#### Pecan Tree Breeding: Challenges and Opportunities of Breeding a Newly Domesticated Crop

#### Dr. Patrick Conner : University of Georgia

Pecan – Carya illinoensis

Juglandaceae family – includes pecans, hickories, walnuts.





#### History of Pecan Production

- Collected from wild and a few seedling orchards prior to 1880's.
- First grafted trees sold in 1880's.
- Boom in orchard planting in Georgia in early 1900's due to land speculation.
- Some of these orchards are still in production.

# Pecan Production Regions



# Floral Biology

- Monoecious (male and female flowers).
- Dichogamous (flowers mature at different times).
- Wind Pollinated
- Inbreeding Depression



## **Characteristics of Pecan**

- Heterozygous
- Clonally propagated
- Seedling rootstock



# Severe inbreeding depression prevents development of inbred lines

## Pecan genetics

- Pecans cultivars are much like people, each is genetically unique.
- When you cross two cultivars you get a lot of variation in the seedlings. Like children, they will resemble their parents, but they will also show much variation.
- Most seedlings will be worse than the worst parent, so you need to look at a large number of seedlings to find a truly good one.

"Quantity makes Quality"



#### Pawnee x Elliot seedlings



#### **Nuts / Pound**

Pawnee = 52 nuts / pound Elliot = 77 nuts / pound

# **Breeding Strategy**

#### **Recurrent Mass Selection**

- 1. Select superior seedlings from chance populations.
- 2. Hybridize among best selections.
- 3. Selection superior offspring for use as parents in the next cycle or as cultivars.

#### **Goals of the pecan breeding program**

- Increase pest resistance
- Stabilize production
- Increase quality
- Change harvest date
- Increase productivity



'Gloria Grande'





### Nuts and bolts of pecan breeding



#### **Pollen Collection**



# **Pollination Technique**











# Seedling Evaluation Phase I

- Initial Screen
  - 10 year selection cycle
  - Evaluate for:
    - nut size and quality
    - tree vigor
    - earliness
    - disease resistance
    - insect resistance



#### Seedling Nursery, 2 years







#### Seedling Orchard Year 1



#### Seedling Orchard – Year 3



#### Seedling Orchard – Year 6



## **Seedling Evaluation Phase I**

#### Initial Screen

- Evaluate for:
  - nut size and quality
  - tree vigor
  - early harvest
  - disease resistance
  - insect resistance





#### **Seedling Evaluation Phase II**

- Propagate best selections for replicated trials
- Compare to elite cultivars

   tree productivity
   alternate bearing intensity
- Use best new selections as cultivars or parents in breeding program.



#### Where are we now?

- Program started in 1999.
- New crosses made each year.
- 106 controlled crosses.
- 10,000 seedlings screened.
- First nuts produced from the 1999 crosses in 2006.





#### **DNA Markers for Pecan Breeding**



DNA markers are signposts along the chromosomes.

If a marker is close to a gene of interest, the marker can be used to select for the gene.



#### Large progenies of pecan are expensive and time-consuming to evaluate.



Each seedling requires 150 square feet (290 trees / acre) for 10 years to be evaluated.



#### **Marker-assisted Selection of Nut Traits**

 Select trees at the seedling stage - may save years of time and expense
 – Nut Size, Harvest Date, Flowering Type



#### **Space limit = 4,000 trees**

• 0 markers – Select from 4,000 seedlings.

 1 marker that eliminates ½ trees. Select from 8,000 seedlings.

 2 markers that each eliminate ½ trees. Select from 16,000 seedlings.



Genetic maps were created for the 'Pawnee' and 'Elliot' pecan using RAPD and AFLP DNA markers.

#### Pawnee:

Large nut size Early maturity Protandrous Scab susceptible



Elliot: Small nut size Protogynous Highly scab resistant



#### **Markers Linked to Genes**





### **Future Work**

- Establish linkages to other important genes

   Scab resistance
   Nut Size
   Harvest Date
- Develop maps for other cultivars



