

A SELECTION SYSTEM FOR SUPERIOR BLACK WALNUT TREES
AND OTHER HARDWOODS

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Abstract. -- Black walnut and several other valuable hardwood species usually grow in mixed unevenaged stands. Unfortunately, the selection of superior trees in mixed, unevenaged stands does not permit the use of comparison trees **as in pure** evenaged stands.

A point system based on knowledge of variation within a species has been developed and applied to black walnut in Indiana. Trees are not compared to **others within the stand but to those throughout the** geographic area of selection. Characteristics rated were **restricted to** the few most important that could be measured objectively and included total height, worth up to 5 points; diameter, 5 points; apical dominance, 10 points; branch angle, 10 points; and crook, 10 points.

Some modifications are suggested for the application of the point system to other species.

Superior tree selection has **generally been accepted as the initial** phase of **any** progressive tree improvement program. Several **sophisticated systems of determining superior trees have been developed, particularly for** coniferous species. Superior tree selection is considered by many to be an "easy" preliminary step in the development of genetically superior forests. However, when one actually gets into the woods, he is suddenly faced with the fact that there are often many trees in each stand that could meet the **basic** criteria for a superior tree and he is confronted with the difficult **task** of deciding objectively which trees to accept and which to reject. It **has** been our experience that **often trees are** brought to our attention simply because of **large size and contains only one short, large diameter log. This situation invariably leads to the** landowner asking, "What's wrong with it? The veneer buyers certainly are after **it.**" **This** selection system answers the question satisfactorily.

In **unevenaged** coniferous forests selection systems have been developed on the **basis** of comparing the superior tree to its evenaged neighbors. However, **in** the Central States and increasingly in the South, we are dealing with hardwood species which often occur in unevenaged stands or as scattered specimens of the species in evenaged stands, comparison trees are either non-existent or unsuitable.

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Therefore, a selection system has been developed based on a point system adapted to existing knowledge of the variation found in black walnut in Indiana. This point system could easily be modified for other hardwood and coniferous species where comparison trees are not available. One advantage of this system over the comparison tree systems is that isolated individuals can be rated in private lawns, along fence rows, or in open fields that otherwise could not be considered. In black walnut some of the better trees are located in these non-forested areas.

Black walnut differs radically from the southern pines in form, site requirements, abundance, and value per tree.

The form of black walnut is best described as undesirable when compared to pine. It tends to fork low on the bole, have an extremely steep branch angle, and it is nearly impossible to find a truly straight stem. The site requirements of walnut for best development are exacting. It requires a moist, yet well-drained, deep soil with an adequate supply of nutrients (Auten, 1945). Black walnut is certainly not as abundant within its range as are the southern pines within their ranges, and black walnut tends to grow in mixed stands with a multitude of other hardwood species (Brinkman, 1957). Black walnut's value per tree is well documented, but it leads to serious problems in the selection program (Brundage and Straszheim, 1968). Most of **these** selections are from private land--mostly small farms with 40 acre woodlots. There is great pressure on these people to sell their black walnut--especially selected trees. Many landowners cooperate exceedingly well and have turned down offers as high as \$7,000 for one of our selections. Others have, of course, succumbed and selections have been cut and sold before seed or grafting material could be obtained. One of our selections sold for \$12,600 but grafting wood **was** obtained and this tree is preserved. At least three selections have been stolen including the tree having the highest point rating in the state.

In considering characteristics of importance to select for, it has been concluded that apical dominance, branch angle, and straightness are probably **of at least** equal importance with rapid growth rate. The one defect that is evident in every black walnut plantation that has been observed is a "bushy" growth habit.

Evidence has been observed to suggest that apical dominance is controlled by genetic factors. The best walnut sites are usually areas of poor air drainage. In one plantation located in a severe frost pocket late frosts occur nearly every spring. These frosts result in the death of the expanding terminal bud. After a late frost, the new growth begins with the whorl of buds directly below the dead terminal bud. The usual pattern is for three to five of these buds to grow at an angle of from 20 to 50 degrees with none asserting dominance, and a forked, bushy tree develops. However, within this plantation there are six trees out of 350 that produce a new shoot which asserts dominance, and the stems continue growing straight year after year. Branches form from the whorl but then grow at 80 or 90 degree angles, thus, allowing the leader to grow straight. This sequence **has** occurred on the same individuals through

five late spring freezes. The plantation is six growing seasons old. It is apparent that these few individuals have a genetic **makeup which** allows them to grow straight, and that branch angle is probably closely associated with straightness.

Walnut has a tendency, even when apical dominance and branch angle are good, to develop slight crooks or "wiggles." It is almost a spiral **growth habit--not** unlike that of many loblolly pines.

Total height and diameter are rated to give some **idea of** the genetic **potential to grow tall, large diameter stems.**

These are the only traits that are evaluated. You may question the lack of age or growth evaluation. This is very unfortunate, but the high **value of** individual trees ^Precludes the use of an increment borer. Some indications of growth rates are being obtained from remeasurement of trees over two to five year periods. Other trees are aged from the dates offered by owners on their knowledge of the history of the land. The bark texture, and ridging is also used as a rough indication of relative vigor. Since black walnut is an intolerant species, most large individuals are dominant in the stand and are generally the oldest individuals in the stand. From this assumption, an indication can be obtained that dominant black walnuts in any one stand are likely to be even-aged, thus the larger individual is usually favored. Remeasurement of selections made 2-5 years ago indicate relatively rapid growth rates. Most selections are growing in diameter at the rate of from 0.2 to 0.3 inch ^Per year with good trees averaging from 0.4 to 0.5 inch at DBH. Two selections are growing at rates as high as 0.7 inch per year in diameter.

Another factor omitted is the rating of wood characteristics. The problem again is one of being unable to bore the selections. In addition, there is considerable argument within the veneer industry as to what constitutes desirable wood (blathers, 1966). Indiana walnut wood apparently has everything the veneer people desire. The color does vary some, but dark wood usually is preferred and heartwood from fast-grown trees is often darker than that from slow-grown trees (Englerth, 1966). Faster growth rate seems to improve veneering, machining, and grain pattern, therefore, increasing growth should not be detrimental to wood quality (Englerth, 1966).

The opinion **has** been advanced by many that the im^Portant trait in veneer log production should be diameter growth and that a **large-crowned, short-boled** tree can accomplish this better than a "forest type" tree (Wylie, 1966). However, too many plantations have been observed in which it was impossible to grow even an eight or sixteen foot log before forking. Thus, in a tree that is genetically prone to forking, forking will occur at any **height--not exclusively** the desirable 16 foot height. It has taken many man hours of pruning to attempt to straighten and repair badly forked and crooked trees in our ^Plantations. The few straight growing individuals require little or no care in the form of **pruning**. Anyone familiar with labor costs today will appreciate this advantage. In addition **the drastic**

Pruning required to straighten stems destroys leaf area which in turn reduces growth rate (Clark and Seidel, 1961), furthermore, it is our goal to strive for more than one log. Since walnut has this genetic potential, attempts should be made to take full advantage of it.

To date 150 trees have been rated. Out of that 150, 57 have been designated "accepted." Most of the 57 are 25 points or above out of the possible 40 points. The tree with the highest rating has 38 points, and 23 trees are 30 points or over. We are attempting to select trees from throughout the state and certain areas have few black walnuts remaining. In such areas we have been forced to accent selections below 25 points. In addition, some trees are particularly outstanding in one characteristic and we have therefore accented them in spite of other undesirable characteristics.

Figure one shows the standard rating sheet with the point breakdown and a definition of terms.

**PURDUE UNIVERSITY
HARDWOOD SUPERIOR TREE
CANDIDATE REPORT**

Tree No.	Species	State	County
Township	Range	Section	Party
Tree Located By		Date	
Tree Graded By		Date	
Remarks			
Recommendation	Accepted Date	Rejected Date	
Landowner	Address		
Tree Marked With			
Selected Tree Rating		MAP	
Date	Measure- ments	% In- creas- ed	Recons- tored
DBH (in.)			
Total ht. (feet)			
Ht. to 1st fork (ft.)			
Apical Dom. (%)			
Branch (degrees)			
Crooks (no. to fork)			
Seed Crop			
Age (yrs.)			
Growth rate (in. per yr.)			
Total Pts.			

Please complete two forms for each candidate. Send one copy to Walter Beineke, Department of Forestry & Conservation, Purdue University, Lafayette, Indiana, and one copy to Richard McWhitt, Assistant State Forester, 607 State Office Building, Indianapolis, Indiana.

INSTRUCTIONS

MAP: Draw a simple map indicating roads (numbered or named), landmarks and distance to tree.

MARKING: Preferable marking is with a band of white paint at head height.

DBH: Measure diameter at 4 1/2 feet to nearest 0.1 inch.

TOTAL HEIGHT: Measure total height to nearest foot with clinometer, Abney or Haga.

APICAL DOMINANCE: Measure stem length to the first fork. Record as percentage of total height. One or more of the following conditions constitutes forking: (a) the smaller of two adjacent branchings exceeds 1/3 the diameter of the larger or (b) the main stem is deflected more than 10° at the juncture or (c) the angle between the branch and main stem is less than 90°.

BRANCH ANGLE: Measure the angle in degrees between the main stem and branch. Measure on the left live branch from the ground located on the central stem or on the dominant form.

CROOKS: Count the number of deviations of the central stem from the vertical plane below the first fork.

SEED CROP: Indicate whether heavy, medium, light, or none desirable on past experience with the species. (Standards for black walnut are: light 1-50 nuts; medium 50-200; heavy over 200.)

AGE: Do not bore black walnut. You may be able to obtain permission to bore cottonwood, sycamore, and other less valuable species. If you can find the approximate age of black walnut, maple, etc. please report and indicate how arrived at.

GRAIN PATTERNS: Select all trees having spiral grain.

SWEEP: Reject all trees having visible or excessive sweep in first 15 feet.

LEAN: Reject all trees which appear to be leaning unless it is caused by streambank erosion.

ROUNDOUS: Select all trees that are obviously not round in cross section.

POINT SYSTEM FOR RATING SUPERIOR BLACK WALNUT TREES

Total Possible Points = 40

Diameter	Height	Apical Dominance	Branch Angle
Over 22" -- 5 pts	Over 120' -- 4 pts	Over 70% -- 10 pts	Over 70° -- 10 pts
18-21" -- 4 "	100-119' -- 1 "	65-69% -- 9 "	65-69° -- 9 "
14-17" -- 3 "	80-99' -- 3 "	60-64% -- 8 "	60-64° -- 8 "
10-13" -- 2 "	60-79' -- 2 "	55-59% -- 7 "	55-59° -- 7 "
6-9" -- 1 "	40-59' -- 1 "	50-54% -- 6 "	50-54° -- 6 "
Below 6.0" -- 0 "	Below 40' -- 0 "	45-49% -- 5 "	45-49° -- 5 "
		40-44% -- 4 "	40-44° -- 4 "
		35-39% -- 3 "	35-39° -- 3 "
		30-34% -- 2 "	30-34° -- 2 "
		25-29% -- 1 "	25-29° -- 1 "
		Below 25% -- 0 "	Below 25° -- 0 "

Number	Over 16" DBH	Under 16" DBH
0	10 pts	10 pts
1	9 "	9 "
2	8 "	8 "
3	7 "	7 "
4	6 "	6 "
5	5 "	5 "

Figure 1. -- Purdue University hardwood superior tree candidate report.

At first glance the point system appears to be very arbitrary. However, it has been designed so that the values bracket the usual range of a given characteristic that has been found in black walnut. For instance, apical dominance of over 50% in black walnut is unusual and over 70% practically non-existent. Out of the 57 trees accepted only two are over 70%, and the average is 52%. In this selection system apical dominance is measured to a fork as defined on the rating sheet, Figure 1.

Branch angle is more difficult to determine than apical dominance. Choosing the branch to be measured for branch angle is not as objective as we would prefer. The third live branch from the ground is often difficult to determine, but once selected, it seems to give a good estimate of the branch angle found in the crown of the tree. One difficulty is encountered with open grown trees where branches are found on the lower bole. These branches often have flatter branch angles than those in the crown, but this is usually compensated for by poor apical dominance. The average branch angle for the 57 selections is 54 and 10 of the 57 are over 70 degrees. Six of the 10 are exactly 70 and only one has a 90 branch angle.

The point system for crooks was divided into two classes based on size. The theory is that a mailer tree has much greater chance of having visible crooks that a very large tree has outgrown. Twenty of the 57 selections have no crooks and only five have as many as three crooks, and three of these are under 16" DBH. Several individuals with four crooks have been rejected, no trees with five crooks have been seriously rated to date. They do quite co only exist but are rejected without rating because their form is too poor for further consideration. Counting crooks is probably the most subjective trait in the rating system and often compromises must be made.

The diameter of the selections ranges from 7" to 45" and averages 21". Their height ranges from 30' to 118' and averages 96'. Some indication of seed crop is asked for on the selection sheet, and frequency and size of seed crops is recorded. Trees that have noticeable or excessive sweep, lean, spiral grain, and poor roundness are rejected without further consideration.

Application of the rating system to other species will require modifications depending on the characteristics of the species. Comparison trees are often available in tulip poplar. In spite of that fact, it will be used for purposes of illustration. In tulip poplar the points for apical dominance and branch angle would necessarily be distributed higher than they are in black walnut. Tulip poplar is also straighter than walnut, thus, fewer-crooks would be allowed. Growth rate might be included, since it is possible to obtain increment cores from tulip poplar. Although we haven't worked much with tulip poplar, the point system might appear as follows:

Apical Dominance

90-100%	--	10 pts
85- 89	--	9 "
80- 84	--	8 "
75- 79	--	7 "
70- 74	--	6 "
65- 69	--	5 "
60- 64	--	4 "
55- 59	--	3 "
50- 54	--	2 "
45- 49	--	1 "
40- 44	--	0 "

Branch Angle

90-100°	--	10 pts
80- 89	--	9 "
75- 79	--	8 "
70- 74	--	7 "
65- 69	--	6 "
60- 64	--	5 "
55- 59	--	4 "
50- 54	--	3 "
45- 49	--	2 "
40- 44	--	1 "
35- 39	--	0 "

Crooks

Number

Over 16"

Under 16"

0	10 pts	10 pts
1	6 "	7 "
2	4 "	6 "
3	2 "	5 "
4	0 "	4 "

Success in the genetic improvement of our valuable hardwood species must be predicated on the thorough and careful selection of superior individuals to be utilized as raw genetic material in seed orchards and breeding programs. Selection systems, such as this one devised for black walnut, will enhance the probability that valuable genetic material will not be irretrievably lost for lack of an objective comparative method of superior tree selection.

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