

#### 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



University of Arkansas System

## 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 they 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 firstyear 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 yieldwise
- <u>Still one of my favorites</u> of all to pick and tote <u>home</u>





#### 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
- <u>This one is worth trying if you</u> <u>have not considered</u>





## 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

RESEARCH & EXTENSION University of Arkansas System

## Von

- 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
- <u>Hardy; a more northern</u> <u>variety</u>
- <u>High chill so be careful in</u> <u>the South</u>
- <u>Quality concerns...tart</u> <u>often</u>



## **Triple Crown**

- Thornless, <u>semi-erect</u>
- Medium-large, 6-8 g
- Ripe late July 10 Aug.?
- Yield high
- <u>Flavor probably best</u> <u>among USDA thornless;</u> <u>local sales a key option</u> <u>with TC</u>
- 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<sup>®</sup>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



# Primocane-Fruiting Blackberries

- 'Prime-Jim<sup>®</sup>' and 'Prime-Jan<sup>®</sup>'
- 'Prime-Ark<sup>®</sup> 45'
- 'Prime-Ark<sup>®</sup> Freedom'
- 'Prime-Ark<sup>®</sup> Traveler'







### Prime-Ark<sup>®</sup> 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<sup>®</sup> 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
- <u>Make sure PF</u> <u>blackberries work</u> <u>where you are...</u>





#### Prime-Ark<sup>®</sup> Traveler



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



#### Prime-Ark<sup>®</sup> 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<sup>®</sup> 45



## Comparing Prime-Ark 45<sup>®</sup> and Prime-Ark<sup>®</sup> Traveler

#### PA 45

- Thorny
- 7-9 g berry; can be jumbo
- Yield often higher
- Nice flavor, some bitterness, SS 10-12%, sub-acid
- Double fruit tendency in heat
- Double tipping required
- Data indicate comparable reversion, leak and soft to PA Traveler

#### **PA Traveler**

- Thornless
- 7-8 g berry; uniform
- Yield equal to lower
- Nice flavor, no bitterness, SS 10-12%, sub-acid
- Double fruit rare in heat
- Double tipping required
- Data indicate comparable reversion, leak and soft to PA 45



#### Prime-Ark<sup>®</sup> 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<sup>®</sup> Freedom



- Intended for home garden or localmarket use, due to not good storage performance
- Is low chill, <u>and</u> <u>showing promise in</u> <u>Florida!</u>
- 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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  - Apache: June 25
  - Triple Crown: June 30
  - Chester: July 10



### 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!













## Thoughts on Blueberry Cultivars for The Southeast

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

NC STATE UNIVERSITY

## **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)

- Poor bush survival
- Market prejudice (species, size, color)
- Ripens too late
- Yield not consistent
- Yield too low
- Won't machine pick

Size

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)

Cultivar	MAY		JUNE			JU	ILY	AUGU	ST	SEP	
CROATAN*											
REBEL											
O'NEAL*											
STAR											
<b>REVEILLE/BLADEN*</b>											
DUKE											
<b>NEW HANOVER*</b>											
LEGACY											
PREMIER*											
COLUMBUS*											
TIFBLUE											
POWDERBLUE											

#### 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?

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



NEW HANOVER -- Southern highbush, NCSU, (2005). Early large-fruited cultivar for hand harvest. Very productive. Some stem tearing will occur.





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** -- <u>Pentaploid</u>, 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



NC STATE UNIVERSITY

## Mid- to Late-Season Cultivars

- Standard Brightwell, Columbus, Tifblue, Powderblue
- Emerging Onslow?
- What's Next? Overtime, Ochlockonee

**COLUMBUS** – NCSU rabbiteye release (2002), ripens in early July (SENC). Excellent flavor, color and shelf life. Difficult to propagate and establish.



**ONSLOW** -- Rabbiteye, 2001. Latest ripening of NC releases, Fruit slightly darker and larger than Powderblue when fully ripe.





#### Blueberry harvest timing by cultivar in southeastern NC (\*NCSU)

В	MAY	JUNE	JULY	A	AUGUST	SEP
CROATAN*						
REBEL						
O'NEAL*						
SUZIBLUE						
STAR						
<b>REVEILLE/BLADEN*</b>						
FARTHING						
ABUNDANCE						
SAN JOAQUIN						
DUKE						
<b>NEW HANOVER*</b>						
CAMELLIA						
LEGACY						
PREMIER*						
COLUMBUS*						
TIFBLUE						
POWDERBLUE						

### **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.



Natural Distribution of Vitis rotundifolia
Regional Area of Adaption for Muscadine Grape Production

Fig. 1-2. Distribution of wild and cultivated muscadines.
Muscadines cultivars can be female or self-fertile (perfect) flowered.

If you only want one vine, make sure it is self-fertile!



Perfect

Female

- 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.



#### 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.





- 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.



- 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.



- 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.

Season	Cultivar	Flower type	
Early	Lane	Self-fertile	
Mid	Supreme	Female	
Mid	Delicious	Self-fertile	
Mid	Ga. 6-2-26	Self-fertile	
Late	Nesbitt	Self-fertile	

#### 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.

Season	Cultivar	Flower type	
Early	Hall	Self-fertile	
Early	Early Fry	Female	
Mid	Fry	Female	
Late	Granny Val	Self-fertile	
Late	Late Fry	Self-fertile	

#### 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)



#### Principal reasons for grafting

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



Chardonel on own roots, 7 years old





#### 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







Anas, O.; Harrison, U.J.; Brannen, P.M.; and Sutton, T.B. 2008. The Effect of Warming Winter Temperatures on the Severity of Pierce's Disease in the Appalachian Mountains and Piedmont of the Southeastern United States. Online. Plant Health Progress doi:10.1094/PHP-2008-0718-01-RS

#### Varieties

Note: Some are "old", some are "new"

	Туре	Color	Grafted?	Positive(s)	Negative(s)
Blanc du bois	Hybrid	White	+ or -	PD tolerance	Wine quality?
Chambourcin	Hybrid	Red	Yes		
Chardonel	Hybrid	White	Yes		
Enchantment	Hybrid	Red	Yes?		
Mourvedre	Vinifera	Red	Yes	Very late bud burst	Extremely winter tender
Norton	Aestivalis hybrid		No	PD tolerant in more northerly areas	
Opportunity	Hybrid	White	Yes ?		
Petit Manseng	Vinifera	White	Yes	Good "wet weather" cv	
Tannat	Vinifera	Red	Yes		Extremely winter tender
Traminette	Hybrid	White	No		
UCD 502 series	Hybrids		Yes	PD tolerance from V. arizonica	

## 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

Wine Grape Production Guide for Eastern North America, Wolf et al., 2008.

#### Nurseries:

Post Familie Vineyards Altus, AR http://www.postfamilie.com/	



# 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?**





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scams and identity their when shopping online this holiday season: spr.ly/60168yHRy

**W** 41

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Promoted

**4** 2

#### Dr. Stafne liked •

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

**1** 

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

#### ✿ NC State CALS Retweeted

47











Messages



#### Primocane fruiting raspberry second year marketable yield data at the Piedmont and Upper Mountain research stations by treatment g/plant





#### 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 phytophtora
- Why plant it? 5-7 days earlier than Chandler



#### "New"

#### **Short Day**

- Benicia (2010/12) Ruby June
- Camino Real (2001/02)
- Flavorfest (2012) •
- Fronteras\* (2014/16)
- Galetta (2010)
- Greneda\* (2014/16)
- Merced (2013/14)
- Palomar\* (2007/08)\* No data

•

• Pentaluma\* (2014/16)

- San Andreas (2008/09)
- Scarlet (2014/16)
  - Sensation (2013/14)
  - Sweet Ann (2009/12)
  - Winter Dawn (2005/10)
  - Winter Star 2011

#### **Day Neutral**

- Albion (2004/06)
- Cabrillo\* (2015/16)
- Lucia (2013/16)
- Monteray (2008/09)
- Portola (2007/08)
- Radiance (2008/09)

#### "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 Anthracnose 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 my 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<sup>®</sup> '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
   Phytopthora
- 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.

Genotype	Total Yield (g/plant)	Total Yield (Ibs/A)	Marketable Yield (g/plant)	Marketable Yield (lbs/A)	Percentage Marketable Yield (% of total)	Marketable Percent of Chandler	Average berry weight (g)
NC10-038	931	35749	771	29605	82.8%	153%	16.4
Monteray	756	29025	696	26695	92.0%	138%	25.4
Camino Real	767	29436	692	26553	90.2%	137%	23.0
Portola	760	29185	659	25283	86.6%	130%	23.3
NC10-156	697	26757	586	22484	84.0%	116%	18.9
Sensation	671	25746	558	21427	83.2%	111%	23.6
Camarosa	637	24431	550	21107	86.4%	109%	21.7
San Andreas	592	22718	520	19971	87.9%	103%	23.9
Winter Star	615	23602	507	19441	82.4%	100%	19.3
Chandler	665	25505	505	19389	76.0%	100%	16.9
Sweet Ann	544	20862	496	19018	91.2%	98%	33.7
Albion	503	19316	468	17963	93.0%	93%	24.2
Winter Dawn	570	21880	463	17784	81.3%	92%	17.8
Scarlet	523	20071	439	16858	84.0%	87%	31.9
Ruby June	485	18608	429	16462	88.5%	85%	24.4
Merced	457	17526	414	15898	90.7%	82%	26.1
Sweet Charlie	488	18712	406	15592	83.3%	80%	17.3
Lucia	383	14710	344	13220	89.9%	68%	25.1
Radiance	394	15103	315	12079	80.0%	62%	20.0
NCL04-17	353	13553	205	7854	58.0%	41%	11.5
		tukey msd		tukey msd			

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

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

# 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

Genotype	2015 Total Yield (g/plant)	2016 Total Yield (g/plant)	2 year average Total Yield	2015 Marketabl e Yield (g/plant)	2016 Marketabl e Yield (g/plant)	2 year average Marketabl e Yield	2015 Marketabl e Percent of Chandler	2016 Marketabl e Percent of Chandler	2 year Marketabl e Percent of Chandler	2015 Average berry weight (g)	2016 Average berry weight (g)	2 year average Berry W <sup>1</sup>
NC10-038	751	931	841	646	771	709	119%	153%	136%	22.5	16.4	19.5
Camino Poal	510	767	642	450	602	575	Q / 0/	1270/	1110/	24.7	22.0	22.0
	319	707	550	439	592	575	6470	11.00	111/0	24.7	23.0	23.0
NC10-156	418	697	558	346	586	466	64%	116%	90%	18.9	18.9	18.9
Camarosa	268	637	452	207	550	379	38%	109%	74%	20.4	21.7	21.0
San Andreas	588	592	590	479	520	499	88%	103%	96%	23.0	23.9	23.4
Chandler	733	665	699	543	505	524	100%	100%	100%	18.0	16.9	17.4
Sweet Ann	396	544	470	329	496	412	61%	98%	79%	37.7	33.7	35.7
Albion	312	503	408	266	468	367	49%	93%	71%	25.8	24.2	25.0
Merced	503	457	480	393	414	404	72%	82%	77%	22.2	26.1	24.1
Sweet Charlie	289	488	388	224	406	315	41%	80%	61%	14.9	17.3	16.1

Table 3. Total yield, marketable yield, percent marketable yield and average berry weight. PRS 2015-16

	, ,		, <b>1</b>		1		/ 0					
Genotype	2015 Total Yield (g/plant)	2016 Total Yield (g/plant)	2 year average Total Yield	2015 Marketabl e Yield (g/plant)	2016 Marketabl e Yield (g/plant)	2 year average Marketabl e Yield	2015 Marketabl e Percent of Chandler	2016 Marketabl e Percent of Chandler	2 year Marketabl e Percent of Chandler	2015 Average berry weight (g)	2016 Average berry weight (g)	2 year average Berry Wi
NC10-038	656	785	720	617	712	664	98%	132%	115%	24.3	17.5	20.9
Camino Real	547	668	607	505	615	560	80%	114%	97%	25.6	21.5	23.5
Camarosa	212	668	440	132	607	369	21%	113%	67%	19.8	18.2	19.0
Chandler	733	669	701	632	539	586	100%	100%	100%	20.8	19.8	20.3
NC10-156	547	558	552	495	485	490	78%	90%	84%	20.7	14.6	17.7
Sweet Ann	709	602	656	614	457	536	97%	85%	91%	35.7	22.4	29.1
Merced	710	473	592	648	421	535	103%	78%	90%	27.3	19.6	23.4
Sweet Charlie	244	337	291	219	306	262	35%	57%	46%	17.3	14.2	15.7
Albion	277	360	318	254	290	272	40%	54%	47%	27.6	20.2	23.9
San Andreas	645	374	509	583	269	426	92%	50%	71%	25.2	18.3	21.7

Table 4. Total yield, marketable yield, percent marketable yield and average berry weight. CCRS 2015 and 2016.

### 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>.

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

<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<sup>z</sup>.

Selection	SSC (%)	рН	Titratable acidity (TA) (% as citric acid)	SSC/TA	Total anthocyanin (mg P3G/ 100 g fwt) <sup>y</sup>	Total phenolic content (mg GA/100 g)
Day 0						
Day 0	7 11	2.02	0 (01-	10 (ab	41 27-	155 (2)
Camarosa	/.10	3.82a	0.090	10.6ab	41.2/a	155.02a
Chandler	6.8b	3.71b	0.69b	10.0ab	48.55a	157.57a
NCS 10-038	7.1b	3.67b	0.75a	9.8b	28.87b	142.05b
NCS 10-156	7.8a	3.78a	0.72ab	11.0a	33.95ab	152.23a
Day 8						
Camarosa	7.6b	3.97a	0.64b	12.1a	51.52a	152.16bc
Chandler	7.6b	3.87b	0.66b	11.6a	45.39ab	158.50a
NCS 10-038	6.9c	3.81b	0.68b	10.2b	29.86c	147.59c
NCS 10-156	8.7a	3.87b	0.77a	11.6a	37.04b	153.21b

<sup>z</sup>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.

<sup>y</sup>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".



# Agent evaluation Andy Rollins, Clemson

Genoty pe	Year	plant vigor	plant healt h	Yield	fruit firmn ess	Fruit color	fruit post harve st	Comments
NCS 10-156	15- 16	5	5	4	5	5	4	Very typical strawberry shape, no 'flat' berries, excellent aroma with a bright red color, flavor with some tartness
Camaro sa	15- 16	5	4	5	4	4	3	Large berries, great yield, color dull red

## 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 lorizzo
- New Strawberry Extension Specialist at 2017 Expo!

# Castle Hayne Marketable yield/plant Senection Trian 2014



Cultivar

# Thanks

- NCDA&CS and NCSU Research Stations
- NC Crop Improvement and NC Foundation Seed Producers
- NCSU Plant Breeding Funds
- SRSFC







erry

sociation

### **Newer UGA Blueberry Varieties**





D. Scott NeSmith Dept. of Horticulture Univ. of Georgia Griffin, GA

### Georgia blueberry commercial industry







### **Blueberry acreage explosive growth**


## **Georgia Blueberry Farm-gate Value**

Year	Value (million \$)
2000	22
2002	30
2004	48
2006	60
2008	75-80
2010	90-110
2012	130-160
2014	250-300



## **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**

SOUTHERN HIGHBUSH		RABBITEYE		
VARIETY	PATENT	VARIETY	PATENT	
Palmetto	USPP 16756	Alapaha	USPP 16266	
Rebel	USPP 18138	Ochlockonee	USPP 17300	
Camellia	USPP 18151	Vernon	USPP 18291	
Suziblue	USPP 21167	T-959 (Titan <sup>TM</sup> )	USPP 24135	
Southern Splendour	USPP 22692	T-1101 (Krewer <sup>TM</sup> )	USPPAF	
TH-819 (Georgia Dawn <sup>TM</sup> )	USPP 24696			
TH-929 (Victoria <sup>TM</sup> )	USPP 25994			
TH-917 (Miss Jackie <sup>TM</sup> )	USPPAF			
TH-921 (Miss Alice Mae <sup>TM</sup> )	USPP 27292			
TH-948 (Miss Lilly <sup>TM</sup> )	USPP 27323			

# **Descriptions of UGA Varieties**









## 'Alapaha' Rabbiteye Blueberry

- Early rabbiteye season (ripens with Climax, before Premier)
- Blooms late, ripens early
- Medium size
- Reliable production
- 500 chill hours





### **5 yr. average berry and plant ratings**

<u>Attribute</u>	<u>Alapaha</u>	<u>Climax</u>
Berry size	7.0	7.0
Berry scar	8.0	8.2
<b>Berry color</b>	7.8	8.0
Berry firmness	7.9	8.3
<b>Berry flavor</b>	7.8	8.0
Plant vigor	8.7	8.0
Flowering	March 18	March 7
Ripening	<b>May 31</b>	<b>May 30</b>
(ield (lbs/bush)	13.2	6.8





## **'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

<u>Attribute</u>	<u>Vernon</u>	<u>Climax</u>	<b>Premier</b>
Berry Size (g)	1.87	1.27	1.80
<b>Berry Scar</b>	8.8	8.2	8.0
Berry color	8.5	8.1	8.0
Berry firmness	8.5	8.3	7.4
Berry flavor	7.5	8.0	8.4
<b>Plant vigor</b>	8.5	8.3	8.8
Flowering	March 14	March 7	March 15
Ripening	<b>May 30</b>	May 30	June 3
Yield (lbs/bush)	12.8	6.8	9.9





## **'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

<u>Attribute</u>	<b>Ochlockonee</b>	<u>Tifblue</u>
Berry wt (g)	<b>1.4</b> g	<b>1.1 g</b>
Berry scar	8.0	8.2
Berry color	8.2	8.7
Berry firmness	7.7	7.9
Berry flavor	7.7	7.4
<b>Plant vigor</b>	9.2	8.8
Flowering	March 27	March 23
Ripening	June 28	June 22
rield (lbs/bush)	17.0	10.1





# **'Titan<sup>TM'</sup> 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.

<u>Attribute</u>	<u>Titan</u>	<u>Alapaha</u>	<u>Vernon</u>	<b>Premier</b>	<b>Brightwell</b>
Berry Size	9.6	7.1	8.0	7.7	6.8
Scar	8.2	7.7	7.8	7.5	7.7
Color	7.3	7.0	7.2	7.3	7.4
Firmness	8.3	7.2	7.8	6.8	8.1
Flavor	7.2	7.9	8.0	7.7	7.1
Cropping	5.5	5.2	4.2	3.2	6.0
Plant vigor	9.8	8.3	8.2	7.8	8.3
Flowering date	Apr. 6	Apr. 3	Apr. 2	Apr. 2	Apr. 5
Ripening date	June 20	June 16	June 14	June 16	June 28





#### Titan (T-959) vs Premier

Premier T-959 Alapaha 6/4/08 Alapaha 6/4/08

### **Titan heavy yielder in Griffin**



# **'Krewer<sup>TM'</sup> Rabbiteye Blueberry**

- Early season
- Very large berry size
- Good firmness
- Good flavor
- Vigorous plant
- High yielding





#### **Krewer**<sup>TM</sup>









# 'Camellia' Southern Highbush Blueberry

- Early-mid season
- Excellent flavor
- Large size
- Excellent light blue color
- Vigorous plant
- 500 chill hours





### 4-year avg. ratings for field grown plants south Ga

	<u>Camellia</u>	<u>Georgiagem</u>	<u>Sharpblue</u>	<u>Star</u>	<u>O' Neal</u>
Fruit size	9.0	7.5	7.7	7.8	8.1
Fruit Scar	7.5	7.0	7.8	7.8	7.9
Color	9.0	7.9	8.4	8.0	7.9
Firmness	7.9	6.7	7.6	7.5	7.6
Flavor	7.6	7.0	7.9	7.3	8.0
Cropping	6.0	4.4	6.3	6.0	4.7
Vigor	9.3	4.0	6.8	6.3	5.1
Flowering	Mar. 9	<b>Mar. 14</b>	Feb. 24	Mar. 2	Mar. 1
Ripening	May 19	<b>May 21</b>	May 18	May 10	May 15





# **'Suziblue'** Southern Highbush

- Early season
- Very good firmness
- Large size
- Consistent crop
- Vigorous plant
- Good flavor





#### **Berry and plant ratings**

<u>Attribute</u>	<u>Suziblue</u>	<u>Star</u>	<u>Rebel</u>
Berry Size	8.7	8.2	8.0
<b>Berry Scar</b>	8.0	8.0	8.5
Berry color	8.0	7.5	7.7
Berry firmness	8.0	7.3	8.0
<b>Berry flavor</b>	7.8	7.2	6.8
Cropping	7.0	5.3	7.0
Plant vigor	9.0	8.5	8.8
Flowering date	March 1	March 1	February 23
<b>Ripening date</b>	May 9	May 8	May 2





# **'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

<u>Attribute</u>	<u>Rebel</u>	<u>Star</u>	<u>O' Neal</u>
Fruit wt.	<b>2.3</b> g	<b>1.8 g</b>	<b>2.0</b> g
Fruit Scar	8.5	8.3	7.3
Fruit Color	7.9	8.0	7.0
Firmness	7.9	7.5	6.9
Flavor	6.8	7.5	7.8
Cropping	7.3	5.8	5.5
Plant vigor	9.1	7.8	6.8
Flowering	<b>Feb 25</b>	March 1	March 8
Ripening	May 3	May 8	May 15





## **'Georgia Dawn**<sup>TM</sup>'

- 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<sup>TM</sup>
- Miss Alice Mae<sup>TM</sup>
- Miss Lilly<sup>TM</sup>

Attribute	Star	Camellia	Miss Jackie	Miss Alice Mae	Miss Lilly
Berry size	7.6	8.9	7.9	7.4	8.4
Berry scar	7.0	7.2	7.5	7.9	7.4
Berry color	7.1	8.7	7.6	7.6	7.8
Firmness	7.2	7.2	7.8	7.6	7.8
<b>Berry flavor</b>	7.0	7.8	7.5	7.9	7.8
Cropping	4.7	5.4	5.9	5.9	5.2
<b>Plant vigor</b>	6.3	9.8	8.5	8.4	7.6
50% bloom	Mar 3	Mar 11	Mar 10	Mar 8	Mar 17
50% ripe	May 8	May 15	May 17	May 8	May 11
FDP	66	65	67	61	55

#### Average berry and plant ratings 2009-2013 at Alapaha site.

### Yield (lb/bush)

Year	Star	Camellia	Miss Jackie	Miss Alice Mae	Miss Lilly
2011	12.7	9.7	10.0	10.4	8.5
2012	11.7	10.5	17.0	9.1	7.2
2013	3.9	15.9	15.5	14.3	7.3
<u>Avg.</u>	<u>9.4</u>	<u>12.0</u>	<u>14.2</u>	<u>11.3</u>	<u>7.7</u>

### Miss Jackie<sup>TM</sup>







### Miss Alice Mae<sup>TM</sup>











### **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/)

Phone	Web site
912-284-0266	www.CorneliusFarms.com
912-632-5708	NA
503-873-1200	www.oreblueberry.com
541-937-2973	www.fallcreeknursery.com
	Phone     912-284-0266     912-632-5708     503-873-1200     541-937-2973



### 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 <u>rthrelf@uark.edu</u>





### 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.ba.ars.usda.gov/hb66/contents.html
- http://www.fruit.cornell.edu/berry/postharvest/index.htm
- <u>http://www.ncsu.edu/enterprises/blackberries-raspberries</u>
- https://attra.ncat.org/intern\_handbook/harvesting.html

### **Other Sources**

- Kader, A.A. 2002. Postharvest Technology of Horticultural Crops Publication 3311, University of California Agriculture and Natural Resources. ISBN# 1-879906-51-1
- Kitinoja, L. and J.R Gorny. 1991. Postharvest Technology for Small-Scale Produce Marketers: Economic Opportunities, Quality and Food Safety, Publication #21. University of California Postharvest Technology
- M. Bolda, M., M. Gaskell, E. Mitcham, M. Cahnf. Fresh Market Caneberry Production Manual. Publication 3535, University of California Agriculture and Natural Resources. ISBN-13: 978-1-60107-697-7

## 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







## 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<sup>®</sup> 45 and Prime-Ark<sup>®</sup> Traveler )
  - Six selections (A-2416, A-2418, A-2434, A-2450, A-2453 and A-2491)





## **Blackberries after Harvest**

- Transported to University of Arkansas, Department of Food Science, Fayetteville
- Randomized for sensory evaluation
- Placed in cold storage (2°C) overnight





## **Blackberry Attributes at Harvest**

Attribute	Range of values	Least	Most
Berry weight (g)	6-14 g	A-2453	Natchez
Berry length (mm)	28-44 mm	A-2453	Natchez
Pyrenes/berry	51-115	A-2453	Natchez
Soluble solids (SS%)	8-11%	A-2418	A-2491
рН	3.0-3.6	A-2450	Osage
Titratable acidity (TA%)	0.7-1.4%	Ouachita	A-2418
SS/TA Ratio	6-16	A-2418	Ouachita





## **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)

UNIVERSITY OF ARKANSAS SENSORY SERVICE CENTER





## **Consumer Sensory Evaluation**

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

(1=extremely dislike; 9=like extremely)
Appearance
Size
Shape
Color
Overall impression
Overall flavor
Firmness

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







## Attributes of Fresh Blackberries Identified by a Consumer Panel



## **Consumer Sensory Results**

### 9-point hedonic scale

### (1=extremely dislike; 9=like extremely)

Attribute	5	Range of values		Le	Least liked		Most liked			
Appearance	9	6.8 to 7.7	6.8 to 7.7		A-2416		Prime-Ark <sup>®</sup> Traveler		aveler	
Size		6.6 to 7.5		A-2416		Prime-Ark <sup>®</sup> Traveler				
Shape		7.0 to 7.5	7.0 to 7.5 (no differences )							
Color		7.1 to 7.9	7.1 to 7.9		A-2416		A-2453			
Overall imp	ression	5.4 to 7.3		A-2434		A-2491				
Overall flav	or	5.3 to 7.3		A-2434		A-2491				
Firmness	mness 6.8 to 7.3 (no differences)									
Dislike I Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neitl Like Disli	her nor ike	Like Slightly	Li Mode	ike erately	Like Very Much	Like Extremely
1	2	3	4	5		6		7	8	9





## **Consumer sensory panel liking of size of fresh blackberries**



Genotypes

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<sup>®</sup> 45 and Prime-Ark<sup>®</sup> 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<sup>®</sup> 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 \$\$\$\$





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- **University of Arkansas Project Team**
- **Project Director**



- Dr. Renee Threlfall, Research Scientist, Institute of Food Science and Engineering
- **Co-Principal Investigators**
- Dr. John R. Clark, University Professor, Department of Horticulture
- Dr. Luke Howard, Professor, Functional Foods Research Program, Department of Food Science
- Dr. Pam Brady, Adjunct Professor, Department of Food Science

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# Questions?





DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System

# 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**

<u>Temperature</u>	Days Shelf Life Blackberry/Raspberry		
32 F	14-20	7-10	
41 F	5-7	3-5	
68 F	1-2	<1	

#### 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) <u>http://www.storeitcold.com/</u>



## **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**









Vents in master for air flow within carton

## Allow Air Movement Between Boxes and Flats

## 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

#### **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**



Pallet top: Flat guard to avoid slipping and weight loss

Tabs to hold masters in place

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

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



Nutrition Fa Serving Size: 1/8 cup (28	acts <sup>3g)</sup>
Amount Per Serving	
Calories 90 Calories fr	om fat 0
% [	aily Value*
Total Fat 0g	0%
Saturated Fat Og	0%
Trans Fat 0g	
Cholesterol Omg	0%
Sodium 10mg	0%
Potassium 360mg	10%
Total Carbohydrate 20g	7%
Dietary Fiber 3g	12%
Sugars 13g	
Protein 1g	
Vitamin A 4% • Vitamin	C 2%
Calcium 0%   Iron 8%	
*Percent Daily Values are based on a 2,00 diet, Your daily values may be higher or lo depending on your calorie needs.	00 calorie wer

### **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











Southern Container Corporation of Wilson, Inc. Serving the Tobacco & Produce Industries for Over 50 Years



Southern Container Corporation of Wilson, Inc.

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



https://shop.montepkg.com/products.php?ItemCode=strawberry

### 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/Shriveling
- 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 Shrivel



Decay





#### **Stem Scar Tears**



#### **Splits**







# Unmarketability Increases during Post-harvest Storage of Muscadines



## 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**





Spotted wing drosophila larva



Decay, Decay, Decay

Immature fruit

Stems in pack

Botrytis







## **Strawberries**



Loss of gloss

Botrytis



Sepal browning



Anthracnose





Leather rot

## Raspberries



#### Fruit darkening





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