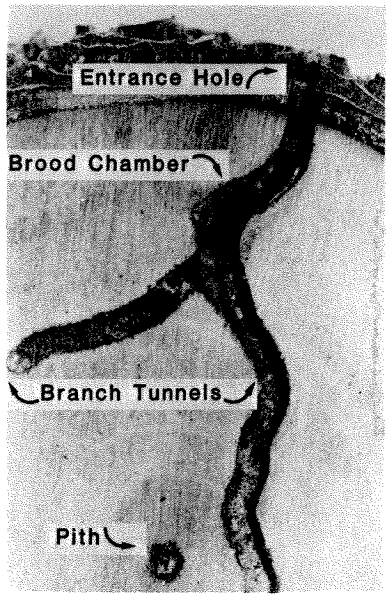

Figure 3.-Adult female ambrosia beetles excavate galleries in host trees and lay their eggs there.

Signs and symptoms of ambrosia beetle attack include pinholes, wilting leaves, stem dieback, and basal sprouts. Pinholes (fig. 4) are the entrance holes made by adult females as they attack the lower stem of trees. Pinholes are approximately 1/32 inch in diameter and are difficult to find except in the spring when sap flows from them. As the adult female excavates the gallery, she introduces a fungus into the wood that often causes wilting of the leaves and stem dieback, the most easily detected symptom of attack. Most ambrosia beetle-infested walnut trees produce basal sprouts that can rapidly replace the original stem (fig. 5). Resprouted trees are rarely attacked a second time by ambrosia beetles.

Figure 4.-Pinholes made by adult females as they attack the lower stem.

Figure 5.-Basal sprouts produced by an ambrosia beetle-infested tree can rapidly replace the original stem.

Ambrosia beetles usually attack the slower growing trees less than 10 feet tall in **a** planting. When you find signs of attacks, remove and destroy dying stems as soon as possible to reduce the beetle population in your planting. During the dormant season, prune away all but the largest basal sprout. Because basal sprouts grow rapidly in the beginning, long-term height and diameter growth of the walnut trees will not be greatly affected.

Direct chemical control of the ambrosia beetle is impractical and not recommended.

Summary

Although stem-boring insects can cause damage, don't panic if you find them in your planting. The initial damage they cause looks much worse than what the long-term damage actually is. Some trees will recover fully by themselves, and you can help most others to recover by following the suggestions above.

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WALNUT NOTES

Preventing Animal Damage

No matter how carefully you tend your black walnut trees, you still have to contend with animals that chew, gnaw, rub, break, or drill holes into the trees. Such damage may cause black walnuts-particularly seedlings and saplings-to grow slowly, fork, and even die. Below are the most common and the most destructive animals in black walnut stands and what you can do to keep them from damaging your trees.

Deer

Buck deer rub against young black walnut trees in the fall to remove the velvet from their antlers, often shredding the bark and leaving it hanging in strips. Larger trees are usually not affected. Deer may also nip the buds of seedlings, causing the main stems to fork. Tree growth may be stunted in areas of large deer populations because terminal buds are eaten by the deer every year.

Control:

- Surround the plantation with a 5-wire electric fence 60 inches high or an 8-foot-high woven wire fence (most effective, but most expensive method).
- Spray chemical deer repellent on trees. These repellents, however, are water soluble and must be reapplied after each rain.
- Hang deodorant bath soap or cloth bags containing tankage (dead animals that have been dried and ground) on every second or third tree around the perimeter of the plantation (least expensive, but probably least effective method).
- Interplant more desirable shrubs for browsing, such as autumn-olive.

Squirrels

Squirrels feed on walnuts while the nuts are still hanging on the tree in late summer and after they have fallen in the fall. Squirrels also dig up planted walnuts, sometimes even after the nuts have germinated. They locate buried seeds by smell and have been known to remove all seeds from some plantings.

Control:

- Place a generous portion of ***fresh*** cow manure on each nut to mask the odor coming from the nut. This is the cheapest and most effective squirrel repellent.
- Locate plantings at least 300 feet from standing timber because squirrels are reluctant to cross open spaces. If possible, delay planting until spring when alternative food sources are available.
- Cover seeds with mechanical barriers such as hardware cloth, wire cones, or burnt, punctured tin cans (fig. 1).

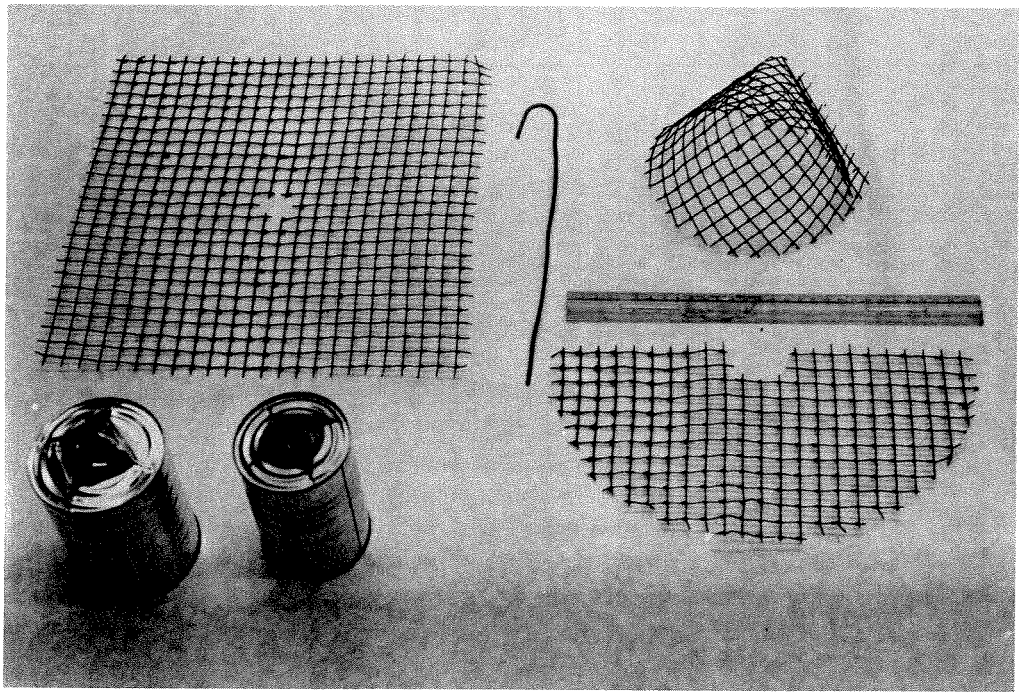

Figure 1.-Mechanical barriers (clockwise from upper left), such as l-foot squares of hardware cloth anchored with wire pins, cones cut from l-foot circles of hardware cloth, or punctured tin cans can prevent squirrels and other rodents from pilfering seed.

Hardware cloth.-A piece of coarse hardware cloth or chicken wire about 12 inches larger than the seed spot will generally protect the seed and allow the seedling to grow through the wire. Use metal pins made from #9 galvanized wire to hold down the corners. The hardware cloth or chicken wire should be removed in the fall after the seedling sheds its leaves.

Tin cans.-Place tin cans in a fire to remove the tin coating (so they will rust and disintegrate). Cut out one end of each can and make an x-cut in the other end. Pry up the four points to make a l-inch opening. Hold the can open end up and add 1 inch of soil. Drop in a nut and pack can full of soil. Place in planting hole with open end down and cover with an inch or two of soil.

Wire cones.-Cut two 12-inch-diameter semicircles from a 12-inch-square piece of hardware cloth. Roll each into a cone and fasten with small pieces of wire leaving a one inch hole at the top.

Mechanical barriers are effective but time-consuming and expensive to prepare and put into place.

Other Rodents

Mice, rabbits, and other small mammals gnaw on the stems of young trees, usually during winter, and remove patches of bark. Their teeth marks are usually visible at the base of the tree.

Control.-Put wire screening around the base of young walnut trees. Mow the plantation in the fall and place tall poles throughout the planting as rests for predatory birds.

Birds

Sometimes birds break the main stems or branches of young black walnut trees by perching on them. The broken main stem or branches usually remain hanging on the tree. Red-wing blackbirds and owls are the most common culprits. Yellow-breasted sapsuckers also damage black walnut trees by drilling holes in the tree and feeding directly on the sap. The sapsucker may drill test holes into several different trees until it finds a favorite tree. Sapsuckers will return to their favorite trees often and may nearly girdle them with peck holes. Although the holes normally heal over quickly, they cause defects and stain in the wood, reducing the value and quality of logs from these trees.

Control.-No measures are known that will prevent sapsucker damage. Warning: Do not remove the sapsuckers' favorite trees or they will move to new trees. For other birds, erect several tall poles at various places within the plantation to provide alternative perches for resting birds and to encourage the presence of predatory birds.

Domestic Livestock

Swine and cattle injure trees by seeking shelter under trees or by grazing too near trees. Their hooves can easily damage exposed roots near the groundline. Such damage may contribute to hollows in mature trees.

Control.-Place fences around trees in black walnut plantations destined for veneer or high-quality timber products.

Other Animals

Beaver damage to black walnut is rare, although trees may be killed because of floodings caused by beaver dams. Plantations near streams in areas of large beaver populations are most susceptible.

Control.-Break up newly formed dams, trap out the beaver.

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WALNUT NOTES

Record Keeping

Maintaining a permanent record of events, expenses, and sales from your walnut plantation or stand can be both enjoyable and profitable. Your permanent record can be a big help when you figure your taxes or establish the value of timber for a sale or insurance loss. For starters, here's what such a record should contain: a tree map; records of expenses, cultural treatments, tree growth and quality; frequent dated photographs of your trees; plus other items of interest to you.

The Record Book

Enter all records in a permanently bound, hard-covered notebook. This notebook will probably get heavy use in your plantation or stand so make sure that its backings are of good quality.

Tree Maps

An accurate map of your plantation or stand is an important part of your permanent record (fig. 1). Labelling the rows and trees within rows makes it possible to identify individual trees for keeping track of growth, form, and nut yields. Usually it is most convenient to letter the rows and number the trees. In natural stands irregular parallel rows can usually be drawn across the stand. Trees are then numbered according to distance from end of rows.

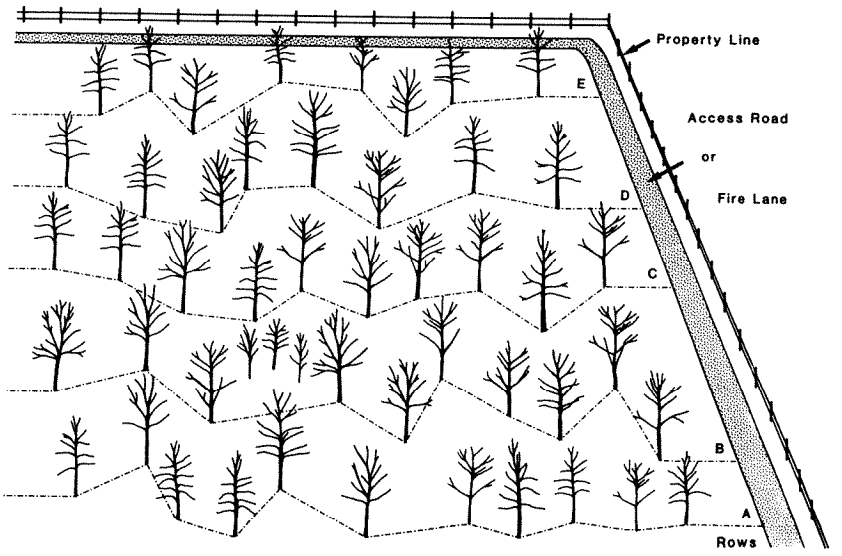
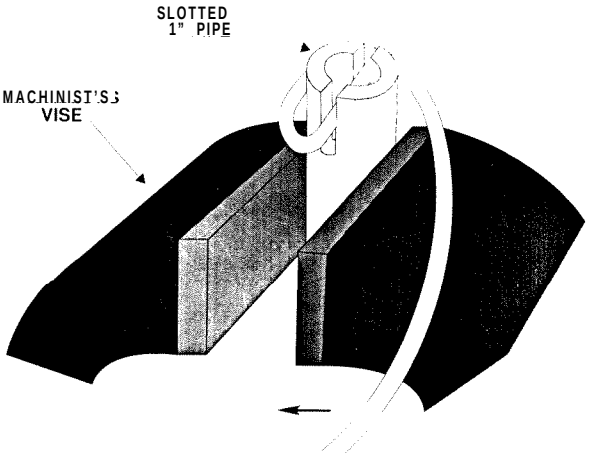


Figure 1.-Tree maps created by drawing irregular parallel rows through the stand make it easy to keep individual tree records.

Records

Maintenance and Expenses.-Record when supplies are purchased or when any work is done in your plantation. For any work done, enter information such as what kind of work, who did it, how long it took, and what it cost. Remember to give yourself minimum wages if you're doing the work yourself. For ideas on what other expenses to include, see economic surveys like those published in the *Walnut Council Bulletin.*

Tree Growth.-Most owners will want to keep some records on how well their trees are growing, especially the crop trees. The most convenient measure is diameter at breast height (4½ feet high on uphill side of tree). Mark a few trees throughout the planting and measure them every few years to determine growth rates. When the trees are large enough, paint letters or numbers directly on the tree with a light-colored latex tree paint to correspond with the letters or numbers on your map. Small trees can be marked with small stakes next to the trees. A permanent stake can be made easily from #9 galvanized wire cut into 2½- to 3-foot lengths with a small loop bent at one end of each to hold an identification tag (fig. 2). A slot cut across the end



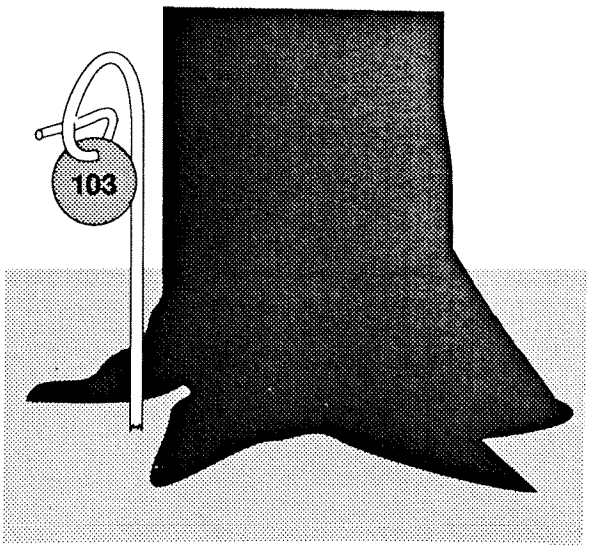


Figure 2.-A permanent wire stake with a bent loop to hold an identification tag can be made by bending a 3-foot length of No. 9 galvanized wire around a slotted l-inch pipe (figure 2A) and placing it near the base of each tree (figure 2B).

of a ½- to l-inch pipe held in a vise works well for holding the end of the wire as you bend the remainder around the end of the pipe. Do not place any metal (nails, fasteners, screws, etc.) in or on the trees. Any galvanized metal or iron in the tree will stain the wood and cause buyers to be cautious of any other timber you have for sale.

High-Value Trees.-By the time trees are 10 inches or larger in diameter, you will have picked out some trees that contain high-quality veneer logs. Mark these trees with a unique identifying mark and enter tree location and your identifying mark into your permanent record. A record such as the one below will help establish a tree's value for insurance purposes in case it is destroyed or stolen.

Tree location							
Stand	Row	Tree no.	D.B.H.	Ht. to first large branch	Defects or other characteristics	Int. log rule ¼" B.F.	Estimated stumpage value
Indian Creek	A	23	18"	10 feet	—	140	$225
	D	15	16"	16 feet	Some birdpeck	180	$310
North Terrace	C	5	20"	14 feet	Pin knots	250	$375
	F	8	15"	16 feet	—	160	$240

Nut Trees.-When managing a stand for nuts and timber, keep records of nut yields and frequency of bearing. Also, record when grafts are made and if they're successful.

J. W. Van Sambeek

WALNUT NOTES

Selling Black Walnut

Walnut timber buyers consider three things primarily when they look at a tree: size, straightness, and number of defects. Tree size includes diameter as well as height parameters. A tall, clear, straight tree will probably have several merchantable logs in addition to the butt log. Straightness is important because straight trees produce more logs. Defects decrease the value of a tree and the logs in it. Examples of defects include cat faces or limbs caused by a lack of branch pruning; seams caused by disease, improper pruning, lightning, or frost damage; holes caused by insects or bird peck; pin knots; hollows; and any ingrown metal objects.

The highest prices paid for black walnut timber are for large trees, 16 inches in d.b.h. or larger. Large trees that are exceptionally straight and defect-free can be used for veneer production; such trees command premium prices. Veneer-quality trees should contain at least one 8½-foot log at least 12 inches in diameter (inside bark) at the small end of the log. In areas of high demand, it is sometimes possible to sell smaller trees, but such smaller timber also commands lower prices.

1. Determine Your Business Strategy

You've found merchantable walnut in your stand and have decided to sell the timber. Now what do you do'!

First, determine the business strategy: how will the trees be sold, as lump-sum or by the board-foot? Lump-sum sales may be appropriate if you want all the timber on a tract removed, but you may want to sell only certain trees on your property. If so, number the trees with nontoxic tree-marking paint and record individual tree dimensions, estimated board-foot lumber content, and tree condition. You might also ask your local or State forestry agencies to "cruise" the potential sale trees and provide some "ball-park" estimates of the value of the timber. The extension agent or area service forester with your Department of Natural Resources may also be able to provide a list of timber buyers in the area.

2. How to Make the Sale

Most hardwood timber is bought on a one-to-one basis between the owner and the timber buyer. However, this is not necessarily the best method for the landowner. A more favorable approach for the timber owner involves inviting buyers to make sealed bids on the timber. Bid notices should clearly define the seller's name, address, and phone number; location of trees to be harvested (legal description and local map); number of trees to be sold, dimensions, and how trees are identified; and special sale instructions and requirements (such as stipulations about timing of harvest, etc.). Bid notice should clearly state that only sealed bids will be accepted and should specify the time and place when bids will be accepted, opened, and awarded.

3. **Draw Up a Sale Contract**

Once the deal is closed, a timber sale contract should be drawn up. Although standard contract forms are available, no standard contract can cover all circumstances arising in all situations. Draw up the contract with advice from an attorney and a professional forester. The contract should stipulate that all timber sold should be paid for before it's removed from the property. The buyer should be given a reasonable amount of time to remove the timber. Normally this is 12 to 18 months and should be stated in the contract although more time may be needed if unusual weather conditions occur. The timber sale contract should include:

a. Names and addresses of seller and buyer.
b. Legal description and location of timber.
c. Number of trees to be sold and how they are marked.
d. The purchase price and how and when it is to be paid.
e. Expiration date of the contract.
f. Special instructions to the buyer about the prevention of fires; condition of fences, roads, and other structures; and an understanding of what is expected if the remaining timber is excessively damaged.
g. The seller's guarantee that the buyer has access to the property for harvesting timber.
h. Name of a third party agreeable to both seller and buyer to handle possible contract disputes.
i. The buyer's proof of liability insurance coverage and workmen's compensation.

The timber sale contract should be signed and dated by both seller and buyer, usually in the presence of a notary public, although any mutually agreeable third party is acceptable.

Check the property on which the sale occurred several times during and after the logging operation to make sure that the buyer complied with the terms of the contract. Once you've determined that the terms of the timber sale contract have been met, provide the buyer with a written release from the contract.

George Rink