

# The Application of Clonal Propagation to the Genetic Improvement of the American Hazelnut – A Holistic Approach

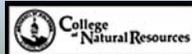
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## Holistic Approach for Genetic Improvement Of The American Hazelnut

- Define end goals
- Keep the focus with these end goals in mind
- Avoid avenues that may seem to contribute, but will not lead towards meeting the end goals (dead ends?)
- In woody plants, clonal propagation is instrumental in achieving rapid gain

## **Define End Goals For American Hazelnut Improvement**

- **Provide growers with high quality, uniform planting stock of “elite” selections for efficient and profitable production of hazelnuts in the Upper Midwest**
- **“Elite” selections will have these traits (among others):**
  1. **Superior and reliable nut yields**
  2. **Superior and reliable nut quality**
  3. **Superior ease-of-culture with performance expected at most sites throughout the Upper Midwest**
    - **Multiple selections will likely be required to cover different sites and to provide cross pollination**

## **Must Have A Horticultural System Upfront Before Selection Begins**

- **Currently a wild crop**
- **Must have a clonal propagation system just to define the horticultural parameters before evaluations can begin**
- **But we do not have to totally reinvent the wheel to start defining those parameters**
- **Blueberry systems are reasonably close to that envisioned for American hazelnut**

## Highbush Blueberry Hort Systems From Micropropagation To Harvest

- The following set of slides show many aspects of blueberry horticulture that are worthy of emulating for hazelnut
- Note in these slides:
  - The high quality of the planting stock
  - The very high uniformity of the planting stock and the plant response after planting
  - How this uniformity allows for a high degree of mechanization

## Blueberry Micropropagation



Ability to micropropagate may be considered a desired trait during selection because MP is essential for virus free stock

## Large Scale Blueberry Greenhouse Plant Production From MP Stock



## Blueberry Liners From MP Stock



## Field Ready Plants In 1 Gal. Pots



Note: Each block may be a different cultivar

## Larger Plants In 3 Gal. Pots



## Planting On A Small Scale



## Planting On A Larger Scale



## After Planting Irrigation



## Two-Line Drip Irrigation



Definitely desirable for American hazelnut production

## Organic Mulch Application



## Black Plastic Mulch



Definitely desirable to have some kind of mulch

## Clean Cultivation



It is likely that between rows will eventually be planted with grass

## Fertilizing



High degree of uniformity allows easy access with large equipment

## Blueberry Plantation In Flower



## Mechanical Harvesting



## Highbush Blueberry Harvester



## Modifications Will Work With Hazels



## But Cannot Justify If Non-Uniform!



## Maximizing Uniformity Aids A Highly Developed Horticultural System



## **Key Stages Where Clonal Propagation Will Facilitate Genetic Improvement**

- **Development and refinement of horticultural parameters**
- **Initial evaluations of wild selections in a properly defined horticultural setting**
- **Subsequent evaluation of breeding progeny**
- **Clonal replication insures that any differences observed are controlled for Genotype x Environment interactions**

## **American Hazelnut Shoot Cultures**



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**For initial horticultural system evaluations we started with an unselected, but easy to culture clone**

## American Hazelnut Micropropagules



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Tiny microplants will provide continuous growth, which yields higher quality plants compared to conventional propagules

## Extremely Uniform MP Plants



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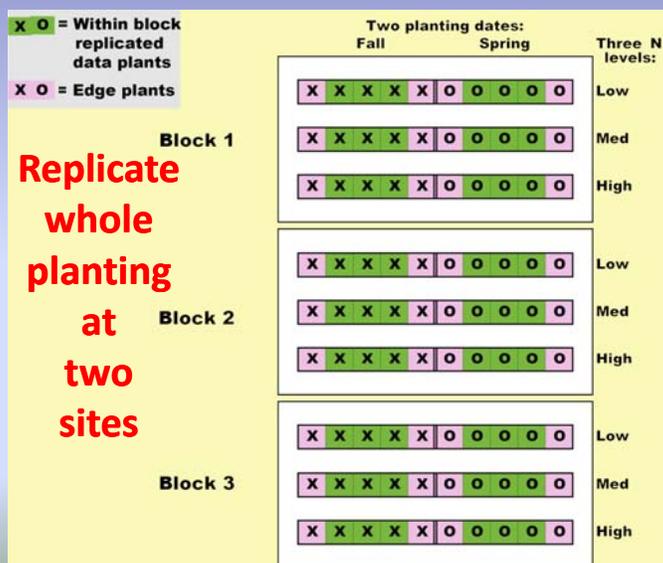
## Extremely Uniform MP Plants



## Initial Horticultural Parameters Evaluated

- Start with hilled blueberry system, two-line drip irrigation, deep mulch and uniform, high quality plants of a single clone
- Three things to test first:
  1. Micropropagated hazel plant survival rate (must be very high to analyze the following)
  2. Fall versus spring planting
  3. Nitrogen fertilization levels

## Experimental Design For Hort Parameters



## Horticultural Parameters Testing

- Measure survival rate
- Measure growth rate
- Evaluate establishment
- Evaluate any differences in plant form (e.g. branching)
- Statistically determine parameter effects on plant growth and form



**Cannot do this with any degree of certainty without clonally propagated plants!**

## Next Step – Replicate Wild Selections and Plug into Horticultural System

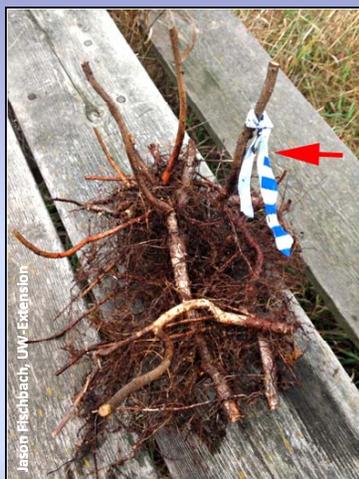
- Identify likely superior plants from the wild based on nut cluster quantity, nuts per cluster and nut size (still ongoing)
- Sacrifice above ground parts and carefully dig bases directly attached – must insure no other genotypes have grafted underground
- Perform collar divisions as the first step in clonal replication (collar region is where root meets shoot)

## American Hazelnut Collar Divisions



Can easily generate three plants from this clearly attached clump

## American Hazelnut Collar Divisions



A more difficult clump where the flagged stem (red arrow) was in fact not attached to the rest of the clump

## Successful Collar Divisions



This is one set of nine wild selections which are also replicated in two other locations through collar divisions

## Successful Collar Divisions



The growth emerging from underground basal buds is particularly desirable for the potential to propagate

Growth is starting to emerge in the greenhouse after suitable cold period to satisfy dormancy



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## Further Steps Summarized

- Use replicated testing of wild clones in proper horticultural system to select parents
- Seedling populations are ideally evaluated using at the very minimum two replicates of each genotype, even better → **Two 3-plant blocks**
- Use transplants that mimic the form and ideally the methods envisioned for that of the final clonal propagation system
- All the while continue to improve horticultural system and plant evaluations along with this

## Target Young Lateral Buds As Source Of Potential Clonal Propagules From Seedlings



Idea: manipulate seedlings to induce six lateral stems and perform layering to recover enough plants for the desired two 3-plant blocks

## Final Steps For Release To Growers

- High performing stock could be released either directly from wild selections or after one or more rounds of breeding
- Feasible clonal propagation systems must be in place to expand testing of selections with sufficient numbers of plants at multiple sites
- Final clonal propagation must be commercially feasible for nurseries to be able to supply stock
- Ability to micropropagate may be part of the selection pressure if no other viable clonal propagation system can be developed

## Summary Of A Holistic Approach To The Genetic Improvement Of The American Hazelnut

- 1) End goal is to provide growers with high quality plants of proven, elite hazelnut clones
- 2) Micropropagation is being used to rapidly generate a large number of uniform clonal plants to help define an appropriate horticultural evaluation system
- 3) Collar divisions will aid in the recovery and testing of wild selections
- 4) Progeny testing should utilize a simple clonal propagation system that matches the anticipated final propagation system
- 5) Final propagation system must be able to supply growers with high quality, uniform plants that is feasible for a commercial nursery to employ

## Questions?



Feedback desired, please!!! Email comments to Eric Zeldin at [elzeldin@wisc.edu](mailto:elzeldin@wisc.edu) and include "Holi Hazel" in the subject line