UNIVERSITY OF MISSOURI CENTER FOR AGROFORESTRY

GROWING BLACK WALNUT FOR NUT PRODUCTION: ORCHARD ESTABLISHMENT AND EARLY MANAGEMENT

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Eastern black walnut trees (*Juglans nigra*) produce high-valued hardwood products and distinctively flavored, highly nutritious, edible kernels. Black walnut kernels are a rich source of fatty acids and contain the highest protein content of any tree nut, as well as vitamins and nutrients such as vitamin A, vitamin B-6, manganese, iron, phosphorus, and potassium. The potential for producing two valuable products on the same tree has captured the imagination of tree planters for years. Both large and small black walnut plantations have been established with the intent to harvest valuable nut crops from trees that will also eventually produce veneer-quality logs. However, if experience has taught us anything about growing black walnut, it is that the optimization of nut production and wood production are not readily achievable on the same tree.

Nut production vs. wood production

Black walnut culture is really the story of two totally different systems all wrapped into one tree species. The first system is walnut timber production, which involves growing tall and straight trees in a mixed hardwood forest. Such timber-type trees growing in either natural stands or in man-made plantations are initially grown closely together with little or no sunlight reaching the forest floor. Looking upwards, you will note a long, branchless trunk topped by a relatively small canopy of leaves with few, if any, nuts among the leaves.

Depending upon the site, black walnut trees often need to grow more than 60-80 years to produce high-quality lumber or veneer.

A black walnut orchard has widely-spaced trees that develop a full canopy.

The second system is black walnut orchard nut production. Orchard trees, by design, have a short trunk, wide spreading branches, and full canopy (see image above). Trees grown in an orchard are widely spaced to allow sunlight to reach the lowest limbs and are grafted using scions of known, proven cultivars with desirable nut-bearing characteristics. Nuts produced on such grafted trees are usually borne on terminal shoots, as well as throughout the tree's canopy on short, stout branches called spurs. These grafted trees will produce thinner-shelled black walnuts yielding high-quality, light-colored kernels that command top price in the marketplace. In addition, most grafted orchard trees are precocious, producing nuts within five to seven years of tree establishment, with the first significant

commercial harvest starting around the age of 10 years, depending on local growing conditions.

Every black walnut tree grows wood in the form of limbs, trunk and roots. And as the tree matures, every tree will produce at least a small nut crop. However, the question is not whether a walnut tree can grow both wood *and* nuts but rather, which crop do you wish to maximize. In this bulletin, we begin to describe the cultural practices and some cultivar choices to consider when planning and establishing an orchard to maximize nut production from black walnut trees. For production recommendations on established and bearing black walnut orchards, please refer to the "Growing Black Walnut for Nut Production: Bearing Years Guide." Recommendations on how to grow black walnut trees for timber production can be found in other resources, including the Walnut Council (www.walnutcouncil.org) as well as USDA Forest Service publications including, "Managers Handbook for Black Walnut" and "Walnut Notes."

Setting goals for the orchard

The ultimate success of a black walnut orchard will be defined by the goals you set for the orchard before a single tree is planted.

Black walnut orchards can be established for multiple reasons, including:

- to provide the family with high-quality black walnut kernels;
- to collect or test black walnut cultivars as a hobby;
- to produce a commercially marketable nut crop.

The methods used to establish an orchard, and the intensity of management required to produce a nut crop, will differ depending on the goals you set for the planting. For a backyard orchardist, only a few black walnut trees will be grown with minimal inputs. Under these conditions, black walnuts will produce an ample supply of nuts in some years allowing the grower to fill their freezer with high quality walnut kernels that can be utilized during years the tree produces little or no nut crop.

In contrast, commercial orchardists make major investments in fertilizers and pesticides to ensure maximum annual nut production. In addition, the commercial orchard must be large enough to justify the efficient utilization of specialized equipment such as orchard sprayers, tree shakers and mechanical nut harvesters.

When planning your black walnut orchard, set realistic goals for both yourself and your trees. It is better to take excellent care of fewer trees than to plant too many trees and become frustrated by not having enough time to keep up with an exhausting work schedule.

Site selection

It cannot be overemphasized enough that site selection is of paramount importance when planting a black walnut orchard. Black walnut trees perform best when grown on deep well-drained soils. Attempts to establish black walnut trees on shallow soils or excessively wet soils commonly fail. Any soil condition that inhibits root penetration to less than three feet will slow tree growth and ultimately limit nut production. Walnut trees will thrive in soils that range from slightly acidic to slightly basic and have a high level of inert fertility. Problems with pH and low phosphorus will need to be corrected during site preparation. Depending upon the site, lime and phosphorus may need to be incorporated to be effective. In addition, removal of tall fescue and other competing perennial vegetation will be required in order to maximize nut production in a black walnut orchard. Commercial orchards should only be established on the very best of black walnut sites, such as those located in broad river bottoms, where deep, rich soils create ideal

conditions for tree growth. Upland sites that possess deep, fertile soil and excellent water-holding capacity also make acceptable orchard sites. However, a commercial orchard should not be established on sites that tend to be droughty. Lack of soil moisture, especially late in the growing season, can severely affect nut quality and accentuate alternate bearing.

Black walnut trees are very sensitive to spring frost injury. Freezing temperatures after the onset of budbreak can result in the loss of an entire nut crop. When establishing a black walnut orchard, avoid planting trees in narrow valleys where frost pockets can develop.

The USDA Natural Resource Conservation Service (NRCS) has a black walnut suitability index online, which uses the web soil survey to help growers define the best sites to use when laying out new orchards. The tool can be found at: websoilsurvey.nrcs.usda.gov/.

Currently, this online tool is supported to evaluate soils in Missouri, Illinois, Indiana, and Ohio. Use this function by specifying the area of interest, then use the soil data explorer to find the vegetative productivity function, and finally, use the black walnut suitability index to view the ratings and descriptions for the set area of interest (Fig. 1).

Cultivar selection

The production of thin-shelled, high-quality nuts is only possible by growing black walnut trees that have been grafted using cultivars known to possess these characteristics. When choosing specific cultivars to include in your walnut orchard, be sure to review all available cultivar information. But remember, there is no such thing as a "perfect" walnut cultivar that provides all positive characteristics in a single tree. Key cultivar traits include: leafing date, nut kernel weight and kernel percentage, disease resistance, and bearing tendency. Recommended cultivars, and their key nut productivity traits are listed in Table 1.

In addition to these data in Table 1, University of Missouri Center for Agroforestry (UMCA) black walnut researchers have created an online tool to aid potential growers in choosing which cultivars will work for them. The tool can be found at: extension.missouri.edu/publications/xm1001.

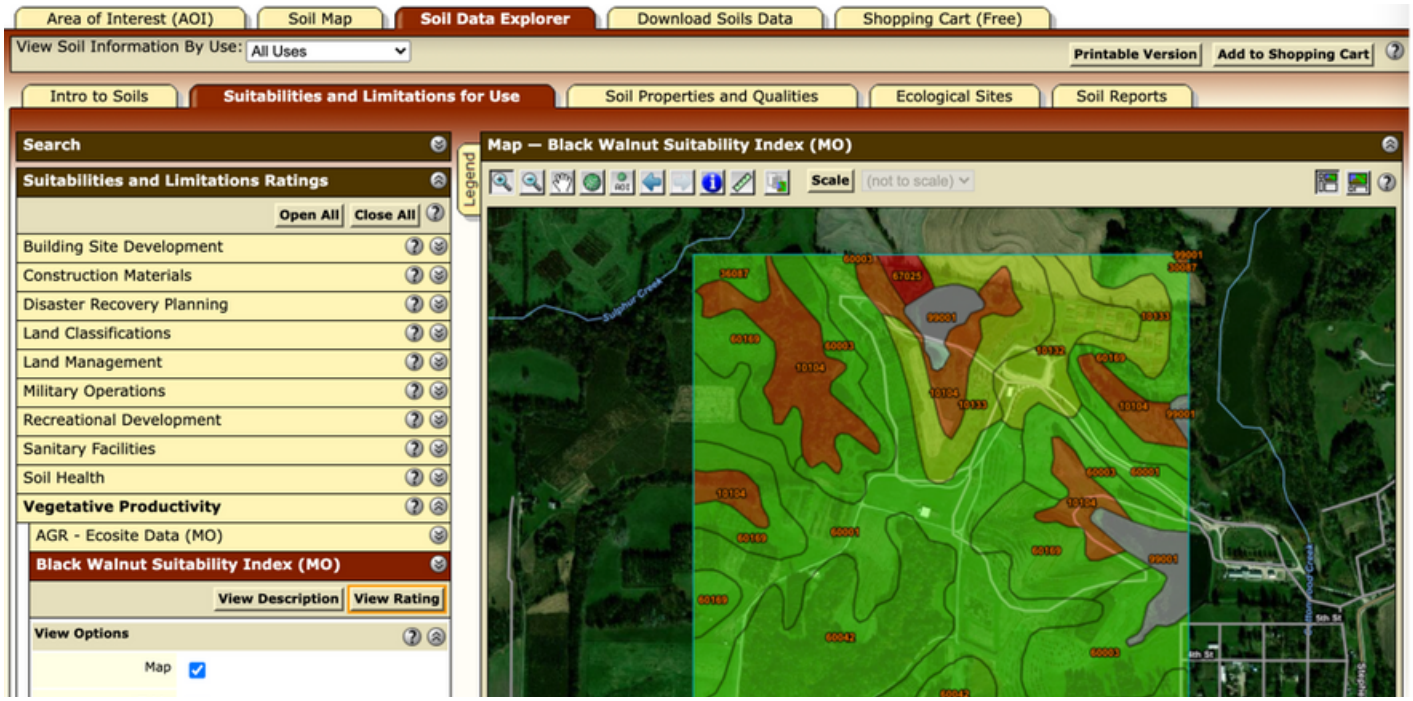

Figure 1. The black walnut suitability index can easily be applied to any area of interest selection on the USDA-NRCS Web Soil Survey.

Table 1. Early phenological and reproductive characteristics of recommended black walnut nut cultivars for Missouri.

Cultivar	Season Length (days)	% Kernel	# Nuts/kg	Anthracnose Score* (1-5)	Alternate Bearing Index** (0-1)	Yield Efficiency*** (kg/cm2)
Bowser	125	31.7	66.4	4	0.81	0.028
Brown Nugget	128	28.4	67.7	5	0.51	0.074
Daniel	132	32.0	63.5	3	0.64	0.021
Emma K	133	33.7	57.8	3	0.86	0.091
Hay	132	31.6	45.9	2	0.36	0.076
Kwik Krop	135	30.3	56.4	3	0.47	0.032
Sparks 127	111	33.6	69.4	3	0.54	0.097
Sparks 147	127	37.2	63.7	3	0.55	0.036
Sparrow	112	28.9	53.4	1	0.41	0.080
Surprise	141	31.5	48.9	5	0.74	0.047
Tomboy	125	25.2	47.8	3	0.54	0.125

*Anthracnose Score: 1 = No defoliation due to anthracnose, 5 = complete defoliation
**ABI: 0 = No alternate bearing, 1.00 = Complete alternate bearing
***Yield efficiency: # nuts produced per cm^2 of stem over a five year period

UMCA Black Walnut Selections Efforts have been underway since 2002 to improve black walnuts for nut production. Some of the named cultivars listed in Table 1 have been used as parents in controlled pollinations to create improved generations of black walnut. The University of Missouri Center for Agroforestry (UMCA) currently has advanced selections under final evaluation, which will ultimately lead to a series of new cultivar releases. These improved black walnut trees have been selected for high kernel percentage, thin shell, early producing, high quality, and low nut defects. Please refer to the black walnut improvement page at www.centerforagroforestry.org for more updates on the status of these advanced generation selections and how/where you may obtain them for your new planting.

Leafing & Flowering Dates Black walnut trees are among the latest trees to break dormancy in eastern deciduous forests. This late-leafing trait is nature's way of ensuring that newly emerging leaves, and developing flowering structures are not injured by late spring frosts, although there are cultivar differences in budbreak timing – some earlier and some later. Temperatures below 26 °F will kill emerging buds and destroy both catkins and pistillate flowers, which will negatively impact, and in some cases eliminate, the potential for nut production in a given year. If your planting site has a tendency towards late spring frosts, planting late-leafing cultivars is essential.

Black walnut cultivars exhibit two different flowering habits which is collectively called heterodichogamy. Protogynous cultivars are those that produce pistillate (female) flowers earlier than the staminate (male) flowers. Protandrous cultivars produce staminate (male) flowers on catkins earlier than the pistillate flowers are visible. Black walnut trees have separate male and female flowers, located on different parts of the same branch (see catkins image, next page). Depending upon cultivar, staminate (or male) flowers, called catkins, start to develop at budbreak along 1-year-old wood. The 2-to 3-inch-long

catkins first appear green, and then turn yellow when shedding pollen. After all the pollen is shed, the catkin turns brown and falls from the tree. Female flowers, also called pistillate flowers, are small, 1/4 inch long, green nutlets tipped with two feathery stigmata that can be red, orange, or green in color. Pollination occurs when pollen is transported by wind to the surface of the stigma.

Catkins are borne on one-year-old wood, while pistillate flowers appear on the terminal end of new shoots

The dates of pollen-shed and female receptivity are closely related to budbreak date. While preliminary studies indicate that some black walnut trees can self-pollinate, cross-pollination increases nut set and many named cultivars having overlapping bloom periods (Fig. 2).

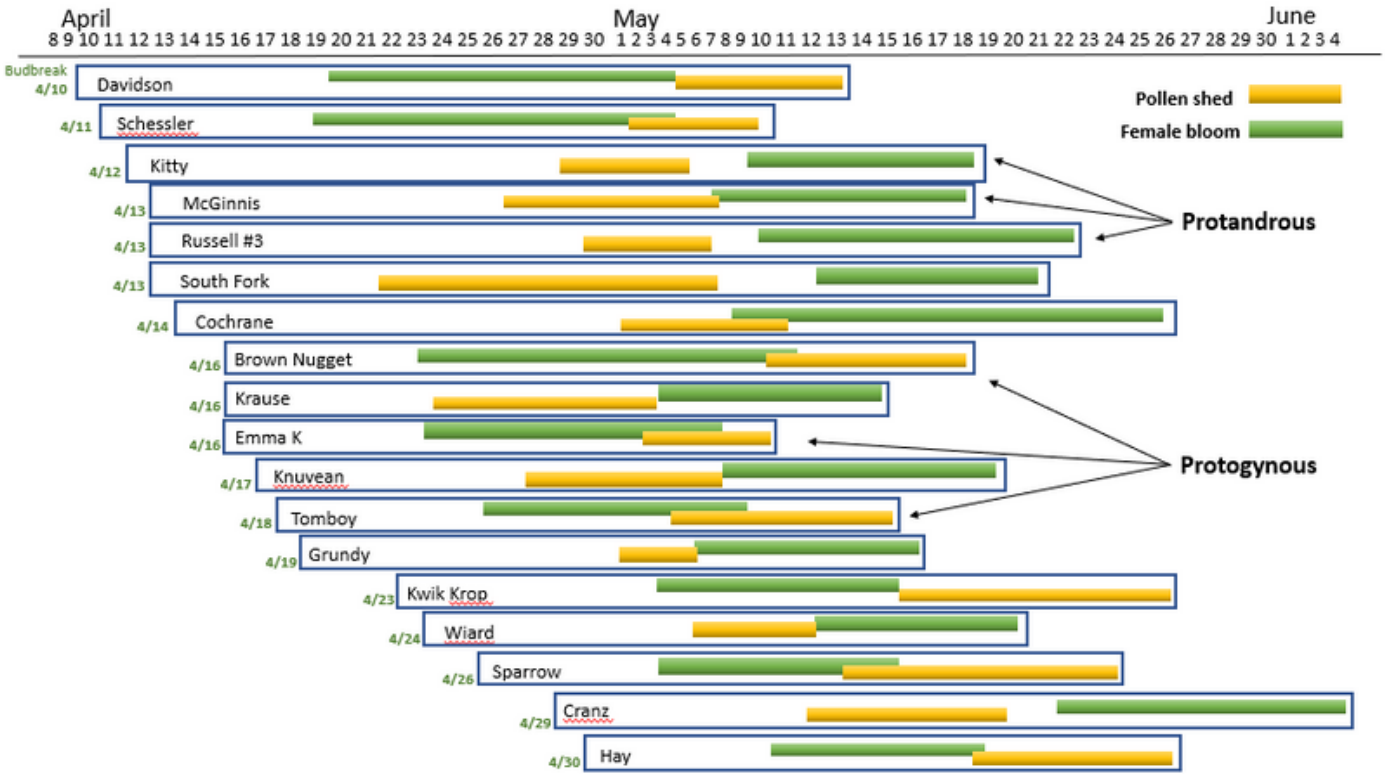

Figure 2. Average pistillate and staminate bloom dates in New Franklin, MO. Selected cultivars exhibit a wide range in the timing of bud break, female bloom, and pollen shed. When selecting cultivars for a commercial planting, it is important to select cultivars with overlapping pollen shed and bloom timing to ensure optimal pollination throughout the orchard.

Nut Bearing Habit Several black walnut cultivars exhibit what can be most accurately described as spur-type growth. Black walnut spurs are short, compact branches that arise along primary limbs (see first image, page 6). These spurs are multi-year-old shoots that grow to a length of 4 to 12 inches and dramatically increase the fruit-bearing capacity of the tree. The best yielding black walnut cultivars are all spur bearing. The UMCA Black Walnut Breeding Program is selecting for high kernel quality, spur-bearing individuals.

Spur-bearing cultivars bear nuts on short branches that arise along main limbs. Black walnut fruiting lateral spurs are 8 to 10 inches long and bear nuts on the branch terminal.

Anthracnose appears as irregular brown spots on the foliage. Infected leaflets yellow before dropping off the tree during the growing season.

Green, anthracnose-resistant tree (center) surrounded by yellowing, partially defoliated anthracnose-susceptible trees in late summer.

Disease Resistance Anthracnose is the most common foliar disease infecting black walnut trees and can be a major cause of poor and irregular nut production (see second image). Spores of the walnut anthracnose fungus (which is native to North America) infect leaves shortly before full leaf expansion and will become noticeable later in the growing season on susceptible trees, resulting in complete defoliation by mid-August. Black walnut cultivars vary in their susceptibility to this disease, but no cultivar has been shown to be fully resistant to infection (see third image). Anthracnose can be controlled with fungicide applications as described in the pest and disease management section of this bulletin.

Nut Production Preliminary data indicates that a grafted orchard growing on a good site under optimal conditions and care may be able to produce 2,000 pounds of husked and air-dried walnuts per acre per year. But historically, many black walnut cultivars were selected solely on their ability to produce nuts with high kernel percentage that were also easy to shell (in contrast to selection based on total nut productivity). Choosing specific cultivars for your orchard should be determined by the goals you have set for your trees. For the backyard grower, total nut yield may not be as important as ease of cracking, while for the commercial grower, high yield is essential.

Cultivar quality has many dimensions. Kernel percentage is the standard measure of a cultivar's ability to produce edible kernels, which historically has been the only basis for naming and propagating black walnut cultivars – all of which were selected from wild, undomesticated sources. For example, black walnut kernel percentages typically range from 10 to 14% from such wild sources, while the newer selections derived from the UMCA breeding program consistently produce between 28 to 38% edible kernel. Generally, the higher the kernel percentage, the easier

the nut is to crack and shell. Kernel quality is assessed by both the color of the kernel (light colored is better) and the absence of kernel venation or mottling. All of these characteristics are equally important for walnut growers who plan on marketing nuts as a shelled product.

As with other orchard tree crops, cultivars will vary in their ability to produce an annual crop. Cultivars that are prone to alternate bearing tend to over-produce one year and yield fewer or no nuts the following year. Because backyard orchardists and hobby growers generally cannot afford expensive sprayer equipment needed to apply crop protection chemicals, these small-scale nut producers will always deal with some level of alternate bearing. In these cases, the selection of alternate bearing cultivars for the orchard may offer enough other advantages (i.e. nut quality, large nut size, etc.) to justify their planting. The commercial black walnut producer should avoid severely alternate bearing cultivars.

Ripening Season Black walnut cultivars can be grouped into three nut ripening periods: early, mid-season and late. For areas with an average 195-day frost-free growing season, such as in central Missouri, early ripening cultivars mature Sept. 1 to Sept. 14. (Frost-free growing season for black walnut orchards can be defined as the number of days of the year with temperatures above 28°F.) Mid-season cultivars ripen Sept. 15 to Sept. 28 and late-ripening cultivars can be harvested after Sept. 28. However, the length of growing season at your location will determine when a walnut cultivar ripens and should influence your cultivar choice. A map of frost-free days is available from the National Climatic Data Center: www.ncdc.noaa.gov/ .

In growing areas with a longer growing season (210 days or greater), the husks of early-ripening cultivars may begin to discolor and soften during the heat of late-August. Such higher temperatures can accelerate husk decomposition, leading to kernel color darkening and a marked decrease in kernel marketability. To avoid heat-related kernel quality problems, growers in long-season climates should avoid early ripening black walnut cultivars.

In contrast, growers establishing orchards in cooler climates (less than 180-day growing season) should avoid planting late-ripening cultivars that may not complete their nut development before the first fall freeze. Nuts that freeze before ripening will produce dark, water-soaked kernels that are unmarketable.

Orchard design

The design of your black walnut orchard should allow trees plenty of room to develop the large canopy needed for optimum nut production. Trees established on well-suited soils will grow quickly and should be established at minimum distance of at least 30 x 30 feet. Trees established on less-than-optimum soils will exhibit slower growth rates and may be planted a higher density at 15 ft x 30 ft. Such high-density plantings on optimal soils may be established only when using improved, highly precocious cultivars. Precocious cultivars will enter into full production more rapidly, mitigating the extra costs associated with planting twice as many trees. Best management practices including adequate water and nutrition must be provided. Growers need to remember that failure to thin such a high-density orchard and allowing black walnut trees to grow too close together will result in tree crowding and lower limb loss before onset of significant nut production. In contrast, wide planting distances (40 x 60 feet) have been used in walnut agroforestry systems which allow for the intercropping of agronomic crops between tree rows. Although intercropping improves cash flow during the years of tree establishment (years 1-7), such wider tree spacing will significantly reduce profits from

nut production during the early years of orchard development (during years 7 through 25).

Commercial walnut orchardists should establish trees with a sequential tree thinning plan in mind to maximize land use efficiency (Fig. 3). Trees established at a high density spacing (15 x 30 feet) will begin to crowd each other after 10-15 years depending on tree growth rate, site conditions, and management. As limbs of adjacent trees start to touch, lower limbs become shaded and nut production will diminish. In standard density orchards (30 x 30 feet), trees will begin to crowd each other in 20-25 years. In an orchard where all trees are performing equally, a thinning at age 20-25 could consist of the following: the orchardist removes every other row of trees on the diagonal, allowing the remaining trees additional room for canopy development (remaining trees at 42 x 42 feet). As walnut trees continue to grow, one additional thinning will become necessary at tree age 40 to 50. Again, every other tree row is removed, leaving remaining trees at a final spacing of 60 x 60 feet. Growth rates in orchards on different planting sites will vary greatly and this thinning timeline should only be considered as an estimate. It is recommended to monitor orchard growth and prune and/or thin trees before crowding occurs.

In many orchards, trees do not grow uniformly. Under such circumstances, the orchardist must carefully select trees to be removed to reach the desired final spacing of approximately 60 x 60 feet. Orchard design should also include the wise placement of specific walnut cultivars within the orchard. As previously discussed, nut production will be increased if orchards include several cultivars to ensure cross pollination. Such cross pollination can be achieved by arranging cultivar rows by date of average leafing. Since flowering dates are closely related to leafing dates, arranging cultivars by leafing date should ensure that flowering dates for adjacently planted cultivars will overlap and increase cross pollination.

Methods for establishing black walnut trees

Establishing black walnut trees in an orchard can be done by using one of three methods – planting grafted trees; planting seedling trees then grafting 2-3 years later; or by direct-seeding nuts, then grafting the resulting seedlings 3-4 years later. Each method offers advantages and disadvantages. Prospective walnut growers should choose the method suited to their skills and economic situation.

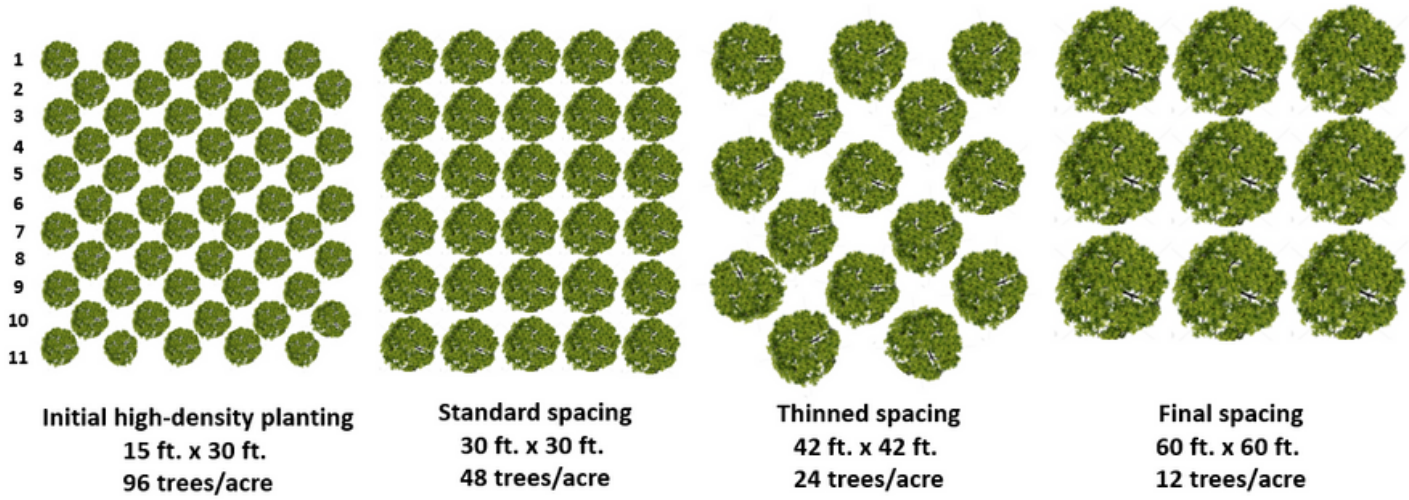

Figure 3. An orchard thinning process, planned around cultivar selection, should be a part of every walnut orchard. Initial high density should only be used when cultivating known, precocious cultivars with best management practices.

Grafted Trees Transplanting grafted trees of desired cultivars is the simplest way to establish a black walnut orchard. Trees should start to bear nuts within four to six years after transplanting, depending on the cultivar. Unfortunately, some recommended cultivars are not always widely available from commercial nurseries, making it difficult to obtain grafted trees.

Seedlings Seedling black walnut trees are widely available and can be purchased from either commercial nurseries or from forest nurseries operated by local state governments. If possible, use seedlings grown from nuts produced from either 'Kwik Krop' or 'Sparrow' cultivars, to serve as rootstocks for your orchard. All seedling trees must be grafted using scions from desired cultivars two to three years after establishment, regardless of seed source. Nut production should begin three to five years after grafting. Starting a walnut orchard with seedlings offers the advantages of low initial costs and the opportunity to establish cultivars not available from commercial nurseries. Disadvantages include a delay in the onset of nut production and the expense and time required to graft your trees. Additional information on grafting walnuts can be found in "Propagating Chestnut, Black Walnut, and Pecan for Agroforestry and Horticultural Systems."

Seed Nuts Walnut trees are easily grown from properly stratified nuts. To start your own trees, collect nuts in the fall that are well filled (i.e., nuts that do no float when washed). Choose nuts from the 'Kwik-Krop' or 'Sparrow' cultivars if possible. Hull (or husk) these nuts, but do not allow them to air dry. Stratify freshly hulled nuts in moist sand by placing them in layers about 3 inches deep, holding them in a cool room or refrigerator (33 to 40 °F) for 90 to 120 days. Be sure the nuts are kept moist (not wet) throughout the stratification process to ensure uniform germination after planting.

Plant stratified seeds in the spring after the danger of frost passes. Seedlings can be grown in a nursery row and subsequently transplanted the following year or planted directly in the orchard. Homegrown seedlings require two to three years to grow large enough for grafting. Starting an orchard from seed has the same advantages and disadvantages as using seedlings. However, be aware that freshly planted walnut seed are susceptible to predation by squirrels.

Transplanting Walnut Trees

For bareroot stock, either grafted trees or seedling trees, transplant them in early spring as soon as the soil can be easily dug. After receiving your trees, plant them as soon as possible, and most importantly, prevent roots from drying prior to planting. Prune off broken or rotten roots and cut the taproot back to 24 inches. Taproot pruning of 1 year old seedlings is usually unnecessary.

Dig your planting hole large enough to fit the entire root system. Hold the tree in position and fill soil in around the roots making sure the fibrous roots are spread out in their natural orientation. It is critical that the tree should be planted at the same depth as it was in the nursery. Water the tree in after transplanting. Do not place soil amendments or fertilizers directly in the planting hole.

For container-grown stock, transplanting can be done in early-October or in March. Dig your planting hole twice as wide as the container but no deeper than the depth of the container. After removing the tree from the container, check for an encircling taproot. Use a pair of pruning shears to cut off the taproot at the point the root starts to circle. Next, use a hay hook to gently pull out the smaller roots that are circling around the outside of the root ball. Place the tree in the planting hole and spread out the fine roots.

Fill in the planting hole with topsoil. The tree should be planted at the same depth as it was in the container. However, be sure to cover the root ball and associated potting soil with about one inch of soil to help keep the root ball from drying out.

Weed control

For growers in Missouri, following tree establishment, sowing sod-forming, shallow-rooted, cool-season grasses (orchard grass, timothy grass, red clover, etc.) or forbs between the planted trees will help to deter the encroachment of tall fescue and weeds into the orchard. Tall fescue and other weeds will compete for resources and/or negatively impact the growth of young, establishing walnut trees through allelopathy. Weeds must be controlled 6 to 7 feet around the newly transplanted tree regardless of orchard size. Complete vegetation control can be achieved by shallow cultivation. Alternatively, herbicide strips can be sprayed down the rows with 6 to 7 feet on both sides of the tree positions several weeks prior to planting.

Herbicide products such as Oust®XP (Bayer Environmental Science, Cary, NC) can be very effective in clearing existing weeds and plants. Be advised, that it is highly important to follow the recommended concentration rates shown on the label for the area of application, as well as to avoid spraying the canopy of any existing trees. Over-applying such effective herbicides may result in toxicity that will kill any tree planted on this site for months or even years. The pesticide label is the law.

Care of non-bearing trees (planting the orchard through year 5)

Once your grafted black walnut orchard is planted, it will take 5 to 8 years until it comes into full production depending on the cultivars planted and the growing site. During this time, close attention must be paid to the developing orchard to ensure the survival of every tree into bearing years. It is important to keep up with plant nutrition, weed control, mowing between the rows, pruning/training each tree, pest control, and tree protection to get the most out of your new black walnut orchard

Water and nutrients

A productive black walnut orchard is enhanced by developing trees with strong trunks and healthy root systems. Adequate soil moisture throughout the growing season and proper fertilization are key to strong, vigorous tree growth. Water newly established walnut trees when conditions become dry by soaking the entire rooting zone deeply once a week in the absence of natural rainfall. Once trees establish a vigorous root system it is often desirable to keep the tree growing rapidly, especially if orchards are established on deep alluvial soils. If newly transplanted trees make 8 to 10 inches of new growth by early-June, spread a half-cup of urea 46-0-0 nitrogen fertilizer around each tree over the entire weed-free area. Nitrogen applications to trees slow to establish themselves (less than 8 inches of new growth) can cause a leaf burn and should be avoided. To ensure survival, keep the tree well-watered throughout the growing season and especially during drought periods.

Once established, apply nitrogen fertilizer twice a year, once in March and again in May, at the rate of one-cup urea 46-0-0 nitrogen fertilizer per inch of trunk diameter. Spread fertilizer over the area within the dripline. Keep the area around the tree weed-free to ensure maximum benefit from water and fertilizer applications.

Check out more black walnut resources on the "Mizzou Agroforestry" YouTube channel!

Pruning

Tip pruning helps shape the young walnut tree and promotes the formation of a strong trunk. Tip prune in February or March by clipping off 3 to 4 inches from all terminal growth. When the tree starts its growth in early spring, these cuts force buds along the entire branch to break. This gives the tree a denser appearance and greater leaf area. Tip prune again in July, but this time, do not prune the central leader. Cutting all lateral branches back stops their growth and channels their photosynthetic energy into strengthening the trunk.

Resist the temptation to "prune the tree up" while the trees are still small. Lower lateral branches should be left on the tree until they are 1 inch in diameter. Once lateral limbs have grown to 1 inch in diameter, remove the lowest one or two limbs each year in March until you have achieved 8 to 10 feet of clear trunk.

Every time you prune walnut trees (dormant or summer pruning), look to correct tree structural problems. If a branch has formed a narrow crotch at the point of connection with the trunk, remove the entire branch to eliminate future problems with limb breakage. If the tree has formed multiple central leaders, prune to a single leader. The goal is to promote two or three well-spaced lateral branches that are oriented evenly around the trunk and staggered with respect to those below them to create a well-balanced crown (see images).

Pest monitoring and control during establishment

Throughout the growing season, scout for insects that can cause complete defoliation of small trees. These insects include the acrobasis moths, walnut caterpillar, fall webworm and yellow-necked caterpillar. These three species of defoliating insects all feed on walnut foliage in large colonies attacking trees sporadically within the orchard. Spot treat only infested trees with an insecticide.

Dormant winter pruning on a young black walnut tree with dead lower limbs removed, a narrow crotch angle removed to establish a central leader, and multiple well-spaced branches selected to open up the canopy for a balanced crown. Before pruning pictured above.

Deer control

Walnut trees are a preferred target for deer damage. Male deer will strip the bark off young trees by rubbing their antlers against the lower portion of the tree. Bucks seem to prefer walnut trees 1.5 to 3 inches in diameter and will begin rubbing in late-summer and continue into the fall. In areas of high deer populations, place a steel T-post (knobby sides pointing outward) on opposite sides of a tree to help prevent buck rub (see image below).

Installing tree protection such as a T-post, tree cage, or tree tube at planting will deter deer and protect young, developing trees.

Tree training

Install tree stakes adjacent to young trees to provide a convenient aid for tree training. Stakes also help prevent wind damage and can aid in preventing deer damage. Wooden stakes, steel conduit pipe and steel T-posts have been used successfully to stake black walnut trees. Tie the tree to the stake using 1-inch-wide plastic ribbon or engineer's flagging tape to help form a straight central leader. Training trees to a stake is especially important for field-grafted trees to prevent wind damage and possible graft loss.

Drive posts in the soil 4-6 inches away from the tree. Steel fence posts have the disadvantage of having a sharp, angular top that can injure young trees as the wind rubs the tree against the post.

To prevent this type of wind injury, some growers cut the neck out of a 16 oz. plastic soft drink or water bottle and slide bottom part of the bottle over the fence post. The plastic bottle provides a smooth surface that does not injure the tree.

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Black walnut orchard establishment supply costs for first three years
(1 acre, 50 trees, 30' x 30' spacing)

Item	Cost	Quantity	Total
Drip irrigation (1,250' tubing, shutoff valve, filter, pressure regulator, air vent, PVC manifold, risers and fittings)	$445.50	1	$445.50
Fertilization costs (Urea 46-0-0 fertilizer)	$45	1	$45
Herbicide strip at base of trees	$130	1	$130
Established grafted walnut trees–wholesale	$20-$40	50	$1000-2000
Shipping costs	$0.75	50	$37.50
10' support stakes	$6	50	$300.00
**Fencing – 100' welded wire fence 60" tall – cut to make tree cages	$138	5	$690.00
Rebar for staking cages down	$195	1	$195.00
Soil analysis	$20	1	$20.00
Year one orchard establishment supplies total:			**$2,862.50-$3,862.50**

**Does not include costs to establish water source (well or pond) or pumps.

Item	Cost	Quantity	Total
Fertilization costs (Urea 46-0-0 fertilizer)	$90	1	$90
Herbicide strip at base of trees	$130	1	$130
Year two orchard supplies total:			**$220**

Item	Cost	Quantity	Total
Fertilization costs (Urea 46-0-0 fertilizer)	$135	1	$135
Herbicide strip at base of trees	$130	1	$130
Year three orchard supplies total:			**$265**

Total material costs for orchard establishment years: (1 acre, 50 trees, 30' x 30' spacing):	**$3,347.5 - $4,347.5**

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