Blueberry Cultivars with Southern Highbush Backgrounds Access Nutrients Differently than Standard Varieties in Upland Soils

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Long-term Trends in Fruit Production

1. Marketing changes have forced growers to increase the number of crops they grow and expand their production beyond traditional “fruit belts.”

2. Perennial plant production depends on “average weather.” In the past decade we have seen an increase in warmer, wetter, and windier weather.

Long-term Trends in Fruit Production

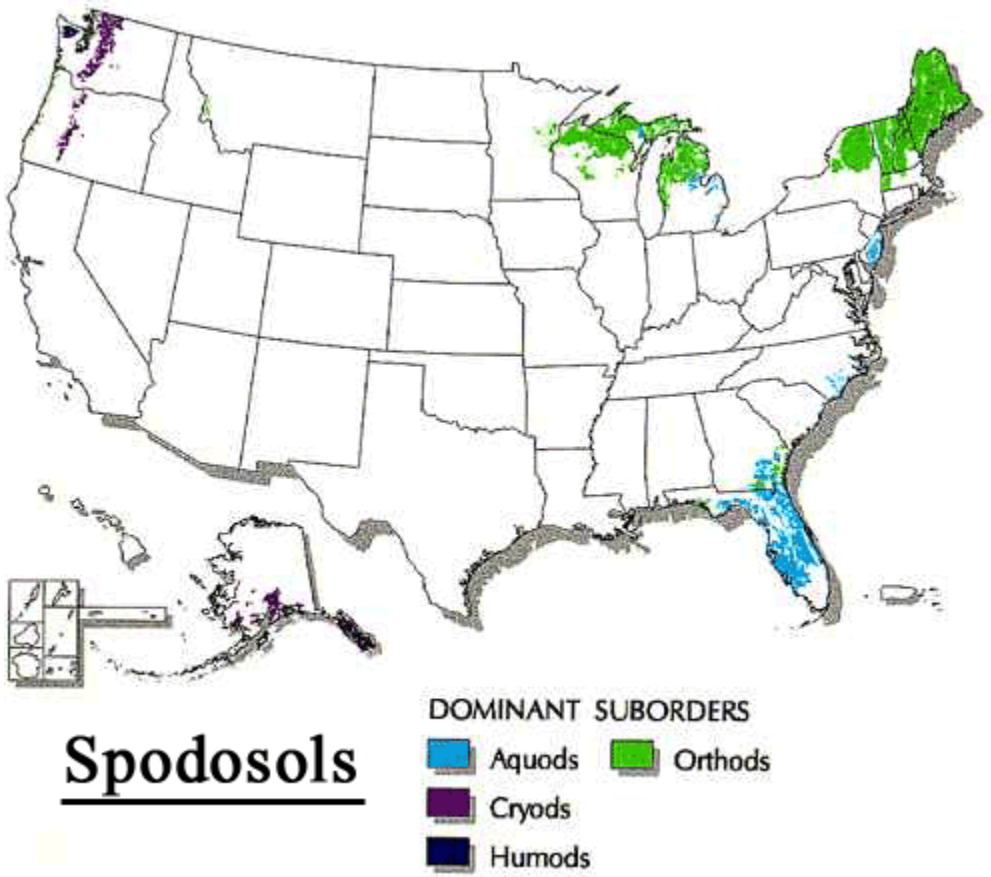
This seminar will take a look at the limitations to the production of this woody perennial fruit crop focusing on problems faced by Pick Your Own growers.

- Blueberry – The right plant in the wrong soil
- After adjusting pH, then what?

The identification, selection and development of novel germplasm is needed to improve 21st Century sustainability.

Blueberry Adaptation to Upland Soils

Spodosols in the US – Natural Blueberry Areas

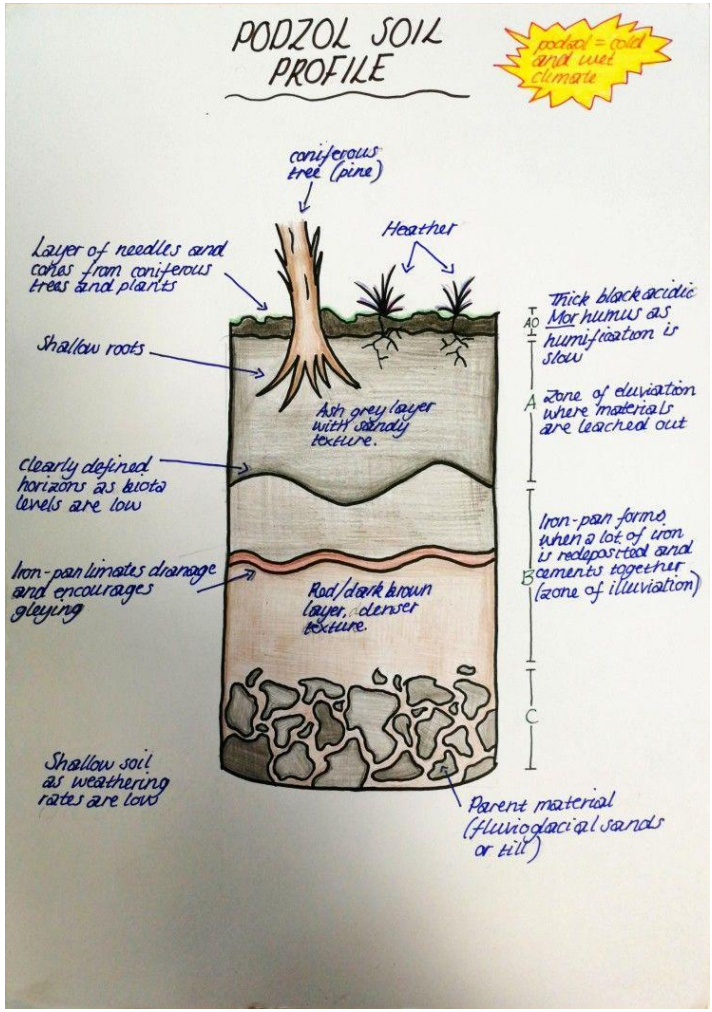


Maine Blueberries
Vaccinium angustifolium

Mid-Atlantic Blueberries
Vaccinium corymbosum

Southern Blueberries
Vaccinium darrowi
Vaccinium ashei

‘Berryland’ Series – High Water Table, Forest Soil



Blueberry: The Right Plant in the Wrong Soil

- Soil Physics
  - Native habitats are organic sands with a high water table (Podzols).
  - Growers transitioning from row crops may also have compacted soil.

- Soil Chemistry
  - Blueberries take up N as ammonium not nitrate.
  - To avoid Fe deficiency, elemental sulfur and/or ammonium sulfate are used to maintain soil pH between 4.0 and 5.5.
  - Soil acidification potential to increase toxicity from Mn and Al.

Commercial Planting: Blueray and New Hanover

Even after pH adjustment, plant establishment
and growth can be slow in mineral soils.
New Hanover plants did well: Blueray plants did not.

Blueberry: The Right Plant in the Wrong Soil

- The two varieties of plants that had showed marked differences in tolerance to Piedmont soils were chosen for a preliminary trial.

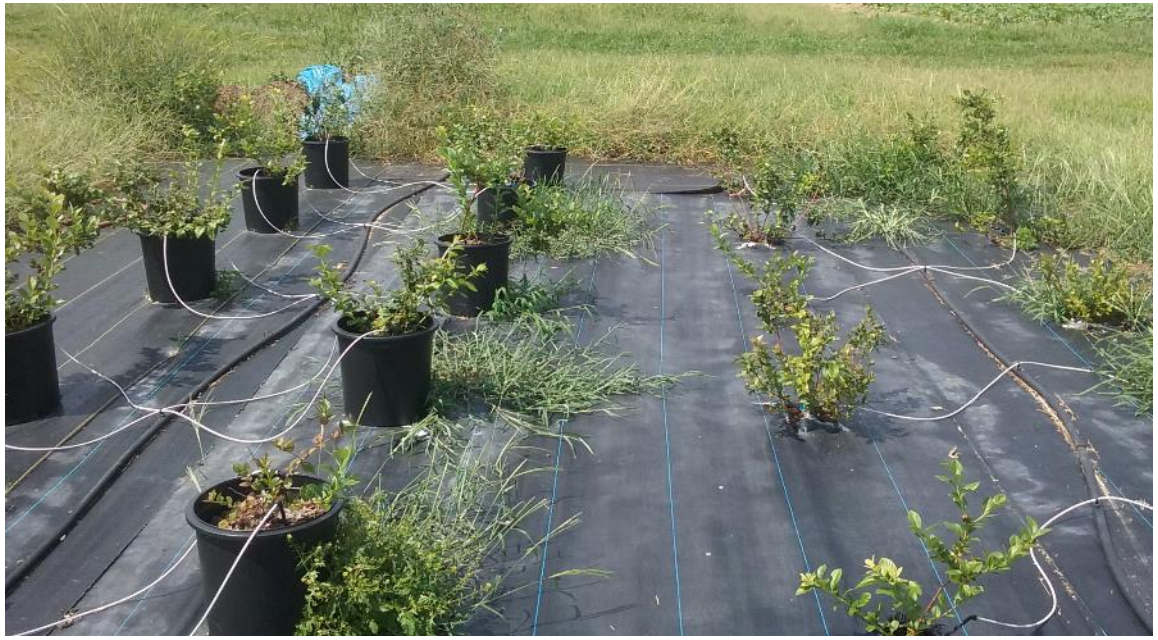
- Amelia Loeb (now at Driscolls) and Lukas Hallman (now at the University of Florida) led a team of undergraduate students in planning and planting a factorial blueberry trial at the MAES facility in Upper Marlboro.

RCB Blueberry Trial at Upper Marlboro

- Cultivar Trial
  - Blueray (Northern Highbush)
  - New Hanover (Southern Highbush)
- Planting System
  - In-ground: soil amended with pine fines
  - Containerized: sand and pine fines to resemble podzolization
  - Drip irrigation and hand fertilization with ammonium sulfate
- Leaf Analyses at Penn State Lab
  - Planting year (data not shown)
  - Second year (results of 32 samples on following slides)

Initial Planting at Upper Marlboro

Planting Year 8/29/18



Blueberry Leaf Analysis – Upper Marlboro

Treatment	Macronutrient Leaf Analysis (percent dry weight)			
	N	P	K	S
Cultivar				
Blueray	1.64	0.80	0.56	0.34
New Hanover	1.51	0.78	0.62	0.25
Planting system				
In-ground	1.64	0.76	0.71	0.20
Containerized	1.49	0.81	0.47	0.39
Anova				
Cultivar (Cv)	NS	NS	NS	*
Planting system (Ps)	*	NS	***	***
Interaction (Cv x Ps)	NS	NS	NS	NS

Blueberry Leaf Analysis – Upper Marlboro

Treatment	Micronutrient Leaf Analysis (parts per million)			
	Fe	Mn	Al	Na
Cultivar				
Blueray	47	311	100	531
New Hanover	43	149	70	224
Planting system				
In-ground	48	213	99	325
Containerized	42	247	72	308
Anova				
Cultivar (Cv)	NS	***	*	**
Planting system (Ps)	NS	NS	*	NS
Interaction (Cv x Ps)	NS	NS	NS	NS

Ghost Forests – Salt (Na) Intrusion

Greenhouse Blueberry Trial in College Park

- Cultivar Selection
  - Five Northern Highbush cultivars
  - Six Southern Highbush cultivars
  - Rooted cuttings in plugs from DeGrandchamp Farms in Michigan
- Planting System
  - Containerized: commercial potting medium and pine fines
  - Ebb and flow fertigation
  - RCB with four blocks
- Leaf Tissue Analyses at Penn State Lab
  - Four randomized complete blocks
  - Results from 44 samples on following slides

Greenhouse Blueberry Trial in College Park

Blueberry Macronutrients – Greenhouse Trial

Treatment	Macronutrient Leaf Analysis (% dry weight)			
	N	P	K	S
Northern Highbush				
Bluecrop	2.10	0.14	0.73	0.19
Blueray	2.07	0.14	0.74	0.20
Draper	1.93	0.13	0.65	0.22
Legacy	1.69	0.11	0.63	0.13
Nelson	1.96	0.15	0.89	0.18
Northern Mean	1.95	0.13	0.73	0.18

Blueberry Macronutrients – Greenhouse Trial

Treatment	Macronutrient Leaf Analysis (% dry weight)			
	N	P	K	S
Southern Highbush				
Cauteret	1.71	0.11	0.70	0.15
Gupton	1.83	0.14	0.94	0.16
Misty	1.74	0.12	0.62	0.16
New Hanover	1.72	0.11	0.65	0.16
O'Neal	1.69	0.14	0.72	0.15
Sharp Blue	1.59	0.11	0.86	0.21
Southern Mean	1.71	0.12	0.75	0.17

Blueberry Macronutrients – Greenhouse Trial

Treatment	Macronutrient Leaf Analysis (% dry weight)			
	N	P	K	S
Northern Highbush				
Blueray	2.07	0.14	0.74	0.20
Legacy	1.69	0.11	0.63	0.13
Southern Highbush				
New Hanover	1.72	0.11	0.65	0.16
Northern Mean	1.95	0.13	0.73	0.18
Southern Mean	1.71	0.12	0.75	0.17
F value (N vs S)	50.51	17.21	NS	17.25
P value	< .0001	.0002	---	.0002

Blueberry Micronutrients – Greenhouse Trial

Treatment	Micronutrient Leaf Analysis (parts per million)			
	Fe	Mn	Al	Na
Northern Highbush				
Bluecrop	42	178ab	8d	324ab
Blueray	41	190a	8d	438a
Draper	40	142c	12ab	364ab
Legacy	41	87d	11bc	214bc
Nelson	38	199a	8d	213bc
Northern Mean	40.4	159.4	9.6	310.6

Blueberry Micronutrients – Greenhouse Trial

Treatment	Micronutrient Leaf Analysis (parts per million)			
	Fe	Mn	Al	Na
Southern Highbush				
Cauteret	37	82d	16a	89c
Gupton	43	153bc	11c	239bc
Misty	40	99d	7d	194bc
New Hanover	38	82d	16a	139c
O'Neal	39	98d	11c	111c
Sharp Blue	38	82d	16a	203bc
Southern Mean	39.2	99.5	13.0	162.3

Blueberry Micronutrients – Greenhouse Trial

Treatment	Micronutrient Leaf Analysis (parts per million)			
	Fe	Mn	Al	Na
Northern Highbush				
Blueray	41	190a	8d	438a
Legacy	41	87d	11bc	214bc
Southern Highbush				
New Hanover	38	82d	16a	139c
Northern Mean	40.4	159.4	9.6	310.6
Southern Mean	39.3	99.5	13.0	162.3
F value (N vs S)	NS	105.5	28.67	36.23
P value	---	< .0001	< .0001	< .0001

Leaf Analysis Recommendations

Macronutrients	
Nitrogen	1.70 – 2.10 %
Phosphorus	0.07 – 0.18 %
Potassium	0.40 – 0.65 %
Calcium	0.30 – 0.80 %
Magnesium	0.20 – 0.30 %
Sulfur	0.12 – 0.20 %

Micronutrients	
Manganese	50 – 500 ppm
Iron	70 – 300 ppm
Copper	5 – 15 ppm
Boron	30 – 50 ppm
Zinc	15 – 30 ppm

Improving Blueberry Plantings on Upland Soils

- Grower Recommendations
  - Minimize sodium in fertilizer and soil amendments.
  - Varietal selection: Test Northern/Southern hybrids on your farm.
  - Legacy is a longer chilling, interspecific hybrid of *Vaccinium corymbosum* and *V. darrowii* with lower levels of Na and Mn in the ebb and flow trial.
  - Southern hybrids should be tested in Maryland as winters are warmer.

- Future Research and Plant Breeding Questions
  - Can sodium and manganese levels predict upland adaptation?
  - Nitrogen levels were inversely related with vigor. Uptake or dilution?
  - Can breeders incorporate Southern Highbush parents with longer chilling requirements into Northern Highbush programs?

Meeting the Long-term Trends in Fruit Production

This seminar has looked at the limitations to the local production of this crop.

The implementation of novel germplasm can improve farm sustainability.

- Blueberry - Select and plant well-adapted Northern Southern hybrids with *V. darrowii* in their parentage.
- Can we predict which Southern varieties will tolerate Manganese, Aluminum, and Sodium in upland soils?

Blueberry Speciation

Cultivar	*Vaccinium* Species (%)			
	V. corymbosum	*V. angustifolium*	*V. darrowii*	*V. ashei*
Elliott, Lateblue	100.0			
Bluecrop	93.6	6.4		
O'Neal	84.0	10.0	3.0	3.0
Legacy	73.4	1.6	25.0	
Bluetta, Patriot	72.0	28.0		

Adapted from "Breeding Blueberries for a Changing Global Environment: A Review"
Gustavo Lobos and James Hancock. 2015

Blueberry Speciation

Cultivar	*Vaccinium* Species (%)			
	V. corymbosum	*V. angustifolium*	*V. darrowii*	*V. ashei*
	USDA ARS (Beltsville, MD) and Rutgers University			
Legacy	73.4	1.6	25.0	
	Elizabeth x US-75 (Florida 4B contributes 25% *V. darrowii)*			
	North Carolina State University			
New Hanover	79.5	6.1	12.5	1.9?
	NC 1522 x O'Neal (Florida 4B contributes 12.5% *V. darrowii*)			

Adapted from "*Impact of Wide Hybridization on Highbush Blueberry Breeding*"
Patricio A Brevis, *et al.* JASHS 133:427-437. 2008.

Thanks to all of those who helped …..

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Are there any questions?