the Southern Region small fruit consortium

Blueberry Workshop for Cooperative Extension Service Agents, June 19-21, 2007

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2007 Blueberry Workshop
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June 19-21, 2007
Duplin County Center
Kenansville, NC

Blueberry Workshop for Cooperative Extension Service Agents

June 19-21, 2007

Sponsored by the Southern Region Small Fruit Consortium

Duplin County Center, 165 Agriculture Drive, Kenansville, NC 28349 (910) 296-2143

Program

Tuesday, June 19, 2007

1:00 – 1:45	Registration
1:45 – 2:00	Welcome and announcements – Tom Monaco, Director, Southern Region Small Fruit Consortium
2:00 – 2:45	Overview of acreage, cultivars and production areas in the southeastern US – Bill Cline, Extension Plant Pathologist, NCSU
2:45 – 3:30	Blueberry breeding, genetics and future trends – Jim Ballington, Professor of Horticultural Science, NCSU
3:30 – 3:45	Break-Sponsored by BASF, Gowan, Valent, Brandt Consolidated and DuPont
3:45 – 4:30	Investment analysis for Blueberry Production in the Southeastern US – Charles Safley, Professor and Extension Economist, NCSU, Presented by Guido van der Hoeven
4:30 – 5:15	Weed management in Southern blueberries– Katie Jennings, Research Assistant Professor, Horticultural Science, NCSU
6:30 --	Sponsored meal-NC Blueberry Council

Wednesday, June 20, 2007

8:00 – 8:30	Coffee and discussion
8:30 – 9:15	Blueberry breeding in Georgia – Scott NeSmith, Professor of Horticulture, UGA
9:15 – 10:00	Blueberry disease identification and control – Bill Cline, Extension Plant Pathologist, NCSU
10:00 – 10:45	Insect pests of blueberry – John Meyer, Professor of Entomology, NCSU
10:45 – 11:45	Cultural practices for the Southern US and potential for Organic production – Gerard Krewer, Extension Specialist and Professor of Horticulture, UGA
11:45 – 12:00	Discussion and wrap-up

12:00 Catered lunch-Sponsored by BASF, Gowan, Valent, Brandt Consolidated and DuPont

1:30 – 5:30 **Field Tour in Bladen and surrounding counties**

- Site selection, site preparation
- Overhead and drip irrigation systems
- Effects of 2007 Easter Freeze (Apr 8) on the NC crop
- Summer pruning
- Weed, disease and insect pests at harvest
- Mechanical harvesting and equipment for processing
- Hand-harvest and fresh packing

6:30 Sponsored meal-Dole Food Company

Thursday, June 21, 2007

8:00 – 9:00 Hotel check-out, travel to Castle Hayne, NC

9:00 – 11:30 **NCSU Horticultural Crops Research Station in Castle Hayne, NC**.

- Tour of field, greenhouse and lath house facilities
- Pick late-ripening highbush and early-ripening rabbiteye cultivars
- Learn to identify fruit rot fungi and other diseases
- Learn to identify insect pests and the damage they cause
- Blueberry propagation procedures and breeding techniques

11:30 Adjourn

Overview of acreage, cultivars and production areas in the Southeast

Bill Cline
Plant Pathology, NCSU
Blueberry Workshop for Agents
June 19-21, 2007

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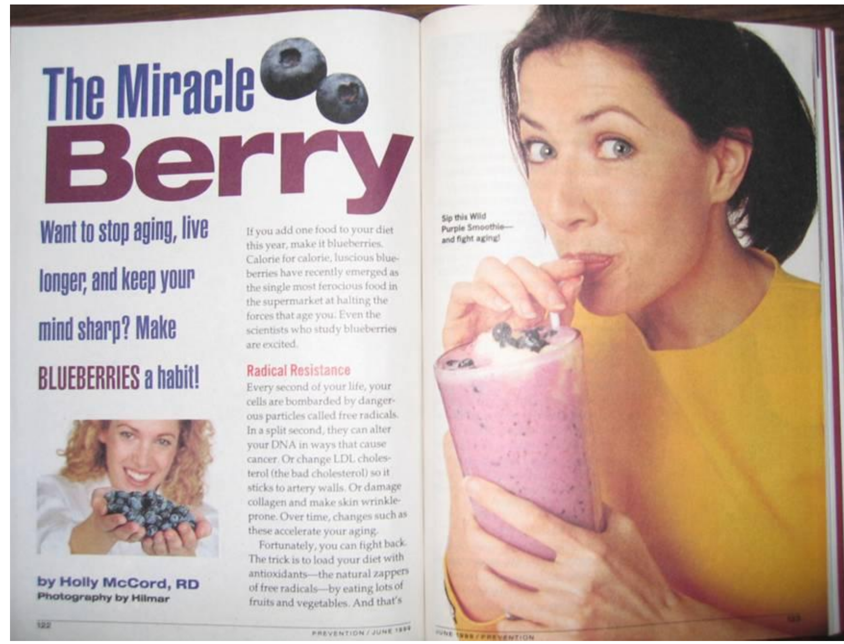
Why all the interest in blueberries?

- USDA -- Health Benefits (*Prevention,* 1999)
- High demand = High $$
- New cultivars inspire new production areas (FL, CA)
- Seasonality makes for unique geographic niches in fresh blueberry market
- Direct market, high value per acre, can be organic
- You can grow your own!



The Miracle Berry

Want to stop aging, live longer, and keep your mind sharp? Make BLUEBERRIES a habit!

If you add one food to your diet this year, make it blueberries. Calorie for calorie, luscious blueberries have recently emerged as the single most ferocious food in the supermarket at halting the forces that age you. Even the scientists who study blueberries are excited.

Radical Resistance

Every second of your life, your cells are bombarded by dangerous particles called free radicals. In a split second, they can alter your DNA in ways that cause cancer. Or change LDL cholesterol (the bad cholesterol) so it sticks to artery walls. Or damage collagen and make skin wrinkle-prone. Over time, changes such as these accelerate your aging.

Fortunately, you can fight back. The trick is to load your diet with antioxidants—the natural zappers of free radicals—by eating lots of fruits and vegetables. And that's

Sip this Wild Purple Smoothie—and fight aging!

by Holly McCord, RD
Photography by Hilmar

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HIGHBUSH AND SOUTHERN HIGHBUSH BLUEBERRY – These cultivars are the basis for fresh market “windows” in April (FL) May (GA) and from mid-May to late June (NC). Some machine harvest, but mostly picked by hand. Highbush also grown at higher elevations in mtns of GA, NC, SC, VA, TN, where suitable soils exist.

RABBITEYE BLUEBERRY – Later ripening than highbush or SHB. With mulch and irrigation, will grow on piedmont soils and in mtns to 2500 ft. 'Ira' (shown) ripens in July/August. These cultivars are the basis of most pick-your-own and home plantings in the southeast.

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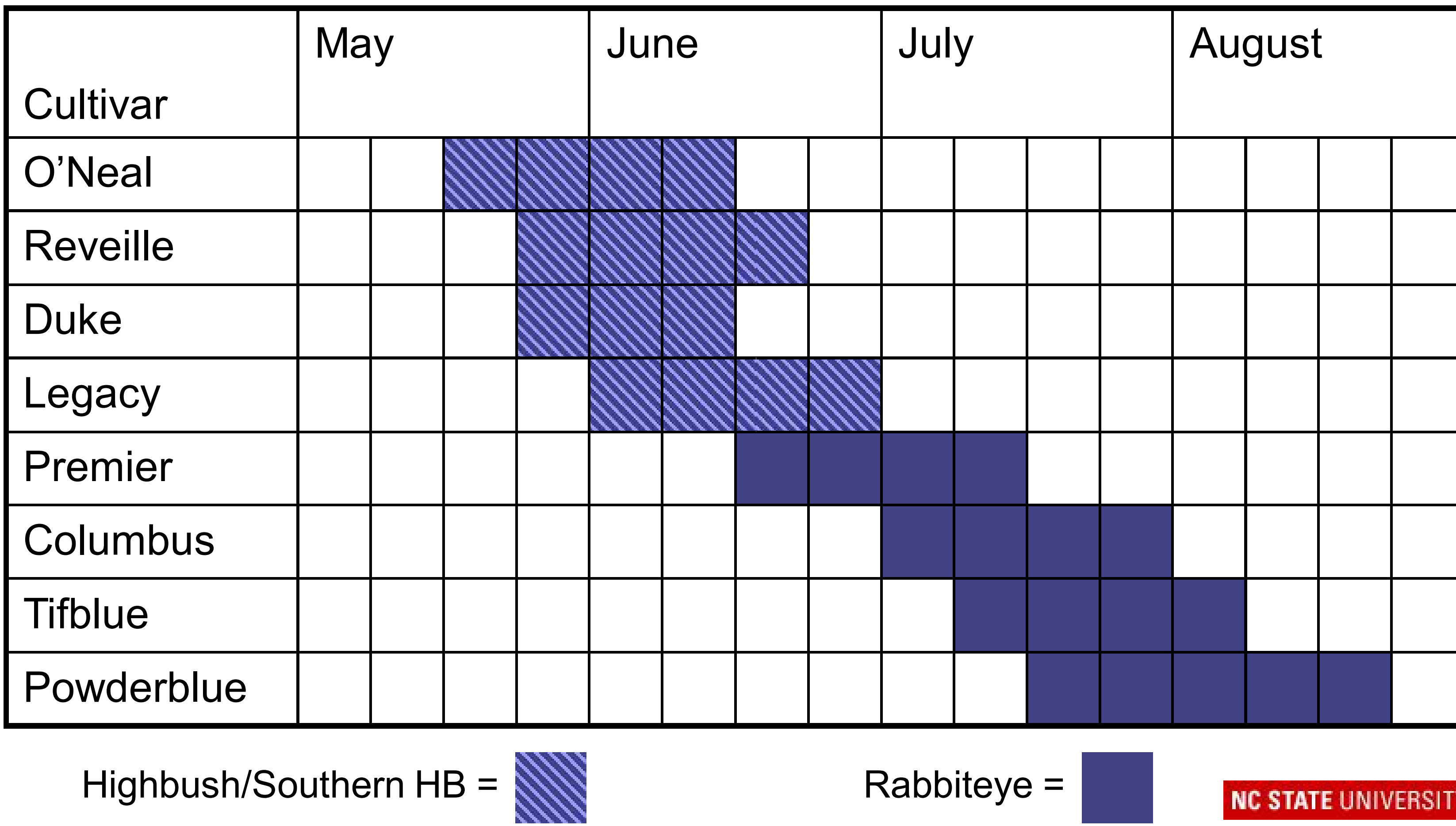
Blueberry harvest timing by cultivar and type in southeastern NC (selected cultivars)



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Startup considerations

- Site selection – blueberries can grow almost anywhere – with enough $$!!
- Level of commitment – blueberries are a year-round job, not a crop for absentee landowners
- Cash flow – it will be several years before you recoup your investment
- Capital -- there will be significant start-up costs

Startup considerations (cont'd)

- Equipment needs (tractor, packing line?)
- Who will pick and pack the fruit?
- Where and how will it be marketed?
- Proximity to commercial handlers?
- PYO, or local farm markets?
- Full-time venture, part-time income, retirement project, or hobby?
- Organic vs Conventional?

Site selection and establishment of a blueberry planting

- pH
- Highbush blueberry -- 4.0 to 5.0
- Rabbiteye blueberry – 4.5 to 5.3
- Drainage
- Surface drainage (bedding, ditching)
- Internal drainage (mulch or bark amendments)
- Irrigation
- Overhead (allows frost protection)
- Drip or micro-sprinkler (conserves water)

NC COASTAL PLAIN -- Good, ‘native’ blueberry soils (Leon or Lynn Haven soil series) have a high organic matter content (>3%), a water table near the surface, and are extremely well drained in the surface layer. On such sites, blueberries can be planted on raised, single-bedded rows with a tobacco setter (as shown) with good survival rates.

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NC COASTAL PLAIN -- ‘Reveille’, same field as previous image, planted with tobacco setter, about $2,200/A startup costs, grower will spend $2,000/A for irrigation when installed (1999 costs)

UPLAND SITES -- Mulched, irrigated PYO highbush planting in Maryland, perhaps $6-10,000/A startup costs (1999)

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BARK BED SYSTEM -- Florida high-density planting ($10,000-20,000/A startup costs in 2000). April – early May market window.

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Major blueberry-producing states in the southeastern US, 2006 (USDA/NASS)

STATE	ACRES	FRESH LBS	TOTAL LBS	% FRESH	$/LB	TOTAL VALUE ($)
Alabama	270	320,000	320,000	100	1.38	442,000
Arkansas	530	1,600,000	1,600,000	100	1.55	2,486,000
Florida	2,500	7,000,000	7,000,000	100	4.70	32,900,000
Georgia	7,000	16,000,000	31,500,000	51	1.90	59,775,000
Mississippi	2,000	2,600,000	4,600,000	56	1.31	6,040,000
North Carolina	4,700	17,900,000	25,500,000	70	1.91	48,745,000
UNITED STATES	52,820	146,130,000	275,520,000	53	1.81	497,702,000

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Major Rabbiteye Cultivars

- STANDARDS: Premier, Tifblue, Powderblue, Climax, Brightwell
- NEWER CVS Alapaha, Vernon, Ochlockonee, Columbus, Onslow, Ira (shown)

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Major Southern Highbush Cultivars

- STANDARDS: O'Neal, Star, Legacy (shown), Reveille, Bladen, Southern Belle, Southmoon
- NEWER CVS: Rebel, Sampson, Springhigh, Emerald, Jewel

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Highbush Cultivars (Mtns?)

- STANDARD: Bluecrop, Berkeley, Jersey, Earliblue, Patriot, Elliott
- NEWER CVS: Duke (Shown), Aurora, Liberty, Draper, Echota, Toro

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An Overview of Blueberry Releases from NCSU – and Other Cultivars of Interest for NC Growers

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

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NC Blueberry Breeding

- Jim Ballington, Susan Rooks, Terry Bland Mike Mainland – Horticultural Science
- Bob Milholland, Bill Cline, Benny Bloodworth -- Plant Pathology
- John Meyer – Entomology
- Grower Cooperators
- North Carolina Blueberry Council

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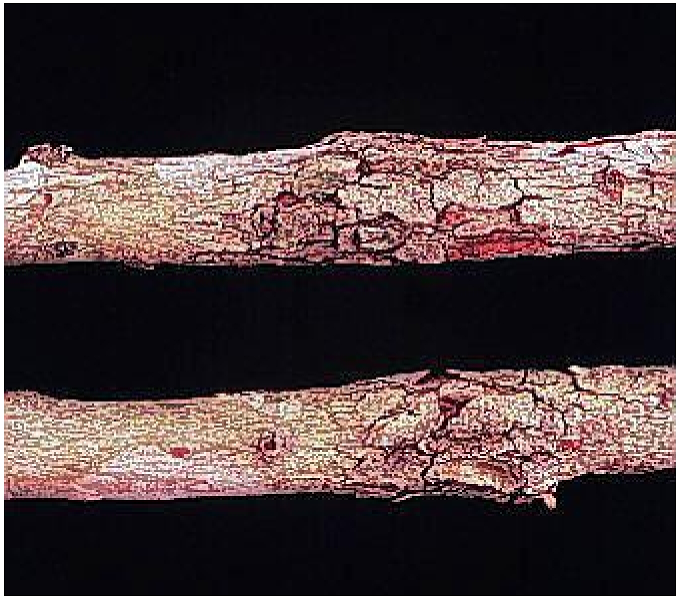
Some breeding priorities --

- Early, fresh, large
- Disease resistance (canker, stem blight)
- Climate adaptability
- Soils
- Seasons
- Quality and shelf life
- Machine for fresh



CROATAN – 40% of commercial acreage in southeastern NC, ripens in late May and early June. Very productive older cultivar (released 1954); resistant to stem canker.

Coastal Plain - YES
Piedmont - NO
Mountains - NO

1987 Releases: BLUE RIDGE, BOUNTY, CAPE FEAR, O'NEAL

- BLUE RIDGE -- Southern highbush, ripens after June 1st in SENC. Capable of tremendous yields and holds well on the bush, but not widely planted due to late ripening. Acreage increasing. Susceptible to mummy berry, stem canker. Wet picking scar.

- BOUNTY -- Highbush. High-yielding and large; susceptible to stem blight when young, but a good survivor after 3rd year; requires a short harvest interval, and sprays for anthracnose ripe rot. Not for marginal soils.

- CAPE FEAR – Southern highbush, ripens slightly ahead of Blue Ridge. Not recommended for planting due to problems with soft fruit.

O'NEAL -- Southern highbush cultivar, released by NCSU. Earliest ripening, better soil adaptation than 'Bladen'. 'O'Neal' is very popular and is planted world-wide. Susceptible to blueberry stem canker.

Coastal Plain - YES
Piedmont - MAYBE
Mountains - NO

REVEILLE –1990, Southern highbush. Medium to small, very firm, machine-harvestable berry. Accounts for around 15% of NC acreage, declining due to low, inconsistent yields. Exceptional, unique flavor. Susceptible to cracking.

Coastal Plain - YES
Piedmont - NO
Mountains - NO

BLADEN – 1991, Southern highbush. Small, machine-harvestable berry. In NC, use is limited to well-drained organic sands (Leon, Lynn Haven series).

Coastal Plain - YES
Piedmont - NO
Mountains - NO

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PENDER -- Highbush, released by NCSU in 1997. Mid-season (5 Jun in SENC) machine harvestable cultivar. Not widely planted because it is later and softer than Reveille and Bladen. Must be sprayed to control twig blight.

IRA, MONTGOMERY, YADKIN -- Rabbiteyes released in 1997. Montgomery is early blooming and early ripening, but berry darkens with handling. Yadkin has exceptional flavor but is late and dark. Ira (shown) ripens in mid-season (July 5 in SENC).

SAMPSON, DUPLIN, SUMMIT (1998), ARLEN (1997) – NCSU Southern highbush, ripen after Croatan in late May/early June. Sampson (shown) is large and very productive, exceptional flavor, BUT young bushes susceptible to stem blight. Often requires careful pruning or hedging at a young age to develop a sturdy upright bush. Duplin and Summit have been inconsistent (vigor, yield) and are not recommended. Arlen is late (6/10).

Coastal Plain - YES
Piedmont - MAYBE
Mountains - NO

ECHOTA -- Highbush, 1998. Mid-season (5 Jun in SENC). Released for western NC. Variable survival in SENC, 800 + chill hrs. High acid, very light blue color. Tight clusters, stem scar fair to good.

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

COLUMBUS – 2002, ripens in early July (SENC). Excellent flavor, color and shelf life. Difficult to propagate and establish. Probably not suitable for machine harvest.

Coastal Plain - YES
Piedmont - YES
Mountains - <2500 FT

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2003 Southern highbush releases CRAVEN, PAMLICO, LENOIR – Selected for vigor, medium size, and machine harvestability.

- CRAVEN -- Early ripening (5/25 in SENC), Upright habit, often has variegated leaves. Susceptible to red ringspot virus.
- LENOIR – Highly vigorous, ripens 6/3 in SENC.
- PAMLICO – (shown) Ripens 6/1 in SENC

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NEW HANOVER -- Southern highbush, 2005. Early (6/1 in SENC), large-fruited cultivar for hand harvest.

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CARTERET -- SHB, 2005. Most vigorous and productive of recent releases, small scar, trialed as machine harvestable for fresh market (we hope!) 500-700 chill hrs

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BEAUFORT -- SHB, 2005. Mid-season (5 Jun in SENC). Released for machine harvest (fresh?) 700-800 chill hrs

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ROBERSON -- Pentaploid, 2005. 400-600 chill hrs, potential for upland sites, earlier than Premier. Fruit soft and unlikely to ship well.

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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

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 - ????

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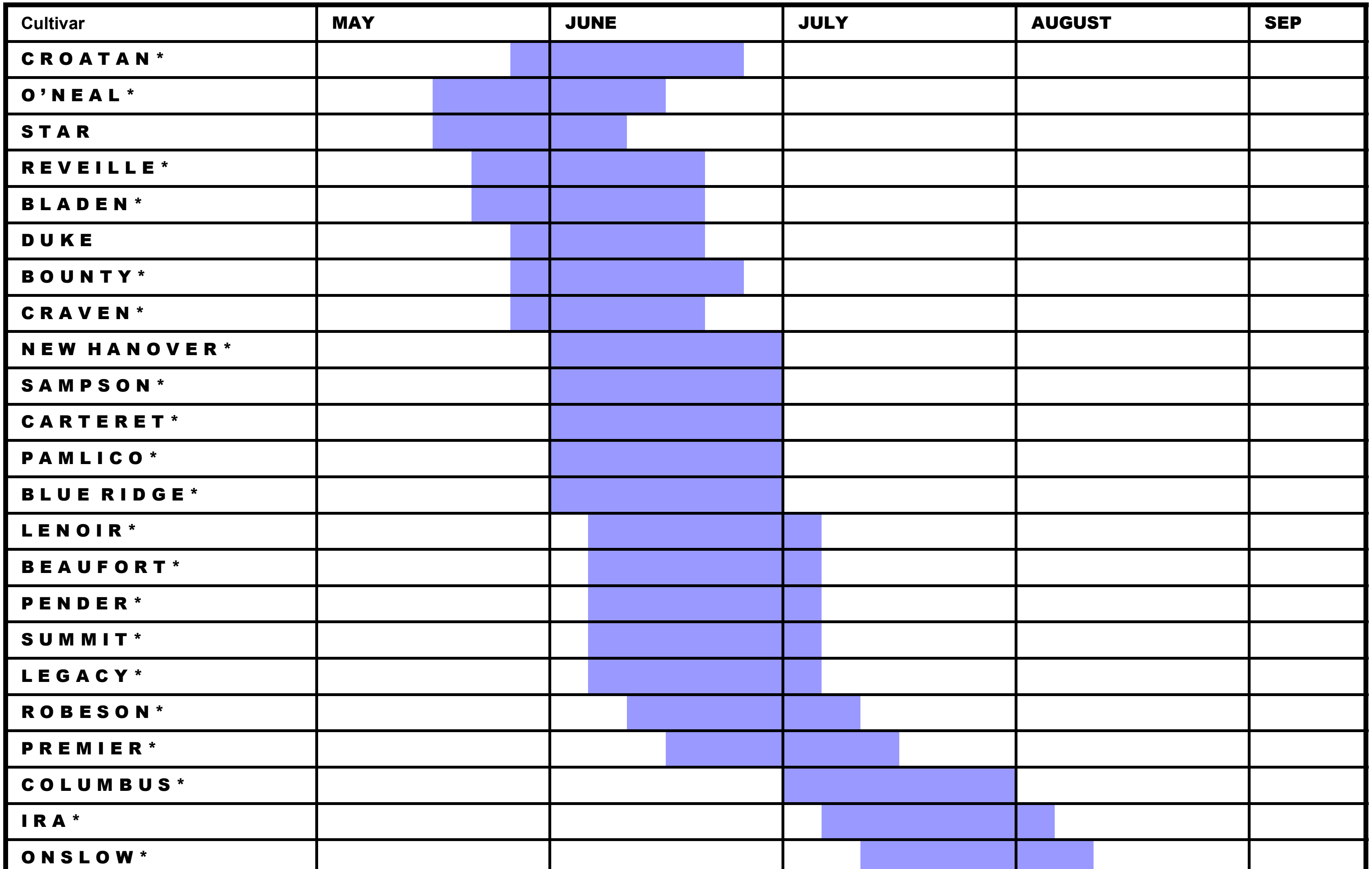
Blueberry harvest timing by cultivar in southeastern NC (*NCSU)



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Blueberry Breeding

Dr. James R. Ballington

N. C. State University

Blueberry Production in 2005

- Highbush types – US - 238 million lbs
  (NC -26 million lbs)
- Lowbush – US – 59 million lbs

(Note: in 2006, the NC industry brought in $48 million)

- Botanical relationships and adapations
- Floral biology
- Origin and history of development
- Breeding systems
- Breeding methods
- Modern breeding objectives
- Achievements and prospects

Botanical relationships

- Family: Ericaceae
- Subfamily: Vaccinioidae
- Tribe: Vaccinae (all the Ericaceae with inferior ovaries) – often collectively called the “blueberries”
- Genus: *Vaccinium* (the most important genus with regard to cultivated crops, but actually only one of 20 genera of “blueberries”)

Vaccinium angustifolium

Gaylussacia brasiliensis

Macleania bullata

Ceratostema lanigerum

Botanical relationships

- Subgenus (Section): *Cyanococcus*

  - A strictly North American section.

  - Includes all “cultivated” types “currently” grown for fruit production.

Adaptation

- Acidiphilic (like most Ericaceae)
- Intolerant of heavy shade
- Pioneers of secondary succession
- Roots typically have endophytic mycorrhiza in nature

Floral biology

- Flowers are usually complete and perfect.
- Self-incompatibility is prevalent across the species, however genes for self-compatibility occur within a number of species.
- The petals are fused to form a cylindrical to urceolate floral tube, with the stamens and pistil enclosed or exerted among the species.

Blueberry flowering habit, morphology and flower structure

Floral biology

- Pollination is by insects, primarily bees (mainly solitary bees in nature).

Cultivated Types of Blueberries for Fruit Production

- Lowbush blueberries
- Highbush blueberries
- Southern Highbush blueberries
- Half-high blueberries
- Rabbiteye blueberries

Origin and history of improvement

- Lowbush blueberries

  Vaccinium angustifolium (2n=4x=48) is the primary species.

  Vaccinium myrtilloides (2n=2x=24) is of secondary importance.

  Vaccinium boreale (2n=2x=24) is of very minor importance.

Vaccinium angustifolium **in experimental plots**

Origin and history of improvement

- Lowbush blueberries (contd.)

  -All lowbush species are lowgrowing and stoloniferous.

  -Self-incompatibility is the rule with all three species, however genes for self-compatibility have been identified in *V. angustifolium*.

  -In general, lowbush fruit is higher in antioxidants than highbush or rabbiteye, based on a standard volume of fruit, because lowbush berry size is much smaller and therefore the skin (where the antioxidants occur) to flesh ratio is lower.

Origin and history of improvement

- Lowbush blueberries (contd.)

-Breeding programs in Maine and Nova Scotia have released six improved cultivars of *V. angustifolium*.

(These were either elite selections from the wild or F_1 generation hybrids.)

-The lowbush industry is still largely based on managing native stands due to problems with establishment and costs of producing plants of improved cultivars, and difficulties with establishing cultivated plantings on the rocky rolling terrain where lowbush have traditionally been grown.

Origin and history of improvement

- Lowbush blueberries (contd.)

  -Current breeding efforts in Nova Scotia are limited to identification of superior parental combinations for production of elite *V. angustifolium* F_1 hybrid progenies.

  -There is also one new breeding program in Scandinavia.

  -The main value of *V. angustifolium* in breeding has been in improvement of highbush and half-high blueberries up to the present time.

Origin and History of Development

- Lowbush blueberries (contd.)

- *Vaccinium myrtilloides* has only been used to a minor extent in cultivar improvement work.

- *Vaccinium boreale* is only involved in the genetic background of a small number of experimental hybrids.

Origin and history of improvement

- Highbush, southern highbush, halfhigh and rabbiteye blueberries are unique crops because the respective industries have all developed as a result of development of improved cultivars by publically-supported breeding programs. (primarily USDA and state experiment stations in the US)

Origin and history of improvement

- Highbush blueberries (i.e. standard or northern highbush)

-As the name implies, are multistem erect to semi-erect plants, 1.5-2.0+ M tall (i.e. “crown-forming” habit).

-Based primarily on tetraploid forms of *V. corymbosum* (2n=4x=48), wild highbush blueberry, which is native from southern New England across to southern Michigan and south to east Texas and north Florida.

-Current cultivated genepool primarily originated from New Jersey northward [with a small but significant contribution from NC, primarily for resistance to blueberry stem canker *(Botryosphaeria corticis*)].

-Incorporation of genes from *V. angustifolium* has also been significant from the beginnings of highbush blueberry improvement.

[*V. angustifolium* has been important in contributing genes for early ripening, short fruit development period, and resistance to blueberry stem blight fungus (*Botryosphaeria dothodia.*)]

-Cultivars are generally self-compatible.

Cultivated Highbush fruit

Cultivated highbush field in eastern NC

Origin and history of improvement

- Highbush blueberry (contd.)

  -Improvement began in 1911 with Dr. Fredrick Coville of the USDA and over the years has expanded to include 6 state experiment stations (often cooperatively with USDA) and five other countries.

  -<u>Up to the present time, a total of 48 cultivars have been released</u> by all these breeding programs.

Origin and history of improvement

- Highbush blueberry (contd.)

  -Standard highbush is by far the most important cultivated type, in North America and throughout the world.

  -It is the predominant type in the major production areas in North America (Mich., NJ, BC, OR, NC, WA), at the present time.

Origin and History of Improvement

- Highbush blueberry (contd.)
- Incorporation of stem canker resistance (from wild NC *V. corymbosum*) into the cultivated highbush genepool made highbush blueberry cultivation feasible in North Carolina (because the disease is endemic here), and was the primary reason for initiating the breeding program at NCSU.

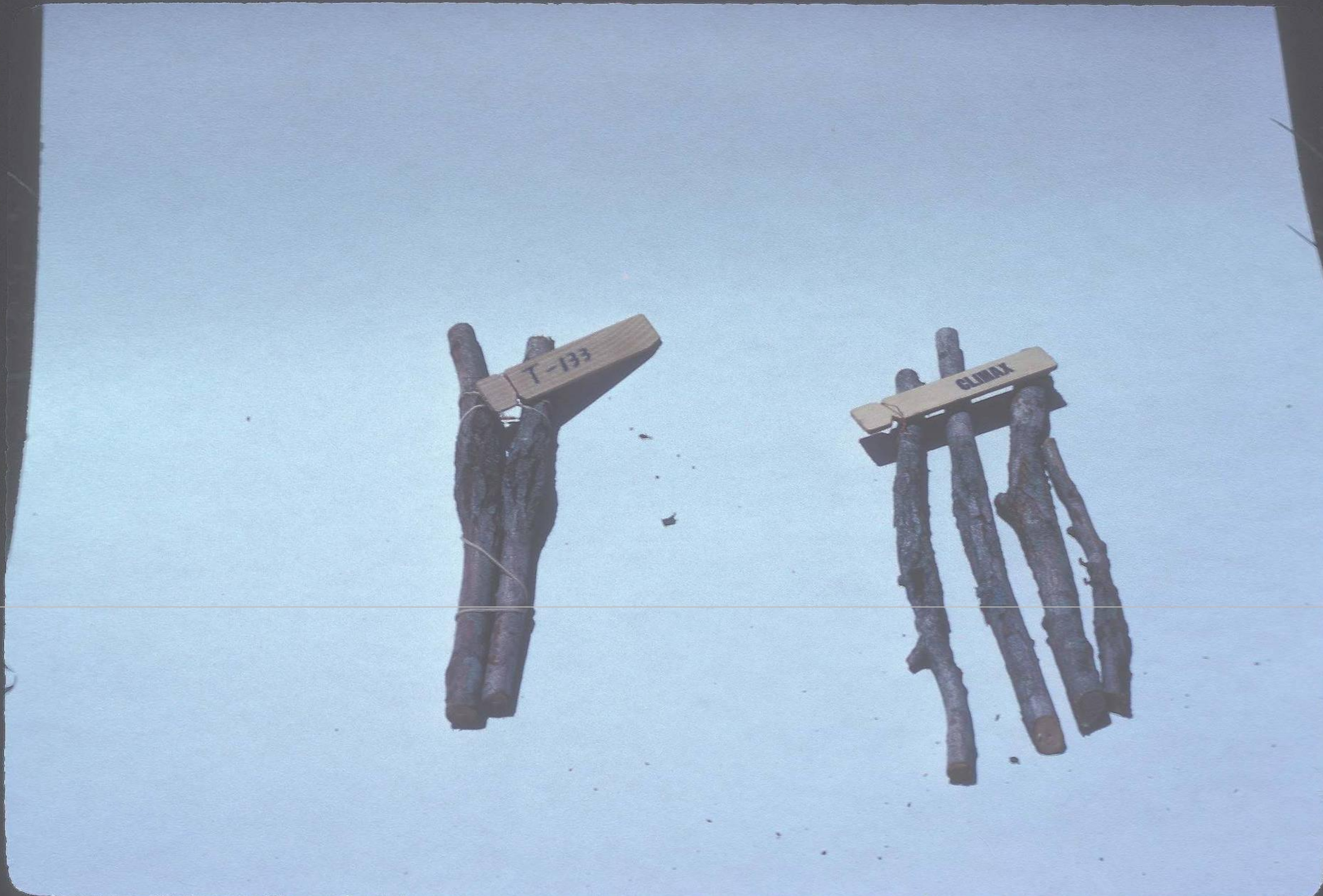
- Further expansion of the standard highbush blueberry industry is limited by:

  -Relatively high chilling requirement (800-1000 hrs below 45^0F) and southeastern NC/Pee Dee SC are the southern limit in the US.

  -Very specific soil and moisture requirements;

    a. well drained sand to sandy loam soil with at least 4% O.M.

    b. a limited and shallow root system that requires a constant but not excessive moisture supply.



Stem cankers on blueberry stems

Ideal highbush blueberry soil profile

Origin and history of improvement

- Southern highbush blueberry

-Is derived from standard highbush but also involves genes from a number of southern US species for reduced chilling requirement (impt. south of NC) and improved adaptation to the warm humid climate of the southeastern US.

- These species include:

V. darrowi (2n=2x=24) extreme S. GA., Fl. and along the Gulf Coast to Texas. (most impt.)

V. virgatum (V. ashei) (2n=6x=72) southeastern US (2^{nd}. in importance)

V. tenellum (2n=2x=24) southeastern US low growing stoloniferous species (ancestral to *V. virgatum*)

- Incorporating genes from these species into the tetraploid blueberry genepool was a major breakthrough in expanding the region of adaptation for highbush-type blueberries into lower latitudes.


Vaccinium darrowii

Vaccinium virgatum cv. Montgomery

Vaccinium tenellum colony, Sandhills

Origin and history of improvement

- Southern highbush (contd.)

-Same basic plant habit as standard highbush.

-Some are self-compatible, some not.

-Breeders have been successful in incorporating heat tolerance and lower chilling requirement into southern highbush cultivars.

-Current southern highbush cultivars are on average somewhat more adaptable to soils than standard highbush, but, still have fairly demanding requirements.

-A limited number of genotypes have proven tolerant to higher pH soils (i.e. pH 6.5)

-In most cases these cultivars do produce superior quality fruit under warm southern conditions.

Origin and history of improvement

- Southern highbush (contd.)

  -Southern highbush improvement began in Florida in the 1950s, and has expanded to include the USDA and four state experiment stations, including North Carolina.

  -37 southern highbush cultivars have been released up to this time.

  -Although a newer type than std. highbush, acreage is increasing rapidly in the southern US and similar climate regions around the world.

  -Southern highbush is the major type being planted in NC at this time.

Origin and history of improvement

- Half-high blueberries

-As the name implies, the plants generally range from 0.5-1.0 M in height, and are intermediate in habit between lowbush and highbush.

-These are derived from hybrids between std. highbush and *V. angustifolium* (most are ¼ lowbush).

-They have been primarily developed in Minnesota, where lower stature is critical so that flower buds will be below the snowline in winter.

Young 'Northblue' halfhigh

Blueberry plants

Origin and history of improvement

- Half-high blueberry (contd.)

  -Cultivars are generally self-incompatible.

  -This is the newest type of cultivated blueberry, and it is being planted widely in regions with severe winter weather including Scandinavia.

  -Halfhighs are not well adapted to warmer regions, particularly from the standpoint of fruit quality.

Origin and history of improvement

- Rabbiteye blueberry

  -It is derived from the vigorous southeastern US hexaploid species (2n=6x=72) *V. virgatum* (formerly *V. ashei*).

  -The “species” is extremely variable in habit, but cultivars are generally crown-forming to crown-forming-suckering with stems 2.0-5.0+ M tall.


'Columbus' rabbiteye blueberry

Origin and history of improvement

- Rabbiteye blueberry (contd.)

  -Most cultivars are at least partially self-incompatible, but there are exceptions, and Premier, Centurion, Ira, Yadkin, and Onslow are fully self-compatible.

  -Breeding has mainly been carried on in the US, involving the USDA and FL., GA.,and NC.

  -<u>35 improved cultivars have been released up to this time</u>.

Origin and history of improvement

- Rabbiteye blueberry (contd.)

-Rabbiteye blueberries are most important in the "deep south" states of Georgia, Florida, and Mississippi, where their superior adaptation to heat and droughty soils with limited organic matter is important.

-A number of rabbiteye cultivars are tolerant to higher pH soils (i.e. 6.5+ pH).

- Current rabbiteye varieties have a long fruit development period. (Early rabbiteye ripen 4 weeks later than early std. and southern highbush.)

Origin and History of Improvement

- Rabbiteye blueberry (contd.)

-Rabbiteye fruit maintain good quality much longer than highbush while still on the bush.

-Postharvest shelf-life of rabbiteye fruit is superior to that of highbush fruit.

-Fresh fruit quality of rabbiteye fruit is not quite as good as highbush on average.

-Frozen fruit of many rabbiteye cultivars develop an unpleasant tough texture after 6 months in the freezer.

Breeding systems

- Species occur in nature at the diploid (2n=2x=24), tetraploid (2n=4x=48) and hexaploid (2n=6x=72) chromosome levels.
- “Species” with the same chromosome number within a subgenus are essentially completely interfertile under experimental conditions.
- “Species” with the same chromosome number primarily maintain their integrity through differences in phenology, ecology, and geography in nature.
- Within a subgenus, blueberry “species” are not really “biological species”.

Breeding Systems

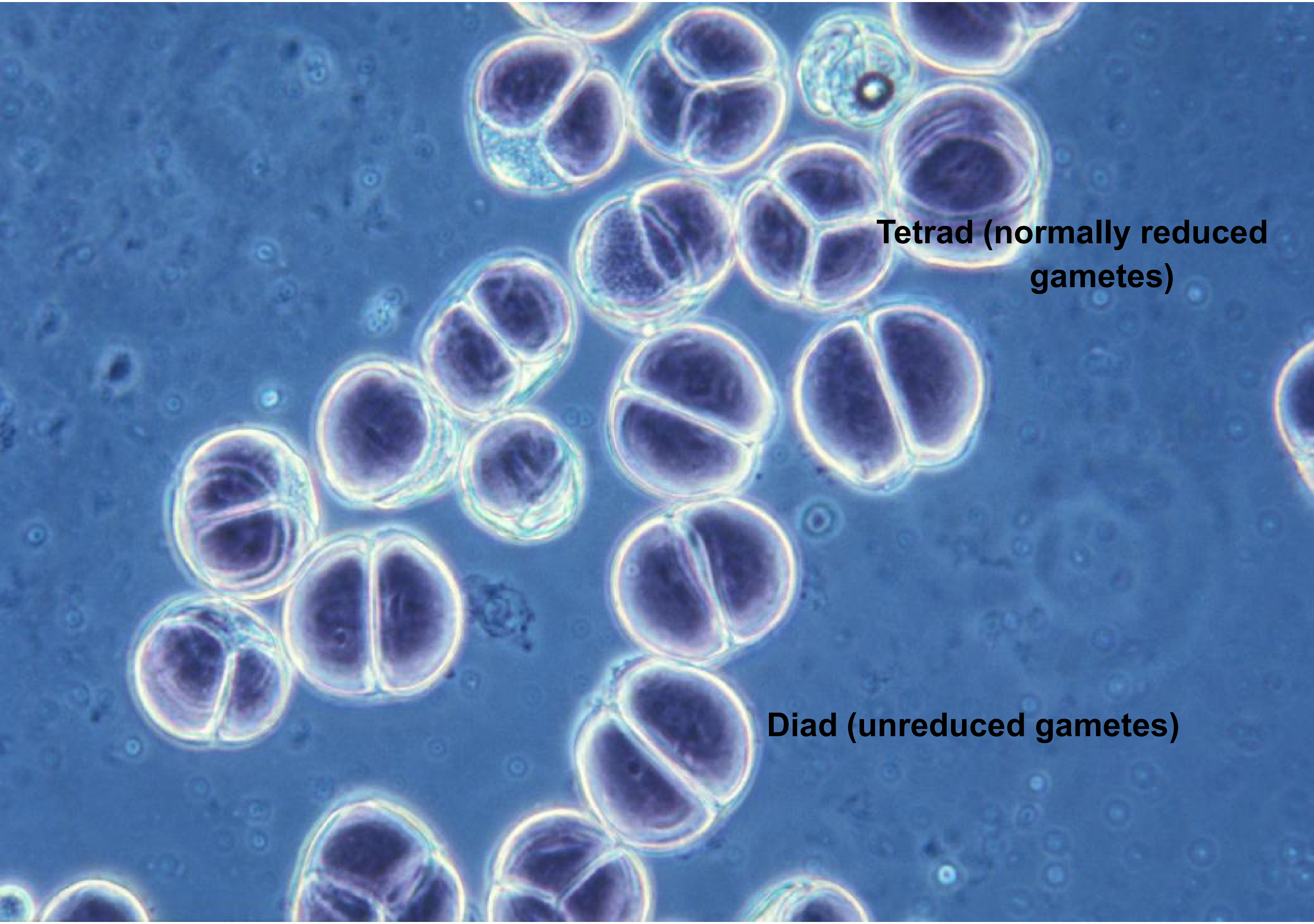
- Tetraploid species are believed to be derived from fusion of unreduced gametes from diploids.

  Ex: 2x *V. corymb.* X 2x *V. corymb.* = 4x *V. corymbosum* (autotetraploid)

  Ex: 2x *V. darrowii* x 2x *V. tenellum* = 4x *V. myrsinites* (allotetraploid)

- Hexaploid species are believed to be derived from fusion of an unreduced gamete from one tetraploid parent with a normally reduced gamete from a second tetraploid parent.

  Ex: 4x *V. pallidum* (unreduced) x 4x *V. pallidum* (reduced) = 6x *V. constablaei* (autohexaploid)


Tetrad (normally reduced gametes)
Diad (unreduced gametes)

Breeding Systems

-When diploids are crossed with tetraploids the resulting progeny (usually small numbers) are usually tetraploid (rather than triploid), resulting from fusion of a normally reduced gamete from the tetraploid parent with an unreduced gamete from the diploid parent.

Ex: US 75 (4x) = FL 4B (2x) (*V. darrowii*)
x ‘Bluecrop’ (4x)

Ex: NC 4304 (4x) = NC 2845 (2x) (*V. elliottii*)
x NC 79-19-2 (4x) (*V. pallidum*)

Breeding Systems

- There is a very strong triploid (2n=3x=36) block, but triploids occasionally occur, and are usually (but not always) highly infertile or sterile.

  Ex: Two slightly fertile triploid southern highbush genotypes in NJ produced a modest size progeny that was mostly hexaploid; i.e. from fusion of unreduced gametes from both parents.

Breeding Systems

- When diploids are crossed with hexaploids the resulting progeny are usually pentaploid.
  Ex; *V. darrowi* (2x) (unreduced gamete) *x V. virgatum* (6x) (normal reduced gamete)

  (The early years of the UFL program produced such hybrids which were then backcrossed to std. highbush for several generations to get back to the tetraploid level and restore full fertility.)

- When tetraploid and hexaploid species occur together pentaploid (2n=5x=60) hybrids do occur, and are quite variable in fertility.

  Two female fertile pentaploid cultivars have been released:

  Pearl River (5x) = G-144 (4x) (*V. corymbosum*) x Beckyblue (6x) (*V. virgatum*)

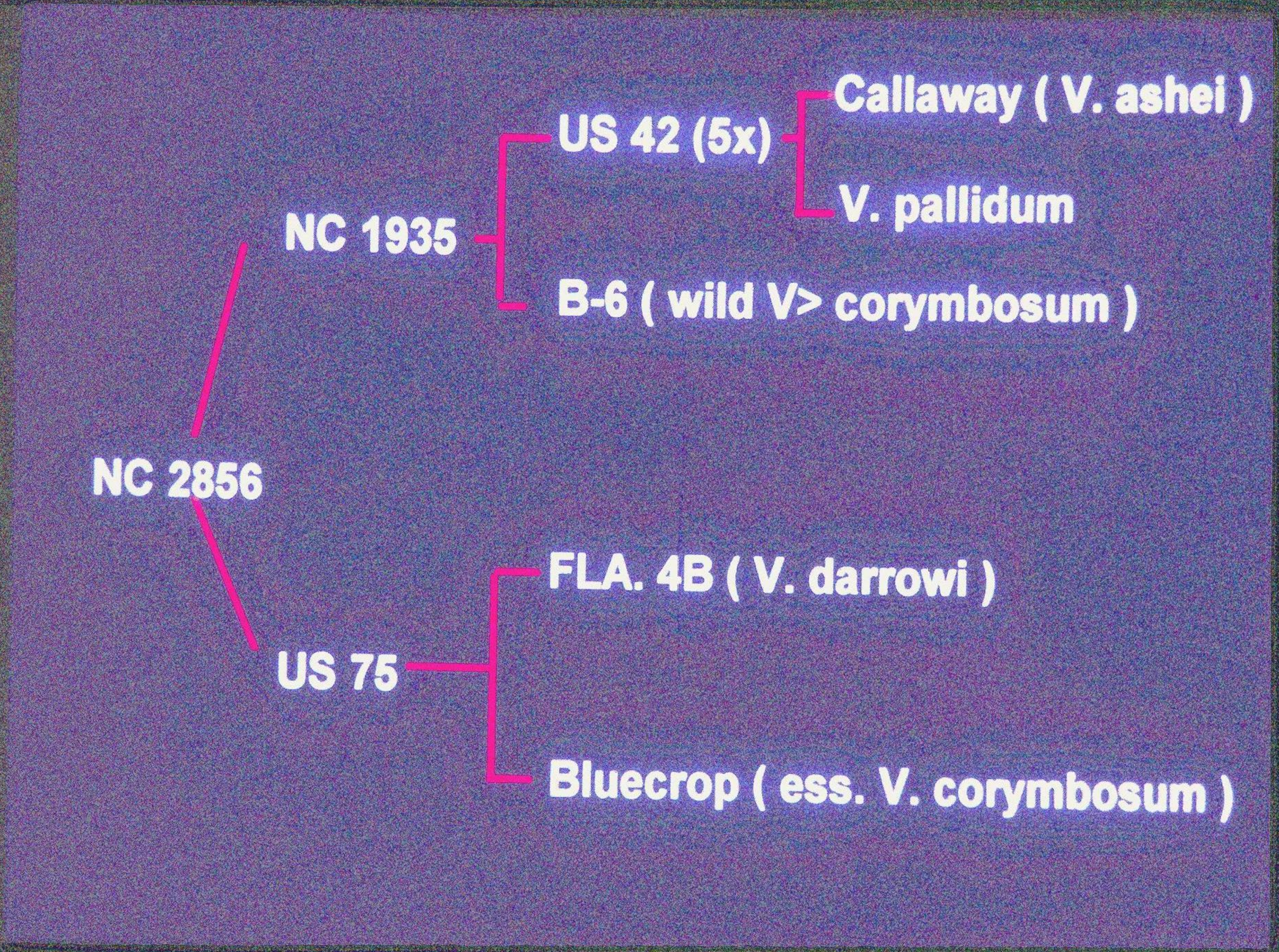
  Robeson (5x) = US 226 (4x) [colchicine doubled US 126 (2x)(*V. myrtilloides x V. corymbosum*)] x Premier (6x) (*virgatum*)

Breeding Systems

- When relatively fertile pentaploids are backcrossed to tetraploids or hexaploids the progeny are usually aneuploid and highly unpredictable with regard to fertility.

Most pentaploid backcrosses to tetraploids are highly infertile, but notable exceptions occur.

Ex: NC 1935, and old selections the UFL program.


NC 2856
NC 1935
US 42 (5x)
Callaway (V. ashei)
V. pallidum
B-6 (wild V> corymbosum)
US 75
FLA. 4B (V. darrowi)
Bluecrop (ess. V. corymbosum)

Breeding Systems

- There is significant inbreeding depression even in self-compatible cultivars.

  (Selfing self-compatible cultivars results in seedling progenies that are weak and of little value.)

- Cross-pollination results in larger and earlier ripening fruit, even with self-compatible cultivars.

Breeding Systems

Crosses among species in different subgenera are quite often possible, but usually result in reduced fertility and vigor, however sometimes fertility is restored through amphidiploidy (spontaneous doubling of chromosome number)

Examples of amphidiploidy through fusion of unreduced gametes from species in different subgenera:

NC 3048 (4x) = [NC 2267 (2x) (3/4 *V. darrowii* / 1/4 *V. corymbosum*) subg. *Cyanococcus*] x [BLJ-13-7 (2x) (*V. ovatum*) subg. *Pyxothamnus*]

NC 3865 (4x) = [NC 84-6-5 (2x) (*V. darrowii*) subg. *Cyanococcus*] x [NC 3730 (2x) (*V. cylindraceum*) subg. *Hemimyrtillus*]

Breeding systems

- Most traits of importance in breeding appear to be controlled by quantitative genes (many genes, each with small effects).
- Additive, dominance and epistatic variances are all important.

Breeding methods

- Two methods have been primarily used by breeders:

  1- Phenotypic assortative mating

  Ex; cross large-fruited x large-fruited & select for transgressive segregates (larger fruit than either parent).

  2- Complementary phenotypic disassortative mating

  Ex; cross disease-res. parent with avg. fruit size and color with a susceptible parent with large fruit size and excellent color, and then practice stringent selection for combining resistance with large size and good color among the progeny.

  (Across generations these in effect result in modified recurrent selection.)

Breeding methods

- Interspecific hybridization, or outcrossing to wild genotypes within the same species, followed by backcrossing has also been important in incorporating adaptation and disease resistance traits.

Ex; Adaptation: Legacy = Elizabeth x US 75 (*V. darrowi* x Bluecrop)

Ex: Stem Canker Res.: Croatan = {F6 [Stanley x Crabbe-4 (wild *V. corymbosum*)] x Weymouth}

Breeding methods

- Non-traditional methods

  1-Tissue culture screening for tolerance to higher pH.

  2-In-vitro chromosome doubling in tissue culture.

  3-Genetic transformation has been successful experimentally.

Current Breeding Objectives

- Broader soil adaptation
  (*V. arboreum, V. virgatum, V. elliottii, V. pallidum, 5X x 4X*)
- Broader climatic adaptation
  (*V. darrowii, V. consangineum*)
- Improved disease and pest resistance
  (*V. virgatum, V. elliottii, V. angustifolium, V. corymbosum*)
- Mechanical management
  (*V. corymbosum, V. darrowii, V. elliottii, V. virgatum*)
- Extension of the ripening season
  (*V. virgatum* -late, *V. boreale* - early)
- Improved precocity
  (southern highbush hybrids, *V. boreale*)
- Improved quality
  (southern highbush hybrids)
- Improved neutraceutical content
  (small-fruited *V. corymbosum, V. angustifolium, V. myrtillus*)

Achievements and prospects

-Remarkable increases in fruit size, productivity, consistent fruit quality, plant adaptation, and disease resistance have been achieved using a narrow genetic base and two to six generations of hybridization and selection.

-Abundant genetic resources are available both within subgenus *Cyanococcus* and related subgenera to meet the needs for further improvement in the various types of cultivated blueberries, and for the development of additional types using conventional methods.

Estimated Costs of Producing, Harvesting, and Marketing Blueberries in the Southeastern United States

Objectives

- Estimate the costs of producing, harvesting and marketing blueberries
  - Enterprise Budget
- Evaluate the profitability of establishing a blueberry planting
  - Cash Flow Analysis
  - Net Present Value
  - Internal Rate of Return

Procedures

- Cost estimates were based on a 100 Acre blueberry planting
- Production practices were based on management practices recommended by Extension Specialists and Farmers
- Equipment costs were based on 2004 purchase prices
- Input prices were collected from farmers and dealers who supply NC blueberry growers

Cultivar	Acres	Lbs per acre
O'Neal	12	8,500
Bladen	4	6,000
Reveille	15	5,500
Croatan	15	7,000
Duke	6	8,500
Sampson	5	7,500
Pender	5	7,500
Blue Ridge	8	8,500
Legacy	5	8,500
Premier	10	7,500
Columbus	5	7,000
Powderblue	10	10,000
Total	100	7,600

Good Highbush Blueberry Soil in NC

- Course sands w/ an organic base, open porous and w/ a water table of at least 14” but not more than 30”
- Most NC plantings are on Lynn Haven or Leon type soils
- Sandy soils characterized by an organic content of 2% or greater in the surface layer, underlain w/ a white sand layer above an organic hardpan

Yield Assumptions – Good Soil

Years	Irrigation	No irrigation
3	2,000	1,500
4	4,000	3,000
5	5,500	4,000
6	7,000	4,500
7 – 9	8,000	5,000
10 -12	7,000	4,000
13 - 15	6,000	3,500
16- 18	5,000	3,000
19 - 20	4,000	2,500

Yield Assumptions – Marginal Soil

Years	Irrigation
3	1,500
4	3,000
5	4,000
6	5,000
7 – 9	6,000
10 -12	5,000
13 - 15	4,000
16- 18	3,500
19 - 20	3,000

Yield Assumptions – Marginal Soil

Years	No Irrigation
3	750
4	1,000
5	2,000
6	2,500
7 – 8	3,000
9 - 10	2,500
11 - 12	2,000
13- 14	1,500
15	1,000

Yield Assumptions

- Fresh Market – 80%
  - 60% hand harvested @ $8.29/flat
  - 20% machine harvested @ $5.67/flat
- Process Market – 18%
  - 1.8% hand harvested (“fresh rejects”)@ $0.83/lb
  - 16.2% machine harvested @ $0.39/lb
- Economic loss – 2%

Harvest Assumptions

- Harvest season lasted 11 weeks – Last week in May through first week in August
- Fresh blueberries were sold for $14.11 per flat
- Processed berries were sold for $0.60 per pound

Note: One flat equals 9 pounds of blueberries

Estimated Annual Costs, 8th Year

Expense	Good Soil	Good Soil	Mar. Soil
Pruning	$ 297	$ 297	$ 297
Weed Control	144	144	144
Disease & Insect	360	360	360
Irrigation	477	0	477
Land Rental	40	40	40
Harvest	6,053	3,784	4,541
Total	$7,371	$4,625	$5,859

Estimated Annual Returns, 8th Year

	Good Soil	Good Soil	Marginal Soil
Receipts	$10,897	$6,810	$8,173
Expenses	- 7,371	- 4,625	- 5,859
Returns	$ 3,526	$2,185	$2,314

Equipment Investment – 1^{st} Year

Tractor, 70 – 80 hp (2)	$65,000
Mower, 5ft, HD	1,000
Fertilizer Spreader	1,200
Herb Sprayer, 200 gal	2,000
Shielded Herb Sprayer	4,000
Tapered Disk, 5ft	1,800
V-bladed Sweep Plow	2,000
Drain Runner (spinner)	1,900
Total	$78,900

Establishment Costs – 1st Year

Land Clearing ($3,000/A)	$300,000
Ditching & Drainage ($120/A)	12,000
Forming Beds ($25/A)	2,500
Plants (1,210/A @ 50¢ /plant)	60,500
Irrigation Pond (4 – 30,000 cu yd)	36,000
Irrigation Well (300 gpm)	15,000
Sprinklers, pipes & valves	120,000
Pumps (4 – 1,400 gpm)	38,000
Total	$584,000

Equipment Investment – 2^{nd} Year

Airblast Sprayer, 220 gal	$7,600
Farm Trailers (4)	4,000
Total	$11,600

Equipment Investment – 3rd Year

Truck, 1-Ton	$ 26,000
Mower, Articulated Flail	12,000
Mower, Flail, 40”	5,000
Metal Building (125’x50’)	156,250
Packing Equipment	35,000
Total	$234,250

Equipment Investment

4th Year	Harvester, Self Propelled	$114,000
5th Year	Farm trailers (4)	$4,000
6th Year	Packing Equipment (line 2)	$35,000
6th Year	Color Sorter	70,000
6th Year	Pneumatic Pruners	12,000

Flow of Funds – Good Soil

Years	Irrigation	No irrigation
1	-$804,064	-$567,974
2	-$ 58,264	-$ 31,174
3	-$193,727	-$190,434
4	$ 60,832	$ 24,867
5	$247,561	$180,069
6	$199,036	$ 68,489
7	$379,090	$217,016
8	$379,090	$217,016
9	$379,090	$217,016

Flow of Funds – Marginal Soil

Years	Irrigation	No irrigation
1	-$804,064	-$567,974
2	-$ 58,264	-$ 31,174
3	-$217,524	-$226,939
4	-$ 2,223	-$101,350
5	$152,979	$ 53,743
6	$ 72,926	-$ 57,890
7	$252,981	$ 90,583
8	$252,981	$ 90,583
9	$252,981	$ 56,110

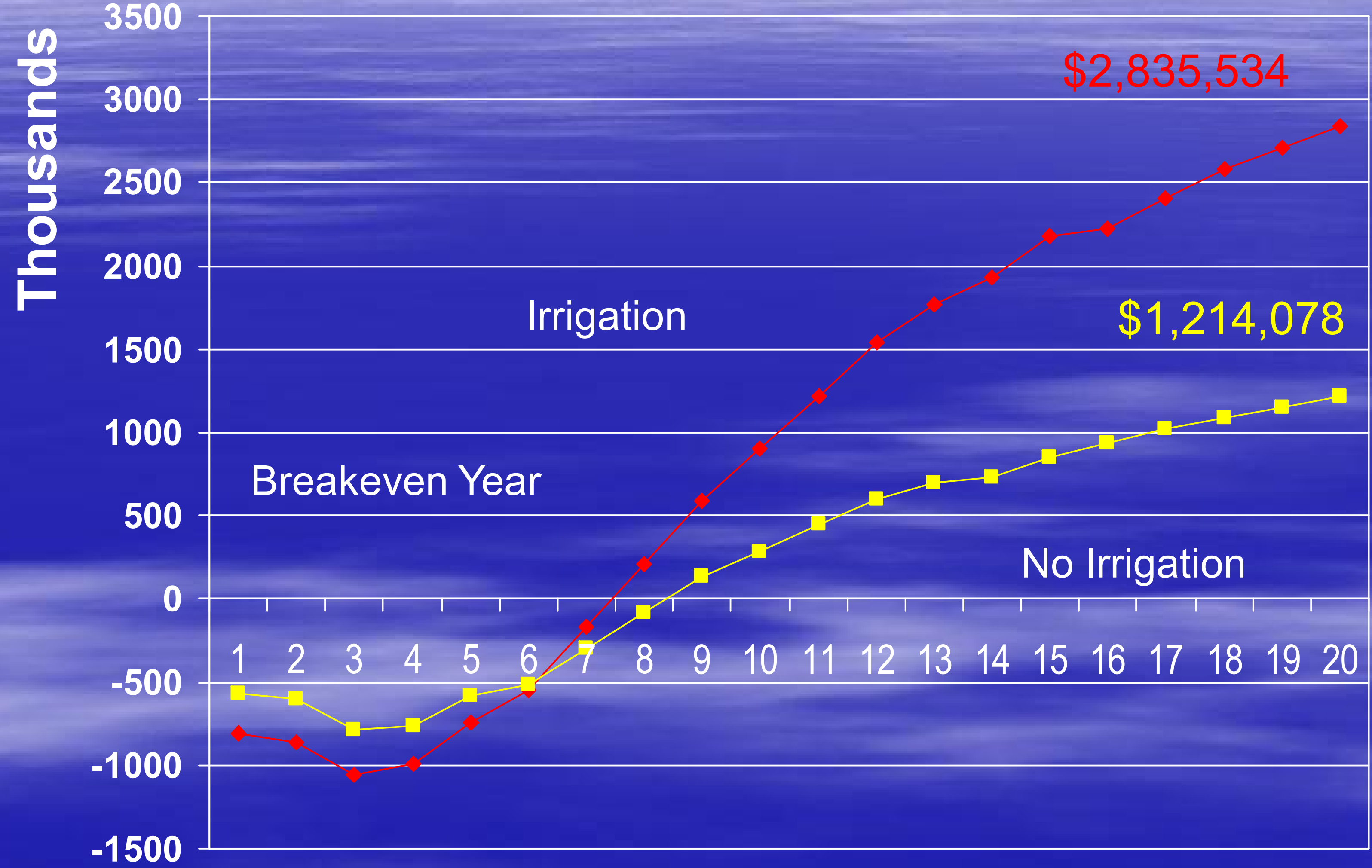
Accumulated Cash Flows – Good Soil

Years	Irrigation	No irrigation
1	-$804,064	-$567,974
2	-$862,328	-$599,148
3	-$1,056,055	-$789,582
4	-$995,224	-$764,715
5	-$747,663	-$584,646
6	-$548,627	-$516,157
7	-$169,537	-$299,141
8	**$209,553	-$82,125
9	$588,664	**$134,892

Breakeven Year

- The year when enough revenue has been generated to cover start-up expenses.
- To secure a loan of shorter duration could leave the farming operation insolvent.

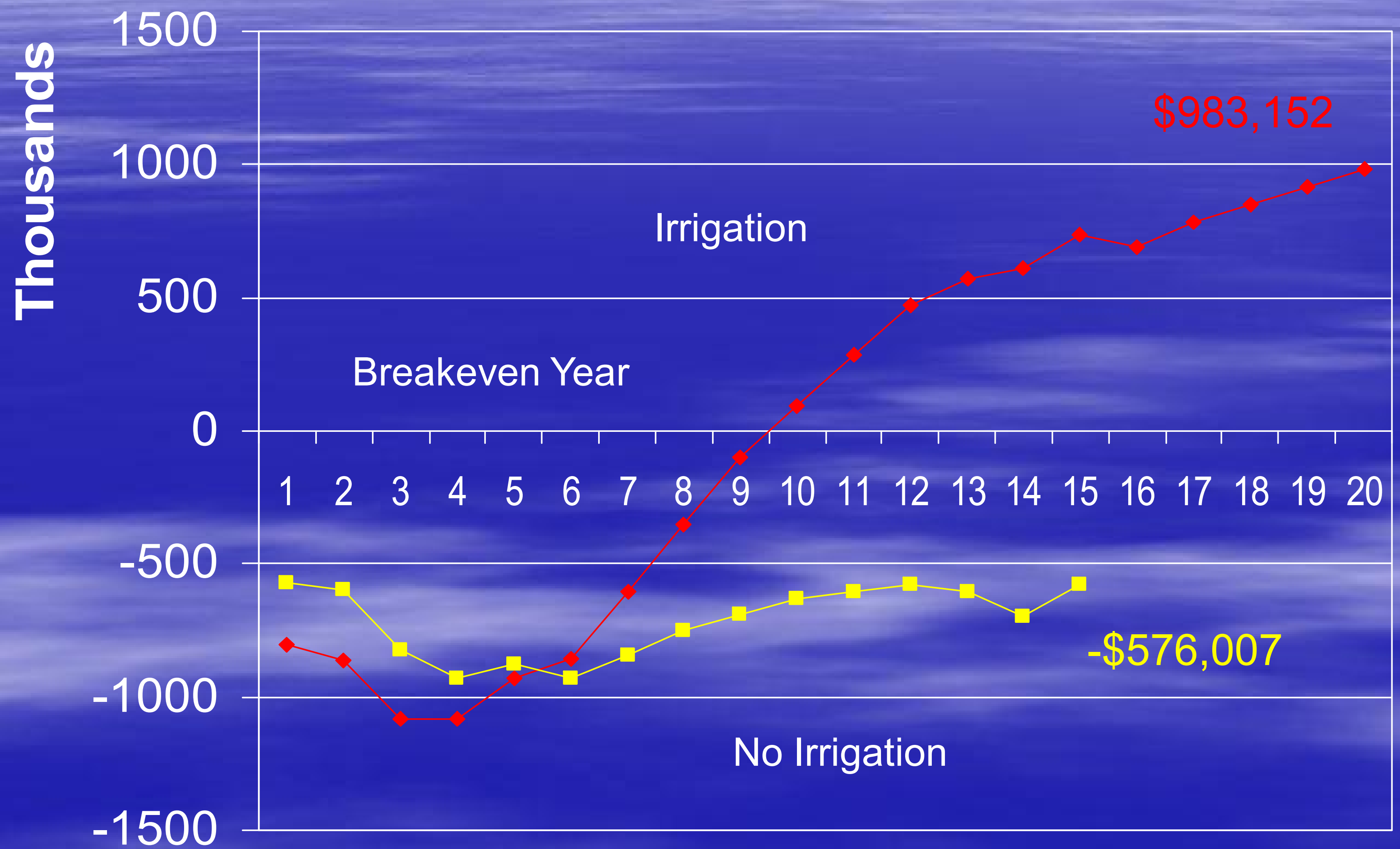
Accumulated Cash Flows – Good Soil



Accumulated Cash Flows – Marginal Soil

Years	Irrigation	No irrigation
1	-$804,064	-$567,974
2	-$862,328	-$599,148
3	-$1,079,852	-$826,087
4	-$1,082,075	-$927,437
5	-$929,096	-$873,694
6	-$856,170	-$931,584
7	-$603,189	-$841,001
8	-$350,208	-$750,418
9	-$97,227	-$691,309
10	**$92,699	-$632,199

Accumulated Cash Flows – Marginal Soil



Net Present Value

- Today's cash equivalent value of the 20 year blueberry planting.
- Assumes you can invest money at a given interest rate
- "Best" interest rate is low risk alternative, e.g. long term certificate of deposit
- Essence is the enterprise should be accepted if the NPV > $0

NPV – Good Blueberry Soil

	Today's Cash Equivalent	
Interest Rate	Irrigated Planting	Non-Irrigated Planting
6%	$1,127,073	$ 372,654
7%	$ 950,795	$ 286,236
8%	$ 795,006	$ 210,000

Today’s Cash Equivalent

- A new 100A blueberry planting on good soil with irrigation is worth $1,127,073 today
- Someone would have to pay a farmer $1,127,073 to bribe him to forget his plans of establishing a 100A blueberry planting
- One could pay up to $11,271 per Acre for good blueberry soil and still do as well as in other investments

NPV – Marginal Blueberry Soil

	Today's Cash Equivalent	
Interest Rate	Irrigated Planting	Non-Irrigated Planting
6%	$ 146,889	-$ 625,119
7%	$ 60,617	-$ 627,689
8%	-$ 15,493	-$ 629,187

Internal Rate of Return for the Blueberry Investment

Conditions	Rate of Return
Good Soil	
- Irrigation	16.6%
- No Irrigation	11.6%
Marginal Soil	
- Irrigation	7.8%
- No Irrigation	-11.7%

Internal Rate of Return for the Blueberry Investment

- Compared to a Treasury bond that yields 4.85%:
  - Blueberry plantings on good soil with an IRR of 16.6% & 11.6% look pretty good.
  - A planting on marginal soil w/ irrigation that has an IRR of 7.8% is not as attractive when you consider the risk and amount of time associated with blueberry production
  - A planting on marginal soil w/o irrigation “yields” an negative IRR

"Limited" Sensitivity Analysis

- Decrease the yields on good blueberry soils and marginal soils w/ irrigation in 9th & 14th by 50%

	Good Soil		Mar Soil
Year	W/ Irrig.	W/O Irrig.	W/ Irrig.
9th	4,000	2,500	3,000
14th	3,000	1,750	2,000

NPV's with Reduced Yields

	Good Soil		Marginal Soil
Interest Rate	Irrigated Planting	Non-Irrigated Planting	Irrigated Planting
6%	$894,117	$230,544	$20,855
7%	$740,244	$157,700	$91,183
8%	$604,431	$93,574	$153,057

Internal Rate of Return for the Blueberry Investment w/ Reduced Yields

Conditions	Rate of Return	
Good Soil	“Ideal” Yields	Reduced Yields
- Irrigation	16.6%	15.0%
- No Irrigation	11.6%	9.7%
Marginal Soil		
- Irrigation	7.8%	5.7%

Benefits of Irrigation

Good Soil	
- Breakeven year for irrigation equipment	7th Year
- Internal Rate of Return	26%
Marginal Soil	
- Breakeven year for irrigation equipment	8th Year
- Internal Rate of Return	22%

Conclusions

- A new 100A blueberry planting on good soil can be a profitable venture
- A new 100A blueberry planting on marginal soil w/o irrigation is a losing venture
- A new 100A blueberry planting on marginal soil w/ irrigation can be a risky venture
- Irrigation for frost protection and soil moisture pays handsomely

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Weed Management in Blueberry

Katie Jennings

North Carolina State University

Weeds reduce crop growth, cause flower abortion, reduce berry quality, reduce berry size, overall yield reduction.

Weeds tend to be patchy

Control weeds in noncrop areas (fencerows, field roads, ditches)


Smilax

The best time to control perennial weeds in blueberries is prior to planting!

Take the time to scout fields the year before planting.

The Worst Weeds

- Perennial weeds
  - nutsedge including annual sedges
  - vines – catbrier, greenbrier, smilax
  - seedling trees – holly, maples, sumac
  - brambles
  - goldenrod
  - red sorrel
  - Maryland meadowbeauty
- Grasses
  - annual grasses
- Annual broadleaf weeds

PRE Herbicide Options in Blueberries
Velpar 2 L/80 DF

- Rate: 0.5 to 1.0 gal/A or 1.3 to 2.6 lb/A
- Direct to soil and weeds before emergence of blueberry leaves.
- DO NOT use on first year plantings.
- Controls some woody plants, red sorrell, dog fennel, panic grass.
- Suppresses goldenrod and briars.
- PHI = 90 days

PRE Herbicide Options in Blueberries
Sinbar 80 WP

- Rate: 0.5 to 2 lb/A
- Plantings established at least one year.
- Control is best if rainfall occurs within 2 weeks of application.
- Controls broadleaf weeds and some grasses.
- Controls annual sedge.

PRE Herbicide Options in Blueberries
Princep 90 DF/4 L

- Rate: 2.2 to 4.4 lb/A or 2 to 4 qt/A
- May be used on first year plantings.
- Use ½ rate on plantings 6 months old or less.
- DO NOT use in bark bed system if blueberry plants are less than 6 months old.
- DO NOT apply when fruit is present.
- Rainfall or irrigation is required for activation.
- Controls grasses and some broadleaf weeds.

Weed Response to Herbicides

	Broom	Golden	Dog	Red Sorrel
Princep	N	N	N	F
Sinbar	G	N	G	G
Velpar	F	E	E	E

PRE Herbicide Options in Blueberries

Surflan 4 AS or Oryzalin 4 AS

- Rate: 2 to 4 qt/A
- May be used on first year plants and established plants.
- May be used in bark bed systems.
- Activation within 14 to 21 days.
- Controls annual grasses and small seeded broadleaf weeds.

PRE Herbicide Options in Blueberries
Devrinol 50 DF

- Rate: 8 lb pr/A
- Use 4 lb/A during first year.
- Newly planted and established plantings.
- Soil surface should be free of residue.
- Apply as a directed spray to the base of plant.
- Activation within 24 hours is best.

PRE Herbicide Options in Blueberries

Solicam 80 DF

- Rate: 0.5 to 5 lb/A
- Dormant application.
- Plants must be at least 6 months old.
- May be used in a bark bed system.
- Rain must occur within 4 weeks.
- Minimal residue on soil surface.
- May bleach the leaves.
- Suppresses y. & p. nutsedge.
- Good control of a. sedge, C. geranium, dogfennel, and goldenrod.

PRE Herbicide Options in Blueberries
Karmex 80 DF

- Rate: 1.5 to 2 lb/A or 2.2 to 1.6 qt/A
- Registered in AR, GA, MS, NC, and SC.
- Must be established at least a year.
- Directed treatment in spring.
- DO NOT apply to soils < 1% OM.
- Good activity on many broadleaf weeds and some annual grasses.

PRE Herbicide Options in Blueberries
Snapshot 2.5 G

- Rate: 150 to 200 lb/A
- Newly planted or nonbearing plants only.
- Allow soil to settle after transplanting prior to application.
- May be used in bark bed system.
- DO NOT apply within one year of harvest.
- Broadleaf weeds and annual grasses.

PRE Herbicide Options in Blueberries
Gallery

- Rate: 0.66 to 1.33 lb/A
- Newly planted or nonbearing plants only.
- Allow soil to settle after transplanting prior to application.
- May be used in bark bed system.
- DO NOT apply within one year of harvest.
- Broadleaf weeds.

POST Herbicide Options in Blueberries
Glyphosate

- Rate: 11 to 22 oz/A
- Use a hooded sprayer or wiper applicator to prevent SEVERE crop injury.
- Be aware of resistance weeds developing.
- PHI = 14 days.

Perennial Weed Control with Glyphosate

Weed Species	% v/v	Timing
Blackberry	1-1.5	Late summer through early Dec.
Smilax	**3**	5 fully expanded leaves in spring
Nutsedge (y/p)	2-3	Flowering; use half rate and sequential applic. 3-4” tall plants.
Poison ivy/oak	2	Two weeks either side of full bloom (early summer)
Virginia Creeper	1.5-2	Late summer prior leaf color change

POST Herbicide Options in Blueberries
Gramoxone Inteon 2 SL

- Rate: 2.5 to 4 pt/A with a hooded sprayer.
- Avoid contact with blueberry plant.
- Nonselective weed control.
- DO NOT make more than 5 applications per year.
- 0 day PHI.

POST Herbicide Options in Blueberries

Rely 1 L

- Rate: 3 to 5 qt/A
- Directed spray.
- Avoid contact with green or uncallused bark on young bushes.
- Max. 12 qt/year
- Good activity on broadleaf weeds – less effective on grasses.
- Apply 3 days prior to or 5 days after applying Poast, Select, or Fusilade.
- 14 day PHI

POST Herbicide Options in Blueberries
Aim 2 EC

- Rate: 1 to 2 oz/A.
- Dormant application directed to base of bush.
- Row middle application in season with hooded sprayer.
- Coverage is essential for satisfactory control.
- Broadleaf weeds.
- PHI = 0 days

Perennial Weed Response to Herbicides

	Bramble	Broom	Golden	Sumac
Rely	100	100	100	88
Roundup	--	99	99	71
Paraquat	0*	71*	76*	0*

*Statistically different

9 week visual rating (Monaco)

POST Herbicide Options in Blueberries

- Poast - 1.5 to 2.5 pt/A
  - Include a COC at 1 % v/v
  - 30 day PHI
- Fusilade -16 to 24 oz/A
  - Use COC or NIS
  - Nonbearing ONLY
- Select – 6 to 16 oz/A
  - NIS at 0.25% v/v
  - Nonbearing ONLY

NEW Formulation! Select Max

- POST for annual and perennial grasses.
- Rate: 9 to 16 oz/A.
- NIS at 0.25% v/v
- Use high rate and sequential applications for perennial grasses (bermudagrass).
- Total use during season can not exceed 32 oz per acre per year.
- Nonbearing only.

Future Herbicide Registrations

- Dual - improve control of sedges (annual and perennial)
- Chateau – probably could be applied in a delayed preemergence program to improve late season weed control; probably improved broadleaf weed control would result

Future Herbicide Registrations

- Sandea
  - POST control of nutsedge.
- Callisto
  - Broadleaf weeds
  - Not real effective on most grasses.

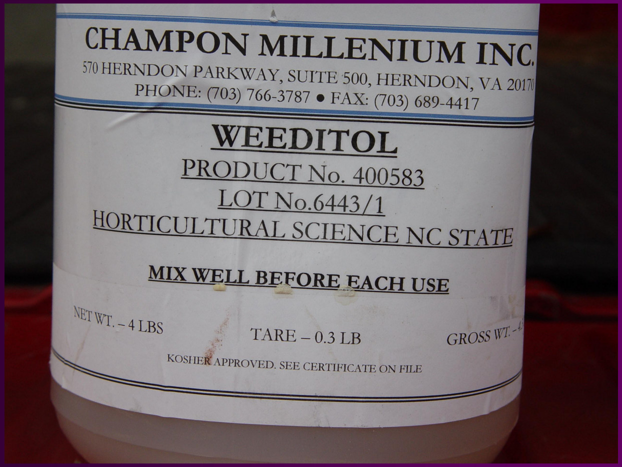
2006 Herbicide Evaluations

- Aim applied to young and established blueberry.
- Chateau applied to established blueberry.
- Sandea applied to several varieties.
- Natural products applied to young blueberry.

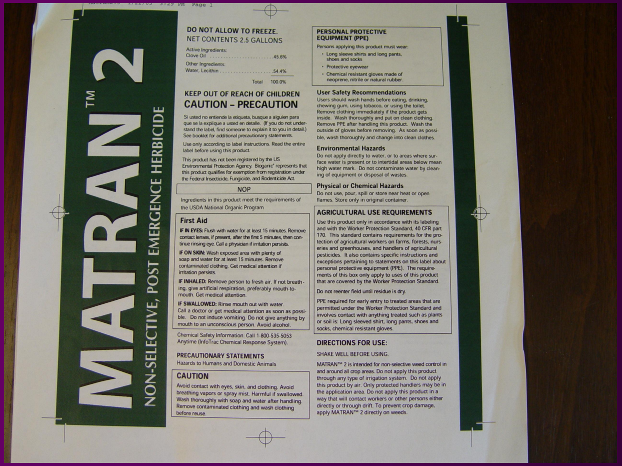
Natural Herbicides

Bradfield vinegar

Vinegar, citric acid, and clove oil



Bitter almond



Clove oil

Research in 2007

- Natural products applied to young blueberry.
- Chateau applied to established and young blueberry bushes.
- Sandea applied to several varieties.
- Painted stems of newly planted bushes.
- Conduct surveys to monitor movement of weeds from ditchbanks to blueberry fields.

Goldenrod

Perennial
Spreads by rhizomes, patchy

Panic Grass




January 7, 2007

Maryland Meadowbeauty

Redroot

Smilax

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Blueberry Cultivar Development at The University of Georgia

D. Scott NeSmith

Dept. of Horticulture

Univ. of Georgia

Griffin, GA

Georgia blueberry industry

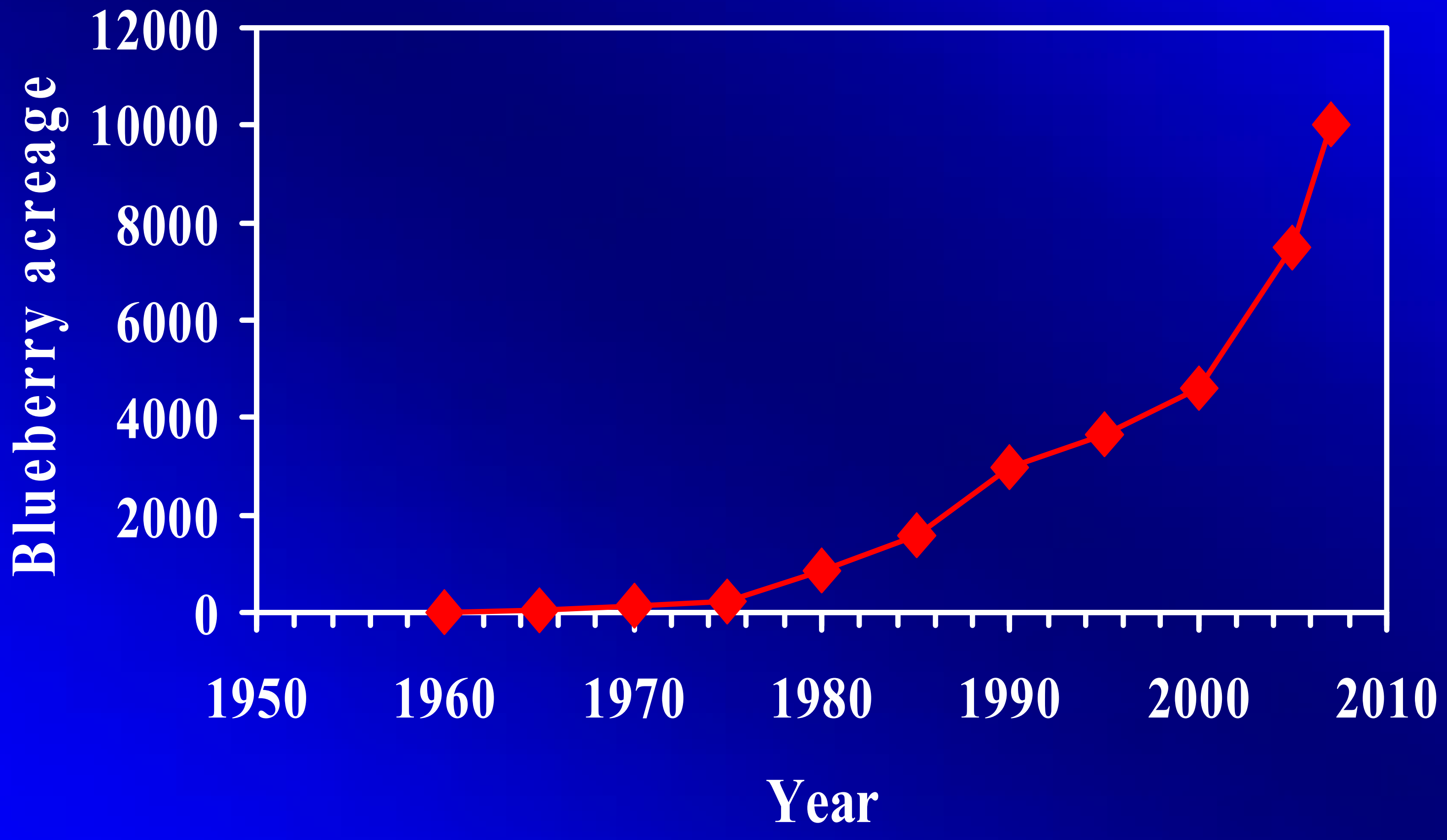
UGA Blueberry Breeding Program History

- Program dates back to 1926, when 12 selections were set out at Tifton.
- In 1939, a collaborative breeding program with USDA was initiated.

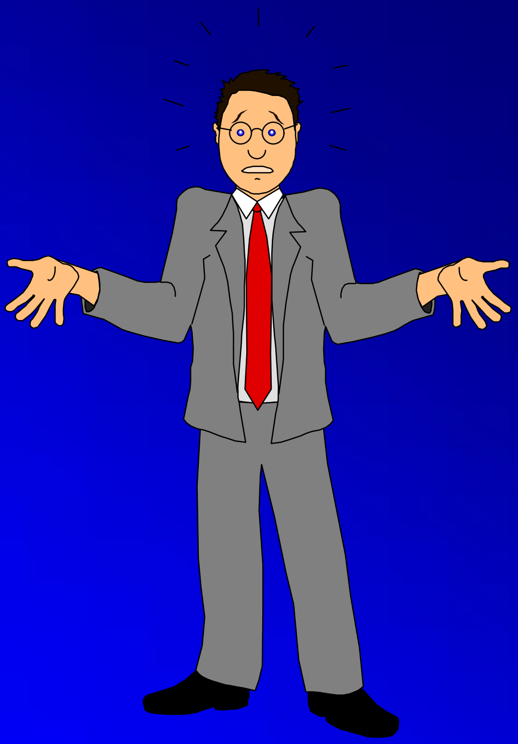
UGA Blueberry Breeding Program History

- **Dr. W. Thomas Brightwell** really gave the program a boost in 1945, when 25 acres of land near Alapaha, GA was dedicated to blueberry cultivar development.
- First 5 decades, primarily bred rabbiteye blueberries, but now also very active in southern highbush cultivar development.

Blueberry acreage in Georgia continues to increase!



What about Cultivar Development Program today?



Today

- Today, program occupies **34 acres** of land at Alapaha and **8 acres** at Griffin.

- New expansion of **15 acres** at Alapaha on virgin soil is underway and **6 acres** of expansion is planned for Griffin.

Breeding Program Overview

Seedling

- Obtained from desired crosses.
- Require 2 to 4 months for emergence.
- Moved into containers and grown in greenhouse for another 3 to 6 months.
- In late spring, plant to high density bed.
- Seedlings fruit 3 years from seed, and screened to advance 2% to 3%.


2002/ 9/16 8:19am

Advanced Seedling

- Transplanted from high density seedling nursery into field as single plants.
- Evaluate fruit and plant characteristics for 1 to 3 years.
- Make selections from the best 3% to 5% of advanced seedlings.

Selection

- Obtain 15 to 20 rooted cuttings from desirable single plant seedlings.
- Grow in multi-plant selection block for 5-8 years to make detailed plant, fruit, and yield evaluations.
- After 5-8 years, 3 to 5 desirable selections are propagated further as advanced selections.

Advanced Selection

- For advanced selections, 100 or more plants are propagated for multiple site evaluation.

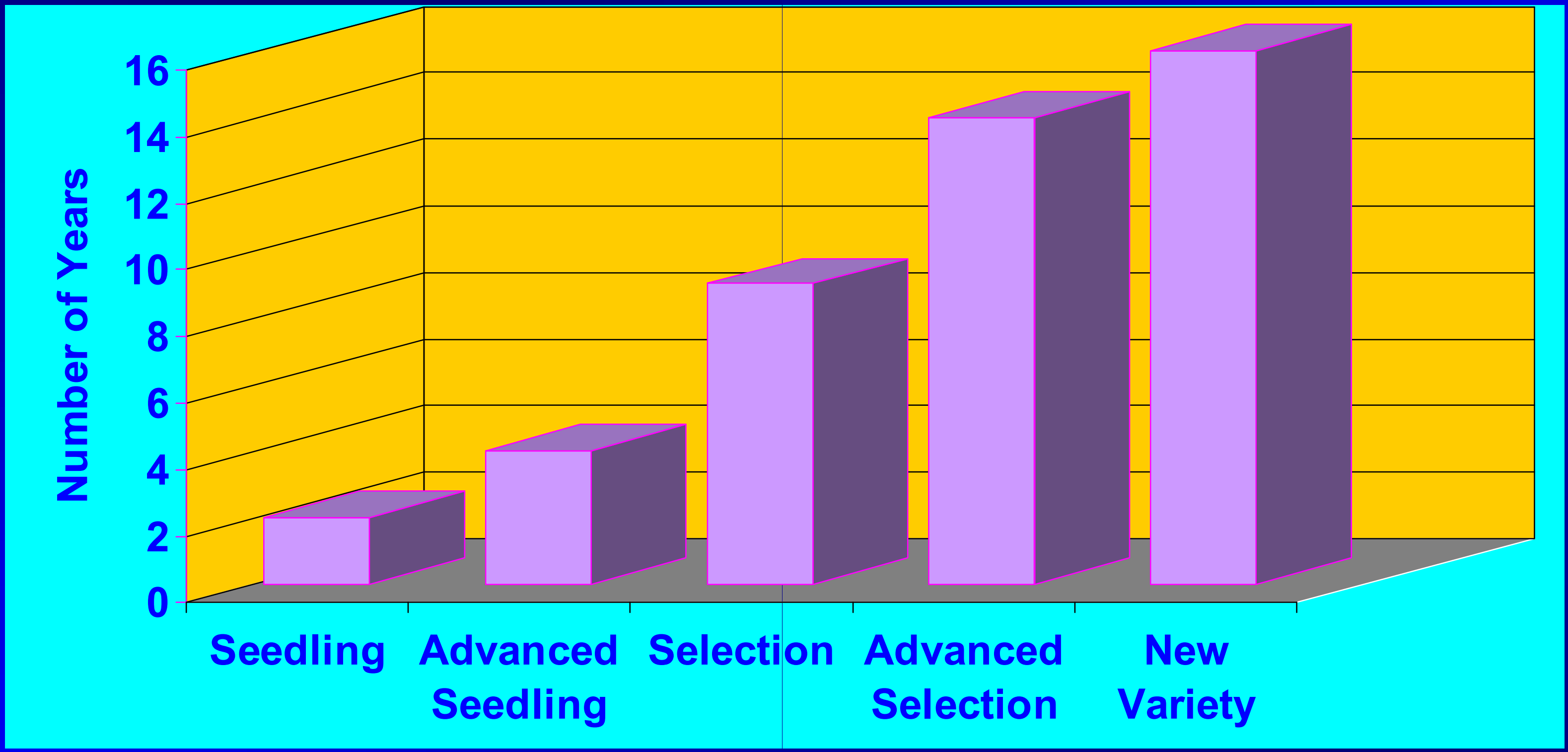
- Advanced selections grown for at least 5 years along with standards, and detailed data is taken at all sites.

- After 5 years, all data compiled to determine potential variety releases.

New Variety

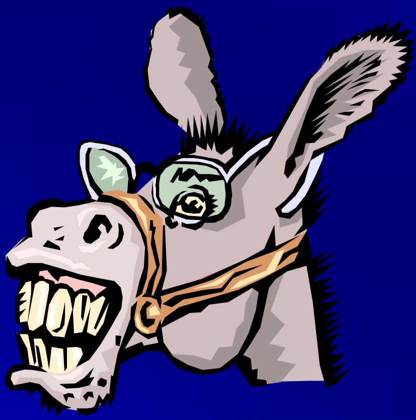
- The very best advanced selections are considered for release.
- A new cultivar must meet rigid standards of uniqueness and superior yield, fruit, and/or plant characteristics.
- New variety must be cleared by UGA release committee.

Blueberry Cultivar Development Timeline

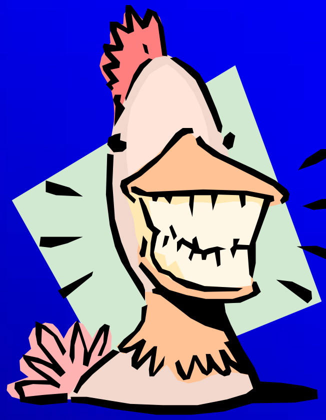


BAD NEWS

Takes 12 to 15 Years



GOOD NEWS



HAVE THINGS AT ALL STAGES

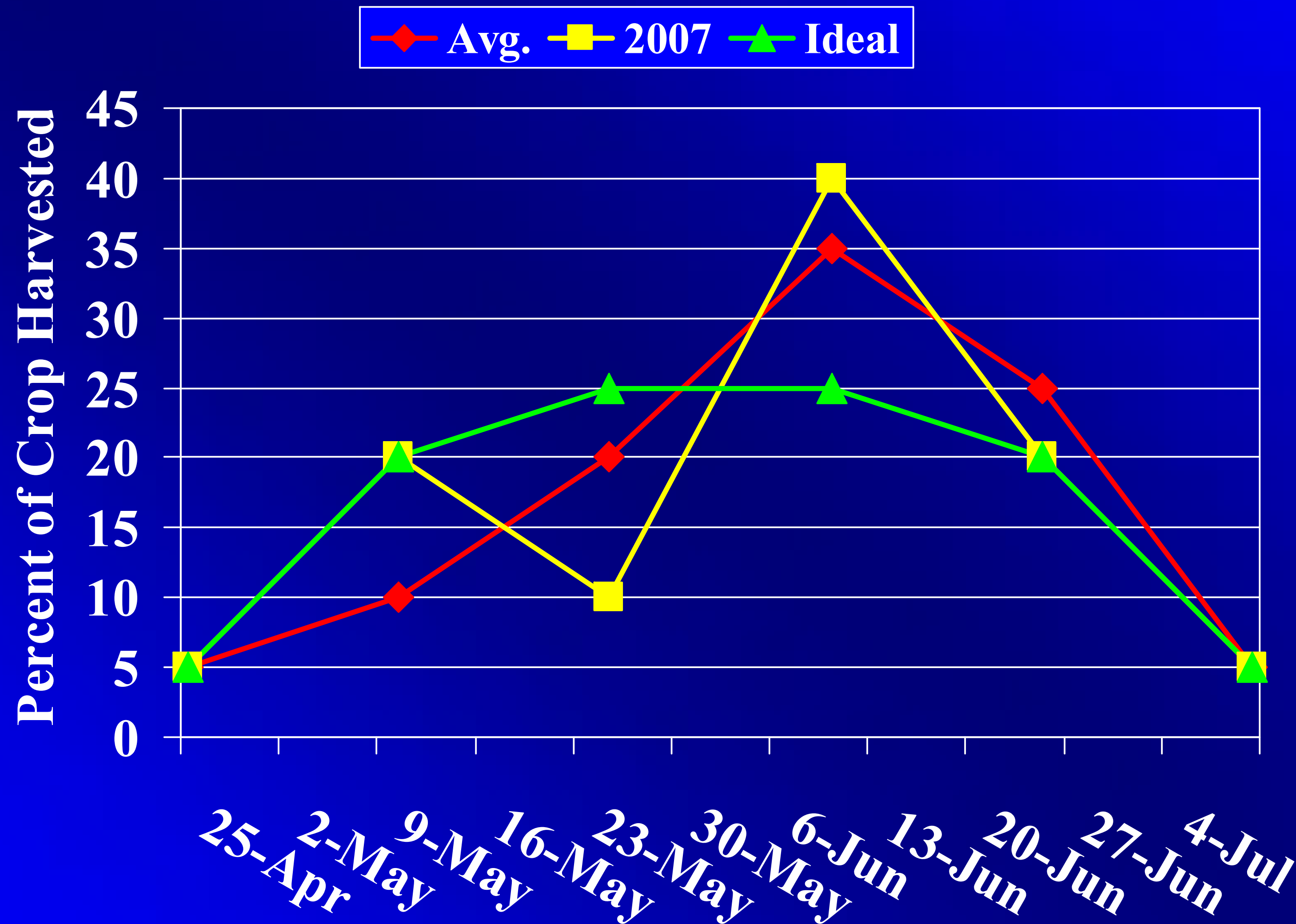
Focus of breeding

- Looking for increased fruit size for rabbiteye blueberries.
- More than 70% of new crosses in past 5 years have been southern highbush.
- Want very firm fruit for SHB.
- Fruit quality is a must for competitive varieties in the future.

Focus of breeding

- High yielding, machineable cultivars when possible.
- Short bloom to ripening periods.
- Later blooming SHB to reduce frost risk.
- SHB varieties carrying us up to rabbiteye season.

Georgia Production Window



New UGA Varieties

‘Palmetto’ Southern Highbush Blueberry

- **Early season**
- **Excellent flavor**
- **Good firmness**
- **Medium size**
- **Concentrated ripening**

‘Camellia’ Southern Highbush Blueberry

- Early season
- Excellent flavor
- Good firmness
- Large size
- Excellent light blue color
- Vigorous plant

‘Rebel’ Southern Highbush Blueberry

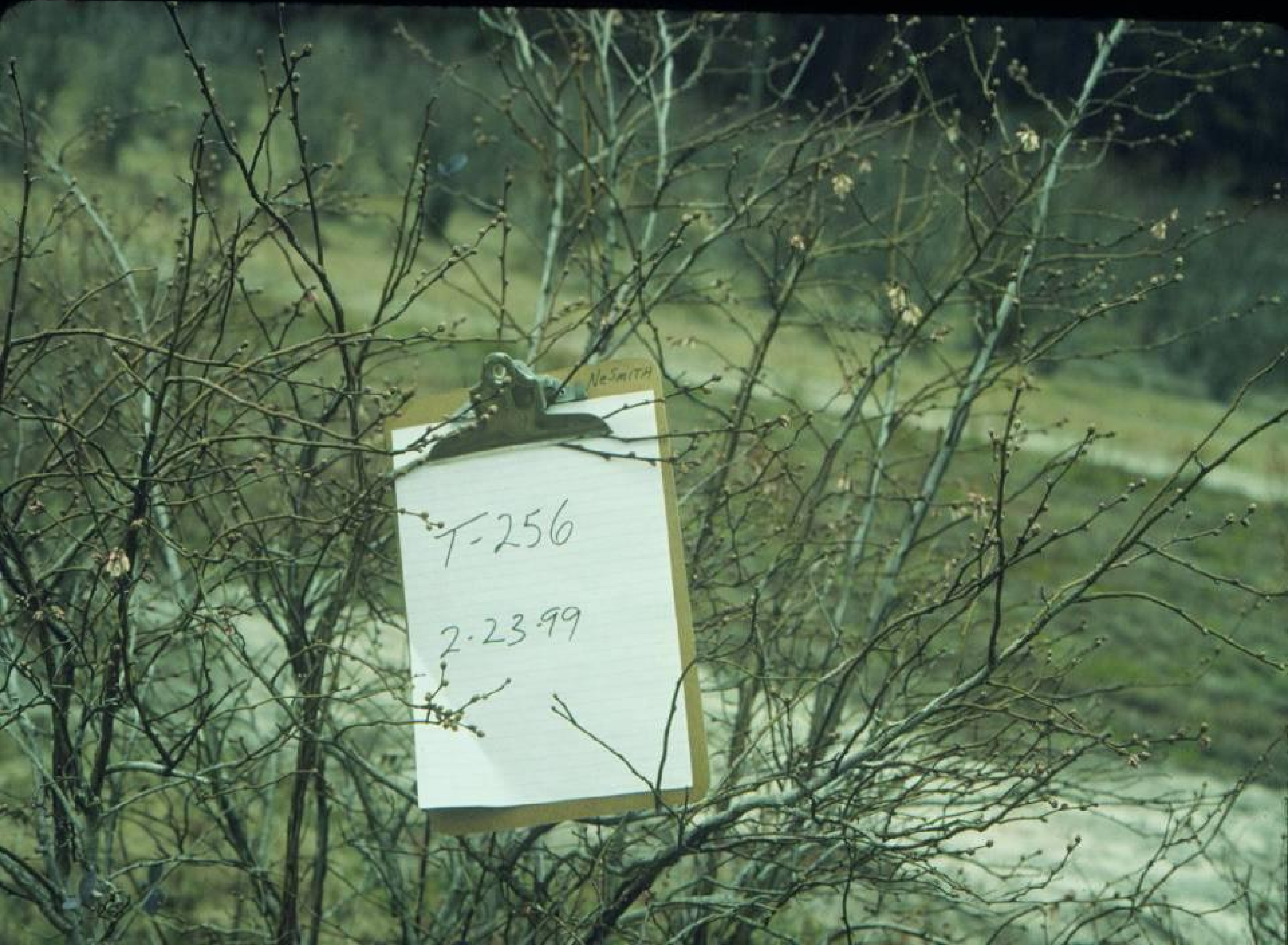
- Very early season
- Good firmness
- Large size
- Very good scar
- Vigorous plant


EMERALD
STAR
TH-642
O'NEAL

‘Alapaha’ Rabbiteye Blueberry

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


NeSmith
Climax
2-23-99


NeSmith
T-256
2-23-99

‘Vernon’ Rabbiteye Blueberry

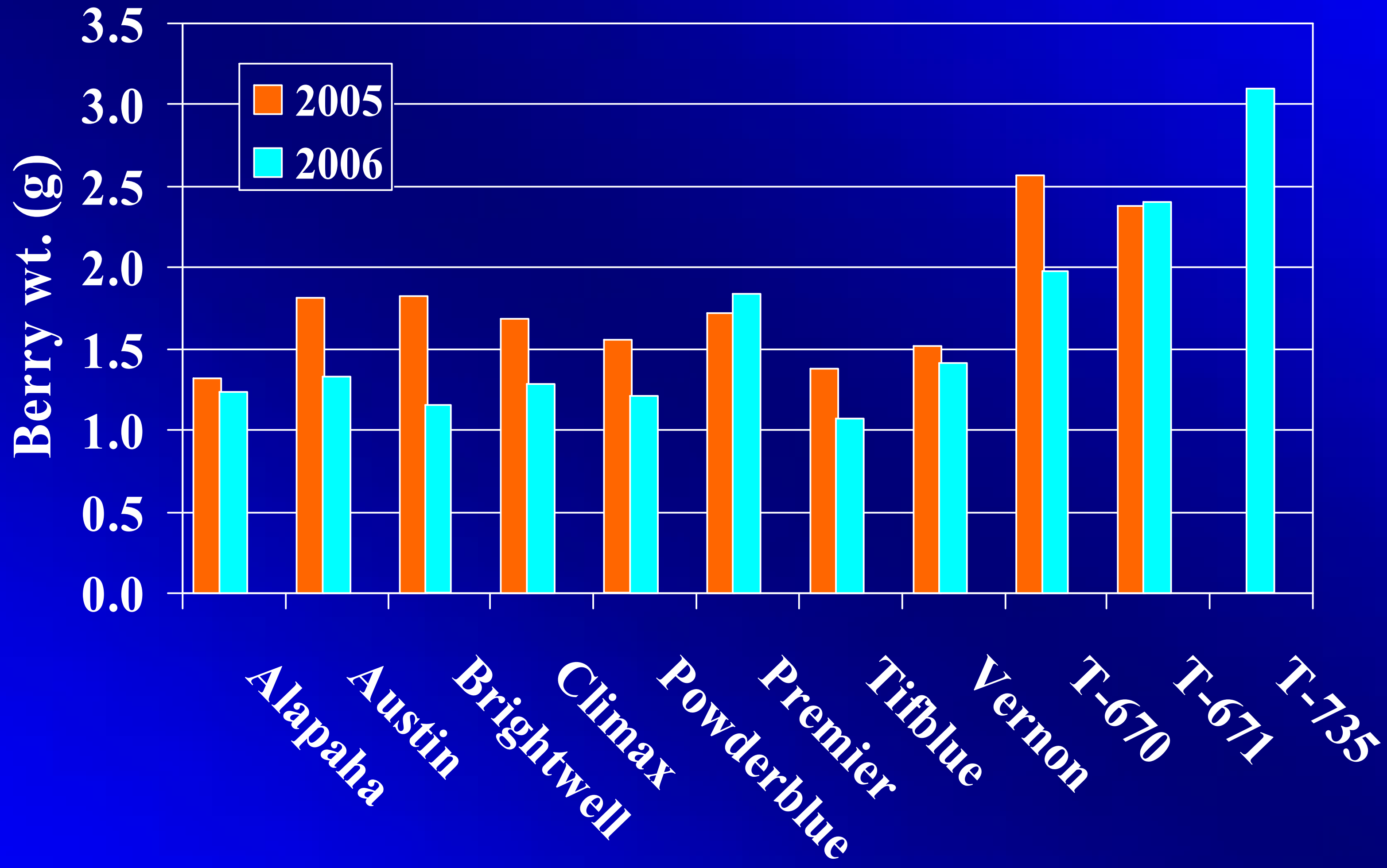
- **Early season (ripens with Climax and Premier)**
- **Blooms late, ripens early**
- **Large size**
- **Vigorous plant**


T-584
PREMIER

‘Ochlockonee’ Rabbiteye Blueberry

- Late season (later than Tifblue and Powderblue)
- Blooms late, ripens late
- Medium to large size
- Less rain splits than Tifblue

Rabbiteye Berry Weight




Tifblue
T-735
Brightwell

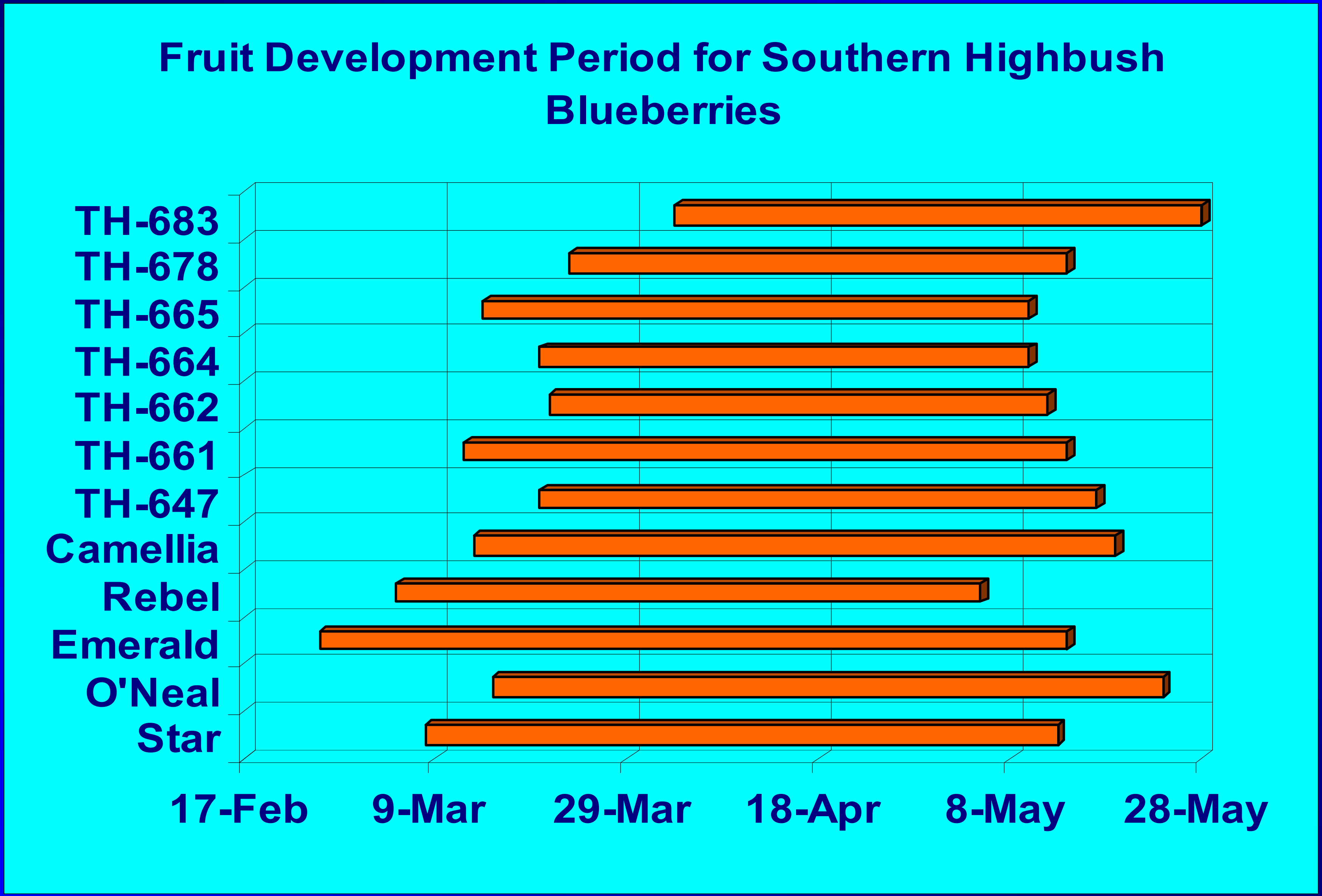

Tifblue
T-735
Brightwell


Severe splits →

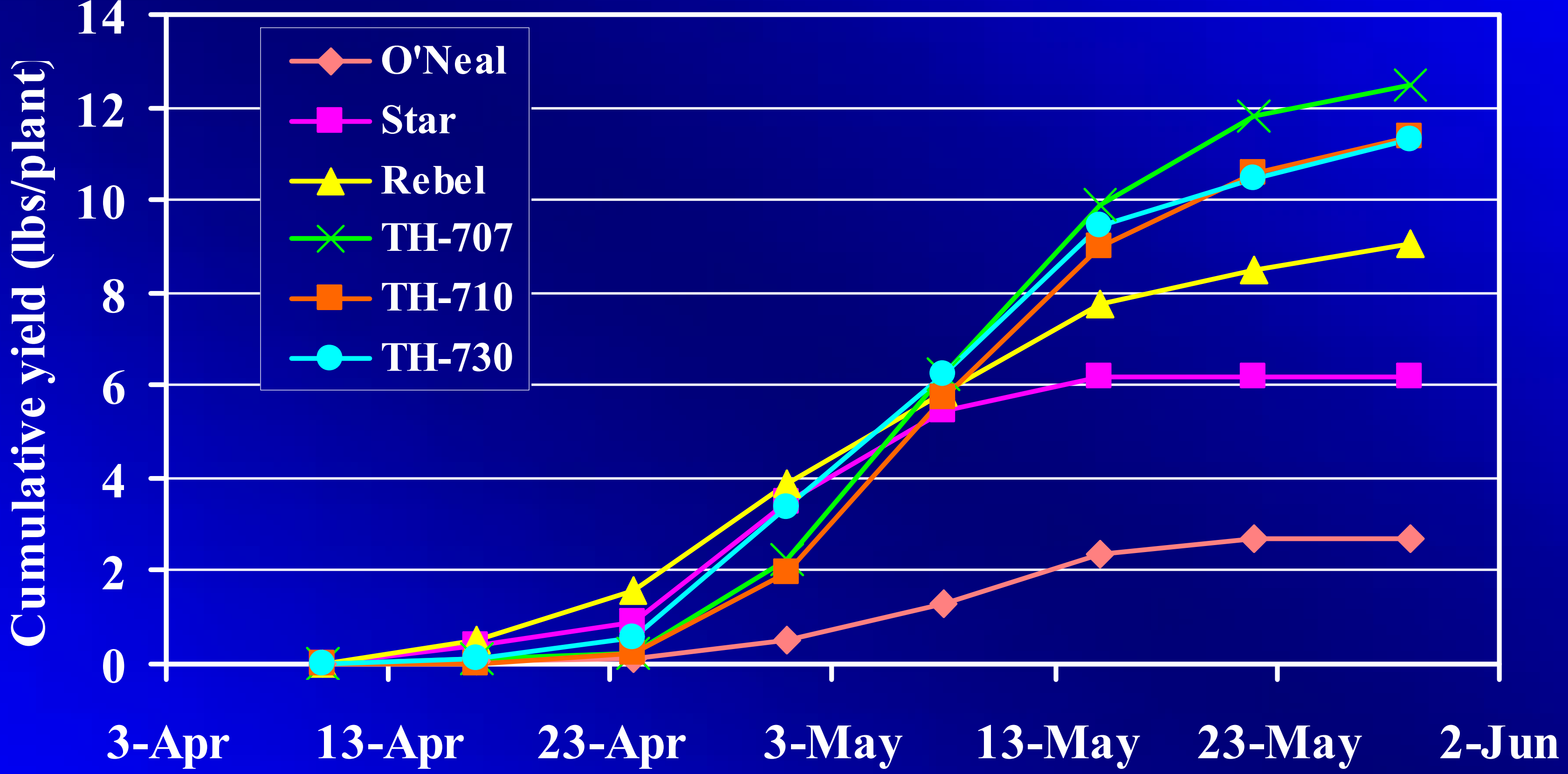
Selection	Fruit cracking (%)	Berry firmness (g/mm)
Alapaha	2-6%	189
Brightwell	10-20%	207
Climax	10-20%	200
Premier	2-6%	172
Powderblue	2-8%	187
Ochlockonee	2-6%	190
T-619	2-6%	220
T-670	15-20%	209
T-671	25-35%	274
T-672	10-20%	200


← Brightwell splits

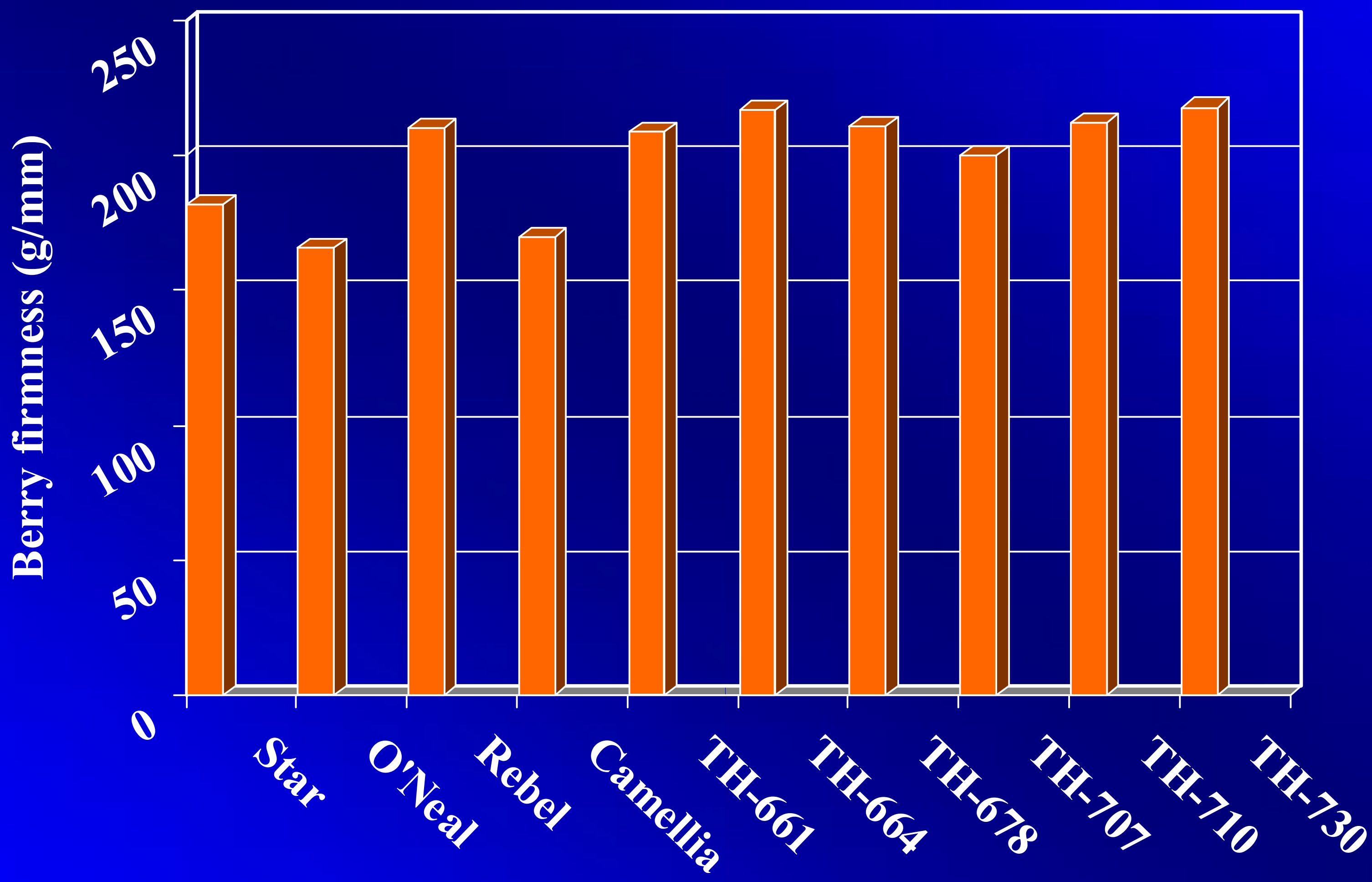

← Alapaha no splits


Fruit Development Period for Southern Highbush Blueberries
TH-683
TH-678
TH-665
TH-664
TH-662
TH-661
TH-647
Camellia
Rebel
Emerald
O'Neal
Star
17-Feb
9-Mar
29-Mar
18-Apr
8-May
28-May

Southern highbush yields in bark beds



SHB Berry Firmness



Summary

- UGA blueberry breeding program is rich in history.
- Cultivar development long term process.
- Program continues to develop rabbiteye and southern highbush blueberries.
- Cultivars grown today likely will not be those grown in 10 years.
- All new cultivars should be grown on a trial basis.

Availability of UGA Cultivars

- Plants are patented cultivars.
- Contact Georgia Seed Development Commission, 2420 S. Milledge Ave., Athens, Ga. 30606 for information on plant source and availability.
- Phone number is 706-542-5640. Web site is www.gsdc.com


Questions????

Blueberry Disease Control in the Southeast

Bill Cline
Plant Pathology, NCSU
Blueberry Workshop for Agents
June 19-21, 2007

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Crop Characteristics

- Perennial, woody plant
- Two species (highbush, rabbiteye)
- Small acreage, high value per acre
- Vegetatively propagated (clonal)
- Site selection/preparation is critical
- Insect pollinated
- Hand harvested, eaten fresh
- Ripen over several weeks
- Perishable fruit

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Woody Perennial Crops

- Disease problems and plant losses are additive – no “starting over” with each new growing season
- Biocidal treatments cannot be used on an annual basis (MeBr)
- Pathogens and insects are often plant-borne, chronic

‘Legacy’ Blueberry

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Small Acreage, High Value

- NC blueberries averaged over $19 per flat in 2006
- "Extreme" measures are justified – frost protection, bird netting, hand pruning and harvesting

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Vegetatively Propagated

- Diseases may be transmitted via cuttings from infected plants
- Clonal -- no multi-line resistance
- Some diseases are unique to plant propagation systems

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Blueberry flowers must be visited by a pollinating insect in order to form a berry. Southeastern blueberry bee (shown) is a very effective wild, native pollinator. *Pollinators can vector some diseases (mummy berry, some viruses).*

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Disease Management Strategies To be Considered Before Planting:

- Geographic location (avoidance)
- Site selection
- Site preparation
- Disease resistant cultivars
- clean planting stock

'Columbus', resistant to fruit rots

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Site selection/preparation

- What are the horticultural requirements of the crop (pH, fertility, organic amendments)?
- Drainage is very difficult to correct AFTER the plants are in the ground

WHAT MAKES A GOOD BLUEBERRY SITE? –

Ashe County, WNC

Bladen County, SENC

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Good drainage, soil aeration, low pH, organic matter and water

- pH
- Highbush blueberry -- 4.0 to 5.0
- Rabbiteye blueberry – 4.5 to 5.3
- Drainage
- Surface drainage (bedding, ditching)
- Internal drainage (soil amendments if needed)
- Irrigation
- Overhead (allows frost protection)
- Drip or micro-sprinkler (conserves water)

Raised beds are commonly used, along with drip irrigation, mulch and soil acidification

Disease Management Strategies Used After Planting:

- Cultural practices
- Sanitation
- Chemical control of pathogens
- Vector control

Dormant mummy berry Pseudosclerotia in winter

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Cultural practices/Sanitation

- Remove bushes infected with blueberry stunt or infested by dodder
- Prune to remove senescent/infected stems
- Disk or mulch to bury mummy berry pseudosclerotia

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Harvest Timing and Handling

- Highbush blueberries–every 5-7 days
- Rabbiteye blueberries –every 10 days
- Pick ALL ripe fruit at each harvest
- Sanitary handling – fruit is not washed
- Once harvested, field heat is rapidly removed with forced-air cooling
- Shelf life is extended with refrigeration and controlled atmosphere (CA) storage

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Chemical Control

- Requires an accurate diagnosis of the disease
- Specialized sprayers are configured to match the plant canopy
- Some fungicides are systemic, most are protectants
- Vector control -- using insecticides to limit insect spread of viruses, phytoplasmas

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Disease-causing “agents”

- Fungi
- Abiotic factors
- Phytoplasmas
- Viruses
- Parasitic plants
- Bacteria
- Nematodes
- Unknown

Some Important Fungal Diseases

- Stem canker *(Botryosphaeria corticis)*
- Stem blight *(Botryospheria spp.)*
- Mummy berry *(Monilinia vaccinii-corymbosi)*
- Twig blight *(Phomopsis vaccinii)*
- Fruit rots *(Colletotrichum, Alternaria)*
- Leaf spots *(Septoria, Gloeosporium)*
- Root rots *(Phytophthora* spp., *Armillaria mellea)*
- Botrytis blight *(Botrytis cinerea)*
- Rust, Mildew *(Pucciniastrum, Microsphaera)*
- Others *(Exobasidum, Cylindrocladium)*

FUNGAL DISEASES

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Mummy berry *(Monilinia vaccinii-corymbosi)*

- Host-specific fungus
- High degree-days can substitute for lack of chilling
- Controlled with fungicides and cultural practices
- Indar, Orbit labeled in 2007
- Pristine has some efficacy

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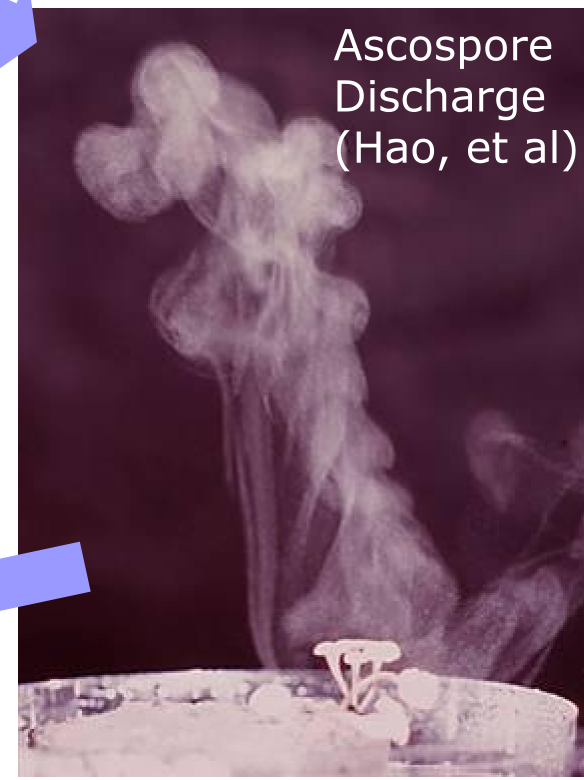
Mummy Berry Disease Cycle (SENC)

Fruit symptoms (May-Jun)

Apothecia emerge from mummies (Feb-Mar)



Conidia on blighted shoots (Apr)

Flower infection (Apr)

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Stem Canker *(Botryosphaeria corticis)*

- 1940s-1970s - in NC , canker devastated ‘Weymouth’, ‘Wolcott’
- Newer cultivars selected for resistance
- Benlate (1970s)
- Better cultural practices
- More cvs (multi-line?)
- Softwood and tissue culture propagation

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Stem Blight (*Botryosphaeria* spp.)

- Wounding required for infection, epidemics can be traced back to specific injury events
- Fall freeze injury predisposes plants in overly fertile soils (site selection)
- Fungicides not effective
- Young bushes at greatest risk (juvenility)

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Fruit rots *(Colletotrichum, Alternaria)*

- Fungicides applied at bloom most effective
- Timely, complete harvesting (every 7 days or less for highbush)
- Handle fruit dry
- Avoid cultivars with wet stem scars
- Post-harvest cooling
- Cultivar resistance

Leaf spots, Rust

- Premature defoliation results in reduced flower bud set
- Reduced yields in the following year
- Loss of leaf photosynthetic capacity
- Managed with pre- and post-harvest fungicides and with mowing

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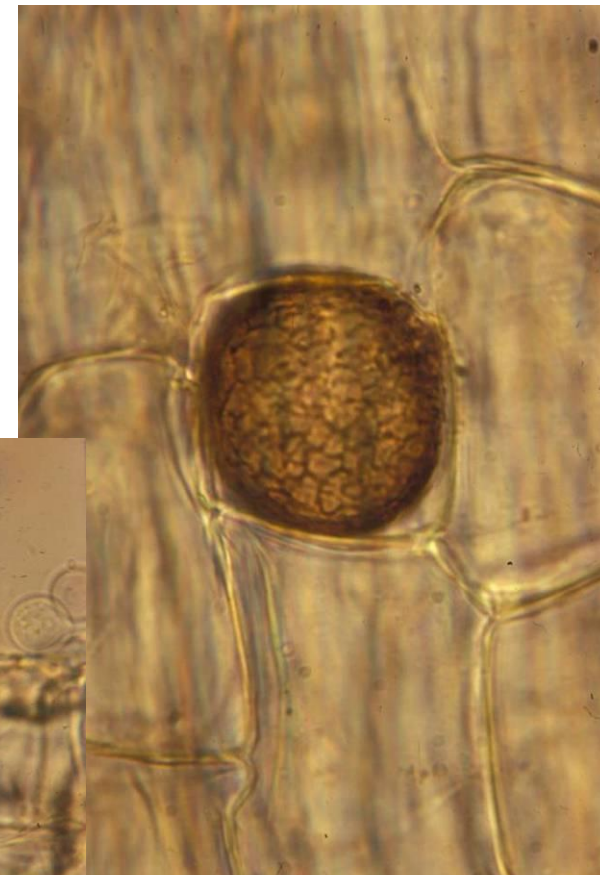
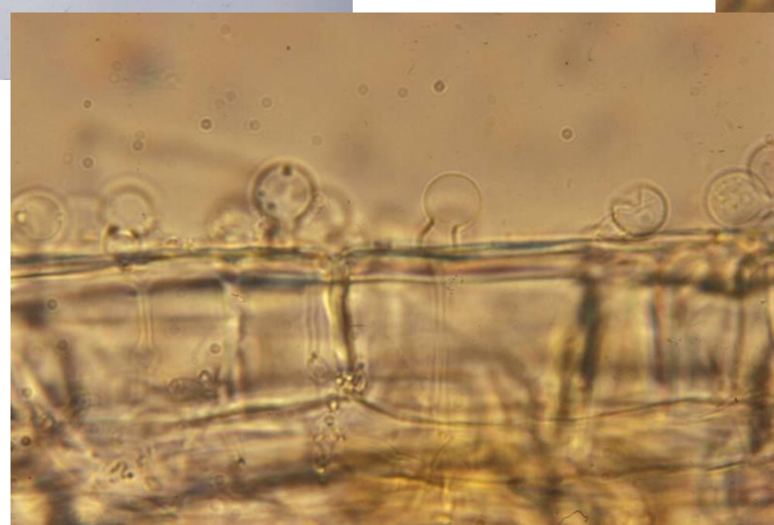
Blueberry root infection by the pathogen *Phytophthora cinnamomi*





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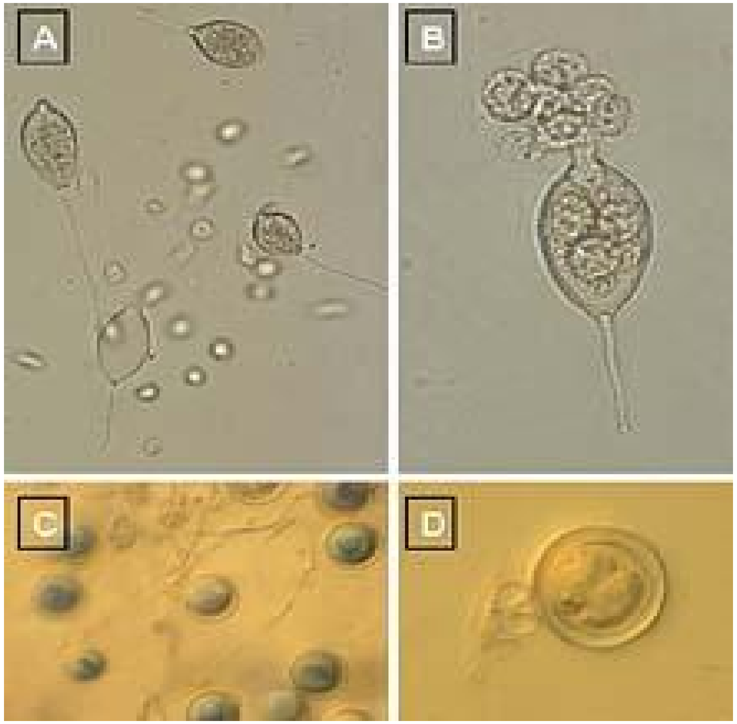
Phytophthora spp.



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Root rot symptoms

- Loss of vigor
- Wilting, stunting
- Yellow leaves
- Poorly anchored
- Early reddening
- Defoliation
- Tip dieback
- Death

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Contributing factors for root rot

- Usually in poorly drained areas with saturated soils (swimming spore!)
- Inadequately bedded (flat) rows
- Heavy soils (poor internal drainage)
- Susceptible cultivars (Southmoon, Southern Bell, Other SHB?)
- Poor sanitation, especially infected transplants (usually potted plants)
- Pond water contamination?

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Control methods

- Drainage is the only lasting solution
- Site selection -- some soils were not meant to grow blueberries!
- Resistance is not really available
- Use sanitation in the nursery to avoid introducing disease into new fields
- Chemical control – not recommended in North Carolina

Drainage considerations

- Provisions for field drainage must be made prior to planting
- Bedding up of rows should be done prior to planting
- If soil is too heavy (poor internal drainage) the soil must be amended prior to planting

V-plow used to sweep middles

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Sweep (front view)

Tapered disk

- Total width of disk based on your row spacing
- Series of blades from large to small on the same spindle
- Mounted on 3 pt hitch

Rows bedded with a tapered disk

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Root Rot in Bark Bed Systems in Georgia

- Phytophthora, Pythium and Rhizoctonia reported as causal agents
- Disease problems have been reported even when new bark is used (Plant-borne pathogens? Infested irrigation water? Soil contact?)
- Drs. Brannen and NeSmith at UGA are leading efforts to control this problem

Phosphite-treated bush (left) vs untreated, in bark beds at Griffin, GA. Control has been demonstrated for both Phytophthora and Pythium. Photo courtesy Dr. Phil Brannen.

Root Rot in Bark Beds (cont’d)

- Phosphonate fungicides (Phosphites) have proven quite effective for control
- Dr. Brannen will likely recommend phosphite applications on all future bark bed plantings, new or re-plant.
- Phosphites also control leaf spots

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What about viruses and virus-like diseases? Look-alikes?

- Viruses have not been a significant problem in the SE US on blueberry, but this could change --
- Stunt (shown) common in eastern NC, SC, not in GA (?)
- Scorch -- threat of introduction??
- Tissue culture anomalies in Ozarkblue, Santa Fe

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Dormant Season

- *Prune* to manage crop load and promote bush health, and to remove diseased or infested stems
- *Dormant oil* may be applied for scale insects as needed
- *Rake under bushes and mulch* to improve moisture retention and remove/bury mummy berry inoculum, cutworms

Pre-bloom to early bloom

- *Apply fungicides as needed* for mummy berry, twig blight, based on previous history of disease on your site.
- *Monitor for evidence* of bud mite damage.
- *Scout fields* for mummy berry apothecia (cup mushrooms)

Bloom

- *Apply fungicides as needed* for diseases – mummy berry, fruit rots, twig blight, flower blight.
- Disease pressure will vary from site to site and cultivar to cultivar – sprays may not be necessary!
- *Do not apply insecticides during bloom*

Petal fall

- *Apply fungicides as needed* for fruit rots
- *First application of insecticides* for cherry fruitworm, cranberry fruitworm, plum curculio
- *Re-apply insecticides* in 10-14 days
- *Organic growers* may use BTs for fruitworms

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Pre-harvest and harvest

- *Monitor yellow sticky traps* for Blueberry Maggotfly (Canada program?)
- Maggotfly sprays applied as long as berries are present AND maggotfly adults are being captured on traps
- *Organic growers* may use Entrust for some insects
- *Labeled fungicides* may be applied as needed for fruit rots and leaf diseases

Postharvest

- *Prune infested branches and spray* as needed for blueberry bud mite
- *Leafspot sprays* as needed, every 14 d
- *Leafhoppers and aphids* may need to be controlled if blueberry stunt or viruses are present
- *Scout and rogue* virus-infected bushes
- *Re-bed rows* in the Fall for drainage

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For Further Information

- Contact Your County Cooperative Extension Service Office
- Horticulture Information Leaflets
  www.ces.ncsu.edu/depts/hort/hil/
- Small fruit information for the southeastern US
  www.smallfruits.org
- NCDA&CS Marketing Division – NC Farm Fresh
  http://www.ncfarmfresh.com
- MSU Blueberry Page
  http://www.blueberries.msu.edu/

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Insect Pests of Blueberry

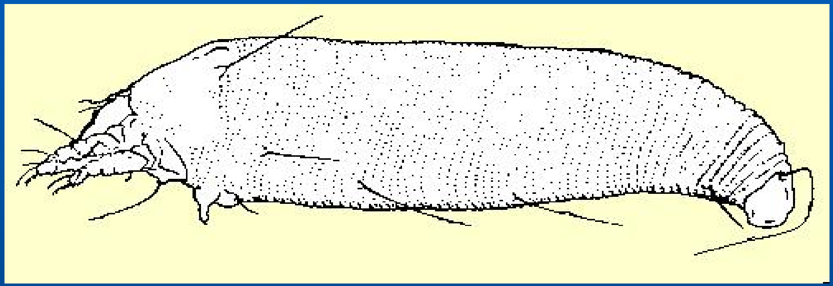
John R. Meyer
Department of Entomology
NC State University

Dormant Season

Dormant Season

Key Pests

Scale Insects



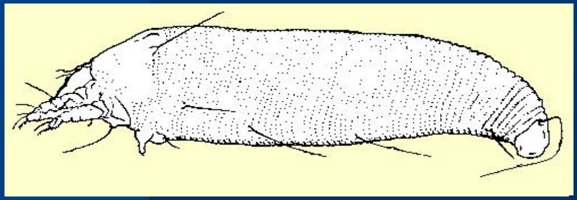
Blueberry Bud Mites

Dormant Season

Terrapin Scale

Dormant Season

Blueberry Bud Mite



Pre-Bloom

Pre-Bloom

Key Pests

Cutworms

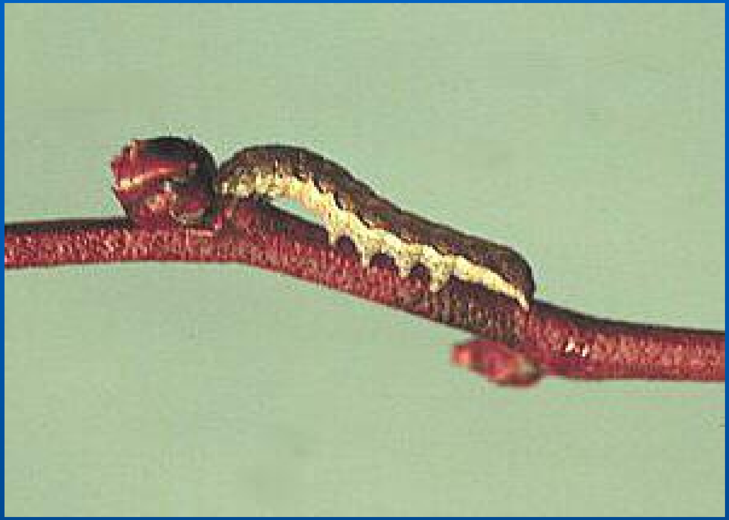
Thrips

Spanworms

Gall midge

Pre-Bloom

Cutworms



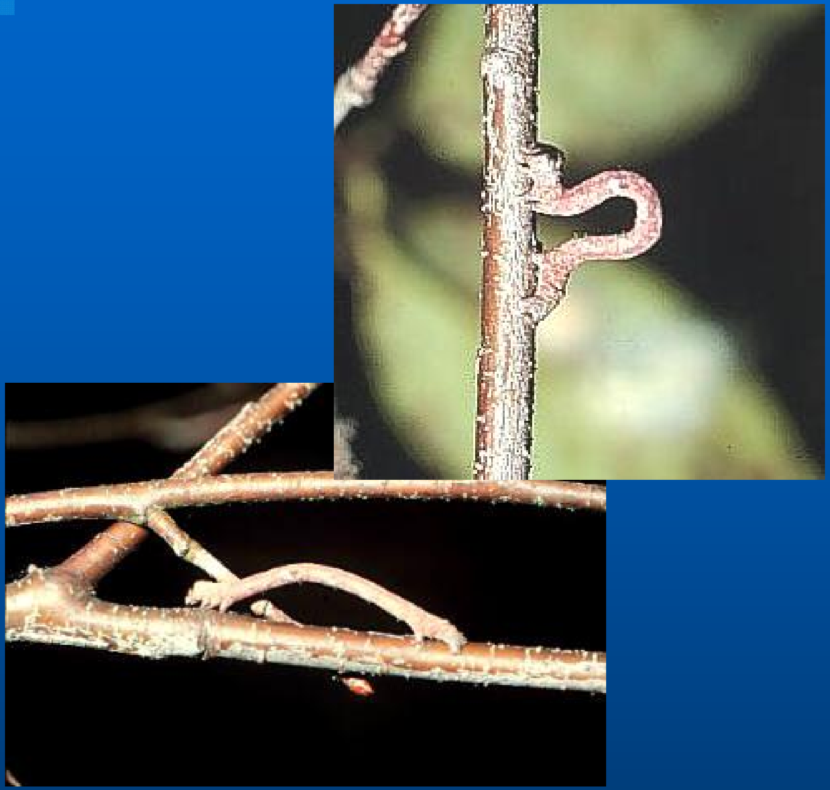
Cutworm and spanworm damage

Climbing cutworms hide near the ground during daylight. Around dusk, they move upward and feed on flower buds during the night. These larvae have five pairs of abdominal prolegs.

Pre-bloom

Spanworms

Adult spanworms are dusky brown moths that are active only at night.



Geometridae larvae are known as spanworms, inchworms, or measuring worms. They have only two pairs of abdominal prolegs.

Pre-bloom

Thrips

Injury to flowers

Adult flower thrips

Pre-bloom

Gall midge

Larvae feed in flowers and developing leaves.

Bloom

Bloom

- Protect Pollinators
- Avoid Insecticides

Honeybee

Bumblebee

Southeastern Blueberry Bee

Petal Fall

Petal - Fall

Key Pests

Cranberry Fruitworm (frass)

Plum Curculio (oviposition scars)

Cherry Fruitworm (damage)

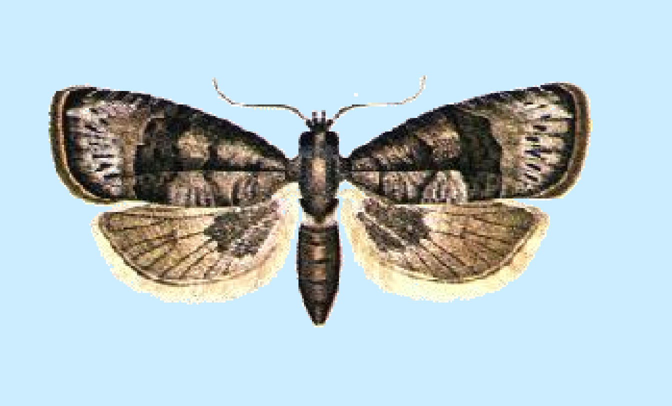
Sharpnosed Leafhopper

Petal - Fall

Cherry Fruitworm

Cherry Fruitworm Damage

Blue, shrunken berries with tiny entry/exit holes are typical of the injury caused by cherry fruitworm larvae. Note the absence of frass (excrement) and silk webbing.



Cherry Fruitworm Adult

Cherry Fruitworm Larva

Petal - Fall

Cranberry Fruitworm

Cranberry Fruitworm Damage

Berries infested by cranberry fruitworm larvae are usually encrusted with silk webbing and brownish frass (excrement).

Cranberry Fruitworm Adult

Cranberry Fruitworm Larva

Petal - Fall

Plum Curculio

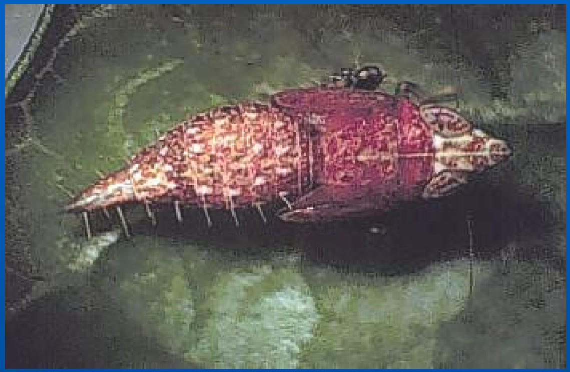
Crescent-shaped scars are
a sign of egg-laying (oviposition)
by female plum curculios.
Infested berries usually ripen
early and fall to the ground.

Adult plum curculio

Petal - Fall

Sharpnosed Leafhopper

First instar leafhopper



Fifth instar leafhopper

Sharpnosed leafhopper adult

Sharpnosed leafhoppers are considered major pests because they are able to transmit a mycoplasma-like pathogen that causes blueberry stunt disease. Leafhoppers pick up the pathogen by feeding on infected plants and then carry the disease to other plants.

Pre-harvest

Pre-Harvest

Key Pests

Fire Ants
(nest site)

Blueberry
Maggot

Pre-Harvest

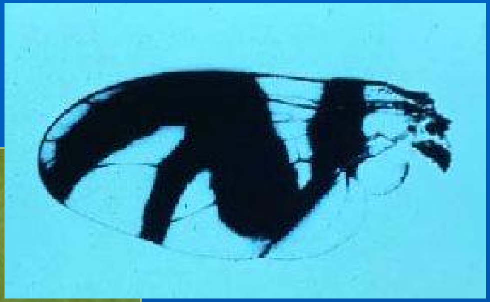
Fire Ants

Fire ant workers feeding on a ripe blueberry

This sandy mound marks the nest site of a fire ant colony.

Pre-Harvest

Blueberry Maggot



Adult & wing pattern of
the blueberry maggot fly

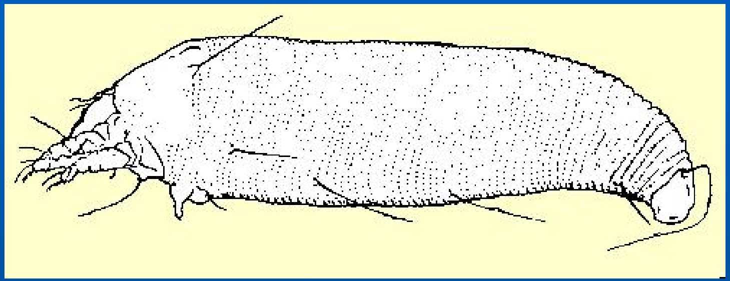
Pre-Harvest

Yellow sticky trap: an important tool for monitoring populations of sharpnosed leafhoppers and blueberry maggots.

Post-Harvest

Post-Harvest

Key Pests

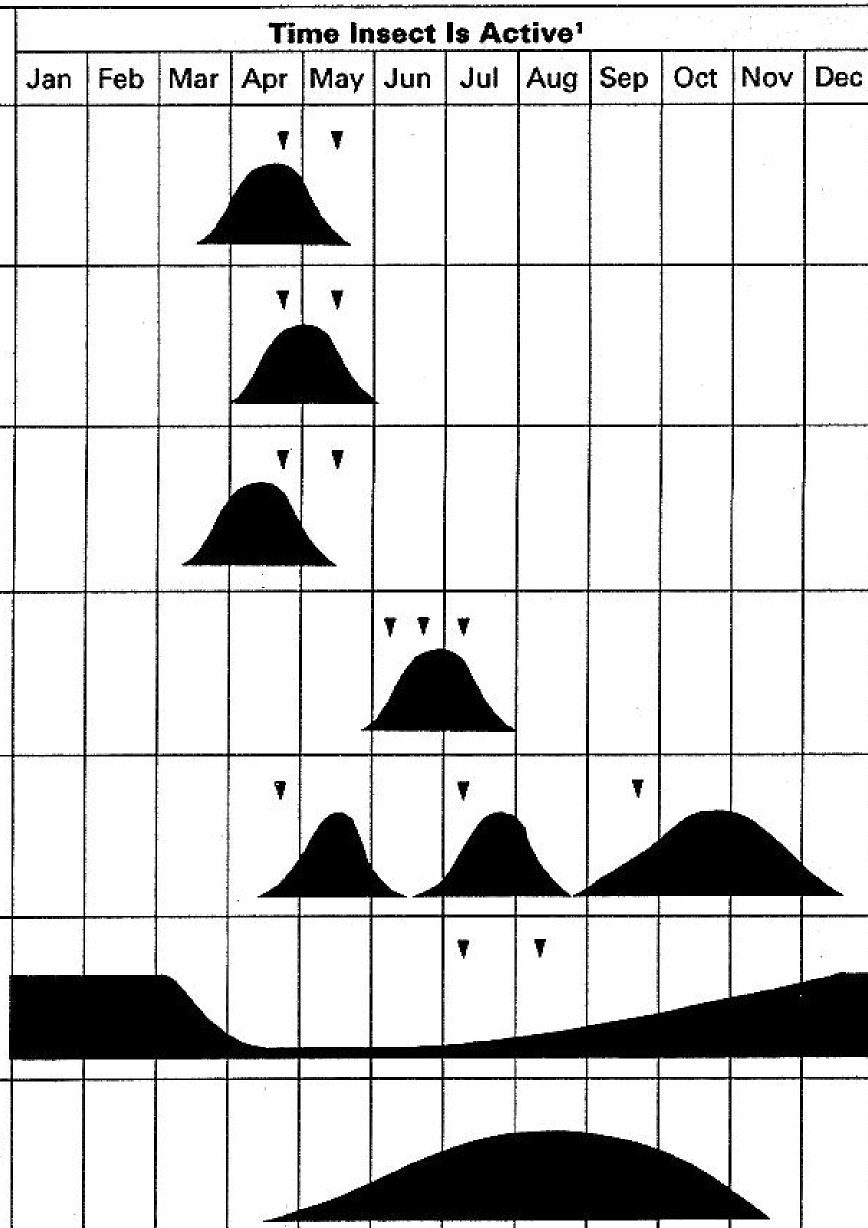


Blueberry Bud Mite

Japanese Beetles

Sharpnosed Leafhopper

Blueberry Insect Management Calendar



INSECT	Control Strategies
Cranberry Fruit Worm	Use clean cultivation, apply insecticides (▼) after bloom and 10 to 14 days later.
Plum curculio	Use clean cultivation, apply insecticides (▼) after bloom and 10 to 14 days later.[2]
Cherry Fruit Worm	Use clean cultivation, apply insecticides (▼) after bloom and 10 to 14 days later.
Blueberry Maggot	Monitor sticky traps, apply insecticides (▼) between pickings, ensure clean harvest.
sharposed leafhopper (stunt vector)	Remove stunted bushes, apply insecticides (▼), clear wild blueberry bushes within 100 yards.[3]
Blueberry budmite	Plant resistant cultivars, prune, apply oil sprays and insecticides (▼).
Insects feeding on leaves	Remove solitary infested canes, apply spot sprays to small infested areas.[4]

Blueberry Pest Management

A Seasonal Overview

by
John R. Meyer and William O. Cline
Departments of Entomology and Plant Pathology
North Carolina State University

Web Site
http://ipm.ncsu.edu/small_fruit/blueipm.html

Cultural Practices for the Southern US and Potential of Organic Production

2007 SR-SFC Agent Training

Gerard Krewer
Small Fruit Specialist and
Professor of Horticulture
Univ. Of Georgia
Tifton Campus

Objectives of today's lecture

- Agents are here from six climate zones USDA 6a (high mountains) , 6b, 7a, 7b, 8a, 8b (S. Ga.)
- What types of blueberries should you consider growing in each climate?
- What production systems are working for blueberry production in various areas?
- What important considerations are there in fertilization?
- How do you prune blueberries?
- What suggestions can we give to organic producers?

Three Types of Blueberries Grown Commercially in the South

- Southern highbush-mostly in "Coastal" South- "Palm Belt"- cultivars are available with a winter chilling of 200-800 hours, 300-400 (Emerald / Jewel-Star /Rebel) in South Ga., 400-800 in SE North Carolina
- Northern Highbush-mostly north of a line from Myrtle Beach, SC to Dahlonega, Ga.-most cultivars need 800-1000 chill hours
- Rabbiteye-Best adapted to the historic cotton belt (some grow well in Ga. mountains)-400-650 chill hours- Plant higher chilling ones in the mountains

Southern Highbush (~75% NHB plus ~25% Darrow's evergreen)

- Southern highbush ripen in April and May in S. Ga.
- Requires high organic matter soil (3-4%)
- Very susceptible to root rot, moist but well drained
- Short lived in South Georgia (probably 10-15 years)
- Bloom in Feb. and early March in S. Ga.-frost protected
- Mostly hand picked

Northern Highbush (*Vaccinium corymbosum*)

- High chilling requirement (800-1000 hours) and low summer heat tolerance as a general rule.
- Special cultivars are adapted to SE NC (Croatan, Murphy, etc.)
- Regular northern highbush (Bluecrop, Bluejay, etc. Perform fairly well in the Ga. Mountains when grown like southern highbush. Some bloom later and ripen before rabbiteyes. Duke, Earliblue, etc. In zone 6b (Ga. mountains) a mix of early Northern highbush (on soil heavily amended soil) and followed by mid and late season rabbiteyes (with modest organic matter addition) will provide fruit for most of the summer.
- Good desert quality, critters like to eat, deer eat flower buds, birds eat fruit, etc.
- Wild forms are found in the Deep South (He-Bush Huckleberry)

Rabbiteye Blueberries (*Vaccinium ashei or virgatum)*

- Native to S.Georgia, Fla., Ala.
- Ripen from late May to late July
- Grow well in soil with moderate amounts of organic matter (2%, maybe less).
- Can often be harvested for the fresh market with a mechanical harvester
- Bloom in early to late March
- Expected life is 30-50 years
- Generally the best type for the Deep South
- Plant frost resistant and high chilling ones in the upper part of the belt (Brightwell,Ira, Tifblue, Powderblue, Ochlochonee, etc.)

Early UGA Tifton work

- Florida wild selections planted by horticulturists at UGA Tifton in 1925
- Showed good yield potential

Blueberry Efforts at UGA

- Breeding program staffed since 1944
- All still alive because of blueberries

Highbush Basics in Georgia

Many ways to skin the highbush cat

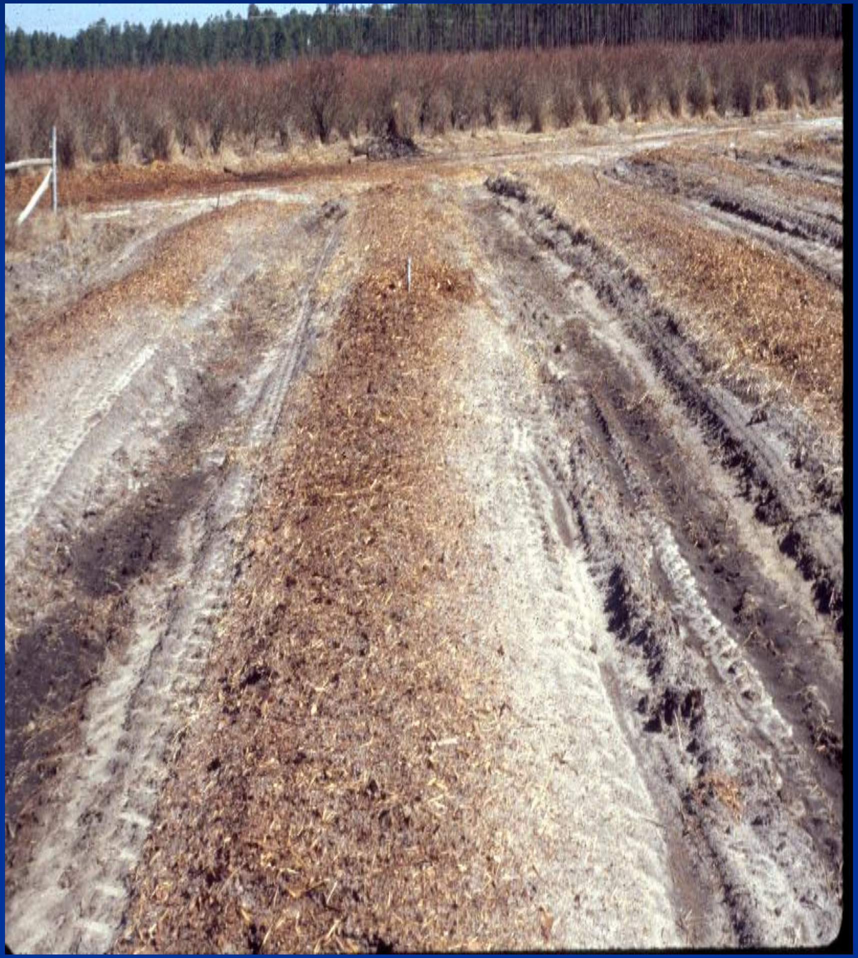
- Spodic *sand* series
- NC soil can be used for fertilizer in Ga.
- Note the three important layers
- Pine bark or pine sawdust amended strips
- Pine bark beds

Highbush production systems

- In S. Ga. the best southern highbush plantings have 3% organic or more. Michigan 2% is OK.
- Pine bark, pine pole peelings, pine sawdust, peat moss are all successful. (Note C:N rations, pine bark 300:1, pine sawdust 1000:1)
- Usually applied in a band 4 to 6 inches deep using a side delivery mulcher and incorporated with a rototiller or cross cut harrow
- Home garden or market gardener: 5 gallons of peat moss or pine bark per plant plant, mix 50/50 with soil

Fig. 2. Dec 2006 appearance of blueberry soil amendment experiment

Pine Bark Amended Strip and Bed Culture –amended strip has lower water requirement but may have more problems with weeds and soil pH, bicarbonates, etc.



Mulching

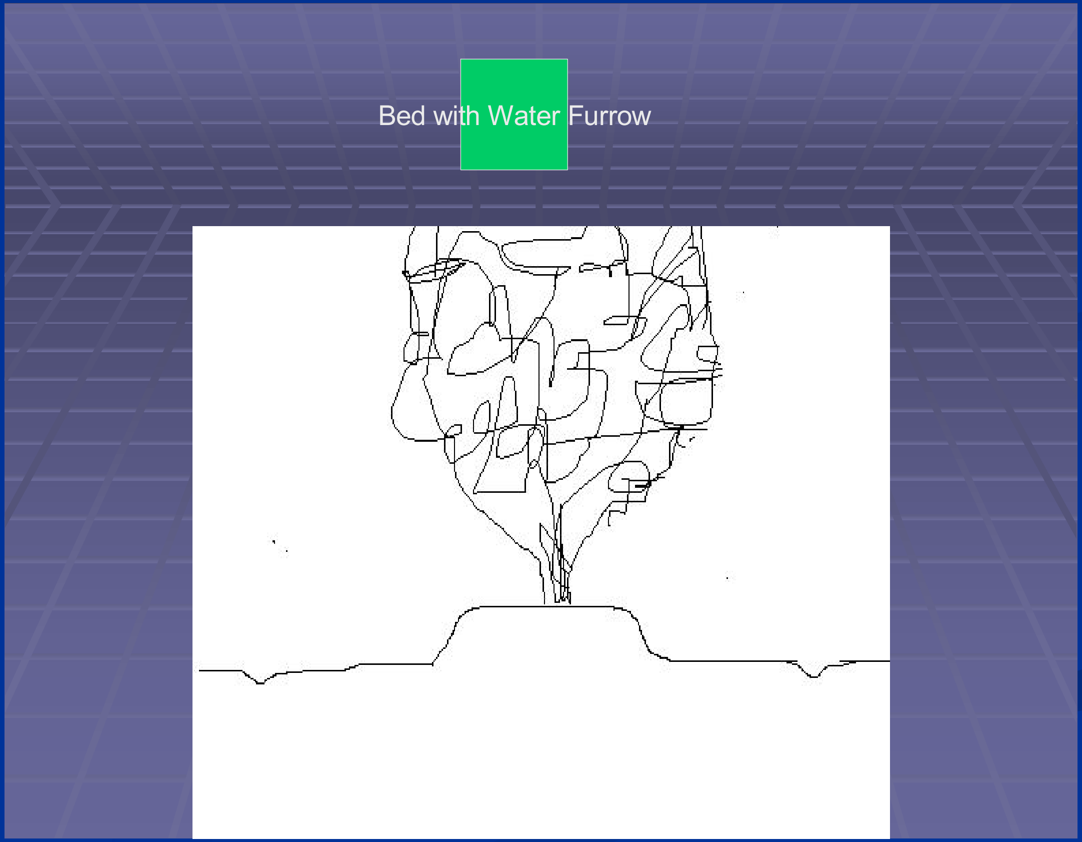
- Excellent responds to mulching southern highbush on most soils in Georgia.

Highbush-Very Important

- Moist but well drained.
- Mellow soil- fingers test
- Good irrigation system and raised beds if needed.

How to create good drainage

- Site selection
- 1-2% drop in aisle
- Ditching
- Wide bed



Bed construction

- Prepare for the wettest week in the next 30 years.
- Rome or Savannah Bedder
- Aisles broken out with a fire break plow or front gangs of a harrow.

Proper beds in marginally wet areas

Planting arrangements

- Southern highbush
- High density (2 or 3 by 5 feet with beds 30 to 34 feet wide-6 to 10 feet tractor aisle)
- Two row (2 or 3 feet by 5 feet with 2 feet on edges-15 feet between bed centers)
- Single row
- 2 to 4 feet in drill
- 9-11 feet between rows
- Single row systems are increasing in popularity

High Density-Good for Small Farms

Double Row

Single Row

Rabbiteyes not rabid eye blueberries

General Requirements for Rabbiteyes

- pH 5.3 or below
- Moist but well drained
- Organic matter content of 2% or above is desirable in S. Ga.
- Avoid sites with very high calcium (over 900 pounds per acre) and phosphorus (over 300 pounds per acre) if possible

Soils for Rabbiteyes

- Grow well on sands, sandy loams and sandy clay loams if chemistry is correct

Rabbiteye Production Systems

- Rabbiteyes grow well on on virgin loamy sands. Will also perform well on low pH sandy clay loams.
- Respond well to mulching

Rabbiteye Spacing

- Single row
- 3 to 6 feet in drill
- 10-12 feet between rows

Frost Protection-Very Important
Passive and/or Active

Fertilization

- Blueberries are a salt sensitive plant (growth reduction at 2 millimoles or electrical conductivity)
- However, they greatly benefit from regular fertilization
- Very rapid growth can be produced by frequent fertilization with small amounts of fertilizer

Fertilization

- Varies greatly with species and system
- Rabbiteyes on rich soil need little N
- In South Georgia in a loamy sand with 1.5% organic matter (typical), about 60 pounds of N per year, 30 at bud break, 30 after harvest

Southern Highbush

- Typically require 80 to 150 pounds of N per acre in S. Georgia.
- High density pine bark systems may need much more in some situations….250 pound of N per acre???
- Heavy hedging greatly increase N requirement (corn silage situation)

N forms

- Ammonium and urea form of nitrogen is preferred
- Helps control pH, some nitrate OK
- Slow release N fertilizer works well
- Small amounts applied frequently work well also. Every 4 weeks if at least 4 inches of rain or irrigation has been applied.

P and K requirement

- Phosphorus deficiency can be a problem
- Virgin sites often have only a few pound of P per acre
- Leaching problem on NC sands (spodic soils)
- We now recommend preplant P in Ga. is soil has less than 20 pounds of P per acre (300 pound per are of triple super P)
- Use of DAP has been beneficial on established plantings (18-0-46). Typically post harvest application.
- In Ga., K is normally not a problem if about 60 pounds is applied per year.

Secondary and Micros

- Magnesium and copper are common deficiencies
- High Mn and B has been a problem (Mn from pine bark??, B from fertilizer and irrigation water??)
- Iron deficiency is common-but leaf analysis is not definative (look for interveinal chlorosis of the new leaves with a pH above 5.3)
- Correct by changing soil pH with sulfur, sulfuric acid, etc.

pH control

- Use of prilled sulfur is standard-harrow in 6 months before planting
- See charts in small fruit web site for preplant rate
- Post plant, apply no more than 300 pounds per acre at one time
- Use of sulfuric acid in the irrigation water is common. Drop pH of water to 5.0-5.5

High Soil and Water pH

- Maintain pH at 4.0 to 5.3 (note that pH varies with season-lower in summer)
- If soils are high in manganese keep pH 4.5-5.3
- High pH-Treat with sulfur a year before planting-about 1000 per acre maybe needed on some soils!
- Add prilled sulfur after planting-max. 300 kg/ha each time (broadcast rate)
- If needed, inject sulfuric acid in irrigation water or use N-phuric

Fertigation

- Blueberries are highly responsive
- Generally applied at the rate of 1 pound of N per foot of bush height per up to 4.5 pounds per acre per week for rabbiteyes and 6 pounds per acre per week for highbush.

Four Primary Goals in Pruning

1. Develop and maintain a vigorous bush.
2. Produce a large annual crop.
3. Maintain fruit quality and size.
4. Shape bush for harvest efficiency.

Pruning Objectives

- Open and shape the bush for good sunlight penetration (roughly vase shape)
- On highbush and southern highbush (early ripening types, etc.) reduce crop load by removing "bush wood"
- Renew canes (Best canes are 3 to 6 years old)
- Keep base clean and tight for mechanical harvest (12 inches wide at 18 inches from ground)

Pruning Terms

- Roof top hedge-Summer pruning to gable roof house shape
- Cane renewal- Cutting out old canes to near ground level (typically 1 or 2 per year). Loppers, saws or pneumatic equipment is used.
- Brush wood- twiggy shoots, excessively branched, with many flower buds
- Money wood-thick shoots, with moderate branching with moderate flower bud density
- Detailed pruning-pruning with hand shears

Mechanical summer hedging

Select fruiting canes with the most desirable flower buds. Left is least desirable and should be removed. Second from left should be removed if there are enough like the two on the right (photo courtesy of Dr. Mike Mainland)

Additional flower bud removal sometimes needed:
Four to 6 flower buds on each flowering shoot is ideal. It can be time consuming and expensive to get the ideal fruit load and distribution especially on cultivars that form many excess flower buds like Misty, Millennium, Reka and Duke. (photo courtesy of Dr. Mike Mainland).

Cane renewal

Remove about 15% of the canopy starting with the oldest canes in the center. Cut low hanging limbs. Diseased and damaged canes, partial cane removal on cultivars with only a few canes (slide courtesy of Dr. Mike Mainland0

Typical pruning by type (mature plants)

- **Southern highbush**: Ga.: June 1 rooftop hedge followed by winter detailed pruning (brushwood removal) and summer or winter cane renewal.
- SE NC: June 15?? rooftop hedge in alternate years, winter detailed pruning (brushwood removal) and winter cane renewal annually
- **Rabbiteye**: S. Ga.: Aug. 1 limited rooftop hedging at 7-8 feet to control height (18 inches max. removal, bushes will regrow about 6 inches the same year), followed by cane renewal, almost no brushwood removal (generally don’t set as heavy a crop as highbush)

Pruning by type (cane renewal)

- Northern highbush- Early June rooftop hedge possible if early ripening cultivar, winter cane renewal followed by detailed pruning (brush wood removal)

Southern Highbush Pruning

- Ripen early- Mostly late spring pruned to a roof top shape. Top of "roof" is about 3 feet in high density (3 by 5 foot spacing) or 4 feet in single row plantings. Regrow about 18 inches to 24 inches during the summer and fall. This results in thick canes with reduced flowering. In winter, some twiggy growth in the lower part of the bush may need removal. As the bushes age, cane renewal postharvest or winter is practiced.

Pruning at Planting

- Balance the top and root system
- Bad roots, cut the heck out of it
- "De-pot" bind plants when set, barely cover with soil
- Cut back ½ at planting to encourage good branching and remove fruit

Young Bushes

- Before and after on bushes with poor vigor. Dead wood and flower buds are removed. (photo courtesy of Dr. Mike Mainland).

Growth Regulators

- See Horticultural Guide
- Ga. – Fall ethephon for bloom delay
- Gibberellic acid for fruit set and freeze rescue in rabbiteyes
- Ga. -Dormex for improved leafing and early cropping in southern highbush

Potential for Organic Production

- About 250 acres now in organic or organic transitional
- Several weed control mulching systems have been successful
- Pine bark, Pine straw, Wheat straw, peanut hulls (maybe)
- White on black plastic or ground cover

Organic Weed Control Establishment Options Used in Georgia

*A weed free band 4 feet wide is needed on young plants

Mulch your first line of defense!

Organic mulch options

- Pine bark-UGA Alapaha
- Pine straw-UGA Alapaha, Miles
- Wheat straw-Taylor, Miles, UGA Alma

Plastic Mulches

* Polyethylene-UGA Alapaha, Hardage

- Ground cover (woven material)-UGA Alapaha, Horner
- Landscape fabric (nonwoven material)-UGA Alma

*Mature Plants-weed wacking-Taylor

2006 Yields
Machine harvested- pounds per plant

UGA Alapaha

- Control 3.4
- Ground cover 5.2
- Pine straw 7.1
- Pine bark 7.3
- Pine bark yield was 5300 pounds/acre at five feet and 6621 pounds/acre at four feet

Ground Cover at Horner Farm

- Ground cover
- Georgia is a major center of manufacturing
- About 12 cents a running foot?

Large scale use of white-on-black plastic

- Provides good weed control except nutsedge
- Soil temperature similar to bare soil
- Nature Safe 8-5-5 applied under plants, later on top
- Some fish emulsion injected, bone meal on top
- Hole sealed with pine bark or shade cloth combo

White on Black Plastic

- End of second season in better areas of field
- Weeds growing up from shoulders were a serious problem last year

2004-05 Trial
Miles Organic Farm, Appling Co., Ga.

- Three mulches tested in organic transitional field
- Pine straw
- Pine bark
- Wheat straw

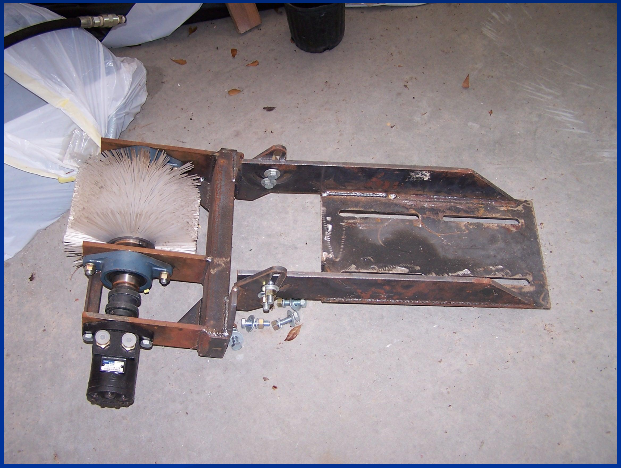
Matran Results-
New formulation- “allowed”

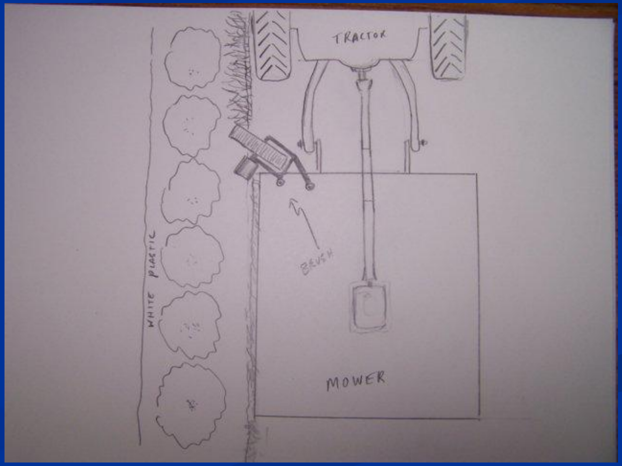
Shoulder management

- Hillside cultivator (angled rolling cultivators)
- Rototilling
- Off set mower
- Matran?? contact herbicide-very expensive
- Sweep running weeds off plastic?

Shoulder sweeper for plastic mulches

- These is a project under trial
- Hydraulic sweeper to sweep weeds into the throat of the rotary mower.
- The first year the brisles were too stiff and short





Summary Suggestions

- Weed control must be very good on young plants
- Pine straw, pine bark and wheat straw are working well for mulches
- Ground cover and plastic mulches also have application in certain situations when organic mulches are too expensive.
- Weed control on bed shoulder is very important. Hill side cultivator is working fairly well.
- Perdue pasturized chicken litter is a good base fertilizer for P and K.
- Nature Safe 8-5-5 and Production Prince 5-4-3 have worked well as a general fertilizer. Keep plants well fertilized with quick N release materials (2-3 month) for rapid growth. Liquid fish can be injected.
- Supplemental K and P may be needed. Mined potassium sulfate and bone meal.
- Flea beetles have been the most serious insect pest during

Organic Blueberry Research and Extension is Expanding

Thank you for the invitation!

SRSFC Blueberry Agent Training
June 19-21, 2007

Training Day Evaluations

Question	Response
What did you like best about the training?	Broad spectrum of presentations
	Cultural management program was excellent! Chance to talk to other agents.
	Information from specialist and researchers
	The information regarding ideal cultural conditions for optimal production were very useful.
	Range of topics covered; Ability to see/taste many different varieties in the field
	Gerard's talk on practical things
	Interacting with specialists and agents from different states, getting different perspectives on blueberry production.
	Tours and literature (CD, notebook, IPM pocket field guide)
	The tour of mechanical harvesting and equipment for Blueberry
	The topics were timely and useful.
	Excellent information and presenters.
	IPM guides, tours of farms—(commercial and research), meeting agents/specialists from other counties and states
	Meeting other specialists and agents from around the area
	Opportunity to talk to other workers one-on-one.
	Overall, a very informational training.
	I felt it was well-planned and the speakers were prepared
	Variety information and sampling!
	Combination of Presentations (covering all aspects of blueberry production) and field tours in the same workshop
	All of it. Great presenters. Very comprehensive for the academic to the practicum
	The combination of lecture and in the field—great facility
	I liked the balance of classroom and field training. Also, I liked the speakers who seemed to be carefully chosen and who were very knowledgeable.
	Personally and as an economist, all the training topics were equally important to me. I needed to know the various cost components that I could use in developing future budgets and each topic provided the information I needed.
	The topics and the field trip to the farms

Question	Response
Which talks/presentations were most helpful to you?	Cultural
	Cultural Management by Gerard Krewer
	Variety of information
	I learned from every presentation so they all were helpful.
	Investment analysis; insects and diseases
	Gerard Krewer's
	Each talk/presentation was helpful. Bill Cline was especially interesting.
	The budget/investment analysis talk, followed by cultural practices. Blueberry breeding in GA, then disease/insect management were the presentations most beneficial.
	All of them, with special emphasis on "Investment Analysis…"
	Blueberry disease and control, Investment analysis
	Investment Analyses and Weed Management stand out…although all were very good.
	I must say the integration of all talks: each complemented the others (or you can say "whatever Bill presented")
	The talks on variety selection and pest control
	They were all good but not particularly enlightening for me.
	All were beneficial.
	All of them. The least helpful was the economic projection
	Economic analysis talks
	All talks/presentations were very useful
	N/A
	Varietal specifics, herbicides
	The variety talks are least helpful to those from other regions. The talks regarding pests and diseases were the most helpful to me.
	All
	They all were very helpful. Also liked the one on one time with presenter and agents

Question	**Response**
Were the field tours useful to you?	Yes
	Great tours.
	Very good!
	Absolutely; seeing plants in production is always worth while. Also enjoyed tasting and eating different varieties.
	Extremely
	Yes, but took too long to get there
	Absolutely! I enjoyed the hands-on part of the training
	Yes, very much! Particularly liked scouting field for diseases, as well as the time spent observing the Blueberry packaging and visiting with the farm manager.
	Yes. Both the Bladen County tour and the NCSU Horticultural Crops Research Station in Castle Hayne, NC were very beneficial.
	Very useful; soil types, effect of freeze damage, packing sheds
	Yes I enjoyed the production/processing; very educational
	Yes! 1) Tell about it 2) Show it 3) Put your hands on it (very few extension programs can provide the total package)
	Extremely useful
	I saw changes on blueberry farms that I had visited in the past. Obviously, if it had not rained, Wednesday afternoon would have been better. I was unable to go on the expt. Stat. tour due to prior commitment.
	Yes, to be able to see cultivars and breeding work
	Very
	Critical! This training would not have been worth it to me without it.
	Yes, it was very instructive
	Yes, the tour gave a feel of the breadth of the industry in NC
	Yes!
	Yes, very.
	Yes
	Yes. This allowed me to see how other blueberry farms work and see soil types.

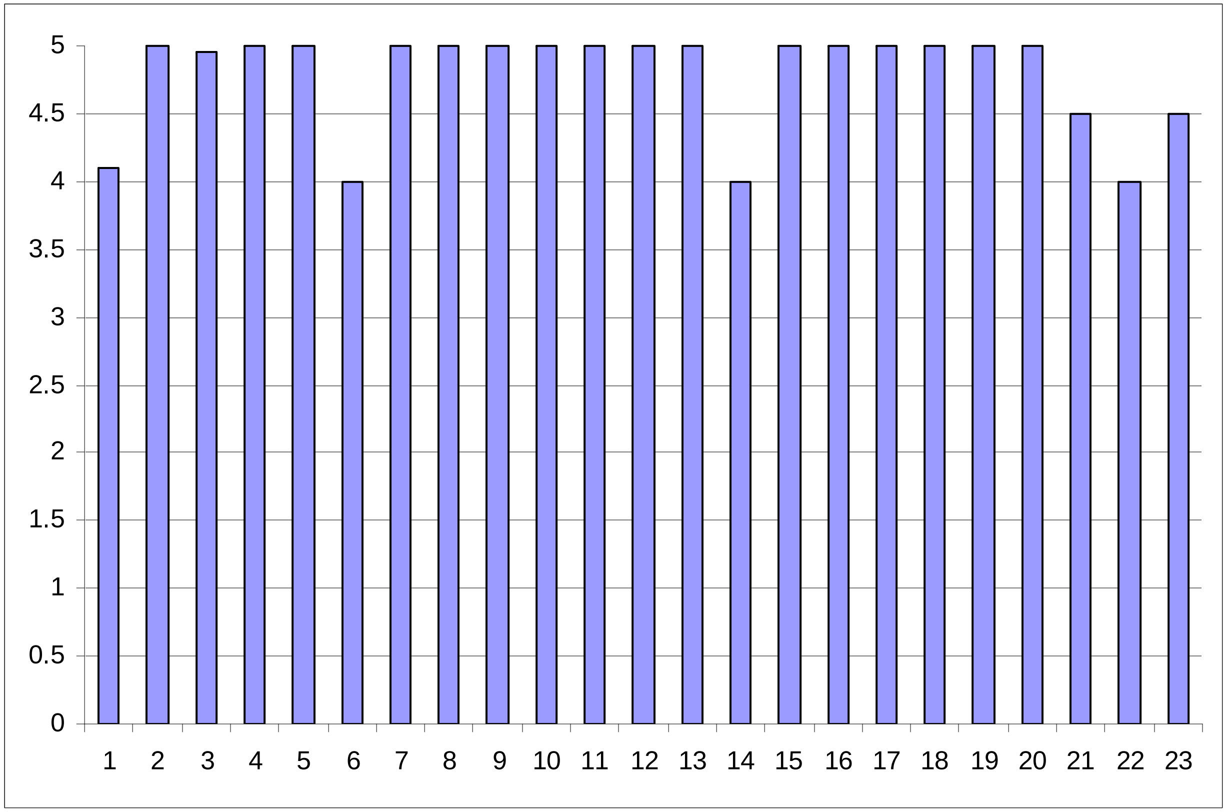
Question	Response
What did you not like about the training?	Genetics got a little too deep
	Benny did not have blueberry pre-picked for us!
	Everything was great!
	The first day was a lot of sitting.
	Nothing—everything was excellent
	Drive
	Would liked to have spent more time on a few subjects, but that is hard to do when you have to cover so many subjects
	Would have liked more one on one, or time spent visiting with growers. What about irrigation/frost protection set ups?
	No dislikes about the training. One of the best I have attended in many years.
	I know and respect Dr. Ballington very much, but I didn't need the depth of genetics I got from his talk. Dr. NeSmith's presentation was more valuable and practical.
	I could have used additional information on varieties, especially northern highbush (a specialist from northern area would have been nice)
	2 fried chicken and BBQ meals back to back (better than a cold hot dog, though)
	It was well planned
	In depth discussion of topics was lacking; most of the info, I could have gleaned from the website.
	Nothing
	Overall, it was very helpful
	Nothing!
	None
	N/A
	All good
	Nothing
	Starting time was too early for me traveling form South GA., other than that like everything.

Question	**Response**
What are your suggestions for improving future agent training sessions?	More economics, harvest, post-harvest, marketing
	Nothing! The format and length of the training is perfect!
	Travel and then talks on the same day is tough.
	Add a component on marketing
	Do more of the same. Keep a good mix of classroom and field activities where possible.
	Increase time exposure to growers (Q&A) during tours.
	Continue to have similar trainings in other areas of fruit production.
	The current program approach is excellent. Having a broad range of topics that includes IPM, new cultivars and basic horticulture.
	Organization and logistics have been excellent. Possible break-up of presentations and tours (we sat a little too long)
	Substitute 1 meal with shrimp, scallops, crab, fish etc. (you know –inexpensive seafood)
	Two nights is just right
	Make sure that sessions are primarily comprised of material that can be gotten off of the website.
	Keep in mind the positives from the 2007 training
	Entomologist talk seemed to miss needed practical experience
	Maybe meeting with a couple of blueberry farmers to better understand blueberry producers need
	Marketing and expanding the industry. Also machine harvesting tour.
	I can’t think of much of anything worth mentioning.
	If possible, the training session should be organized in the same hotel where participants are living to avoid waste of time and facilitate participants movements to and from the conference hall.
	I would not change anything. You had the right mix of classes and tours

Question	**Response**
What topics dealing with small fruits would you identify as high priorities for future training sessions?	Marketing--Buyer, how to get into these markets
	Blackberry/raspberry production; Peach production or figs, plums etc. Cold hardy citrus--? Any possibilities for production of this crop?
	Strawberry production; small scale/local production on any small fruit.
	Similar training covering strawberries; training covering economics of small fruit for new producers—deciding what to grow
	Maybe more specific training, for example, diseases of small fruits. This would allow more specific training, but on a variety of crops.
	Grapes—and the fast growing wine industry!
	Besides blueberries, topics on muscadines and blackberries would be helpful.
	New cultivars with disease resistance, Pruning by variety of types, IPM
	Propagation of stock and grafting for vineyards, blueberry and brambles
	Perhaps small-scale pick-your-own economics and post-handling if enough attendees are from non-commercial areas.
	Maybe a session on brambles
	Food Safety issues that are facing the industry including small fruit producers.
	Monies and varieties
	Updated cultivars for taste, regions etc. for both highbush and rabbiteye berries
	Any alternative/specialty berries/fruits, --kiwi etc.
	Keep the balance between field and classroom education.
	Brambles is the most necessary in for my area. We continue to have a demand that far exceeds our supply of berries.
	Any
	Blueberries, Strawberries, Bunch Grapes of the South and Blackberries.

Question	**Response**
Other comments/suggestions?	More on blueberry marketing, labor, budget
	Having specialists on-hand and in the field to ask questions was helpful. Fantastic job, thanks!
	Thank you!
	I found the training very educational! Thanks for the scholarship and opportunity to attend!!
	Again, one of the BEST agent's trainings I attended in a very long time!!
	Agent training is always a good idea. Everyone eventually gets better at what they do. As agents get better, specialists will get better and everyone's knowledge will increase.
	Please notify us when the updated presentations are posted. Thanks for an excellent workshop.
	Thank you for the scholarship. This training was well planned and well executed. Excellent job, and worth every day. Any participants who had to leave early really missed a great opportunity.
	I think that the training was our usual high quality and excellent training for county agents, particularly those whose main responsibilities and primary training are not in small fruit horticulture.
	I thoroughly enjoyed the training. Although it was a long way away, it was well worth my time!
	The workshop was very well organized. I want to thank Dr. Monaco for his time.
	Excellent training
	Bill Cline served as excellent tour guide—I learned a lot that I have already used in my county
	This training initiative is crucial to extension agents, specialists, and growers as well. The organizing committee did a wonderful job to put all these together and I hope this will continue to other small fruits as well.

On a scale from 1-5 with 1 being the lowest rating and 5 being the highest, what rating would you give the training overall?



Average = 4.82

23 evaluations

Highest rating = 5
Lowest rating = 4