Agent Training, January 5, 2017, Savannah, GA

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Small Fruit Cultivars: What’s Tried and True, What’s New and What’s in the Pipeline?

Blackberries

John R. Clark
Distinguished Professor of Horticulture
Cutting to the Meat of the Matter

• Folks in the South call and ask me: “Which of the Arkansas blackberries should I plant” If they don’t have prior info, right now I say:
  – Ouachita
  – Natchez
  – Osage
Further Cutting to the Meat of the Matter

• They then ask “some more than others as far as plant numbers or area?” and I say:
  – Ouachita – 1/2
  – Natchez - 1/4
  – Osage -1/4
  – Of an area (such as an acre)
Further Cutting to the Meat of the Matter

• They then ask “I have heard of so and so variety, should I consider that one?” and I say:
  – Tell me what you have heard
  – Where did you hear it
  – Then I spread out to consider other options based on what they know, their specific expertise, weather, location, market, etc
Blackberry Cane Fruiting Types

Floricane fruiting – no flowers on primocanes; summer season fruiting.
The standard type for the SOUTH

Primocane-fruiting – fruiting on first-year canes, autumn season; Almost all world blackberry production is floricane-fruiting. The first primocane-fruiting production commercially appeared Five years ago. Challenging in the PC crop production in the SOUTH
Today’s Focus

• Major Arkansas varieties
• Other varieties I hear about
• Comments on new ones coming
• A few key criteria I use to guide variety selection
Ouachita – The Arkansas Standard

- The most widely planted and adapted
- Consistent production
- Over 2 million plants sold 2010-2016
- *If you plant one Arkansas variety, plant this one*
Ouachita – Other Comments

- Berry size 6-7 g
- Excellent shipping capability
- Reduced acidity
- Mid chill
- Good hardiness
- Working well on the RCA/Shift Trellis
- Just not a lot of complaints on this one!
Natchez – Start out BIG

- Over 1.3 million plants sold since 2010
- Earliness is the key, a week before Ouachita
- Quite low chill (300 hours?)
- Very high yield potential, don’t let it overcrop
Natchez

- Can be tart early, can be the BEST also; 9.5% soluble solids, higher and lower

- Large, fills the clamshell mighty quick; Berry size large, 8-10 g or more; remain large season-long

- Postharvest handling a little trickier, more reversion and softer than others; pick and handle early in the day to avoid heat impacts
Natchez

- Working well on RCA/Shift trellis yield-wise
- Still one of my favorites of all to pick and tote home
Osage—The Newest Arkansas Thornless, Floricane-fruiting Blackberry

- Released in 2012, over 300,000 plants sold thus far
- Ripens (In Ark.) between Natchez and Ouachita, ave. June 10 beginning harvest – a COMPLEMENT TO OUACHITA
- Yields have been consistent and good, comparable to higher than Ouachita
- 5 – 6 g, slightly smaller than Ouachita
- Flavor is a key attribute of Osage, lower acid flavor with notable flavor components coupled with high soluble solids
- Great postharvest handling potential
Osage

• Folks are saying “The FLAVOR IS GREAT – BRING THAT ONE HOME!!”
• Packs really easy particularly in smaller clamshells due to fruit size and shape
• The best plant health!
• Not many reports on Osage on the RCA/Shift trellis
• *This one is worth trying if you have not considered*
Apache

- Over a half a million plants sold 2010-2016, though an older variety (1999)
- Ripens after Ouachita and Navaho, a key value
- Good yields, good plants and great flavor
Apache

- Very good postharvest potential
- High chill, 800 hours – not for the deep SOUTH!!
- White drupe limitation is a major concern and at one time, shippers were not recommending this variety
- Reports are is working well on RCA/Shift trellis as this reduces light exposure and greatly reducing white drupes
Navaho

• Patent has expired so no plant sales data reported
• Not likely as widely planted now
• Value is later, good storer, flavor
• Produces basal buds that can fruit later, can be of value....
Navaho

• No comments on RCA/Shift trellis available
• Orange rust always a concern...size can be small
Kiowa

• Sold about 200,000 plants since 2010 (older release, from 1996)
• Thorny, semi-erect
• Very large, 9-14 g (ave. 12 g)
Kiowa

- Postharvest potential fair but not for shipping
- Chilling 200-300 hours – among lowest of Ark. Group
- No RCA/Shift trellis comments – thorns undesirable
- Mentioned today as still has some strong following, particularly in Alabama
Von – from NC State Univ
Von

- ‘Von’ produces fruit in the mid-late season, with average date of harvest in NC commencing in the third week of June, peaking in the second week of July and ending the first week of August.
- In post harvest evaluations, when blackberries were held 7 days at 4 C, 90% RH in pint clamshells, ‘Von’ had a marketable score of 90.6, which is as good or better than the leading commercial cultivars.
- Soluble sugars content of ‘Von’ was 9.4% and pH was 3.6, traits that characterize ‘Von’ as sweet with low acid.
- Ervin Lineberger comments it has strong in primocane growth and plant longevity; and a recommendation over Navaho for later season now
• Dr Fernandez, yo baby!
• Saw LOTS of fruit on it near Lincolnton, NC early June when many varieties with half a crop or so; break buds later
Chester Thornless

• USDA Beltsville, MD, 1985
• Thornless, semi-erect
• Medium, 5-7 g
• Ripe 10 July
• Yield very high-25,000 lb/a (not in Arkansas)
• Flavor  fair to good, among best USDA thornless; 8-9% SS

• Postharvest handling excellent–commercially among the most important in the world
• **Hardy; a more northern variety**
• **High chill so be careful in the South**
• **Quality concerns…tart often**
Triple Crown

- Thornless, semi-erect
- Medium-large, 6-8 g
- Ripe late July – 10 Aug.?
- Yield high
- Flavor probably best among USDA thornless; local sales a key option with TC
- Postharvest handling does not appear adequate for shipping; local market option
- Hardiness? Have had reports of less hardy than Ouachita, some say hardy in the North
Blackberry Planting Considerations

• Order of ripening, Clarksville, Arkansas
  – Natchez: June 5
  – Osage: June 10
  – Ouachita: June 12
  – Navaho: June 20; Von similar likely?
  – Apache: June 25
  – Triple Crown: June 30
  – Chester: July 10
Others, Skipping Details Today

- Comanche
- Cherokee
- Cheyenne
- Shawnee
- Choctaw
- Arapaho
- Chickasaw

- Black Satin
- Hull Thornless
- Dirksen Thornless
- Brazos
- Tupy
- Oregon Varieties
What About Primocane-Fruiting Varieties?

• Prime-Ark®45 is the most planted variety
• This one and all others continue to suffer in the Arkansas heat in primocane fruit set and quality
• Some pretty good success in NC, not in GA, potential in higher elevations
• In general the PC crop is less than the FC crop on the PF varieties as of now
– ‘Prime-Jim®’ and ‘Prime-Jan®’
– ‘Prime-Ark® 45’
– ‘Prime-Ark® Freedom’
– ‘Prime-Ark® Traveler’
Prime-Ark® 45

- The largest Arkansas seller, over 2.5 million plants sold 2010-2016
- Most planted in California
- Thorny, primocane fruiting
- Large, productive; floricanes and primocanes (in moderate climates) produce fruit
- Is changing the production of blackberries in the late summer and fall months in the US
Prime-Ark® 45

- Value of floricane fruit can be high due to very early and high quality – is being used some in the South for this
- No info on RCA/Shift trellis use – thorns an issue
- **Make sure PF blackberries work where you are...**
Prime-Ark® Traveler

- 150,000 plants sold since 2014 release
- Great fruit quality and intended for shipping market
Prime-Ark® Traveler

- Medium size – 7 g
- 9-11% SS, reduced acidity
- No info on RCA/Shift trellis use
- Just learning about this one, not as precocious as Prime-Ark® 45
## Comparing Prime-Ark 45® and Prime-Ark® Traveler

<table>
<thead>
<tr>
<th><strong>PA 45</strong></th>
<th><strong>PA Traveler</strong></th>
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<tbody>
<tr>
<td>Thorny</td>
<td>Thornless</td>
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<tr>
<td>7-9 g berry; can be jumbo</td>
<td>7-8 g berry; uniform</td>
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<td>Yield often higher</td>
<td>Yield equal to lower</td>
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<td>Nice flavor, some bitterness, SS 10-12%, sub-acid</td>
<td>Nice flavor, no bitterness, SS 10-12%, sub-acid</td>
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<tr>
<td>Double fruit tendency in heat</td>
<td>Double fruit rare in heat</td>
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<td>Double tipping required</td>
<td>Double tipping required</td>
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<tr>
<td>Data indicate comparable reversion, leak and soft to PA Traveler</td>
<td>Data indicate comparable reversion, leak and soft to PA 45</td>
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</table>
Prime-Ark® Freedom

• Over 200,000 plants sold since 2013
• FC crop ripens 7-10 days before Natchez – really early
• 9-11% SS
• Primocane berries up to 16 g in (cool places)
Prime-Ark® Freedom

- Intended for home garden or local-market use, due to not good storage performance
- Is low chill, and showing promise in Florida!
- No RCA/Shift trellis information
So, What’s Coming in New Floricane-Fruiting Varieties?

• Major areas of focus
  – Making them taste even better
    • Aromatics
    • Sweetness
    • Reduced acidity
  – Complements to Natchez, for earliness
  – Diversity of varieties throughout the season
  – Healthy plants, productive
  – Later varieties a challenge to develop that have target flavor
So, What’s Coming in New PF Varieties?

• Major areas of focus
  – Fruit firmness and postharvest handling
  – Thornlessness
  – Earlier ripening PCs
  – Healthy plants, varied architecture?
  – Increased yield and precocity; intensification of the PF trait
  – Continuing to move traits from FF genotypes including crispy, low acid, various other traits
Further Variety Choice Criteria

• Fruit use/market
• Season of ripening/marketing
• Any specific problems in production area
  – Orange felt, algae; spur blight; viruses
• What works already in a area – well established success
Blackberry Planting Considerations

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Comments on “Other” Technologies

• Rotatable Crossarm Trellis – also called the Shift Trellis – Pictures from Georgia, 2016
Comments on “Other” Technologies

• High Tunnels – heat a big issue, success in NC
Final Comment, Common Sense

• NOTHING beats healthy plants to overcome problems tho.....clean stock, well cared for, no winter injury, not “old” plantings, top notch management pays off...time and again!
Arkansas Fruit Breeding-Still More Good Things Coming! For 53 Years!!!!
AND THANKS FOR YOUR TIME and SHARING ABOUT ARKANSAS BLACKBERRIES!
jrclark@uark.edu
Thoughts on Blueberry Cultivars for The Southeast

Bill Cline
Entomology & Plant Pathology
North Carolina State University
Horticultural Crops Research Station
Castle Hayne, NC
Blueberry Types/Species

- **Rabbiteye** (*Vaccinium virgatum* syn. *V. ashei*) native to deep South, hexaploid 6X
- **Highbush** (*Vaccinium corymbosum*) “Northern highbush” domesticated in NJ, but also native into the South; tetraploid 4X
- **Southern highbush** (*Vaccinium corymbosum* X ?) complex interspecific hybrids with lower chill requirement, greater soil adaptability
- **Pentaploid** 5x between rabbiteye & highbush
Limitations on use of blueberry species and cultivars (NC examples):

- **Soil adaptability** = rabbiteyes are the best choice for Piedmont, homeowner, PYO
- **Winter hardiness** = northern highbush best choice in WNC mountains above 2500 ft
- **Chill requirement** = (i) some cultivars @ less than 350 hrs do really well in areas of FL and CA but are too risky for SENC (Snowchaser, Ventura, Jewel, Emerald, etc.), while (ii) some N. highbush do not get enough chilling in SENC to bloom and leaf normally (Bluecrop, etc.)
Further limitations – “I wouldn’t grow that one because…”

- Stems don’t detach
- Cracking
- Wet stem scar
- Too soft
- Poor flavor (esp. tart)
- Disease
- Color (too dark)
- Size
- Poor bush survival
- Market prejudice (species, size, color)
- Ripens too late
- Yield not consistent
- Yield too low
- Won’t machine pick

See NC “short list” on handout
LOCAL testing & evaluation is very important – esp. on-farm with growers

Mike Mainland, Hort Sci Emeritus Prof.
### Blueberry harvest timing by cultivar in southeastern NC (*NCSU)

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<th>Cultivar</th>
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**EARLY >>> MIDSEASON >>> LATE**

HIGHBUSH    SOUTHERN HIGHBUSH    RABBITEYE
The best native NC blueberry soils are organic sands (>3% organic matter) with a water table within 12-24” of the surface; fields are bedded to improve root aeration.
Early-ripening southern highbush in bark beds, south Georgia, 2009
Bark mulch added to increase organic matter, lower pH and improve drainage (note raised beds)
Surface mulch holds moisture and suppresses weeds. Use organic mulch (bark, wood chips, pine straw), black plastic, or weed barrier fabrics.
Earliest Cultivars (NC)

- Standard – O’Neal, Star
- Emerging – Rebel, Suziblue
- What’s next? – FL98-325 (Indigocrisp), TH 948 (Miss Lilly), Meadowlark, Georgia Dawn?
O’NEAL -- Southern highbush cultivar, released by NCSU. Early ripening, fairly good soil adaptation, Extended bloom period reduces freeze risk. ‘O’Neal’ is planted world-wide. Susceptible to blueberry stem canker.
Early Midseason Cultivars

- Standard – Croatan*, Duke, New Hanover
- Emerging – Farthing, Abundance, San Joaquin
- What’s next?

*Phasing out rapidly
DUKE – Northern highbush, short bloom-to-ripe interval, early and productive. May not chill adequately some years in SE NC, requires careful pruning to prevent over-cropping. Tight clusters, mild flavor.

Coastal Plain - YES
Piedmont - MAYBE
Mountains - YES
**FARTHING** – good for machine harvest, productive, compact plant, but fruit has green/red backs at time of harvest – hold at 70 F for a day to allow them to turn blue?
Midseason Cultivars

- Standard – Legacy, Premier
- Emerging – Camellia, Robeson
- What’s Next? – TH 917 (Miss Jackie), Gupton, Vernon
LEGACY -- Southern highbush from USDA, developed in NJ. Ripens early June in southeastern NC and is widely soil-adapted -- a possible choice for marginal sites.

Coastal Plain - YES
Piedmont - MAYBE
Mountains - ????
GUPTON  southern highbush from USDA/ARS, Poplarville, MS, 2012. Same pedigree as Camellia (MS-122 × MS-6). Possible machine-harvest cultivar. SHB in Rabbiteye window in NC. Susceptible to mummy berry!
ROBESON -- Pentaploid, 2005. 400-600 chill hrs, potential for upland sites, earlier than Premier. Fruit soft and unlikely to ship well fresh.
ROBESON has found a place with PYO growers wishing to produce berries ahead of rabbiteye season on marginal soils. Highbush berry qualities but too dark and soft for fresh shipping. Possible processing berry for growers phasing out rabbiteye cultivars.
Krewer 10 June 2016 – new rabbiteye from UGA – would like to see tested widely
Mid- to Late-Season Cultivars

- Standard – Brightwell, Columbus, Tifblue, Powderblue
- Emerging – Onslow?
- What’s Next? – Overtime, Ochlockonee
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<th>Blueberry harvest timing by cultivar in southeastern NC (*NCSU)</th>
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Muscadine Cultivar Recommendations

Dr. Patrick Conner – UGA Horticulture Dept.
Muscadine Production Regions

Generally require 100 days to fruit.

Growing region rarely falls to 0-10 °F.

Frost is seldom a problem due to late flowering.
Choosing a muscadine cultivar.

Muscadines cultivars can be female or self-fertile (perfect) flowered.

If you only want one vine, make sure it is self-fertile!
Choosing a muscadine cultivar.

1. Juice or fresh eating?

- Wine/juice cultivars need high yields and good brix, berry size and skin toughness is unimportant.

- Fresh-market grapes need to be large, firm, with a dry picking scar. Newer cultivars have a crisper skin.
Choosing a muscadine cultivar.

2. Flower type.

- Yield of female vines reduced due to “cap-stick”, smaller cluster size, lack of pollination. Female cultivars may have only about ½ yield of self-fertile cultivars.

- Female vines are still grown because they often have bigger berries and better eating quality than self-fertile vines.
Choosing a muscadine cultivar.

3. Berry size.

- Self-fertile cultivars are usually smaller than female cultivars, but more consistent in size.
- Minimum size needed = 10-11 grams, 1 inch diameter.
- Clamshell berries can be smaller than boxed berries.
Choosing a muscadine cultivar.

4. Dry stem scars and firm flesh.

- Torn and split berries are often juiced rather than packed. Often juice up to 1/3 of cultivars with wet scars.
Choosing a muscadine cultivar.

5. Vigorous, disease resistant vines.

- Much easier to grow purple varieties as they seldom have much trouble with fruit rots. Bronze berries will rot if not sprayed well, especially when grown in the coastal plains.
Recommended fresh market purple cultivars.

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<thead>
<tr>
<th>Season</th>
<th>Cultivar</th>
<th>Flower type</th>
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<tbody>
<tr>
<td>Early</td>
<td>Lane</td>
<td>Self-fertile</td>
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<td>Mid</td>
<td>Supreme</td>
<td>Female</td>
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<td>Mid</td>
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<td>Ga. 6-2-26</td>
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<td>Late</td>
<td>Nesbitt</td>
<td>Self-fertile</td>
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</table>
Prominent features of ‘Lane’ muscadine

• ‘Lane’ has moderate vigor and productivity.
• Size is similar to other self-fertile cultivars (9 g).
• Currently the only self-fertile early black cultivar.
• Berries have a very firm flesh and hold on the vine well with high brix.
‘Lane’ recommendation

‘Lane’ has moderate yields and can split at the stem scar. We currently recommend planting ‘Lane’ for early season black production and transitioning into ‘Supreme’ for main season black production.
Prominent features of ‘Supreme’ muscadine

• Most popular fresh market cultivar.
• Excellent size (15 g) and fruit firmness with crisp skin.
• Vine vigor is low, and heavy cropping can stunt vines.
• Berries often split on picking scar.
• Cold-hardiness is not good.
‘Supreme’ recommendation

The size and quality of ‘Supreme’ currently makes up for its fussy growth habits. Growers should reduce crop load if vines set too many berries or vine death can occur. Growers in northern regions may see heavy losses in cold years.
Prominent features of ‘Delicious’ muscadine

• Medium size (10 g).
• Self-fertile.
• Can overcrop badly.
• Tough skin and soft pulp.
• Available mostly from Florida nurseries.
• OK for clamshell sales.
Prominent features of ‘Nesbitt’ muscadine

• Self-fertile flowers.
• Mid to late season cultivar.
• Good cold hardiness and disease resistance.
• Soft pulp and tough skin.
• Very useful for home garden or pick-your-own.
Coming Attractions: Ga 6-2-26

- Self-fertile flowers with a size (15g) similar to female cultivars.
- Main-season self-fertile replacement for ‘Supreme’.
- Excellent storage ability.
- Excellent picking scar.
### Recommended fresh market bronze cultivars.

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<td>Early</td>
<td>Hall</td>
<td>Self-fertile</td>
</tr>
<tr>
<td>Early</td>
<td>Early Fry</td>
<td>Female</td>
</tr>
<tr>
<td>Mid</td>
<td>Fry</td>
<td>Female</td>
</tr>
<tr>
<td>Late</td>
<td>Granny Val</td>
<td>Self-fertile</td>
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<tr>
<td>Late</td>
<td>Late Fry</td>
<td>Self-fertile</td>
</tr>
</tbody>
</table>
Prominent features of ‘Hall’ muscadine

- ‘Hall’ has good vigor and productivity.
- Better brix and flavor than ‘Tara’.
- Very good picking scar, low percentage of splits and tears.
- Color is more yellow than other bronze cultivars.
- Size is similar to other self-fertile cultivars (10g).
Prominent features of ‘Early Fry’ muscadine

- Female vine with large berry size (15g) and very good flavor.
- Berries are often somewhat dirty in appearance.
- Variable productivity.
Prominent features of ‘Fry’ muscadine

• Main season female cultivar.
• Large size (13 g) and great flavor, even when picked before peak ripeness.
• Variable productivity.
• Very disease susceptible and wet picking scar.
• Growers want a replacement, we don’t really have one yet.
Prominent features of ‘Late Fry’ muscadine

- Late season self-fertile cultivar.
- Fruit rot is an issue.
- Soft berry with a wet scar.
Prominent features of ‘Granny Val’ muscadine

- Late season self-fertile cultivar.
- Can be over-productive.
- Flavor is average to poor.
- Better disease resistance than ‘Late Fry’.
Juice Cultivars

- 'Noble' – Small purple grape. Extremely vigorous and disease resistant. Holds juice color better than most muscadines. Poor fresh fruit value.
Juice Cultivars

• ‘Carlos' – Small bronze grape. Extremely vigorous and productive. Only good for juice.
Information Sources

• Google “UGA Muscadine Breeding” for cultivar information.

• Sources of plants
  – Ison’s Nursery
  – Bottoms Nursery
  – Agri-starts
Wine grape variety considerations for the southeast US

Dr. Tony K. Wolf
Viticulturist
Virginia Tech
Challenges /considerations

- Response to heat and winter cold (thermal “fitness”)
- Pierce’s Disease tolerance
- Overall disease tolerance
- Wine quality potential
- Consumer variety name recognition
- Crop value (important for independent grape producers)
**Vitis taxonomy**

- **Vitis**
  - **Euvitis** "True grapes"
    - *Vitis vinifera* Middle asia origin (e.g., 'Chardonnay')
    - *Vitis aestivalis,* *Vitis labruscana* and other North American spp. (e.g., 'Concord')
  - **Vitis amurensis** and other Asiatic spp.
  - **Muscadinia**
    - *Vitis rotundifolia* (e.g., 'Carlos' and 'Scuppernong')
  - Interspecific *Vitis* hybrids (e.g., 'Traminette')

---

Traminette
Principal reasons for grafting

- Confer vigor/vine capacity
- Confer tolerance to phylloxera
- Confer some field resistance to nematode-transmitted viruses (e.g., TmRSV)

Chardonel on own roots, 7 years old

Nodosity of grape root caused by phylloxera feeding
Rootstocks

Examples
- C-3309
- 101-14
- 420-A
- riparia Gloire
Climate/Maturity groupings, adapted from Greg Jones. It is based on the average growing season (Apr-Oct) temperature.

Insufficient heat:
- Unripe grapes; herbaceous character; elevated pyrazine levels, etc.

Excess heat:
- Cooked qualities; loss of aromatic flavor and aroma compounds, excessive alcohol, etc.
A few words about the quality of nursery material

- “Protocol 2010” material:
  - Micro-shoot-tip propagated and screened
- Foundation Plant Services and National Clean Plant Network
- “Certified” vs. non-certified plant material
- Have extension clients ask nurseries about the quality of their plant material
## Varieties

*Note: Some are “old”, some are “new”*

<table>
<thead>
<tr>
<th></th>
<th>Type</th>
<th>Color</th>
<th>Grafted?</th>
<th>Positive(s)</th>
<th>Negative(s)</th>
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<tr>
<td>Blanc du bois</td>
<td>Hybrid</td>
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<td>+ or -</td>
<td>PD tolerance</td>
<td>Wine quality?</td>
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<tr>
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<td>Red</td>
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<tr>
<td>Enchantment</td>
<td>Hybrid</td>
<td>Red</td>
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<tr>
<td>Mourvedre</td>
<td>Vinifera</td>
<td>Red</td>
<td>Yes</td>
<td>Very late bud burst</td>
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<tr>
<td>Norton</td>
<td>Aestivalis hybrid</td>
<td>Red</td>
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<td>PD tolerant in more northerly areas</td>
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<td>Opportunity</td>
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<tr>
<td>Petit Manseng</td>
<td>Vinifera</td>
<td>White</td>
<td>Yes</td>
<td>Good “wet weather” cv</td>
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<tr>
<td>Tannat</td>
<td>Vinifera</td>
<td>Red</td>
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<td>Traminette</td>
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<td>UCD 502 series</td>
<td>Hybrids</td>
<td>White</td>
<td>Yes</td>
<td>PD tolerance from V. arizonica</td>
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</tbody>
</table>
Parentage of ‘Enchantment’ red wine grape from University of Arkansas
Parentage of ‘Opportunity’ white wine grape from University of Arkansas

Photo credit, University of Arkansas
Susceptibility to other pests and diseases

- Fungal pathogens affect most vinifera, hybrids and muscadines to some extent
- Powdery and downy mildew
- Black rot
- Ripe rot (Colletotrichum gloeosporioides and C. acutatum
- Phomopsis
Summary

- Consider the principal challenges in your environment
- Consider consumer interest
- Understand that some recent releases have not had widespread trial over diverse geographic regions
- Hedge your bet with 2 or 3 varieties if vineyard space allows
Additional resources and grapevine nurseries


## Nurseries:

<table>
<thead>
<tr>
<th>Nursery Name</th>
<th>Location</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double-A grapevine nursery</td>
<td>Fredonia, NY</td>
<td><a href="https://doubleavineyards.com/">https://doubleavineyards.com/</a></td>
</tr>
</tbody>
</table>
Raspberries: Tried and True, New and in the Pipeline?

SRSFC Agent Training
January 5, 2017
Gina_Fernandez@ncsu.edu
Raspberries- Summer or Fall Fruiting?

• Summer-fruiting (Floricane)
  – Advantages
    • Earlier season?
  – Challenges
    • Hot summer harvest
    • Postharvest warm fruit
    • Fruit is softer than in fall
    • White drupelets
    • Pruning is time consuming (summer and winter)
    • Not adapted to Peidmont and CP
    • Loose vigor over time
Raspberries- Summer or Fall Fruiting?

- Fall-fruiting (Primocane)
  - Advantages
    - Pruning is easier
    - Potential for 2 crops per year
    - Suited for production where summers are cool if the growing season is long
    - Many cultivars to choose from
  - Challenges
    - Tunnel production highly recommended
    - Tunnels necessary to protect fruit in fall for frost
    - Harvest labor problems in fall
Raspberry varieties by NC region

• Mountains and foothills
  – Nantahala, Latham, Autumn Britten, Autumn Bliss, Caroline, Anne, Nova, Esta, Jaclyn, Josephine, Heritage
  – Himbo Top, Joan J?, Imara, Kweli and Amira (BP1)

• Piedmont
  – Southland, Dormanred, Mandarin
  – Caroline, Moutere on trial basis

• Coastal Plain
  – Dormanred
  – Mandarin on trial basis
Tried and True
Raspberry varieties by NC region

• Mountains and foothills
  – Nantahala, Latham, Autumn Britten, Autumn Bliss, Caroline, Anne, Nova, Esta, Jaclyn, Josephine, Heritage
  – Himbo Top, Joan J?, Imara, Kweli and Amira (BP1)

• Piedmont
  – Southland, Dormanred, Mandarin
  – Caroline, Moutere on trial basis

• Coastal Plain
  – Dormanred
  – Mandarin on trial basis
New
2016 observations

- Piedmont Research Station, Salisbury NC (near Charlotte) 4 plant plots
  - Amira (BP1): dead
  - Imara: small red fruit, not adapted, but alive
  - Kweli: Dead
2016 observations

• Upper Mountain Research Station, Laurel Springs NC, 3 plant plots
  – Amira (BP1): Weak plot, largest fruit of 3, flavor fair, Japanese beetle damage severe
  – Imara: Moderate vigor (least Japanese beetle damage), nice flavor, high potential yield
  – Kweli: Weak plants, medium size fruit, Japanese beetle damage, latest of 3
In-the-pipeline
Caneberries in Future?
Dr. Stafne liked

Fruit Growers News @FG... · 53s
Dale-Illa Riggs: I don't think there's any other way to grow raspberries other than under a tunnel. #NABerry

Fruit Growers News @FGN... · 3m
Cautions: Management for trellising, check all nozzles before application, wet berries at dusk. Commercially acceptable control. NABerry

NC State CALS Retweeted

NC Cattlemen's Assoc @N... · 5h
Primocane fruiting raspberry second year marketable yield data at the Piedmont and Upper Mountain research stations by treatment g/plant
Nantahala

Caroline
When it rains...
Thank-you!
Strawberries for the South: Tried and True, New and In the Pipeline

Gina E. Fernandez, Rocco Schiavone, Penny Perkins-Veazie and Guillermo Chacon-Jimenez
Tried and True
Tried and True

- Chandler
- Camarosa
- Sweet Charlie
Chandler

- UC, 1983
- Short day plant, early-mid season
- High yielding variety
- Produces large fruit
- Many culls due to irregular fruit early in season.
- Short shelf life
- Water damage issues due to thin skin
- *Why plant it? Industry standard, widely adapted, known performance*
Camarosa

- UC, 1993
- Short day
- Mid to late season
- Fruit is larger and firmer than Chandler, good flavor
- Can fruit over an extended period in warmer regions
- Good post harvest traits-can be used for local-market and shipping
- Low yields may be observed in cooler regions or after insufficient degree day accumulation
- *Why plant it? Better post harvest than Chandler*
Sweet Charlie

- UC, 1994
- Short Day
- 2 weeks of early fruit, then drops off
- Low yield
- Resistant to C. acutatum (fruit rot)
- Susceptible to phytophthora
- *Why plant it? 5-7 days earlier than Chandler*
<table>
<thead>
<tr>
<th>“New”</th>
</tr>
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<tbody>
<tr>
<td><strong>Short Day</strong></td>
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<tr>
<td>Benicia (2010/12)</td>
</tr>
<tr>
<td>Camino Real (2001/02)</td>
</tr>
<tr>
<td>Flavorfest (2012)</td>
</tr>
<tr>
<td>Fronteras* (2014/16)</td>
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<tr>
<td>Galetta (2010)</td>
</tr>
<tr>
<td>Greneda* (2014/16)</td>
</tr>
<tr>
<td>Merced (2013/14)</td>
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<tr>
<td>Palomar* (2007/08)*</td>
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<tr>
<td>Pentaluma* (2014/16)</td>
</tr>
<tr>
<td>Ruby June</td>
</tr>
<tr>
<td>San Andreas (2008/09)</td>
</tr>
<tr>
<td>Scarlet (2014/16)</td>
</tr>
<tr>
<td>Sensation (2013/14)</td>
</tr>
<tr>
<td>Sweet Ann (2009/12)</td>
</tr>
<tr>
<td>Winter Dawn (2005/10)</td>
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<tr>
<td>Winter Star 2011</td>
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<tr>
<td></td>
</tr>
<tr>
<td><strong>Day Neutral</strong></td>
</tr>
<tr>
<td>Albion (2004/06)</td>
</tr>
<tr>
<td>Cabrillo* (2015/16)</td>
</tr>
<tr>
<td>Lucia (2013/16)</td>
</tr>
<tr>
<td>Monterey (2008/09)</td>
</tr>
<tr>
<td>Portola (2007/08)</td>
</tr>
<tr>
<td>Radiance (2008/09)</td>
</tr>
</tbody>
</table>
“New” cultivars
Albion

• UC 2004
• Day neutral
• large to very large fruit. Fruit is mostly conical, very firm and red in color
• Flavor is very good
• Resistant to verticillium wilt, phytophthora crown rot and has some resistance to anthracnose crown rot
• Low yield for just spring crop
Benicia

- UC 2010
- Short day
- High yields
- Firm, flavorless
- It is disease resistant although is susceptible to Verticillium wilt
Camino Real

- UC 2001
- Short day
- Plants compact, open, and erect
- Fruit is larger and yields are somewhat greater than Camarosa
- Dark red external and internal fruit color darker than Camarosa
- Good flavor and appearance
- Low cull rate 7.84%
- Moderately susceptible to common leaf spot, resistant to Verticillium wilt and Phytophthora crown rot, and relatively resistant to Anthrascnose crown rot
Festival

- UFL, 2000
- Short day
- Nice mild flavor
- Low yield in 2015, comparable to Sweet Charlie
- Dominated FL until 2012
Flavorfest

- USDA 2012
- Top-yielding, large- fruited selection in the plasticulture - Beltsville, MD, BUT not in NC
- Excellent flavor, bright red, and plump
- Fruiting season in plasticulture is similar to that of 'Chandler,'
- Resistant to anthracnose, Colletotrichum accutatum, one race of C. fragariae
- Did not perform well in NC?
Galletta

- NCSU, released in 2010
- Early season and produces large berries
- Attractive, glossy fruit have excellent flavor
- It is rapidly growing in popularity in the midwest and northeast
- Too soft for southern climates
Lucia

- Lasson Canyon 2015
- Day Neutral
- Yield slightly more than Albion CCRS, lower than Albion, PRS (less than 1 lb/plant)
- Large fruit 17-25 g
- Can be acidic, burnished skin at CCRS
Merced

- UC 2013
- Short-day (June bearing)
- Similar to ‘Camarosa’ but with greater productivity.
- Higher quality fruit, less vigorous plant, and lighter colored fruit.
- Yield compared to Chandler
  - 77% CCRS, 90% PRS
- “Looks plastic”
Monteray

• UC 2008
• Day Neutral
• Yield compared to Chandler
  – 80% CCRS, 90% PRS
• Pretty, nice shape, good fill, some water damage
• #1 in CA in 2016
Portola

- UC 2007
- Day neutral
- First year observed
- 130, 96% yield compared to Chandler
- Firm, watery, light color
- 5 out of 9 flavor
- # 3 in CA in 2016
Radiance (Fortuna in EU)

- UFL 2000
- Short Day
- Adapted for winter production in Florida.
- 36 and 62% yield compared to Chandler (CCRS and PRS)
- Smaller berry on average
- Early season plant collapse can be caused by *Colletotrichum gloeosporioides* (Anthracnose crown rot)
- Highly susceptible to crown and root rots (*Phytophthora cactorum*)
- #1 in FL (59%) in 2016-17
Ruby June

- Lassen Canyon 2014
- Short Day
- 82 and 85 % yield compared to Chandler at CCRS and PRS
- Fruit size at PRS (24 g) and CCRS (20.6) statistically same as Camarosa
- Nice appearance, has potential
San Andreas

- UCD 2009
- Moderate day-neutral with a production pattern similar to Albion
- Fruit color is slightly lighter than Albion.
- Flavor may be an issue
- Yields higher than Albion
- Achenes are deep, crunchy, looks rough (2015 looked better)
- #2 in CA in 2016
Sweet Ann

- Lassen Canyon 2012
- Day-neutral strawberry
- 85 and 98% Chandler yield at CCRS, PRS
- 22-24 g berry
- Sweet fruit with an excellent flavor (HS kids)
- NCSU panels gave it a 5 out of 9 on flavor
- Blotchy in 2016
Scarlet

- Lassen Canyon 2015
- Short day
- 56 and 87% Chandler yield, CCRS and PRS
- 24 to 31 g fruit
- Has nice flavor despite lack of color
- Not red as name implies
Sensation

- UFL, 2013
- Short day
- 76 to 111% yield compared to Chandler
- 19 to 24 g berry
- Some protruding seeds, crunchy (in a good way)
- #2 in FL in 2016-17
Sweet Sensation® ‘Florida127’

• Commercial since 2014-15
• Large fruit size
• Excellent juicy texture
• Excellent flavor and aroma
• Has the best potential of FL varieties for the mid-Atlantic and Southeast – potentially a ‘Sweet Charlie’ replacement
• Like ‘Sweet Charlie’ it is sensitive to *Phytophthora cactorum* and is also moderately susceptible to powdery mildew
Winter Dawn

• UFL, 2009
• Short day (but low/no chill)
• Resistant to C. gleo. Susceptible to Phytophthora
• 92% yield compared to Chandler, PRS
• 17 g berry
Winter Star

- UFL, 2011
- Short day
- 70 to 100 Chandler yield
- Decent flavor
- Dark shoulders on ripest fruit
In the (NCSU) pipeline

- NCS 10-038
- NCS 10-156
- NCL 04-17
- NCK several selections
NCS 10-156

- Selected in 2010 PRS
- NCH 05-73P OP
- Early season – short day strawberry
- Very nice appearance
- Uniform conical fruit with red glossy exterior and light interior
- 90 to 116% yield compared to Chandler, higher than SC
- Good fruit size 18 g
- Can be soft like Chandler
- More suitable for local market
- The one we all like to eat!!!
NCS 10-038

- Selected in 2010 at PRS Salisbury NC,
- NCH08-07 OP
- Late season-short day strawberry
- Uniform blunt conical fruit with firm flesh and light red exterior and interior
- Moderately vigorous plant, open growth habit
- Awesome yield 132 and 153% yield compared to Chandler
- Uniform production through season
Overall impressions

- NCS 10-156 sweetest, but not firm, best for local markets
- NCS 10-038 quality similar to Camarosa, potential shipper?
Questions?
# TABLE 1. Total yield, marketable yield, percent marketable yield and average berry weight. Piedmont Research Station (PRS), Salisbury, NC 2015-16.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Total Yield (g/plant)</th>
<th>Total Yield (lbs/A)</th>
<th>Marketable Yield (g/plant)</th>
<th>Marketable Yield (lbs/A)</th>
<th>Percentage Marketable Yield (% of total)</th>
<th>Marketable Percent of Chandler</th>
<th>Average berry weight (g)</th>
</tr>
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<tbody>
<tr>
<td>NC10-038</td>
<td>931</td>
<td>35749</td>
<td>771</td>
<td>29605</td>
<td>82.8%</td>
<td>153%</td>
<td>16.4</td>
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<tr>
<td>Monteray</td>
<td>756</td>
<td>29025</td>
<td>696</td>
<td>26695</td>
<td>92.0%</td>
<td>138%</td>
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<tr>
<td>Camino Real</td>
<td>767</td>
<td>29436</td>
<td>692</td>
<td>26553</td>
<td>90.2%</td>
<td>137%</td>
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<tr>
<td>Portola</td>
<td>760</td>
<td>29185</td>
<td>659</td>
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<td>130%</td>
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<td>NC10-156</td>
<td>697</td>
<td>26757</td>
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<td>84.0%</td>
<td>116%</td>
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<td>Sensation</td>
<td>671</td>
<td>25746</td>
<td>558</td>
<td>21427</td>
<td>83.2%</td>
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<tr>
<td>Camarosa</td>
<td>637</td>
<td>24431</td>
<td>550</td>
<td>21107</td>
<td>86.4%</td>
<td>109%</td>
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<td>San Andreas</td>
<td>592</td>
<td>22718</td>
<td>520</td>
<td>19971</td>
<td>87.9%</td>
<td>103%</td>
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<td>Winter Star</td>
<td>615</td>
<td>23602</td>
<td>507</td>
<td>19441</td>
<td>82.4%</td>
<td>100%</td>
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<td>Chandler</td>
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<td>25505</td>
<td>505</td>
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<td>Sweet Ann</td>
<td>544</td>
<td>20862</td>
<td>496</td>
<td>19018</td>
<td>91.2%</td>
<td>98%</td>
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<td>Albion</td>
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<td>93%</td>
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<td>Winter Dawn</td>
<td>570</td>
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<td>463</td>
<td>17784</td>
<td>81.3%</td>
<td>92%</td>
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<td>Scarlet</td>
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<tr>
<td>Ruby June</td>
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<td>Merced</td>
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<td>17526</td>
<td>414</td>
<td>15898</td>
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<td>82%</td>
<td>26.1</td>
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<tr>
<td>Sweet Charlie</td>
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<td>18712</td>
<td>406</td>
<td>15592</td>
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<td>80%</td>
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<tr>
<td>Lucia</td>
<td>383</td>
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<td>344</td>
<td>13220</td>
<td>89.9%</td>
<td>68%</td>
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<tr>
<td>Radiance</td>
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<td>15103</td>
<td>315</td>
<td>12079</td>
<td>80.0%</td>
<td>62%</td>
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<tr>
<td>NCL04-17</td>
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<td>13553</td>
<td>205</td>
<td>7854</td>
<td>58.0%</td>
<td>41%</td>
<td>11.5</td>
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</tbody>
</table>

Tukey msd 9752  Tukey msd 10046  Tukey msd 5.64
<table>
<thead>
<tr>
<th>Genotype</th>
<th>Total Yield (g/plant)</th>
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<th>Marketable Yield (g/plant)</th>
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<th>Percentage Marketable Yield (% of total)</th>
<th>Marketable Percent of Chandler</th>
<th>Average berry weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC10-038</td>
<td>785</td>
<td>30131</td>
<td>712</td>
<td>27309</td>
<td>90.6%</td>
<td>132%</td>
<td>17.5</td>
</tr>
<tr>
<td>Camino Real</td>
<td>668</td>
<td>25619</td>
<td>615</td>
<td>23603</td>
<td>92.1%</td>
<td>114%</td>
<td>21.5</td>
</tr>
<tr>
<td>Camarosa</td>
<td>668</td>
<td>25619</td>
<td>607</td>
<td>23290</td>
<td>90.9%</td>
<td>113%</td>
<td>18.2</td>
</tr>
<tr>
<td>Chandler</td>
<td>669</td>
<td>25690</td>
<td>539</td>
<td>20698</td>
<td>80.6%</td>
<td>100%</td>
<td>19.8</td>
</tr>
<tr>
<td>Portola</td>
<td>649</td>
<td>24909</td>
<td>520</td>
<td>19942</td>
<td>80.1%</td>
<td>96%</td>
<td>19.8</td>
</tr>
<tr>
<td>NC10-156</td>
<td>558</td>
<td>21400</td>
<td>485</td>
<td>18603</td>
<td>86.9%</td>
<td>90%</td>
<td>14.6</td>
</tr>
<tr>
<td>Sweet Ann</td>
<td>602</td>
<td>23104</td>
<td>457</td>
<td>17549</td>
<td>76.0%</td>
<td>85%</td>
<td>22.4</td>
</tr>
<tr>
<td>Ruby June</td>
<td>497</td>
<td>19085</td>
<td>443</td>
<td>17011</td>
<td>89.1%</td>
<td>82%</td>
<td>20.6</td>
</tr>
<tr>
<td>Merced</td>
<td>473</td>
<td>18163</td>
<td>421</td>
<td>16160</td>
<td>89.0%</td>
<td>78%</td>
<td>19.6</td>
</tr>
<tr>
<td>Sensation</td>
<td>456</td>
<td>17517</td>
<td>410</td>
<td>15725</td>
<td>89.8%</td>
<td>76%</td>
<td>18.8</td>
</tr>
<tr>
<td>Monteray</td>
<td>487</td>
<td>18707</td>
<td>388</td>
<td>14886</td>
<td>79.6%</td>
<td>72%</td>
<td>20.1</td>
</tr>
<tr>
<td>Winter Star</td>
<td>468</td>
<td>17964</td>
<td>379</td>
<td>14547</td>
<td>81.0%</td>
<td>70%</td>
<td>16.9</td>
</tr>
<tr>
<td>Sweet Charlie</td>
<td>337</td>
<td>12941</td>
<td>306</td>
<td>11725</td>
<td>90.6%</td>
<td>57%</td>
<td>14.2</td>
</tr>
<tr>
<td>Scarlet</td>
<td>490</td>
<td>18797</td>
<td>304</td>
<td>11680</td>
<td>62.1%</td>
<td>56%</td>
<td>23.9</td>
</tr>
<tr>
<td>Lucia</td>
<td>390</td>
<td>14982</td>
<td>291</td>
<td>11155</td>
<td>74.5%</td>
<td>54%</td>
<td>17.4</td>
</tr>
<tr>
<td>Albion</td>
<td>360</td>
<td>13811</td>
<td>290</td>
<td>11149</td>
<td>80.7%</td>
<td>54%</td>
<td>20.2</td>
</tr>
<tr>
<td>San Andreas</td>
<td>374</td>
<td>14342</td>
<td>269</td>
<td>10317</td>
<td>71.9%</td>
<td>50%</td>
<td>18.3</td>
</tr>
<tr>
<td>Radiance</td>
<td>220</td>
<td>8461</td>
<td>196</td>
<td>7520</td>
<td>88.9%</td>
<td>36%</td>
<td>16.8</td>
</tr>
<tr>
<td>Winter Dawn</td>
<td>227</td>
<td>8710</td>
<td>182</td>
<td>7002</td>
<td>80.4%</td>
<td>34%</td>
<td>12.7</td>
</tr>
<tr>
<td>NCL04-17</td>
<td>253</td>
<td>9709</td>
<td>174</td>
<td>6675</td>
<td>68.8%</td>
<td>32%</td>
<td>7.6</td>
</tr>
</tbody>
</table>

*Table 2. Total yield, marketable yield, percent marketable yield and average berry weight. Central Crops Research Station (CCRS), Clayton, NC 2015-16.*
Comments on 2016 season

• In both locations, NCS 10-038 had the highest total and marketable yield
• Berry size of NCS 10-038 is comparable or slightly smaller than Chandler.
• At PRS, 10 genotypes had marketable yields as high or higher than Chandler (Table 1), while at CRS, 4 genotypes had yields as high or higher than Chandler (Table 2).
• NCS 10-156, had yields higher and lower than Chandler. Berry size was either slightly larger or smaller than Chandler
• Camino Real, Camarosa and NCS 10-038 higher yields than Chandler, both locations, both years.
More comments on 2016 season

• Camino Real and Monterey had the highest yield of all the UC Davis cultivars.
• Sensation had the highest yield of all the Florida cultivars.
• Sweet Ann, from Lassen Canyon had the largest berry size of all the genotypes in these trials.
• Ruby June (Lassen Canyon) lower yield than Chandler and Camarosa, larger berry
But that was only one year...
Comments on 2 seasons 2014-15 and 2015-16

• Table 3 and 4 show how yield data can vary from year to year in the same location.
• Compared to Chandler, NCS 10-038 higher yield both years, both locations
Table 3. Total yield, marketable yield, percent marketable yield and average berry weight. PRS 2015-16

<table>
<thead>
<tr>
<th>Genotype</th>
<th>2015 Total Yield (g/plant)</th>
<th>2016 Total Yield (g/plant)</th>
<th>2 year average Total Yield</th>
<th>2015 Marketable Yield (g/plant)</th>
<th>2016 Marketable Yield (g/plant)</th>
<th>2 year average Marketable Yield</th>
<th>2015 Marketable Percent of Chandler</th>
<th>2016 Marketable Percent of Chandler</th>
<th>2 year Marketable Percent of Chandler</th>
<th>2015 Average berry weight (g)</th>
<th>2016 Average berry weight (g)</th>
<th>2 year average Berry Wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC10-038</td>
<td>751</td>
<td>931</td>
<td>841</td>
<td>646</td>
<td>771</td>
<td>709</td>
<td>119%</td>
<td>153%</td>
<td>136%</td>
<td>22.5</td>
<td>16.4</td>
<td>19.5</td>
</tr>
<tr>
<td>Camino Real</td>
<td>519</td>
<td>767</td>
<td>643</td>
<td>459</td>
<td>692</td>
<td>575</td>
<td>84%</td>
<td>137%</td>
<td>111%</td>
<td>24.7</td>
<td>23.0</td>
<td>23.8</td>
</tr>
<tr>
<td>NC10-156</td>
<td>418</td>
<td>697</td>
<td>558</td>
<td>346</td>
<td>586</td>
<td>466</td>
<td>64%</td>
<td>116%</td>
<td>90%</td>
<td>18.9</td>
<td>18.9</td>
<td>18.9</td>
</tr>
<tr>
<td>Camarosa</td>
<td>268</td>
<td>637</td>
<td>452</td>
<td>207</td>
<td>550</td>
<td>379</td>
<td>38%</td>
<td>109%</td>
<td>74%</td>
<td>20.4</td>
<td>21.7</td>
<td>21.0</td>
</tr>
<tr>
<td>San Andreas</td>
<td>588</td>
<td>592</td>
<td>590</td>
<td>479</td>
<td>520</td>
<td>499</td>
<td>88%</td>
<td>103%</td>
<td>96%</td>
<td>23.0</td>
<td>23.9</td>
<td>23.4</td>
</tr>
<tr>
<td>Chandler</td>
<td>733</td>
<td>665</td>
<td>699</td>
<td>543</td>
<td>505</td>
<td>524</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>18.0</td>
<td>16.9</td>
<td>17.4</td>
</tr>
<tr>
<td>Sweet Ann</td>
<td>396</td>
<td>544</td>
<td>470</td>
<td>329</td>
<td>496</td>
<td>412</td>
<td>61%</td>
<td>98%</td>
<td>79%</td>
<td>37.7</td>
<td>33.7</td>
<td>35.7</td>
</tr>
<tr>
<td>Albion</td>
<td>312</td>
<td>503</td>
<td>408</td>
<td>266</td>
<td>468</td>
<td>367</td>
<td>49%</td>
<td>93%</td>
<td>71%</td>
<td>25.8</td>
<td>24.2</td>
<td>25.0</td>
</tr>
<tr>
<td>Merced</td>
<td>503</td>
<td>457</td>
<td>480</td>
<td>393</td>
<td>414</td>
<td>404</td>
<td>72%</td>
<td>82%</td>
<td>77%</td>
<td>22.2</td>
<td>26.1</td>
<td>24.1</td>
</tr>
<tr>
<td>Sweet Charlie</td>
<td>289</td>
<td>488</td>
<td>388</td>
<td>224</td>
<td>406</td>
<td>315</td>
<td>41%</td>
<td>80%</td>
<td>61%</td>
<td>14.9</td>
<td>17.3</td>
<td>16.1</td>
</tr>
</tbody>
</table>
Table 4. Total yield, marketable yield, percent marketable yield and average berry weight. CCRS 2015 and 2016.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>2015 Total Yield (g/plant)</th>
<th>2016 Total Yield (g/plant)</th>
<th>2 year average Total Yield</th>
<th>2015 Marketable Yield (g/plant)</th>
<th>2016 Marketable Yield (g/plant)</th>
<th>2 year average Marketable Yield</th>
<th>2015 Marketable Percent of Chandler</th>
<th>2016 Marketable Percent of Chandler</th>
<th>2 year Marketable Percent of Chandler</th>
<th>2015 Average berry weight (g)</th>
<th>2016 Average berry weight (g)</th>
<th>2 year average Berry Wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC10-038</td>
<td>656</td>
<td>785</td>
<td>720</td>
<td>617</td>
<td>712</td>
<td>664</td>
<td>98%</td>
<td>132%</td>
<td>115%</td>
<td>24.3</td>
<td>17.5</td>
<td>20.9</td>
</tr>
<tr>
<td>Camino Real</td>
<td>547</td>
<td>668</td>
<td>607</td>
<td>505</td>
<td>615</td>
<td>560</td>
<td>80%</td>
<td>114%</td>
<td>97%</td>
<td>25.6</td>
<td>21.5</td>
<td>23.5</td>
</tr>
<tr>
<td>Camarosa</td>
<td>212</td>
<td>668</td>
<td>440</td>
<td>132</td>
<td>607</td>
<td>369</td>
<td>21%</td>
<td>113%</td>
<td>67%</td>
<td>19.8</td>
<td>18.2</td>
<td>19.0</td>
</tr>
<tr>
<td>Chandler</td>
<td>733</td>
<td>669</td>
<td>701</td>
<td>632</td>
<td>539</td>
<td>586</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>20.8</td>
<td>19.8</td>
<td>20.3</td>
</tr>
<tr>
<td>NC10-156</td>
<td>547</td>
<td>558</td>
<td>552</td>
<td>495</td>
<td>485</td>
<td>490</td>
<td>78%</td>
<td>90%</td>
<td>84%</td>
<td>20.7</td>
<td>14.6</td>
<td>17.7</td>
</tr>
<tr>
<td>Sweet Ann</td>
<td>709</td>
<td>602</td>
<td>656</td>
<td>614</td>
<td>457</td>
<td>536</td>
<td>97%</td>
<td>85%</td>
<td>91%</td>
<td>35.7</td>
<td>22.4</td>
<td>29.1</td>
</tr>
<tr>
<td>Merced</td>
<td>710</td>
<td>473</td>
<td>592</td>
<td>648</td>
<td>421</td>
<td>535</td>
<td>103%</td>
<td>78%</td>
<td>90%</td>
<td>27.3</td>
<td>19.6</td>
<td>23.4</td>
</tr>
<tr>
<td>Sweet Charlie</td>
<td>244</td>
<td>337</td>
<td>291</td>
<td>219</td>
<td>306</td>
<td>262</td>
<td>35%</td>
<td>57%</td>
<td>46%</td>
<td>17.3</td>
<td>14.2</td>
<td>15.7</td>
</tr>
<tr>
<td>Albion</td>
<td>277</td>
<td>360</td>
<td>318</td>
<td>254</td>
<td>290</td>
<td>272</td>
<td>40%</td>
<td>54%</td>
<td>47%</td>
<td>27.6</td>
<td>20.2</td>
<td>23.9</td>
</tr>
<tr>
<td>San Andreas</td>
<td>645</td>
<td>374</td>
<td>509</td>
<td>583</td>
<td>269</td>
<td>426</td>
<td>92%</td>
<td>50%</td>
<td>71%</td>
<td>25.2</td>
<td>18.3</td>
<td>21.7</td>
</tr>
</tbody>
</table>
What about post harvest and taste?

- Perkins-Veazie lab tests
  - Storage life
  - Fruit composition
TABLE 1. Subjective ratings of strawberry fruit held at 4 C for 8 days averaged for 2014 and 2015 seasons.<sup>z</sup>

<table>
<thead>
<tr>
<th>Selection</th>
<th>Overall appearance&lt;sup&gt;y&lt;/sup&gt;</th>
<th>Fruit shrivel</th>
<th>Fruit darkness</th>
<th>Calyx brown</th>
<th>Calyx shrivel</th>
<th>Fruit firmness</th>
<th>Berries with mold (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camarosa</td>
<td>3.8a</td>
<td>3.9ab</td>
<td>3.7bc</td>
<td>3.8a</td>
<td>3.6a</td>
<td>4.3a</td>
<td>3.1a</td>
</tr>
<tr>
<td>Chandler</td>
<td>4.0a</td>
<td>4.3a</td>
<td>3.8b</td>
<td>3.9a</td>
<td>3.8a</td>
<td>3.2b</td>
<td>4.6ab</td>
</tr>
<tr>
<td>NCS 10-038</td>
<td>4.0a</td>
<td>4.4a</td>
<td>4.2a</td>
<td>3.4a</td>
<td>3.6a</td>
<td>3.8b</td>
<td>6.1ab</td>
</tr>
<tr>
<td>NCS10-156</td>
<td>3.3b</td>
<td>3.3b</td>
<td>3.2c</td>
<td>3.0b</td>
<td>3.0a</td>
<td>2.2c</td>
<td>12.3b</td>
</tr>
</tbody>
</table>

<sup>z</sup>All fruit quality attributes were given subjective ratings of 1 to 5 where a higher number indicates better fruit quality. Berries with mold was determined by 100% x (no. berries with mold/total no. berries).

<sup>y</sup>Means within column with same letter indicate no significant difference using Tukey’s HSD, p<0.05.
TABLE 2. Fruit composition of fully ripe freshly harvested strawberry selections grown at Piedmont, NC in 2014 and 2015.

<table>
<thead>
<tr>
<th>Selection</th>
<th>SSC (%)</th>
<th>pH</th>
<th>Titratable acidity (TA) (% as citric acid)</th>
<th>SSC/TA</th>
<th>Total anthocyanin (mg P3G/100 g fwt)\textsuperscript{y}</th>
<th>Total phenolic content (mg GA/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 0</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camarosa</td>
<td>7.1b</td>
<td>3.82a</td>
<td>0.69b</td>
<td>10.6ab</td>
<td>41.27a</td>
<td>155.62a</td>
</tr>
<tr>
<td>Chandler</td>
<td>6.8b</td>
<td>3.71b</td>
<td>0.69b</td>
<td>10.0ab</td>
<td>48.55a</td>
<td>157.57a</td>
</tr>
<tr>
<td>NCS 10-038</td>
<td>7.1b</td>
<td>3.67b</td>
<td>0.75a</td>
<td>9.8b</td>
<td>28.87b</td>
<td>142.05b</td>
</tr>
<tr>
<td>NCS 10-156</td>
<td><strong>7.8a</strong></td>
<td>3.78a</td>
<td><strong>0.72ab</strong></td>
<td><strong>11.0a</strong></td>
<td><strong>33.95ab</strong></td>
<td><strong>152.23a</strong></td>
</tr>
<tr>
<td><strong>Day 8</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camarosa</td>
<td>7.6b</td>
<td>3.97a</td>
<td>0.64b</td>
<td>12.1a</td>
<td>51.52a</td>
<td>152.16bc</td>
</tr>
<tr>
<td>Chandler</td>
<td>7.6b</td>
<td>3.87b</td>
<td>0.66b</td>
<td>11.6a</td>
<td>45.39ab</td>
<td>158.50a</td>
</tr>
<tr>
<td>NCS 10-038</td>
<td>6.9c</td>
<td>3.81b</td>
<td>0.68b</td>
<td>10.2b</td>
<td>29.86c</td>
<td>147.59c</td>
</tr>
<tr>
<td>NCS 10-156</td>
<td><strong>8.7a</strong></td>
<td>3.87b</td>
<td><strong>0.77a</strong></td>
<td><strong>11.6a</strong></td>
<td><strong>37.04b</strong></td>
<td><strong>153.21b</strong></td>
</tr>
</tbody>
</table>

\textsuperscript{z}Each selection consists of a mean of 3 to 7 samples, representing 3 harvest dates per year. Means within column with same letter indicate no significant difference using Tukey’s HSD, p<0.05.

\textsuperscript{y}P3G and GA are pelargonidin 3-glucoside and gallic acid equivalents, respectively.
Comments on post harvest attributes

• NCS 10-038 high overall appearance
• NCS 10-038 comparable firmness to Chandler
• NCS 10-156 is consistently rated with the highest flavor ratings
• Ruby June also scored high in our flavor ratings (data not shown)
• San Andreas was the firmest berry (data not shown)
Growers comments

• “156”: comparable to Sweet Charlie early on
• “038”: has potential for ENC, good vigor, good canopy cover in heat
• Need more feedback in 2017!
Researchers comments

• Powell Smith (NCS 10-156)
  – “Most people think that the shape, taste, and aroma are superior to ‘Camarosa’ this year. It appears to be a really good strawberry”.

![Strawberries](image)
# Agent evaluation Andy Rollins, Clemson

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Year</th>
<th>plant vigor</th>
<th>plant health</th>
<th>Yield</th>
<th>fruit firmness</th>
<th>Fruit color</th>
<th>fruit post harvest</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCS 10-156</td>
<td>15-16</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>Very typical strawberry shape, no 'flat' berries, excellent aroma with a bright red color, flavor with some tartness</td>
</tr>
<tr>
<td>Camarosa</td>
<td>15-16</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>Large berries, great yield, color dull red</td>
</tr>
</tbody>
</table>
The plan for NCS 10-156 and NCS 10-038

- MPRU has cleaned up
- One nursery licensed to propagate
- USPP data 80% collected
- Fingerprinting 2017
- On-Farm trials 2016-7
- If they continue to do well, we will release after 2017 harvest season

NCSU Elite Breeding Strawberry Selections

From data collected in 2016 and previous years, two lines have moved to trialing at locations outside of the research station system, the next step in evaluation for cultivar release. NCS 10-156 (Figure 1) is an early genotype that has uniform fruit with excellent flavor and a rich red color with consistently good yields. It is a potential ‘Sweet Charlie’ replacement. It is comparable or better than ‘Sweet Charlie’ or ‘Chandler’ in firmness. The other promising selection is NCS 10-038 (Figure 2). It is a potential ‘Chandler’ replacement with high yields, firmer fruit and more uniform production across the season.

Figure 1. Strawberry selection number NCS 10-156.

Figure 2. Strawberry selection number NCS 10-038.
Looking ahead

• Anthracnose
  – Ray Jacobs/Jeremy Pattison
    NCK selections
  – Guillermo Chacon-Jimenez
    • Time course of infection
      (RNAseq)
  – Field screening
  – Frank Louws/Massimo Iorizzo

• New Strawberry
  Extension Specialist at
  2017 Expo!
Castle Hayne
Marketable yield/plant
Selection Trial 2014

Cultivar

Mkt yld/plant

7.22.1 7.24.1 8.8.6 9.2.1 Benicia Camarosa Chandler Festival NCH 10-041 NCS 10-005 NCS 10-030 NCS 10-032 NCS 10-043 NCS 10-053 NCS 10-088 NCST 10-079 Radiance SC Treasure WS
Thanks

• NCDA&CS and NCSU Research Stations
• NC Crop Improvement and NC Foundation Seed Producers
• NCSU Plant Breeding Funds
• SRSFC
Newer UGA Blueberry Varieties

D. Scott NeSmith
Dept. of Horticulture
Univ. of Georgia
Griffin, GA
Georgia blueberry commercial industry
Blueberry acreage explosive growth
<table>
<thead>
<tr>
<th>Year</th>
<th>Value (million $)</th>
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<tbody>
<tr>
<td>2000</td>
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<td>2002</td>
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<tr>
<td>2004</td>
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<td>2006</td>
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<td>2008</td>
<td>75-80</td>
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<tr>
<td>2010</td>
<td>90-110</td>
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<tr>
<td>2012</td>
<td>130-160</td>
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<tr>
<td>2014</td>
<td>250-300</td>
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Two major species in Southeastern U.S.

- Rabbiteye blueberries (*Vaccinium ashei*)
- Southern highbush (*Vaccinium* hybrids)
Rabbiteye Advantages

- Later flowering time
- More vigorous plants
- Grow better on upland soils; require less organic matter
- More heat and drought tolerant
- Firmer fruit
  - Possible machine harvest even for fresh market
  - More suitable for long distant shipping
Southern highbush advantages

- Ripen early
- Generally larger berry size
- Most varieties are self fruitful whereas rabbiteye varieties are not
- Typically smoother textured berry
## Recent UGA Commercial Blueberry Variety Releases

<table>
<thead>
<tr>
<th>SOUTHERN HIGHBUSH</th>
<th>RABBITEYE</th>
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<tbody>
<tr>
<td><strong>VARIETY</strong></td>
<td><strong>PATENT</strong></td>
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<tr>
<td>Palmetto</td>
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<tr>
<td>Rebel</td>
<td>USPP 18138</td>
</tr>
<tr>
<td>Camellia</td>
<td>USPP 18151</td>
</tr>
<tr>
<td>Suziblue</td>
<td>USPP 21167</td>
</tr>
<tr>
<td>Southern Splendour</td>
<td>USPP 22692</td>
</tr>
<tr>
<td>TH-819 (Georgia Dawn™)</td>
<td>USPP 24696</td>
</tr>
<tr>
<td>TH-929 (Victoria™)</td>
<td>USPP 25994</td>
</tr>
<tr>
<td>TH-917 (Miss Jackie™)</td>
<td>USPPAF</td>
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<tr>
<td>TH-921 (Miss Alice Mae™)</td>
<td>USPP 27292</td>
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<tr>
<td>TH-948 (Miss Lilly™)</td>
<td>USPP 27323</td>
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</table>
Descriptions of UGA Varieties
‘Alapaha’ Rabbiteye Blueberry

• Early rabbiteye season (ripening with Climax, before Premier)
• Blooms late, ripens early
• Medium size
• Reliable production
• 500 chill hours
### 5 yr. average berry and plant ratings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Alapaha</th>
<th>Climax</th>
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</thead>
<tbody>
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<td>8.2</td>
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<tr>
<td>Berry color</td>
<td>7.8</td>
<td>8.0</td>
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<tr>
<td>Berry firmness</td>
<td>7.9</td>
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<td>Berry flavor</td>
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<tr>
<td>Plant vigor</td>
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<td>8.0</td>
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<tr>
<td>Flowering</td>
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<td>March 7</td>
</tr>
<tr>
<td>Ripening</td>
<td>May 31</td>
<td>May 30</td>
</tr>
<tr>
<td>Yield (lbs/bush)</td>
<td>13.2</td>
<td>6.8</td>
</tr>
</tbody>
</table>
‘Vernon’ Rabbiteye Blueberry

- Early RE season (ripens with Climax and Premier)
- Blooms late, ripens early
- Large berry size
- Vigorous plant
- 550 chill hours
## 5-year average berry and plant ratings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Vernon</th>
<th>Climax</th>
<th>Premier</th>
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<tbody>
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<td>Berry color</td>
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<tr>
<td>Berry flavor</td>
<td>7.5</td>
<td>8.0</td>
<td>8.4</td>
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<tr>
<td>Plant vigor</td>
<td>8.5</td>
<td>8.3</td>
<td>8.8</td>
</tr>
<tr>
<td>Flowering</td>
<td>March 14</td>
<td>March 7</td>
<td>March 15</td>
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<tr>
<td>Ripening</td>
<td>May 30</td>
<td>May 30</td>
<td>June 3</td>
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<tr>
<td>Yield (lbs/bush)</td>
<td>12.8</td>
<td>6.8</td>
<td>9.9</td>
</tr>
</tbody>
</table>
‘Ochlockonee’ Rabbiteye Blueberry

- Late season (later than Tifblue and Powderblue)
- Blooms late, ripens late
- Medium to large size
- Less rain splits than Tifblue
- 650 chill hours
### 5-yr average berry and plant ratings

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Ochlockonee</th>
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</thead>
<tbody>
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<td>Berry wt (g)</td>
<td>1.4 g</td>
<td>1.1 g</td>
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<td>8.0</td>
<td>8.2</td>
</tr>
<tr>
<td>Berry color</td>
<td>8.2</td>
<td>8.7</td>
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<tr>
<td>Berry firmness</td>
<td>7.7</td>
<td>7.9</td>
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<tr>
<td>Berry flavor</td>
<td>7.7</td>
<td>7.4</td>
</tr>
<tr>
<td>Plant vigor</td>
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<td>8.8</td>
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<tr>
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<td>March 23</td>
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<td>June 28</td>
<td>June 22</td>
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<tr>
<td>Yield (lbs/bush)</td>
<td>17.0</td>
<td>10.1</td>
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</table>
‘Titan™’ Rabbiteye Blueberry

- Early season
- Very large berry size
- Excellent firmness
- Good crop
- Vigorous plant
- High yielding
## Average berry and plant ratings 2008-2010 at Griffin.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Titan</th>
<th>Alapaha</th>
<th>Vernon</th>
<th>Premier</th>
<th>Brightwell</th>
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<td>7.1</td>
<td>8.0</td>
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<td>6.8</td>
</tr>
<tr>
<td>Scar</td>
<td>8.2</td>
<td>7.7</td>
<td>7.8</td>
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<td>7.7</td>
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<td>7.0</td>
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<td>7.3</td>
<td>7.4</td>
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<td>7.2</td>
<td>7.8</td>
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<td>7.9</td>
<td>8.0</td>
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<td>4.2</td>
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<td>8.3</td>
<td>8.2</td>
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<td>Apr. 2</td>
<td>Apr. 2</td>
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<td>June 20</td>
<td>June 16</td>
<td>June 14</td>
<td>June 16</td>
<td>June 28</td>
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</table>
Titan (T-959) vs Premier

T-959
Alapaha 6/4/08

Premier
Alapaha 6/4/08
Titan heavy yielder in Griffin
‘Krewer™’ Rabbiteye Blueberry

- Early season
- Very large berry size
- Good firmness
- Good flavor
- Vigorous plant
- High yielding
Krewer™
‘Camellia’ Southern Highbush Blueberry

- Early-mid season
- Excellent flavor
- Large size
- Excellent light blue color
- Vigorous plant
- 500 chill hours
<table>
<thead>
<tr>
<th></th>
<th>Camellia</th>
<th>Georgiagem</th>
<th>Sharpblue</th>
<th>Star</th>
<th>O’ Neal</th>
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<td>8.1</td>
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<td>7.0</td>
<td>7.8</td>
<td>7.8</td>
<td>7.9</td>
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<td>8.4</td>
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<td>4.4</td>
<td>6.3</td>
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<td>May 21</td>
<td>May 18</td>
<td>May 10</td>
<td>May 15</td>
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‘Suziblue’ Southern Highbush

- Early season
- Very good firmness
- Large size
- Consistent crop
- Vigorous plant
- Good flavor
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Suziblue</th>
<th>Star</th>
<th>Rebel</th>
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<td>7.7</td>
</tr>
<tr>
<td>Berry firmness</td>
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<td>7.3</td>
<td>8.0</td>
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<tr>
<td>Berry flavor</td>
<td>7.8</td>
<td>7.2</td>
<td>6.8</td>
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<tr>
<td>Cropping</td>
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<td>7.0</td>
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<td>Plant vigor</td>
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<td>8.8</td>
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<tr>
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<td>February 23</td>
</tr>
<tr>
<td>Ripening date</td>
<td>May 9</td>
<td>May 8</td>
<td>May 2</td>
</tr>
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‘Rebel’ Southern Highbush Blueberry

- Very early season
- Good firmness
- Large size
- Very good scar
- Vigorous plant
- 400 chill hours
# 3 yr avg data south Ga

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Rebel</th>
<th>Star</th>
<th>O’Neal</th>
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<td>Fruit Color</td>
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<td>Cropping</td>
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<td>5.5</td>
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</table>
‘Georgia Dawn™’

- Very early season
- Good firmness
- Medium to large size berry
- Vigorous, upright plant
- Very good flavor and scar
Georgia Dawn plants during flowering
Georgia Dawn fruit
Introducing 3 new “Southern Misses” SHB varieties

• Miss Jackie™
• Miss Alice Mae™
• Miss Lilly™
Average berry and plant ratings 2009-2013 at Alapaha site.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Star</th>
<th>Camellia</th>
<th>Miss Jackie</th>
<th>Miss Alice Mae</th>
<th>Miss Lilly</th>
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<tbody>
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<td>7.9</td>
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<td>8.5</td>
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<td>50% bloom</td>
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<td>Mar 10</td>
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<td>50% ripe</td>
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<td>May 17</td>
<td>May 8</td>
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<td>Avg.</td>
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<td>7.7</td>
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</table>
UGA Variety Availability

• Patented cultivars

• For information on licensing contact:
  
  University of Georgia Research Foundation
  Innovation Gateway
  808 GSRC Boyd Building
  Athens, Ga. 30602-7411

• Phone number is 706-542-1404

• (http://research.uga.edu/gateway/)
<table>
<thead>
<tr>
<th>Licensee</th>
<th>Phone</th>
<th>Web site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alma Nursery</td>
<td>912-632-5708</td>
<td>NA</td>
</tr>
<tr>
<td>Oregon Blueberry</td>
<td>503-873-1200</td>
<td><a href="http://www.oreblueberry.com">www.oreblueberry.com</a></td>
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<tr>
<td>Fall Creek Nursery</td>
<td>541-937-2973</td>
<td><a href="http://www.fallcreeknursery.com">www.fallcreeknursery.com</a></td>
</tr>
</tbody>
</table>
Southern Region Small Fruit Consortium Agent Training 2017
Picking, Cooling, Storing, Shipping and Consumer Tasting Small Fruits

Dr. Penelope Perkins-Veazie
North Carolina State University
Plants for Human Health Institute
NC Research Campus
Kannapolis, NC
Penelope_perkins@ncsu.edu

Dr. Renee Threlfall
University of Arkansas
Institute of Food Science and Engineering
Fayetteville, AR
rthrelf@uark.edu
Afternoon Agenda

1:30-2:00  What Consumers Want in a Blackberry?
2:00-2:30  Assessing Ripeness, When Should you Pick?
2:30-3:00  Keep it Cool: Importance of Temperature Control at Harvest and During Storage of Small Fruits
3:00-3:15  BREAK
3:15-4:00  Tour of NCSU Pack N Cool
4:00-4:30  A Growers Perspective: Market Requirements Local and Shipped for Small Fruits
4:30-4:45  Trends in Packaging of Small Fruits
5:00-5:30  Evaluating Small Fruits for Postharvest Storage Potential
Online Sources

- http://www.bae.ncsu.edu/programs/extension/publicat/postharv/
- http://postharvest.ucdavis.edu/
- http://www.fruit.cornell.edu/berry/postharvest/index.htm
- http://www.ncsu.edu/enterprises/blackberries-raspberries
Other Sources

What Consumers Want in a Fresh-Market Blackberry

Renee T. Threlfall, Research Scientist
Institute of Food Science and Engineering, University of Arkansas

John R. Clark, Distinguished Professor
Department of Horticulture, University of Arkansas

Olivia S. Hines, Honors Undergraduate Student
Department of Horticulture, University of Arkansas

Daniela M. Segantini, Visiting Researcher
Department of Horticulture, University of Arkansas
Introduction

• Blackberries (*Rubus* subgenus *Rubus*) are grown worldwide for both fresh and processing markets

• University of Arkansas has one of the largest blackberry breeding programs

• Limited data on sensory evaluation of fresh blackberries
Sensory Evaluation

The sensory panelist is the analytical instrument used in sensory evaluation.

- Provides consumer perception of products
- Supplements compositional data
- Demonstrates market potential
Sensory Evaluation Objectives

Use consumer sensory panel to identify and evaluate attributes of fresh blackberry genotypes (selections and cultivars) developed at the University of Arkansas.
Study Design

- Consumer Sensory
- Berry weight, berry length, and pyrenes/berry
- Soluble solids (SS), pH, titratable acidity (TA), and SS/TA ratio
What is a Consumer Sensory Panel?

• Uses non-trained consumers as panelists
  • Need >70 consumers of the product

• Involves quantification of sensory attributes
  • Rates liking of attributes
  • Yields statistical data
Blackberries at Harvest

• Grown at University of Arkansas Fruit Research Station, Clarksville

• Harvested at full ripeness (shiny black) in June 2014
  • Five cultivars (Natchez, Osage, Ouachita, Prime-Ark® 45 and Prime-Ark® Traveler)
Blackberries after Harvest

- Transferred to University of Arkansas, Department of Food Science, Fayetteville
- Randomized for sensory evaluation
- Placed in cold storage (2°C) overnight
# Blackberry Attributes at Harvest

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Range of values</th>
<th>Least</th>
<th>Most</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berry weight (g)</td>
<td>6-14 g</td>
<td>A-2453</td>
<td>Natchez</td>
</tr>
<tr>
<td>Berry length (mm)</td>
<td>28-44 mm</td>
<td>A-2453</td>
<td>Natchez</td>
</tr>
<tr>
<td>Pyrenes/berry</td>
<td>51-115</td>
<td>A-2453</td>
<td>Natchez</td>
</tr>
<tr>
<td>Soluble solids (SS%)</td>
<td>8-11%</td>
<td>A-2418</td>
<td>A-2491</td>
</tr>
<tr>
<td>pH</td>
<td>3.0-3.6</td>
<td>A-2450</td>
<td>Osage</td>
</tr>
<tr>
<td>Titratable acidity (TA%)</td>
<td>0.7-1.4%</td>
<td>Ouachita</td>
<td>A-2418</td>
</tr>
<tr>
<td>SS/TA Ratio</td>
<td>6-16</td>
<td>A-2418</td>
<td>Ouachita</td>
</tr>
</tbody>
</table>
Sensory Evaluation Procedure

- Performed at University of Arkansas Sensory Service Center, Fayetteville
- Berries removed from cold storage, gently rinsed, served at room temperature (24°C)
- Each panelist evaluated 3-4 berries per genotype
- Sample plates labeled with random codes
- Presentation order to panelists randomized
- Samples served one genotype at a time (monadically)
Consumer Sensory Evaluation

- Consumers recruited based on consumption habits and liking of fresh blackberries
- Consumers evaluated 11 blackberry genotypes
- 74 consumers evaluated liking attributes

9-verbal point hedonic scale
(1=extremely dislike; 9=like extremely)

<table>
<thead>
<tr>
<th></th>
<th>Appearance</th>
<th>Size</th>
<th>Shape</th>
<th>Color</th>
<th>Overall impression</th>
<th>Overall flavor</th>
<th>Firmness</th>
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<tbody>
<tr>
<td>Dislike Extremely</td>
<td>1</td>
<td></td>
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<td>Dislike Slightly</td>
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<tr>
<td>Neither Like nor Dislike</td>
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<tr>
<td>Like Moderately</td>
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<tr>
<td>Like Very Much</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Like Extremely</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please observe and taste this product. All things considered, which statement best describes your OVERALL IMPRESSION of the blackberries?

![Emojis]
Attributes of Fresh Blackberries Identified by a Consumer Panel
# Consumer Sensory Results

## 9-point hedonic scale

(1=extremely dislike; 9=like extremely)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Range of values</th>
<th>Least liked</th>
<th>Most liked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>6.8 to 7.7</td>
<td>A-2416</td>
<td>Prime-Ark® Traveler</td>
</tr>
<tr>
<td>Size</td>
<td>6.6 to 7.5</td>
<td>A-2416</td>
<td>Prime-Ark® Traveler</td>
</tr>
<tr>
<td>Shape</td>
<td>7.0 to 7.5</td>
<td>(no differences)</td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>7.1 to 7.9</td>
<td>A-2416</td>
<td>A-2453</td>
</tr>
<tr>
<td>Overall impression</td>
<td>5.4 to 7.3</td>
<td>A-2434</td>
<td>A-2491</td>
</tr>
<tr>
<td>Overall flavor</td>
<td>5.3 to 7.3</td>
<td>A-2434</td>
<td>A-2491</td>
</tr>
<tr>
<td>Firmness</td>
<td>6.8 to 7.3</td>
<td>(no differences)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dislike Extremely</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dislike Very Much</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dislike Moderately</td>
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</tr>
<tr>
<td>Dislike Slightly</td>
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<td></td>
<td></td>
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<tr>
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<tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Like Extremely</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Consumer sensory panel liking of size of fresh blackberries

Genotypes were evaluated by 74 consumer panelists. Means with different letter(s) for each attribute are significantly different (p < 0.05) using LSD.
Consumer sensory panel liking of overall impression of fresh blackberries

Genotypes were evaluated by 74 consumer panelists. Means with different letter(s) for each attribute are significantly different (p < 0.05) using LSD.
Consumer Sensory Results

• Consumers liked the appearance, size, shape, color, overall impression, overall flavor, and firmness of the blackberries, but could not detect differences in shape or firmness.

• Consumers liked the appearance and size of Prime-Ark® 45 and Prime-Ark® Traveler the most and liked the appearance, size, and color of A-2416 the least.

• Consumer liked the color of A-2453 the most.

• Consumers liked the overall impression and overall flavor of A-2491 and Prime-Ark® Traveler the most and A-2434 the least.
What Attributes Do Consumers Want in Fresh-market Blackberries?

- Berry weight of 8-10 g
- Soluble solids of 9-11%
- Titratable acidity of 0.9-1%
- Soluble solids/titratable acid ratio of 10-13
What Attributes Do Growers Want in Fresh-market Blackberries?

• $$$$$ SOLD $$$$$$
Acknowledgements

Sponsored through a grant from the USDA Arkansas Agriculture Department Specialty Crop Block Program

University of Arkansas Project Team
Project Director
Dr. Renee Threlfall, Research Scientist, Institute of Food Science and Engineering
Co-Principal Investigators
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Dr. Pam Brady, Adjunct Professor, Department of Food Science

Sponsored through a University of Arkansas Dale Bumpers College Grant and Honors College Grant for our undergraduate honors student working on the project
Questions?
Keep It Cool: Importance of Temperature Control at Harvest and during Storage of Small Fruits
Small Fruits Need To Be Cold

- Remove field heat
- Cooling choices: room, forced air
- Cooling delays decay
- Cooling reduces respiration/weight loss
# Temperature and Shelf Life

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Days Shelf Life</th>
<th>Blackberry/Raspberry</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 F</td>
<td>14-20</td>
<td>7-10</td>
</tr>
<tr>
<td>41 F</td>
<td>5-7</td>
<td>3-5</td>
</tr>
<tr>
<td>68 F</td>
<td>1-2</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

**If delay cooling:** *After 2 h will lose 20% per hour delay*

- Storing at Colder Temperatures Can Triple Shelf Life
The Cold Room Chain

- Maintain cooling and coldness from field to consumer
- Remove field heat
- Keep coldness in fruit
- Avoid rewarming
Steps to Minimize Heat

• Harvest when cool (before noon or at night)
• Keep fruit in shade
• Take fruit to coolers frequently
Keep Fruit Shaded While Picking
Packing System 1

- Pick into clamshell
- Place clamshells in tomato box
- Transport to shed
- Check/repack fruit in clamshells
- Place in masters and put in cold room
Packing System 2 Field Only

- Pick into clamshell
- Pick into clamshells
- Bring to field pack house
- Sort for leak, damage
- Place into reefer
Cooling Steps

• Fruit brought into pack house
• Placed in cold room until ready for forced air cooling
• Moved into cold room once forced air done

• Most small fruits will not freeze if kept below 32°F
• Generally stored at temperatures of 33-38°F
• Used to avoid possible freezing; 41°F often used by small producers
Types of Cold Rooms

• Railway cars/ship containers + electric motor + diesel generator
• Self-constructed
• Used restaurant cold/freezer rooms
• Often fa is inside a larger cold room
• Convert ac unit to cooling (cool-bot)

http://www.storeitcold.com/
Needs for Cold Rooms

• Must be well insulated, especially doors/ceilings
• Have refrigeration capacity for expected heat load and volume
• Placed under in shade to keep down cooling load
• Leave in room for stacking and moving pallets
Room Cooling

Allow Air Movement Between Boxes and Flats

Vents in master for air flow within carton
Forced-air Cooling (Tunnel)

Forces cold air through directed paths in boxed fruit
- Can be field portable
- Room portable
- Built-in
After Cooling

• Load into refrigerated transit quickly
• Unload cold product into refrigerated storage quickly
• Monitor temperature during transit using recorders
• Warming fruit to room temperature after cooling will cut shelf life in half
COOL BOT

AC UNITS:
10,000 TO 25,000 BTU ($300-600)

NOT ALL BRANDS WORK—CHECK THE WEBSITE!

http://www.storeitcold.com

Use this system to make an inexpensive cold room or for portable cooling
Mobile Cooler Fitted with Cool Bot Technology
Trends In Packaging of Small Fruits
Handling and Packaging Critical in Shelf Life

- The wrong package or overfill can injure fruit
- Package style can affect cooling rate and field heat removal
- Packages affect marketing and consumer appeal
Determine your Market and What They Want

• Wholesalers and grocery stores want a certain size, sometimes a style of clamshell

• Direct markets, especially farmers markets, may want a more retro look
Containers

2 LB Basket for Local Only

1 Gall Bucket - blueberry, Strawberry

Pulp Box with Plastic Lid
Clamshells (most wholesalers require)

Plastic clamshell: 6 oz to 20 oz common, vented top and sides and lids

Clamshell with round holes

Clamshell with slits

STACKABLE
Prevent Damage in Package

• The right packaging prevents berry damage
  • Less smashed berries
  • Less leakage in the package
  • Less fungal growth on berries

Layers of protection around clamshell
Rule of Thumb

- **Box weights**
  - Allow for weight loss and inspectors
  - A 20 oz fruit-filled clamshell can lose 1 oz from harvest to store
  - Assume 5% weight loss from respiration or temperature mismanagement

- **Don’t overfill**
  - Causes smashing and leaky berries
Container Size

- Small fruits are fragile
  - Crushed by own weight
  - Usually picked into final container in field
- Recommended amount of fruit in containers dependent on fruit type and cultivar
  - Raspberry-no more than 2 layers per clamshell
  - Blackberry-up to 3-4 layers of fruit per clamshell
  - Blueberry-can use 1 gallon plastic buckets or 5 gallon containers for pack house sorting
  - Strawberry, muscadine-2 layer per clamshell or 1 gallon buckets for UPICK
Master Flats or Cartons

- Reinforced corners
- Sides stack vertically
- Forced-air vents
- Holds 8-12 clamshells

Tabs to hold masters in place

Pallet top:
Flat guard to avoid slipping and weight loss

Master with air vents
Pallet Stacking

Make sure they are stacked securely and straight!

Pallets hold 90-96 cartons, 100 lbs of fruit, $1000
Additional Packaging Steps

Palette modified atmosphere using film overlay with injected CO2

OR

Film overlay followed by slight evacuation
Achieves self created modified atmosphere (CO2 from respiring fruit)
Be Aware: Food Safety, Gaps, FSMA

- Overarching principles: cleanliness, sanitation in field, pack house, transit systems
- Make sure containers are kept clean, NOT reused no matter what your market
Packaging Labels

• Draws attention of the consumer
• Allows consumer to see in the package
• List enough information so consumer knows what the product and where it was packaged
• Nutrition facts panels sometimes added
• Extras
Challenges in Packaging

• Bigger berries
• Elongated berries instead of round
• New crisp-type blackberry, blueberry, muscadine-firmer
  • may need apple/peach-type packing
Ongoing Research in Packaging

• Reduce weight loss
• Reduce decay
• Slow softening
• Add physical barriers like fruit coatings
• Add active packaging either as sachets or in plastics to build up CO2, slow decay/softening
• Add sachets to slow ethylene
• Add natural antimicrobials
Where to Buy Packaging

http://socontainers.com/berry-fruit-packaging/

Evaluating Small Fruits for Postharvest Storage Potential
Why Worry about Post Harvest Storage

- Loss in quantity and quality between harvest and consumption
  - 5-25% loss of products (=loss $)
  - Varies by crop and cultivar
- Need to start with best fruit to endure the market chain from farm to consumer
  - Consider length of market chain
GENERAL STORAGE LIFE:

Raspberries: 2-10 days
Blackberries: 5-21 days
Strawberries: 5-18 days
Blueberries: 14-40 days
Muscadines: 7-28 days

Depends heavily on variety, ripeness, cooling time, cold chain, field conditions
Pre-Harvest Protocol

• Pre-harvest spray for disease/pests
• Follow Good Agricultural Practices (GAP)
  • Field and labor sanitation
  • Clean harvest lugs/boxes
  • Clean pack shed
Harvest Decisions Impact Post Harvest Storage

- Limit disease/damage of fruit
- Pick fully ripe fruit
- Pick when cool and dry
- Limit handling of fruit
- Cool quickly after harvest
- Pack in appropriate containers
  - Clear-vented clamshells or Plastic cartons
What Happens to Fruit During Storage

- Desiccation/Shrivelng
- Leakage
- Pathological Breakdown
  - Bacterial and fungal
- Color changes
- Softening
- Splitting
Parameters to Evaluate Post Harvest Storage

- Unmarketable (%)
- Weight loss (%)
- Composition
  - Soluble solids (%)
  - pH
  - Titratable acidity (%citric or tartaric acid)
- Force to penetrate berry skin (N)
- Color of berry (L value of 0=black and 100=white)
Evaluations of Unmarketability

- Fill the container with fruit
- Evaluate at harvest 1 per week for 4 weeks
  - Count the total number of berries
  - Count the berries with signs of unmarketability
  - Unmarketability = unmarketable fruit / total fruit * 100
- Discontinue after container has more than 50% unmarketability
Muscadines

• Uneven ripening
• Stem scar tears
• Bruises create soft spots
• Susceptible to ripe rot
Unmarketable Berries

- **Shrivels**
- **Decay**

- **Leaky**
- **Stem Scar Tears**
- **Splits**

**Browning**
Unmarketability Increases during Post-harvest Storage of Muscadines

<table>
<thead>
<tr>
<th>Year</th>
<th>Unmarketable (%)</th>
<th>Weight loss (%)</th>
</tr>
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<tbody>
<tr>
<td>2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 10% unmarketable fruit after 1 week
- 20% unmarketable fruit after 2 weeks
- 45% unmarketable fruit after 3 weeks
Blackberries

- Decay
- Leakage
- Red drupe formation
- Desiccation
Blackberry Color Reversion

- Fruit categorized using rating scale after storage:
  - RD_0: no red drupelets
  - RD_1: one red drupelet
  - RD_2-3: two or three red drupelets
  - RD_4-5: four or five red drupelets
  - RD>6: six or more red drupelets
Blueberries

- Stems in pack
- Spotted wing drosophila larva
- Botrytis
- Immature fruit
- Decay, Decay, Decay
Strawberries

- Loss of gloss
- Botrytis
- Sepal browning
- Anthracnose
- Leather rot
Raspberries

Fruit darkening

decay

SWD LARVA
On-farm Post Harvest Evaluations

- Place fruit in container used for selling/shipping
- Store berries for 3 weeks at 2-3 °C and 85-95% relative humidity
  - Use onsite cold room, large or small refrigerators, or wine refrigerator
- During storage evaluate unmarketable fruit and weight loss of container
- Keep data on how fruit types and cultivars perform