# Spacing Hardwood Trees to Grow Veneer Quality Timber


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Establishing a planting of hardwood trees is the culmination of effort and careful planning. When your goal is growing veneer quality hardwood trees the complexity escalates. There are many aspects of planting trees, but this guide focuses on the importance of properly spacing those trees to help ensure they have the opportunity to grow into veneer quality hardwoods.


### *A Special Thanks*

This project began with extensive efforts by the Missouri Chapter, Walnut Council's ***"Missouri Hardwood Tree Establishment Working Group".*** The guide captures the technical knowledge, research experiences and practical knowledge from many Walnut Council members and numerous professional foresters and woodland owners in the Midwest and Canada. Without their combined expertise and ideas, this guide would not have been possible.

# Spacing Hardwood Trees to Grow Veneer Quality Timber

The first step in planting is to prepare a ***"planting plan"*** for the site that helps ensure long-term success. There are many considerations in an effective plan, but one critical element when trying to grow veneer quality timber is the *spacing of the seedlings or the density of the nuts* if broadcasting the seeds. This *guide* will assist you in making the best choices for selecting the *ideal spacing* for your planting. Our focus is *"establishing a stocking level to grow hardwood trees capable of producing veneer quality logs both efficiently and economically".*

We provide information to assist your planning process that offers the pros and cons of typical planting options. Then, it's up to you to decide what may work best for you. This does NOT discuss aspects of actual tree planting. We strongly recommend you utilize the services of a professional forester to assist in developing a thorough planting plan that includes topics such as which species to plant on your soils!


**Figure 1:** Row spacing and tree density are critical to minimizing the need for grass control and pruning side branches while trees also grow straight and tall.

## ***Your "Planting Plan" should consider these important factors:***

- Match selected site and soils with appropriate tree species.
- Consider your capabilities and resources in establishing the planting or seeding,
- the size of the planting area,
- the mixture of trees to be planted or seeded,
- your capabilities and resources to: prune branches, apply herbicides around the trees to reduce competition for at least the first 3 – 5 years, eventually thinning the stand as needed, and
- the plant spacing options best suited for your situation.

Stocking levels can influence the form of the tree stems, crown shape, lateral branching, and growth rates. Higher density plantings encourage the crop trees to grow straight and tall. Limited sunlight due to tighter crowns reduces branching which then minimizes the need for pruning and the number of years of herbicides that might be required to control competing grasses. The literature, combined with our own experience, tells us higher density plantings may somewhat reduce growth rates. There are trade-offs. Growing high quality walnut or oak trees is not easy nor inexpensive! Trying to balance the current costs of production to grow veneer logs for harvest in 50-70 years that could be worth $25,000 — $60,000 or more per acre at harvest (assuming 35 crop trees per acre) is not a simple process. Planting trees on a 10' x 10' row spacing may not be your best planting option, yet that spacing has been widely used for many years. So, lets consider what may be best for you.

## What are YOUR resources, capabilities and limitations?

Here are ***four general categories*** of woodland landowners. Where do you fit?

1) Inexperienced planter with limited access to mechanical equipment
2) Inexperienced planter with mechanical equipment or willing to contract the planting out to a professional

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3) Experienced planter with mechanical equipment and willing to prune and thin your trees

4) Experienced planter preferring to minimize manual tree pruning.

Doing a realistic assessment of your resources is important before deciding the best planting options for you.

## Pros and Cons of Planting Rates:

The objective is growing potential veneer quality trees within the stand of hardwood timber. This increases the value of the butt logs to a possible A-grade veneer quality over the life of the trees. It is important to know your market, however, the life of your trees will be 50-70 years! If you feel your site can produce target log lengths of: 8'6"; 10'6", 12'6", 14'6", or longer in your plantation or existing timber stands you will be well on your way to growing veneer logs. Limbs and knots are the main reason most trees do not yield A-grade veneer while secondary defects include: small diameters, wire, lightning, bird peck, and wind throw. The secondary defects are beyond your control, but you can manage for log lengths and minimize limbs and knots.

Managing the amount of sunlight reaching the butt log directly impacts the amount of limbs sprouting from the tree. Dormant limb nodes are triggered by the presence of sunlight to shoot out limbs essential to supporting the entire tree canopy which is the food factory for your trees. Sunlight is critical also, for the all important central leader which determines tree height and straightness. The amount of sunlight can be altered by adjusting the spacing of your rows or the density of your broadcast seeding. The number and species of plants per acre impacts the amount of sunlight. More sunlight triggers more limb development.

The numbers of trees planted per acre or the number of seeds/nuts spread per acre influence your production costs as well as the growth rates of your trees. If you are concerned about a ***Return on Investment*** of your money today over the life of your timber stand, controlling the density of planting stock is critical. The more trees or seeds per acre directly increases the eventual cost of thinning operations. "Pros" for increasing the number of stems per acre is a likely reduction in the need for pruning, and the frequency of herbicides applied under tree canopies to control grass competition. Potential "*Cons"* are thinning costs will increase and planting too many stems may reduce diameter growth rates.

Planting at wider spacings can produce quality trees, but only if the landowner and/or their successors are willing and able to prune regularly. If that is in question, then closer spacings may be advisable. A widely spaced planting that is not pruned regularly is likely to result in trees with low forks and large side branches that can only be salvaged, if at all, with considerable time, effort and costs for extensive corrective pruning. A closely spaced planting that is not thinned regularly may experience reduced growth rates, but tree form will be good and growth rates increase after thinning. Balance is the key.

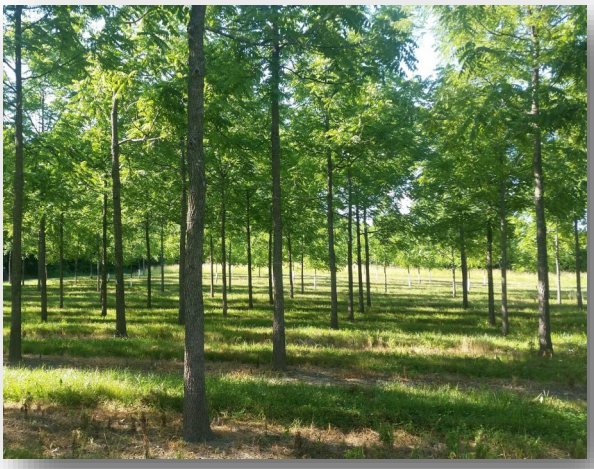

**Figure 2:** - Crown closure is limiting sunlight.

If you are planting rows, determining the most ideal row spacing for your planting site is key. Consider spacings that provide between ***302 and 1742 plants per acre***, however, planting rates can go even higher if the situation warrants. The use of "trainer trees" (conifers to include bald cypress, white pine, firs; swamp white oak, ash, alder) that provide competition and force the central leaders to grow straight and tall while also minimizing the lateral branching is common. An alternative recommended by researchers is to do a mixed planting of hardwoods with similar growth rates (black walnut, red oak and black cherry, for example) rather than a monoculture. Since the growing conditions may vary over the planting area, this allows the species of trees to choose the site on which they thrive best and will ultimately dominate the competition. It also reduces the risk of loss due to pests or diseases in the future (think Emerald Ash Borer and the possibility of Thousand Cankers Disease).

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Once the crop trees reach a height and diameter where they are considered stable from wind throw, the trainer trees can be gradually thinned out resulting in a stand of hardwood crop trees that approximates a 30 x 30 spacing at harvest.

## Will you need Financial Assistance?

This guide does not address the numerous funding sources available to you for financial assistance from state or federal agencies or potentially from private interest groups promoting the establishment of woodland and/or wildlife habitat. If you will be applying for financial assistance to establish your tree planting, regardless of the source, the work may need to comply with the USDA Natural Resources Conservation Service ***"Tree/Shrub Establishment"*** practice standard #612. However, it is imperative you find out the specific program requirements *AND* receive written approval from the agency or interest group *BEFORE* starting your planting project! Funding sources have specific requirements that may vary from the #612 practice standard for tree planting. Growing veneer requires higher density plantings likely well beyond that standard.

**Figure 3:** This two-person crew using a tree planter is essential for larger projects.

## How will you establish this tree planting?

Here are five options for establishing hardwood trees. Which of the following methods best describes your intentions?

1) **Direct seeding broadcasting hardwood seeds into tilled soil using a fertilizer buggy, manure spreader, etc.**
2) **Direct seeding planting nuts in rows**
3) **Planting tree seedlings in rows**
4) **Planting container grown trees in rows**
5) **Managing your Natural Regeneration**
6) **Hybrid - combination of one or more of the above.**

The ***Direct Seeding Broadcasting*** option requires mechanical and/or hand equipment to spread seed evenly over a tilled planting area. The planting area can be the entire field, strips or spots within that field. Apply approved contact herbicides to kill existing grass vegetation, till the soil, distribute the seeds then ensure you have good seed to soil contact possibly using a cultipacker or light drag. Use a minimum of 3000 seeds per acre (on average this equals 75 lbs. of black walnut or 25 lbs. of white oak seed - for validation see A-7 in the "***Illinois Direct Seed Handbook"***), but you may decide to increase that rate. The mixture and seeding rate should be determined in consultation with a forester depending on your soils and objectives for the plantation. Refer to the section in this Guide on **Seeding Rates** (Page 6) for more guidance in the volume of seed needed per acre.

***Direct Seeding Planting Nuts*** requires either a machine seed planter or hand tools to place seeds or nuts into the soil. As with broadcasting, use of an approved herbicide is critical to kill competing grasses in the planting zone. Use a minimum of 1500 seeds per machine or hand planted acre, but you may decide to increase this rate. Again, the same advice for your planting mix applies with this option: Consult a forester to determine your ideal planting mix and seeding rate. Planting, typically, will be done in rows. The spacing between rows and spacing within rows is critical. Spacing will depend on the size of your planting equipment, how you will maintain the planted rows, your budget, and the amount of hand pruning you are willing to perform. Refer to the section on **Seeding Rates** for more guidance.

***Planting Tree Seedlings*** is the most common option used to establish hardwood plantations. As a guide, plantings larger than 5 acres per year will likely require access to a mechanical tree planter pulled by a tractor or using a professional hand planting crew. Smaller plantings can be carried out by one or two individuals. Planting will be done in rows. The spacing between rows and spacing within rows is critical. Refer to the section on ***Row Spacing*** for guidance.

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***Planting Container Grown Trees*** **(see photo - right)** is the least common method used on larger projects simply because of the cost for individual trees combined with the labor to plant and stake the trees. If you need to produce a stand of hardwoods quickly for aesthetic or windbreak purposes, using container stock may be your best choice. The number of trees planted can be reduced to 48 trees per acre to comply with the #612 practice standard, however, this results in an initial planting spacing of 30' x 30' which we do not recommend for growing veneer quality hardwoods ***unless*** you surround those potential crop trees with trainer trees. Using mechanical equipment for larger plantings is ideal, but experienced planting crews can plant several container grown trees per day depending on soil conditions, field slope and the tools available.

***Managing Natural Regeneration*** is often carried out in alluvial areas along creeks that experience occasional, temporary flooding for a day or two maximum, depressional areas too wet to machine or hand plant, sites likely to be invaded by soft-mast or light seed species, and sites that are within 300 feet of existing mature woodlands and adjacent to desirable seed sources. Your role is managing the competition to include pruning (**see photo - right)** or "crop tree release" which is killing or stunting competing trees and shrubs to the benefit of the crop trees.

**Hybrid** - This method entails using a **c**ombination of one or more of the above methods. For example, you could plant tree seedlings on a 10 x 10 spacing and plant walnuts or acorns within the rows, between the seedlings, creating a 5 x 10 or 3.33 x 10 spacing while still maintaining the 10 ft row width for equipment access. Or substitute container stock for seedlings on the 20 x 20 locations with the seedlings on the remaining 10 x 10 locations. Another approach is to plant seedlings or seeds/nuts randomly 5' out and around the hardwood crop trees to serve as trainer trees for the crop trees.

***Managing the Competition*** within your timber stand is critical. Your goal at harvest time is having 35-40 mature hardwood trees per acre. You plant ***"400 to harvest 40"*** is the concept. Your ratio may be 800:40 or 1200:40. The numbers of seedlings or seeds can vary greatly depending on your capabilities and limitations, and your resources in time and money. The following row spacings are ***guidelines*** for planting seedlings to be finalized with your forester:

**Row Spacings and Plants Per Acre:**

| Spacing in Feet | Plants Per Acre | Spacing in Feet | Plants Per Acre | Spacing in Feet | Plants Per Acre |
|---|---|---|---|---|---|
| 5 x 5 | 1742 | 8 x 9 | 605 | 12 x 12 | 302 |
| 6 x 6 | 1210 | 9 x 9 | 538 | 14 x 14 | 222 |
| 6 x 8 | 907 | 8 x 10 | 544 | 16 x 16 | 170 |
| 7 x 10 | 622 | 10 x 10 | 436 | 18 x 18 | 134 |
| 7 x 7 | 889 | 10 x 12 | 363 | 20 x 20 | 109 |
| 8 x 8 | 680 | 11 x 11 | 360 | 30 x 30 | 48 |

**Direct Seeding Rates Per Acre:**

**Row Seeding:** Use a minimum of 1500 seeds or nuts per machine or handplanted acre with a **suggested range** of 2500 to 4000 seeds/acre. (See Note 2:).

**Broadcast Rates Per Acre:** Use a minimum of 3000 seeds and/or nuts per acre with a **suggested range** of 5,000 to 15,000 seeds/acre.

**Note:** Supplement with light-seeded species (i.e. ash, maple, linden, etc.) to increase stocking levels.

***Note 1*:** NRCS planting rate per acre for hardwood trees ranges from ***302 to 544***.
See **green highlighting** in the table.

**Note 2:** Refer to Page A-26 of the "**Illinois Direct Seeding Guide…."** for row seeding spacings.

**Modifying the Table Spacings:**

You can modify the table to a result that best fits the row spacing you require when planting seedlings or the spacing needed to achieve the desired plant density. A tree benefits equally from a given square feet of space, whether that space is square or rectangular.

- **Calculating trees per acre, within the row spacings and spacings between rows.**

  There are 43,560 sq. ft. / acre. An 8 ft x 8 ft spacing takes up 64 sq. ft. (Think of a box with a tree in the center and the sides spaced half the distance to the next tree, 4 ft in this example, in each direction. The box would measure 8 ft x 8ft. = 64 sq. ft.) Therefore 43,560 / 64 = 680 trees / acre.

- **If you wanted to maintain the same planting density of 680 trees / acre or 64 sq. ft. / tree, but needed to increase the distance in the rows to 10 ft for equipment access, what would the distances between the trees in the row be?**

  64 sq. ft. / tree. Row spacing = 10 ft. Therefore, 64 / 10 = 6.4 ft between trees in the row.

- **If you prefer 20 ft spacing between the rows for equipment access and you are willing to plant the trees in the row 7 ft apart how many trees would be planted per acre?**

  20 ft x 7 ft = 140 sq. ft. Therefore, 43,560 / 140 = 311 trees / acre.

  **On the other hand, if those 311 trees are planted on a square grid what would be their spacing?**

  Using a calculator the square root of 140 = 11.8 ft., therefore, the spacing would be 11.8 ft x 11.8 ft

Your ***ideal spacing should consider:*** management objectives, soils, the economics of the planting in relation to your resources, access to mechanical equipment for planting and maintenance or a willingness to hire a planting contractor.

Here are three options in numbers of trees per acre to consider that give you the opportunity to grow **veneer** hardwoods:

| | |
|---|---|
| GOOD | 544 trees per acre |
| BETTER | 680 trees per acre |
| BEST | 889 trees per acre |

## Density of Plants Per Acre:

The number of seeds and/or nuts to either **broadcast or direct plant** per acre are influenced greatly by the same factors listed under row spacing. Your personal capabilities and limitations have a direct impact on the volume of planting stock you can use. It is becoming more common to use higher rates in an effort to force the crop trees to grow taller and straighter while also reducing branch development and minimizing the need for herbicide spraying to control competing grasses. Rates of 4000 seeds/nuts per acre with a goal of growing 800 to 1,700 stems per acre are becoming more common. There are consequences with higher rates: increased costs in thinning, eliminates access within the stand by mechanical equipment, and seed costs increase greatly *unless* the seeds/nuts are planted in rows to reduce their volume.

The density of trees per acre also impacts: grass control, the number of developing branches which means pruning, the straightness and height of the trees and the amount of thinning needed. Determining the most ideal tree spacing for your situation is critical!

If you will be applying for financial assistance, consider the planting requirements of the funding provider before finalizing your planting plan. ***You must meet their minimum stand requirements!***

**Figure 6:** This black walnut plantation (above) has been thinned twice and needs thinning now. Tree canopies are competing reducing the rate of growth for remaining "crop trees". Grass competition, as shown here, significantly slows the growth rate of trees. It competes for nutrients and the sod prevents rainfall from penetrating to the root zones.

In contrast, in **Figure 7:** (right), the forest floor has minimal grass due to the mixture of hardwoods, like oaks, with dense, opaque leaves that prevent sunlight from penetrating the forest floor. In contrast, walnut leaves are translucent with high light transmissivity allowing much of the sunlight to reach the grass as in **Figure 6**.

*Remember:* only **35 to 40** of these trees will be remaining at harvest although 400, 800, 1200 or more plants were planted!

**Figure 7:** This stand of mixed hardwoods was direct seeded in 2004 by broadcasting seeds and nuts through a manure spreader onto tilled soil. The walnuts and other fine hardwoods still require some pruning, but much less than with traditional wide-row plantings. This tree farmer uses ***"crop tree release"*** as his thinning technique.

## Significant "Other" Management Considerations:

- The control of grass, invasive species and competing non-crop trees and shrubs is critical to the overall success of your planting. If you have a small acreage planting it may not be critical to use a tractor, utility vehicle or ATV to mow or spray herbicides within the stand. Larger plantings are more likely to be dependent on mechanical equipment for maintenance. The width of that equipment influences row spacing! Remember, the first influence on row width is the space needed for the planting equipment. Secondly, thinning operations, or the deadening of brush and invasive trees, may result in the felling and removal of trees. It takes free space to fell trees without damaging your crop trees. Allowing thinned trees or brush to die slowly on the stump and then falling to the ground over time is a common practice in high density plantings to avoid damaging the remaining crop trees.
- There is a relationship between the spacing of hardwood trees and tree growth. Wider spacings tend to produce faster diameter tree growth, however, those plantings produce more limbs that must be pruned and more aggressive stands of grass. Thinning will be less of an issue, but it cannot be avoided. The converse is true as well. Closer spacings can reduce pruning and grass control concerns, but diameter growth rates may be somewhat reduced and thinning will be a greater concern because there are more stems per acre to remove. Higher density plantings tend to force trees to grow taller at a faster rate, but their diameter growth rates may be somewhat slowed until thinning.
- **The challenge is finding the right balance in stand density for your needs!** One consideration in decision making is the fact many landowners feel it is easier to learn how to thin hardwood trees than it is to properly prune trees. Plus, pruning continues over several years of the tree's growth while thinning occurs at intervals of the stand's age. Thinning should be scheduled based upon **"crown closure".** Most stands will undergo three thinning's:

  A. 1st thinning to occur approximately **10 to 12-years** after planting with a...

  B. 2nd thinning to occur **20-years** after planting adjusting timing based on crown competition, and

  C. A final ***commercial thinning*** maybe at **40-years** after planting IF needed with trees at 17" to 19" DBH.
- Higher density plantings using tree seedlings may not be cost-effective over the life of the planting regardless of whether you or your contractor performs the work. You can reduce those costs by broadcasting seeds/nuts into tilled soil if you desire to increase your stand density towards the higher end of the spectrum. i.e. more than 800 trees per acre. Regardless of which planting method you choose, consider your costs over the life of the plantation.

**Figure 8:** This apparent lower density planting of red and black oak is misleading. The initial stand included ***"trainer trees"*** within these existing rows to provide competition forcing the trees to grow straight and tall.

# Your Decision Tree:

This segment of the guide will step you through to the most logical planting option suited for your operation. It starts with your personal assessment. Begin by finding your category mentioned on pages 2 and 3.

1) ***Inexperienced planter with limited access to mechanical equipment.*** Assuming your planting site is less than 5 acres in size, we recommend you plan a traditional row spacing layout looking at possibly 8' x 8' = 680 trees / acre . Adjust the numbers of trees and row spacing that best suites your resources keeping in mind the pros and cons of narrow or wide rows.

2) ***Inexperienced planter with mechanical equipment or willing to contract the planting out to a professional.*** All of the planting options are available to you assuming you or your contractor has a tractor, tillage equipment or access to a tree planter or a hand planting crew. We recommend a basic rate of seed/nuts if broadcasting, and a more traditional spacing if planting seeds or seedlings in rows. Select planting in rows to access the stand for maintenance.

3) ***Experienced planter with mechanical equipment and willing to prune and thin your trees.*** All of the planting options are available to you assuming you or your contractor has a tractor, tillage equipment or access to a tree planter or a hand planting crew. Because you have planted before and likely used a more traditional row spacing method, we recommend staying with the process you used previously, so all of your planting sites can be maintained in the same manner. The 8' x 8' row spacing is popular, but that row width may be too tight for your current maintenance operations. If that's the case, widen the rows to accommodate your equipment, but consider including trainer trees within the rows to reduce sunlight and the amount of pruning needed.

4) ***Experienced planter who would prefer to minimize manual tree pruning.*** All of the planting options are available to you assuming you have a tractor, tillage equipment or access to a tree planter. Because you have planted before and likely used a more traditional row spacing method, this planting may be a starting point to expand your experience by using high densities in seed or seedlings to compare and contrast with your existing plantings. For example, set a target of between 680 and 1700 trees per acre then determine your spacings by referring to ***"Modifying Table Spacings***" on page 6. However, you can also accommodate a wider row spacing of 20' x 21' with trainer trees planted on 7' centers within the row that increases the stem count to 311 seedlings per acre giving you those advantages while also permitting the opportunity to use equipment between the rows.

# Conclusions:

This guide does not explain how to plant a tree. In fact, there are many tasks we do not touch on, yet those details are critical to the survival of any single tree and to the success of your plantation. But, that information is available elsewhere including the Internet and it captures years of research and field studies. However, I have found there is very little information that goes into detail about the proper "*spacing"* of trees although this element is vital to the success of our efforts.

Unfortunately, there is no single right answer! Only you, together with your forester, can determine what option best fits your unique situation. Hopefully, we have given you a lot to think about!

A Past President of the Missouri Chapter, Walnut Council, ***Ellen Lebold,*** once told me during a field day, *"Don't put a single tree in the soil unless you can take care of it!".* Ellen passed away at age 92, but the importance of her message lives on. Before planting your trees, give a lot of thought to what is required in caring for those trees during their lifespan.

# *Suggested References*

Tree planting is a conservation practice that may extend beyond our lifetimes. Do not rush your planning process! The ***Planting Plan*** becomes a very important document in your tree farm operations. We cannot overstate the value of working with a professional forester to plan and possibly carryout your planting project. Also, consider joining organizations like Walnut Council, your state forestry association, local woodland interest groups, National Woodland Owners Association, or the American Tree Farm System where you have the opportunity to interact with experienced tree planters and woodland owners. Here are a few technical references you may find useful:


1) ***"Site Preparation and Competition Control Guidelines for Hardwood Tree Plantings",*** Stringer et al., reprinted 2009, https://forestry.ca.uky.edu/sites/forestry.ca.uky.edu/files/for107.pdf

2) **"Tree and Shrub Establishment Practice Standard",** practice code 612, and supporting **"Tree and Shrub Establishment Direct Seeding Job Sheets",** Missouri NRCS Field Office Technical Guide. Click on: https://efotg.sc.egov.usda.gov. Select "Missouri" from the "select a state" dropdown box. Click on the blue arrow to submit. On the next page view the box on the left of the page and select "Section 4 - **Practice Standards and Supporting Documents**". Under the "Index" click on the down arrow to the right of **"Conservation Practice Standards and Supporting Documents".** Scroll down to **"Tree and Shrub Establishment (612)"** and select it. This pops up a list of documents to select from, including the 612 practice standard, worksheets and job sheets.

3) ***"Planting Black Walnut",*** Leaflet Number 84, W.R. Mattoon and C.A. Reed, USDA, 1932, archived.

4) ***"Direct Seeding of Hardwoods in Wisconsin",*** Greg Edge, WDNR, Division of Forestry, 2004, archived.

5) **"Crown Competition - A Measure of Density",** John E. Krajicek, Kenneth A. Brinkman, and Samuel F. Gingrich, Central States Forest Experiment Station, USFS, USDA, http://cmapspublic3.ihmc.us/rid=1N4TSFQX6-GWW4BN-14PZ/Crown%20competition%20-%20A%20measure%20of%20density.pdf

6) "**Designing and Establishing a Fine Hardwood Timber Plantation",** James R. McKenna and Lenny D. Farlee, Proceedings of the Seventh Walnut Council Research Symposium, COTR-NRS-P-115, pages 48 to 67; https://www.nrs.fs.fed.us/pubs/gtr/gtr-p-115papers/07mckenna-p-115.pdf

7) **"The Black Walnut Chronicles",** John Kelsey, http://thescalepit.com/ContentBW/aaaContentBW.htm

8) **"Growing Space Requirements",** John E. Krajicek, North Central Forest Experiment Station, Carbondale, Illinois.

9) **"Spacing Trials in Black Walnut, White Ash and Silver Maple Plantations",** Information Report O-X-365, F.W. Von Althen, Great Lakes Forest Research Center, Canadian Forestry Service, Government of Canada, 1985, http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/9040.pdf

10) **"Illinois Direct Seeding Guide - A Reforestation Guide - 2003",** Association of Illinois Soil and Water Conservation Districts (AISWCD) Forestry Committee; https://www.nrcs.usda.gov/wps/portal/nrcs/detail/il/technical/?cid=nrcs141p2_030634


**Note:** A few listed references have been *archived* and are no longer available online.

## To learn more about the Missouri Chapter, Wanut Council and the "Missouri Black Walnut Initiative"


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**Missouri Chapter, Walnut Council**