

Characterizing Crown Architecture for Black Walnut (*Juglans nigra* L.)



Ideotypes in North Central Indiana

Kejia Pang, Kayla Leach, and Charles Michler

Department of Forestry and Natural Resources, Hardwood Tree Improvement and Regeneration Center, USDA Forest Service Northern Research Station, Purdue University, West Lafayette, IN, USA. Email: kpang@purdue.edu



Introduction

- In terms of crop tree breeding, ideotype is a tree model which can yield a maximum of its economic product under a certain management regime (Dickman 1985).
- Ideotype has been defined and applied for some agronomic crops, fruit trees, and conifer species, but never for a fine hardwood species, such as black walnut.
- Crown architecture is one important component of the ideotype. It refers to the shape of the crown and the spatial pattern of its composition. (Poorter et al 2006)

Objectives

- We hypothesized that these black walnut clones will vary in:
 - Growth of diameter at breast height (DBH), height, and crown dimensions;
 - Branch angle and branch density (number of branches per unit of height)
 - Projected whole tree leaf area.

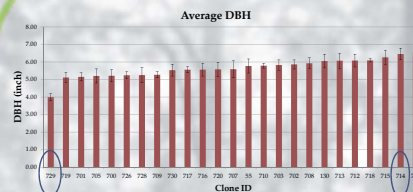
Methods

- The 25 black walnut clones (5 to 10 trees per clone, total 212 trees) were planted in 2002 in West Point, IN, and managed by ArborAmerica, Inc.
- Five – ten trees were randomly selected from each clone for study.
- DBH, height, and crown dimensions were measured in the end of 2010 growing season.
- Branch number, diameter (including pruning scars), angle (between branch and stem), and branch height were measured at the end of 2010 growing season.
- Cluster analysis (K-means) was performed.

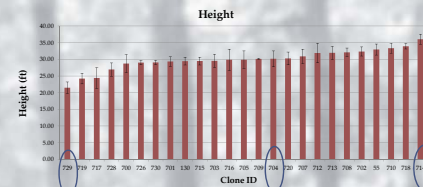


Results

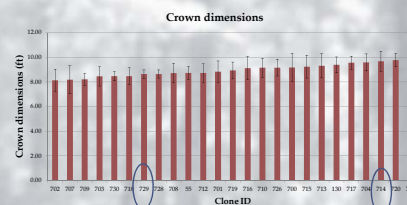
1. DBH



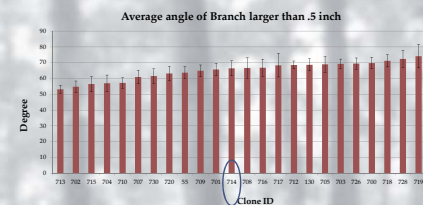
2. Height



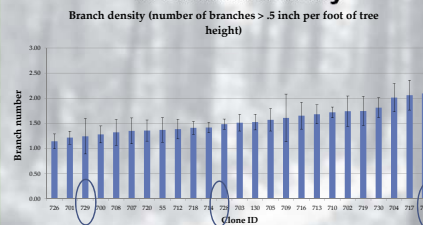
3. Crown dimensions



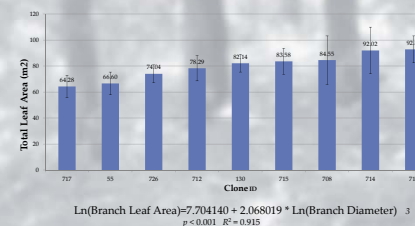
4. Branch angle



5. Branch density



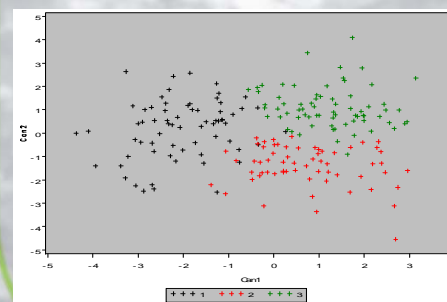
6. Projected whole tree leaf area of selected clones



$$\ln(\text{Branch Leaf Area}) = 7.704140 + 2.068019 * \ln(\text{Branch Diameter})$$

$p < 0.001 \quad R^2 = 0.915$

7. Architectural groups



8. Grouping results

Clone groups	Height (ft)	DBH (in)	Crown dimensions (ft)	Avg. Branch Angle	Quantity of branches
1. 700, 701, 703, 705, 708, 712, 719, 720, 726, 728, 729, 709					
Sparse	29.26	5.43	8.84	68.78	38
2. 702, 704, 710, 713, 715					
Dense	31.51	6.13	9.15	57	61
3. 130, 55, 707, 716, 717, 718, 730, 703, 714					
Moderate	31.55	5.92	9.08	64.12	49

Discussion/Conclusions

- There are significant differences ($P \leq 0.001$) in DBH, height, crown dimensions, branch density, branch angle, and projected whole tree leaf area between contrasting clones, indicating a certain set of traits may be chosen from those characteristics for the crown ideotype.
- Clone 714 is the best clone in terms of growth performance and timber quality, while 729 is the worst in terms of DBH and height.
- Three architectural groups were obtained by K-means cluster analysis. Although the lines between groups are somewhat vague, we have three types of crowns: dense, moderately dense, and sparse.
- It has been found that clones with dense crown often have smaller branch angles as well, while the sparse crowned trees tend to have larger branch angles. Those trees with larger DBH may indicate higher growth efficiency.
- In the next steps, degree of taper will be evaluated on those clones due to its importance on timber quality. Also, genetic analysis will be conducted to verify the crown ideotypes. Diversity analysis, parentage analysis, clonal identification may be performed also to enrich the knowledge base for black walnut ideotype research, and future ideotype breeding may benefited from this.

Acknowledgements

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References

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