ABSTRACT BOOK

XI International VACCINIUM SYMPOSIUM

April 10-14, 2016 | Orlando, Florida

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HOSTED BY

ISHS International Society for Horticultural Science

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TABLE OF CONTENTS

Blueberry varieties.
UF/IFAS Photo: Tyler Jones.

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XI International VACCINIUM SYMPOSIUM

UF IFAS UNIVERSITY of FLORIDA **HOSTED BY** ISHS International Society for Horticultural Science

Welcome to the XI International Vaccinium Symposium!

Dear participants:

On behalf of the Vaccinium Species Working Group of the Vine and Berry Fruits Section of the International Society for Horticultural Science (ISHS), myself and the organizing Committee, we welcome you to the XI International Vaccinium Symposium in Orlando, Florida! Back in North America for 2016, you will be enjoying the beauty and attractions of the Sunshine State. This year's symposium has a focus on research important to the various cultivated and wild Vaccinium species. Join us for presentations covering breeding, genetics, horticulture, physiology, soil and nutrient management, organic production, postharvest, plant pathology, and entomology. With over 130 scientific presentations to share, there will be oral sessions over the span of two and a half days, as well as two poster sessions. Our keynote address will be given by world-renowned cranberry breeder and geneticist Nicholi Vorsa, and will cover the timely topic area of phytochemical compounds in *Vaccinium* species and their impact on human health. Included in the agenda is a full-day tour of blueberry production in central Florida. Join us on the bus – but remember to bring a hat and sunblock!

In 2016 we celebrate the 100th anniversary of blueberry cultivation, so it is fitting that we will come together to enrich our knowledge of this important berry crop in one of the newest and rapidly expanding blueberry production areas. The University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS) has been a major contributor to this expansion, with blueberry research and extension activities ongoing for over 60 years. We are pleased to partner with ISHS to bring you this symposium.

Our great appreciation goes to everyone who contributed to this year's event. We would like to recognize our organizing and scientific committee members, who have worked tirelessly to make this event happen. We greatly appreciate presenters and attendees that are traveling from all corners of the globe to present their latest scientific information and contribute to the discussion. Very special thanks goes to Mandy Stage and the skilled team at the UF/IFAS Office of Conferences and Institutes for their excellent assistance in managing the logistics of this symposium. And finally, we would not be able to create such a wonderful symposium without the generous donations from our sponsors. Their contributions were critical in our being able to provide attendees with the full agenda and tour.

We look forward to the next few days of presentations and interaction, with opportunities to meet old friends, and the chance to make new ones. Once again, ***we hope you will find this symposium a rewarding and valuable experience.***

James Olmstead

Convener
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SPEAKER ABSTRACTS

Listed in order of presentation

OPENING SESSION AND KEYNOTE ADDRESS

Monday, April 11, 2016

8:00am – 10:00am

Vaccinium Phytochemicals Beneficial for Human Health: Bioactivities, Bioavailability, Metabolism and Clearance

Nicholi Vorsa, Rutgers University, P.E. Marucci Center, Chatsworth NJ 08019, United States of America; vorsa@aesop.rutgers.edu (presenting author)

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Vaccinium species, particularly blueberry and cranberry, are recognized for their potential to benefit human health due to having high levels of phenolic compounds, especially flavonoids. Three major *Vaccinium* flavonoid classes, anthocyanins, proanthocyanidins and flavonols are recognized as potent anti-oxidants, and may provide benefit to cardiovascular, urinary tract, and cognitive health, as well as having anti-aging properties. *In vitro* based bioactivities of cranberry A-type proanthocyanidins include anti-bacterial adherence of uropathogenic *E. coli*, cytotoxicity towards ovarian cancer cells and the dental caries pathogen. Cranberry triterpenoids have cytotoxicity toward colon cancers. Other constituents of potential benefit include chlorogenic acids and certain organic acids, e.g., benzoic and quinic. However, conclusions from clinical studies have been variable. For example, cranberry proanthocyanidins effect on urinary tract, have been less compelling than was hoped, while a blueberry anthocyanin supplemented diet provided evidence of enhanced cognitive effects. In animal studies, a cranberry flavonoid supplemented diet provided ameliorating effects on molecular mechanisms associated with metabolic syndrome. The journey from test-tube, e.g., ORAC, to established clinical efficacy is less clear. *In vitro* identified bioactivities need to be clinically evaluated. The efficacy of a phytochemical/constituent will depend on its absorption, disposition, metabolism and excretion (ADME) properties. Bioavailability of proanthocyanidins appears extremely low while anthocyanins have been detected in plasma and urine but at very low levels. However, *Vaccinium* appears to be particularly high in the flavonols with the most abundant aglycone quercetin being associated with numerous bioactivities. However, in *Vaccinium*, quercetin occurs largely in a conjugated form, largely as glycosides of galactose and arabinose. The sugar moiety appears to mediate bioavailability, metabolism and clearance *in vivo*. An improved understanding of how various *Vaccinium* phenolics are absorbed, metabolized and cleared by humans is needed.

HORTICULTURE/PRODUCTION SESSION

Monday, April 11, 2016

10:30am - 12:00pm

Blueberry Culture in Turkey, Today and in The Future

Prof. Dr. Huseyin Celik, Univ.of Ondokuzmayis, Faculty of Agriculture, Department of Horticulture, 55139 Samsun, Turkey; huscelik@omu.edu.tr (presenting author)

Turkey is one of the most popular country by both plant diversity and numerous growing areas with its different climatic condition. In Turkey, 4 Vaccinium species grow wild and have not been improved through breeding for commercial growing. The introduction of blueberry plants into Turkey began in 1999 but commercial blueberry culture made slow progress. Today, blueberry culture and fruit consumption increased rapidly and by 2014, blueberries were planted on about 200 ha and fruit production had increased to 1000 t. Additionally, some fresh and frozen blueberry fruit are imported from foreign countries to meet the demands of the Turkish consumers who are preferring blueberry for the health and nutraceutical benefits. About 30 cultivars of northern highbush blueberries have been studied for adaptation in Turkey. Recently more than 5 cultivars of southern highbush and several rabbiteyes are tying to test. Based on soil conditions and air temperature, blueberry growing regions may be divided into two zones in Turkey; a) northern highbush are grown in the Black Sea Region (Artvin, Rize, Trabzon, Ordu, Giresun, Samsun, Sinop, Zonguldak) and Marmara Region (Istanbul, Bursa, Yalova and Kırklareli). These areas include both lower altitudes beginning from eastern part of Black Sea and the highland areas of the western part of the same region that are relatively cool and rainy during the growing season (April to October), b) southern and rabbiteye blueberries are trying to grow in southern part of Turkey and western part of Black Sea Region which is warmer during the winter. 21 provinces (Ordu, Giresun, Trabzon, Rize, Artvin, Gümüşhane, Bartın, Bolu, Düzce, Samsun, Sinop, Zonguldak, Karabük, Kastamonu, Kocaeli, Sakarya, Bursa, Çanakkale, İstanbul, **Kırklareli** and Yalova) are mainly under study for their satisfied soil and climatic conditions for blueberries. Turkish consumers prefer fresh, large and sweet blueberry fruit. It is easy to produce high quality fruit, because of average rain at the beginning of growing season and balanced during the whole season and good, sandy loam and loamy clay soils with proper pH range.In Turkey, adaptation studies by southern and rabbiteye blueberry cultivars, mulching and mineral nutrition, post harvest and storage and cultural studies with integrated pest management, pruning and training research will established for the future. In the next years, the blueberry growing area is expected to expand to 2,000 ha, and production volume will be increased to 6,000-8,000 t. Total blueberry fruit consumption in the country is estimated to increase to 30,000 t.

The Blueberry Industry of China: The Past Ten Years and Future

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In the past 10 years, the planting area of blueberries in China increased from 681 ha to 31210 ha, and the total production increased from 342 tons to 42 344 tons from 2006 to 2015 respectively. Greenhouse and tunnel production area in Northern China increased from 17 ha to 560 ha, and 9 ha to 1165 ha from 2006 to 2015 respectively. At present, more than 27 provinces have began blueberry commercial culture in China, ranging from the Northeast to the Southwest, from the east to the west. The main cultivars are “Duke”, “Bluecrop”, “Northland” and “Bluegold” in the north production area, and “O’neal”, “Misty”, ”Legacy”, ”Brightwell” and “Baldwin” in the south production area. The fresh fruit could be harvested from early April to the end of August by production regions or production system. More than 2/3 fruit be used for fresh fruit and be used in domestic market. As a health benefit berry, blueberry becomes more and more popular in China and the domestic market. Major problems and markets for blueberry production in China are also presented in this paper.

The Frequency of Freeze Events in Subtropical Blueberry Growing Regions in Florida

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Freeze events during January and February, when plants are flowering or have immature fruit, can result in major crop and economic losses for growers of low-chill, early-ripening varieties of blueberry (*Vaccinium* spp.) in Florida. Overhead irrigation for freeze protection is commonly used by growers in order to fill a niche market window for early season fruit production in the United States. Freezes are typically categorized as either radiative or advective. Radiation freezes are characterized by clear skies, winds less than 8 kilometers per hour (kph), and the development of a temperature inversion layer. Advective freezes are characterized by cloudy skies, winds greater than 8 kph, and the absence of a temperature inversion layer. The objective was to use historical weather data in order to provide growers with additional information for their selection of passive and active freeze protection strategies. Three sites in Florida were chosen as representative of major blueberry growing regions and weather data from 2000-2015 were downloaded from the Florida Automated Weather Network (FAWN) and analyzed. Hourly temperature, wind speed, and relative humidity were used to determine the average of number of days per month with sub-zero temperatures, the average duration of freeze events, and to classify each event as a radiation, advective, or mixed freeze. Radiation freezes were the most common type of freeze event in Alachua County, Florida, whereas Polk County had fewer freeze events including some years without sub-zero temperatures, but without a clear prevalent freeze event type. Ultimately, the frequency and severity of freeze events, based on historical data, can be used to further inform grower investments in freeze avoidance and protection.

Evaluations of Pre- and Post-emergence Herbicides for Dodder Management in Cranberry

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Dodder (*Cuscuta* spp.), an obligate parasitic plant, is one of the most problematic weeds for Massachusetts cranberry growers. Despite the fact that dodder has been prevalent on farms for over half a century and that numerous research projects have been directed towards its control over the years, the need for efficacious management strategies still exists. We screened 15 herbicides (chlorimuron-ethyl, flumioxazin, imazethapyr, indaziflam, mesotrione, metribuzin, metsulfuron, oryzalin, oxyfluorfen, pendimethalin, pyroxasulfone, two formulations of quinclorac, rimsulfuron, and trifluralin) for preemergence dodder control between 2013 and 2015 in greenhouse trials. All preemergence herbicides were applied in the equivalent of 3,742 L water per ha to simulate application by chemigation. In 2014 and 2015, we screened eight herbicides for postemergence control of dodder (chlorimuron-ethyl, dipotassium salt of endothall, mesotrione, metsulfuron, quinclorac, rimsulfuron, sodium salt of acifluorfen, and an herbicide that is a combination of sodium salt of bentazon and sodium salt of acifluorfen) applied as spot treatments in the equivalent of 281 L water per ha in greenhouse trials. In 2015 we screened two herbicides (imazethapyr and rimsulfuron) applied in the equivalent of 3,742 L water per ha to simulate application by chemigation as field trials.

We have identified five herbicide-rate combinations (365 and 730 ml/ha of a 19.05% a.i. indaziflam formulation, 4.7 L/ha of a 22.3% a.i. oxyfluorfen formulation, and 280 and 420 g/ha of a 51% a.i. flumioxazin formulation) that suppressed dodder seed germination. Flumioxazin will be the focus of future testing and is currently being evaluated for crop safety and field efficacy in fall/spring applied field trials. Imazethapyr (438 ml/A of a 22.87% a.i. formulation) was identified as a possible postemergence control. Greenhouse and field trials are planned for the 2016 field season. Other management strategies using currently registered herbicides are also being investigated.

Potential for Commercial UAV Use in Wild Blueberry Production

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Recent advancements in unmanned aerial vehicle (UAV) and associated imagery technologies have resulted in the use of these and other precision agriculture technologies throughout the agricultural sector. To assess the potential impact of UAV technologies, efforts were made to identify a suitable UAV system for wild blueberry production and to evaluate its ability to estimate topographical features, blueberry coverage, pest pressures and berry yields. Trimble Navigation's UX5 system was selected due to its image quality, data accuracy, operating ruggedness, versatility and automated data processing capabilities. The UAV and associated GIS technologies examined resulted the provision of: (i) improvements in field boundaries; (ii) identification of blueberry coverage and bare spots; and (iii) generation of topographical maps being obtained in an accurate, precise and efficient manner. The UX5 system was also able to easily document equipment operator challenges and also appeared to have pest scouting potential with goldenrod pressures being easily identified. However, use of the UX5 or similar UAV systems requires pilot training and certification, regulation compliance and expertise with data acquisition, processing and analysis. Despite these challenges, these emerging technologies have the potential to significantly improve field assessment for plant and pest related factors, reduce agrochemical usage, decrease the cost of production and improve the overall sustainability of the wild blueberry production system.

Evaluation of Fruit Quality Traits in Southern Highbush and Rabbiteye Blueberries

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The two main blueberry types grown in Georgia are southern highbush (species complex between *Vaccinium corymbosum* L. and *V. darrowii* Camp) and rabbiteye (*V. virgatum* Aiton). In 2014, both blueberry types accounted for 49,000 metric tons in 16,600 acres, making Georgia the number one producer in the US. Southern highbush and rabbiteye blueberries are rarely thought to have similar fruit quality characteristics, although there is a limited amount of information available on varieties that are currently grown. The objective of this research was to examine physical and chemical fruit quality attributes of southern highbush and rabbiteye blueberry varieties that currently compose the majority of the commercial blueberry market in Georgia. Seven southern highbush varieties: 'Camellia', 'Emerald', 'Farthing', 'Legacy', 'Meadowlark', 'Rebel', and 'Star'; and seven rabbiteye varieties: 'Alapaha', 'Brightwell', 'Ochlockonee', 'Powderblue', 'Premier', 'Tifblue', and 'Vernon' were grown and harvested at approx. 50% ripe at the University of Georgia Blueberry Research Farm near Alapaha, GA in 2014. Physical characteristics evaluated included: skin strength (puncture) and berry firmness (Kramer Shear). Chemical characteristics evaluated included: sugar profile and fiber (NDF and ADF). Overall, there was not a significant difference between highbush and rabbiteye blueberries for skin strength, however, rabbiteye had firmer fruit than highbush blueberries ($P<0.05$). For sugars, rabbiteyes were significantly higher than southern highbush for °Brix, sucrose, and total sugar. However, no significant differences were observed between types for glucose and fructose. For fiber, rabbiteyes were significantly higher than southern highbush for NDF, ADF, and lignin content. Results from this study will be compared with subsequent seasons to further understand these quality traits characteristics.

ENTOMOLOGY SESSION

Monday, April 11, 2016

1:00pm - 2:00pm

Identification of Biorational Insecticides for Managing Spotted Wing Drosophila in Organic Blueberry Production

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The spotted wing drosophila (SWD), *Drosophila suzukii* (Matsumura) is the most serious threat to blueberry production in the United States. Estimated losses over the past year have exceeded $100 million USD. The female SWD fly use its serrated ovipositor to puncture the skin of ripening berries and lay eggs beneath the surface. Larvae hatch and develop inside the berry, causing rapid decay and increased risk of secondary infections. Growers of conventional blueberry have multiple tools (insecticides) in different classes available for SWD management. However, organic blueberry growers have much fewer tools to manage SWD populations. The objective of this study was to evaluate and identify compounds that can be used to manage SWD populations on organic farms. The experiment was conducted at a certified organic blueberry farm in central Florida. A randomized complete block design with 12 treatments and four replicates was used. Each plot consisted of a 7.6 m row of single-planted southern highbush blueberry bushes, spaced 1 m apart. The treatments were applied four times at 7-d intervals using an air-blast sprayer. Adult SWD were sampled weekly using clear plastic cup traps with entry holes and traps were baited with 200-ml of a yeast sugar water mixture. Larval infestation was evaluated by collecting 10 ripe berries weekly from each plot. Berry samples were incubated in polystyrene cups at 23°C, ~65% RH, and 16:8 [L:D] h). After 14 days, adult male and female SWD were identified and counted. Entrust® and Venerate® treatments consistently captured similar numbers of adult SWD to the control plots. The insecticides Entrust® and Venerate® had infested berries beginning in week 3 from 2.5 to 12.5% and both treatments were not effective in managing SWD populations. Traditionally, Entrust® is the most commonly used, effective organic insecticide against SWD. However, the same level of control with Entrust® was not seen in this study. Other compounds that were found to be effective at managing SWD were Grandevo®, Azera®, Oxidate®, and Veratran D®. These compounds reduced the number of SWD below the control. Currently Grandevo® and Azera® are labeled for blueberries and SWD in Florida. Entrust is used extensively in organic blueberry production in Florida and the reduction in control seen in this study could be localized events. Further testing of Entrust® with other populations of SWD is needed to finally determine its fate in future IPM programs.

Spotted Wing Drosophila in High Elevation and Culturally Significant *Vaccinium* species in Southwest Washington State and Northwest Oregon

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The Spotted Wing Drosophila, *Drosophila suzukii* **Matsumura (Diptera: Drosophilidae), is a recently introduced pest of commercial** *Vaccinium* **species. In 2013, multiple reports of 'wormy' berries from wild harvest pickers were investigated at high elevation huckleberry picking fields of Indian Heaven Wilderness Area of the Gifford Pinchot National Forest of Washington State, United States of America. Fields in production were a mixture of** *Vaccinium ovalifolium* **and***V. membranaceum*. Beginning in 2013, locations in the Gifford Pinchot National Forest in Washington State and the Mount Hood National Forest in Oregon were sampled for the occurrence of adult *D. suzukii* **flies in both low and high elevation wild harvest huckleberry fields using baited traps. Samples and traps were placed in August and September of 2013, 2014 and 2015. Fruit samples were also collected upon harvest to determine the successful colonization of high elevation huckleberries. Up to twenty-three sites were sample for infested fruit and fourteen sites were trapped for adults beginning at elevations from 29 meters to 1570 meters above sea level.** *D. suzukii* **adults were reared f of huckleberries from fourteen locations including the highest sampled elevation (1570m). Adults were collected in baited traps from all locations sampled, including the highest elevation sampled of 1377m. During the collections made in 2013, berries collected were stored individually to determine the percentage fruit infested. Infestations of 47% were documented at an elevation of 907m and 18% at 1570m. These high infestation rates were recorded in extremely productive huckleberry picking fields that have been harvested for over** 10,000 years by humans and are both a significant economic and cultural resource for Pacific Northwest Native American Tribes.

Monitoring and Distribution of Blueberry Gall Midge, *Dasineura oxycoccana* Johnson, in Rabbiteye Blueberries in Florida

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Blueberry gall midge (BGM), *Dasineura oxycoccana* Johnson, is a major pest of blueberries in the South Eastern United States. In rabbiteye, BGM larvae infest developing leaf and flower buds, whereas they mainly infest leaf buds of Southern Highbush blueberries. Larval feeding injury to flower buds in rabbiteye blueberries can cause up to 80% yield loss if infestation is high and bushes are left untreated. In addition, injury to leaf buds of rabbiteye and southern highbush blueberries can reduce yield the following season. Mature larvae fall to the ground and pupate in the soil. Proper monitoring is essential to ensure that insecticides are applied when adults are emerging from the soil before females lay their eggs in developing buds. Our previous research has shown that bucket emergence traps and clear panel traps are effective monitoring tools. However, the panel trap is not practical for use by growers and the bucket trap needs to be placed properly to accurately monitor midge emergence. The objectives of this study were to 1) determine if a clear sticky sheet would provide a practical and effective alternative to the panel trap, 2) to determine at what height the clear sticky sheets should be hung, and 3) to determine at what distance from the bushes the majority of midges pupate. Clear sticky sheets performed as well as panel traps and, when they are hung low in the bush, caught the most midges. Most (78%) of the gall midge larvae pupate within 48 cm of blueberry plants. Therefore, clear sticky sheets are an effective and practical tool for monitoring blueberry gall midge and should be hung with their bottom ~ 5 cm from the ground. If bucket traps are used, they should be placed as close to blueberry bushes as possible to ensure accurate emergence monitoring.

Blueberry Leaf Scorch: What can be learned from Other *Xylella fastidiosa*-mediated Diseases

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Blueberry Leaf Scorch has emerged as a significant disease of Southern highbush blueberry (*Vaccinium corymbosum* L. x *Vaccinium darrowi* L.) in Florida during the last decade. It is incited by a bacterium, *Xylella fastidosia* (XF), and is transmitted by several species of leafhoppers such as the glassy-winged sharpshooter [*Homalodisca vitripennis* (Germar), formerly *Homalodisca coagulata* (Say)]. Other XF-mediated diseases include Pierce's disease of grapevine, plum leaf scald, phony peach disease and scorch diseases of almond, pecan and numerous ornamental and forest species. Both the bacteriium and the leafhopper vectors are obligate xylophages. XF diseases are extremely difficult, if not impossible, to control in the southeastern United States for several reasons. First, the host ranges of both the bacterium and the leafhopper vectors includes hundreds of plant species, and the host range is limited only by the number of plant species surveyed. XF exists in a benign presence in virtually all of these native species. Second, leafhopper vectors are highly mobile and often switch host plants based on the nutrient content of xylem fluid. Insecticide applications at least once or twice a week for almost the entire year would be required to partially control the insect vectors. Third, leafhoppers are highly fecund and may lay hundreds of eggs during their lifetime. The rabbiteye blueberry (*Vaccinium virgatum* Aiton) is native to northern Florida and southern Georgia and appears to tolerate XF; however, some Southern highbush blueberries appear to be particularly susceptible. Clearly, the best solution for controlling bacterial scorch of blueberry is host plant resistance. Due to the ubiquitous nature of XF and the leafhopper vectors we suggest that resistance to XF be considered as a screening tool prior to release of Southern highbush blueberries for the southeastern United States.

SPECIAL SESSION: CELEBRATION OF 100 YEARS OF BLUEBERRY

Monday, April 11, 2016

2:00pm - 2:30pm

Celebrating the 100th Anniversary of Highbush Blueberry Domestication - The Contributions of Frederick Vernon Coville and Elizabeth White

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The first shipment of highbush blueberries resulting from controlled crosses and grown under managed cultivation occurred in 1916. Two individuals, Frederick Vernon Coville and Elizabeth Coleman White are credited with the domestication. Frederick Coville, born 1867 in Preston, N.Y., graduated from Cornell University in 1887 and in 1888 began a 50 year career as Botanist and Chief Botanist at the U.S. Dept. of Agriculture. He was botanist on the 1890 Geological Survey of Arkansas, 1891 Death Valley Expedition and was the youngest member of the famous Harriman Expedition to Alaska in1899. Some of the other contributions were: standardized plant names, Desert Botanical Laboratory, National Herbarium, National Research Committee of National Geographic Magazine and National Arboretum in Washington. Coville was concerned that his children (Stanley 11, Katherine 9, Cabot 3 and Fredrick 1), growing up in Washington, would never learn the rural skills that he had acquired in his childhood. In 1905 a friend told him about a 40 acre farm for sale near Greenfield, New Hampshire which was purchased for $400. Blueberries, both highbush and lowbush flourished in the area. Less than a year after coming to Greenfield, his interest was attracted to blueberry culture. After extensive observations the first of many selections was made in July of 1908. This important selection, 'Brooks", was named after the owner of the farm where it was found. Between 1906 and 1910 the soil requirements, cultural practices and techniques required for cultivar development were determined. These studies were published as "Experiments in Blueberry Culture", U.S. Dept. of Agriculture Bul. 193, Nov.15, 1910 and in National Geographic Magazine as "Taming the Wild Blueberry", Feb. 1911. The cooperation between Frederick Coville and Elizabeth White that lead to the release of the first 15 cultivars, began in 1911 and continued until his death in 1938.

BREEDING/GENETICS/EVALUATION SESSION

Monday, April 11, 2016

3:30pm - 5:00pm

Prolific Triploid Production in 4x *V. corymbodendron* by 2x Section Cyanococcus Crosses

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V. corymbodendron (Section *Pyxothamnus*) is a tetraploid species native to high-altitude locations in Peru, Colombia, and Venezuela, and is of considerable interest because it flowers at times when nighttime temperatures drop below freezing. It also is notable for its profuse, concentrated flowering, and monopodial plant structure both of which may be useful in breeding for mechanical harvest. Initial hybridization experiments of 4*x V. corymbodendron* with a range of 2*x* species from Section *Cyanococcus* found virtually all hybrids were triploids, whereas 4*x* × 2*x* crosses in conventional *Vaccinium* germplasm typically result in an almost absolute block of triploid offspring. The triploids expressed very low fertility as both males and females, nonetheless, several were used successfully in crosses. A single hybrid from 4*x V. corymbodendron* × 2x *V. vitis-idaea* (lingonberry) was unexpectedly found to be tetraploid and was highly fertile. These crossing results suggest *V. corymbodendron* either possesses no ploidy barriers to hybridization, or possesses genomic dosage factors that differ from Section *Cyanococcus* species. Understanding these crossing relationships may open new avenues for exploitation of this germplasm and other tertiary genepool germplasm.

Fruit Quality Profiling of Blueberries for Parental Choice in Breeding: Aroma and Texture at Harvest and in Postharvest

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Parental choice is a key process in blueberry (*Vaccinium* spp.) breeding. This holds in particular for traits that are still poorly defined and known like flavour and texture but that are crucial for consumer acceptance. Breeding selection of these traits is generally based on non-analytical observations assessed at a unique time point. The aim of this work was to obtain a high throughput quality profiling of blueberries at harvest and postharvest, with regard to two complex and commercially important traits like aroma/flavour and texture, in order to unravel the variability present in the germplasm and use the information for breeding advancements. We profiled 60 accessions among which different species of *Vaccinium*: southern, northern, lowbush, half-high blueberries and rabbiteyes. The analyses were carried out at harvest and after storage, at2°C for three and six weeks at normal atmosphere conditions, in order to monitor the dynamics of the different parameters of the traits for each genotype. Texture was measured by Texture Analysis and the volatile profile by Proton Transfer Reaction TimeofFligh Mass Spectrometry (PTRToFMS). Data have been evaluated and are reported with particular regard to an explanatory knowledge toward an optimized parentals choice for quality in blueberries breeding programs at harvest and postharvest.

Wild Relatives of Blueberries from Vietnam

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From 25 October to 14 November 2015, wild relatives of cultivated blueberry were collected during a cooperative Vietnamese-US expedition in Northern Vietnam. This expedition was sponsored by the US Department of Agriculture, Plant Exchange Office, with permission and cooperation of the Vietnamese Ministry of Agriculture and Rural Development and the administration of four Vietnamese National Parks. About 33 accessions of 19 species of the genera*Agapetes, Gaultheria*, and *Vaccinium* were collected. These evergreen Ericaceous species were plentiful in the high elevations of Hoang Lien Son National Park on Fansipan as reported; Ericaceous species observed in Tam Dao, Phja Oac-Phja Den, and Ba Be National Parks were not previously reported from those locations. Root samples for propagation and seeds were collected from 1200 to 3100 m elevation. Chilling degrees in these habitats were estimated to be 50 to 160 hours per year. Growing habitats varied from terrestrial to lithophytic (epipetric) and epiphytic. Most terrestrial species were vigorous, crown-forming, and exceeded 3 m in height; two species were rhizomatous subshrubs of 0.3 m. Inflorescences of *Agapetes* contained immature and mature solitary fruit; *Gaultheria* had > 50 flowers/fruit per panicle; *Vaccinium* ranged from solitary flowers/fruit to 10 per raceme. Flowering phenology of these genera were not synchronized with their counterparts of the temperate zone. In October-November after the rainy season ended, these species simultaneously displayed all stages of phenology from bud break to fruit development. Past-ripe fruits were persistent on *V. bracteatum* var. *thysanocalyx* and *G. fragrantissima*. Fruit colors of these blueberry wild relatives included pink, bright red, fuchsia, as well as purple to black. The wealth of diversity of the Ericaceous species in the high elevation regions of Vietnam suggested floristic similarities with highland areas in Taiwan, Southern China (Yunnan), and the Himalayas. This plant material will be established and evaluated for descriptive characters in Vietnamese and US genebanks.

Florida Native Blueberries and Their Use in Breeding Cultivars

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Three *Vaccinium* sections are represented in the Florida native flora. Section *Batodendron* has one species in Florida (diploid *V arboreum*), *Polycodium* one (diploid *V. stamineum*), and *Cyanococcus* six: two highbush species adapted to swampy areas with moist, organic soils (diploid and tetraploid *V. fuscatum*), two evergreen, rhizomatous lowbush species, adapted to frequently-burned forests (diploid *V. darrowii* and tetraploid *V. myrsinites*), diploid *V. elliottii*, a tall, crown-forming species having small, highly-deciduous leaves, a very short style, and very small berries, adapted to riverbanks and sandy uplands in north Florida, and one or more hexaploid species (depending on taxonomic philosophy), including the vigorous, polymorphic rabbiteye blueberry (*V. virgatum*), which appears to have evolved and spread independently from several distinct points of origin in the southeastern United States. Florida tetraploid *V. fuscatum* occurs from Gainesville north in the northern peninsula. Of all the Florida blueberries, it most nearly resembles the highbush cultivars, with which it crosses readily. Clones of cultivar quality can be selected from seedlings of the first backcross. Diploid *V. fuscatum* can be found all the way south to Lake Okeechobee. It resembles the tetraploid but has smaller leaves and berries, and plants from south Florida are nearly evergreen. These make vigorous hybrids with tetraploid highbush, but only a few, because of the ploidy difference. *V. elliottii* is very hard to cross with highbush cultivars, apparently making very few unreduced gametes. Its tetraploid hybrids with highbush produce dark, soft berries that taste good and ripen extremely early. Using tetraploid plants produced with colchicine, both *V. arboreum* and *V. stamineum* can be crossed with highbush cultivars, producing hybrids of varying vigor and fertility. Backcrosses to highbush may introduce useful characteristics, but commercial cultivars are unlikely before the second backcross generation

Microsatellite Markers Assess Genetic Diversity of Wild Southeastern American *Vaccinium*

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The United States Department of Agriculture (USDA)-Agricultural Research Service (ARS)-National Clonal Germplasm Repository (NCGR) in Corvallis, Oregon, USA preserves genetic resources of many temperate fruit crops, including blueberry. This genebank contains > 1,750 *Vaccinium* accessions from 39 countries, with cultivars and selections stored as living plants, and wild relatives stored as seed. Wild species representatives from northwestern, central and south Florida, and neighboring US states collected during multiple USDA expeditions, are preserved at the NCGR-Corvallis. This invaluable wild germplasm is vulnerable to loss due to habitat encroachment from human development. The objective of this study was to evaluate genetic diversity in 67 accessions from several domestic US expeditions. More than 44 primer pairs flanking microsatellite or simple sequence repeats (SSRs) identified in *V. corymbosum* were screened for polymorphism in 14 accessions of four species. Fourteen SSRs proved polymorphic and easy to score in these species and were used to estimate genetic diversity of the 67 individuals including 35 *V. darrowii*, 19 *V. elliottii*, 12 *V. fuscatum*, and one *V. myrsinites* accessions. Genetic distance was closest among the two named cultivars: *V. darrowii* 'Everblue' and 'Johnblue'. *Vaccinium darrowii* Florida 4B, a well-known breeder selection used for introducing the economically valuable low-chilling trait into the cultivated highbush gene pool, was obtained from two sources. The two Florida 4B samples had dissimilar fingerprints, while two accessions of *V. darrowii* with different New Jersey selection numbers had identical fingerprints. Cluster analysis separated the wild accessions into species groups. This work illustrates the importance of DNA fingerprinting in maintaining accurate and diverse germplasm collections to ensure scientific and breeding utility. Future analyses will include confirming the identity of the Florida 4B genotypes, and evaluating the genetic diversity and population structure of these wild accessions.

ORGANIC PRODUCTION SESSION

Monday, April 11, 2016

5:30pm - 6:30pm

The Organic Blueberry Industry in Oregon: Results of In-person, On-site Interviews with Growers in 2015

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Certified organic blueberry area in the U.S.A. grew nearly ten-fold from 2003 to 2011. In 2015, there were an estimated 283 ha of certified organic blueberry in Oregon. New transitional and organic blueberry fields continue to be planted in this region by small and diversified organic farmers at a rapid growth rate. In 2015, a survey was developed to conduct on-site in-person interviews with certified and transitional organic growers in Oregon. Quantitative and qualitative data were collected including pre-planting practices and soil amendments, management systems, cultivars and area grown, soil pH and fertility programs, pruning, irrigation and pest management, average yields, harvesting and postharvest practices, sales and marketing. Different farm sizes and business structures were included in the 32 interviews conducted. Although the diversity of farms varied, the majority of operations were small farms with less than 2 ha of blueberries. Fifty percent of the farmers interviewed had diverse organic production systems including crops other than blueberry and 90% were located along the entire length of the western part of the State. Production systems were diverse among farms including: half using drip and half using overhead irrigation; half planted on raised beds, while the others were on flat ground; 40% had fields with plants at least 10-years-old; and all pruned at least some part of their fields annually. Soil and tissue testing, use of soil amendments, and nitrogen and other fertility management practices varied widely among growers. The most important pest problems noted by growers were weeds, Spotted Wing Drosophila (*Drosophila suzukii*), Mummy berry (*Monilina vaccinii-corymbosi*) and Blueberry Shock Virus (BlShV). Other important pests included birds, rodents and deer. Growers described a wide variety of harvest methods and marketing outlets for their blueberry fruit with the vast majority of them producing for direct costumer sales or for fresh wholesale buyers.

Organic Farming Systems in Increasing the Anthocyanin and Vitamin C Content of Rabbiteye Blueberry (*Vaccinium ashei* Reade var. Tifblue) on a Heavy Soil

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Increased concerns over the last several decades on environmental problems have stimulated farmers to accept organic farming as an alternative to inorganic agriculture. Blueberries are one of the richest sources of antioxidant phytochemicals having a high level of anthocyanins. Anthocyanins are phenolic compounds that posses antioxidant activities. Rabbiteye blueberry (*Vaccinium ashei* Reade var. Tifblue) was grown on Memphis Silt Loam soil (Typic Hapludalf, silty, mixed, thermic). Two organic manure treatments (worm castings, cow manure) were applied in basins around each plant. Control treatment received regular inorganic fertilizer. All treatments received pine bark and pine needle uniformly. No chemicals were applied to control pests, diseases, and weeds. Percent canopy cover, LAI, canopy width and height, stem diameter, and yield were significantly higher in organic plants treated with worm castings. There was no significant difference in size, diameter, and degree Brix of the fruit, but the content of total anthocyanins and vitamin C were higher in fruit treated with worm castings. There was no difference in microbial load and no pathogens were found in the fruit. Concentrations of nitrate-N and P were higher in surface soils treated with organic manures, but there was no trend in N or P enrichment in lower layers of the soil. The leaching of N and P into subsurface layers from inorganic fertilizer was highly significant. Blueberry can be grown successfully on heavy soils with forest waste that can maintain soil structure and acidity, and worm castings increases yield and fruit quality of this crop.

Weed Management Strategies in Long-term Organic Blueberry Production Systems Impact of Mulch Type and Weed Control Methods on Plant Growth, Yield, and Economics

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Weed management was identified as one of the most challenging aspects of organic blueberry production by an advisory panel of growers. A long-term research trial was established in autumn 2006 to evaluate several components of organic production of northern highbush blueberry (*Vaccinium coymbosum*), including the use of three weed management strategies: sawdust mulch; yard debris compost topped with sawdust mulch (compost+sawdust); and a black, woven polyethylene ground cover (weed mat). Also compared were planting bed type, nitrogen fertilizer source and rate, and cultivar. Weeds were managed by hand pulling in sawdust and weed mat mulched plots, and a combination of hand pulling, propane flaming, and targeted applications of organically-approved post-emergent herbicides to the compost+sawdust plots, depending on year. Mulch type affected establishment costs, weed presence, and weed management costs (application of herbicides and labor required for hand weeding). During establishment, all mulch treatments had overall economic losses (as is typical in blueberry), but losses were greatest for compost+sawdust due to increased weed presence and high weed management costs relative to the other treatments. Costs were lowest for weed mat, where almost complete weed control was achieved. Weed mat significantly increased cumulative yield (years 2-8 of plant growth) by 4% compared to the organic mulches, while mulch type had little effect on fruit quality. Weed presence increased as the planting aged and costs of weed management continued to increase with organic mulches whereas the weed mat had relatively low weed control costs throughout the life of the product (5-7 years). The cumulative labor requirements to control weeds in the weed mat, sawdust, and compost+sawdust treatments were 270, 1085, and 1309 $h \cdot ha^{-1}$, respectively. Even with the small increase in yield, weed mat was the most economical method of weed control, reducing labor and herbicide costs relative to the organic mulches tested.

Root Production, Distribution, and Turnover in Conventional and Organic Northern Highbush Blueberry Systems

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Northern highbush blueberry (*Vaccinium corymbosum* **L.) is a shallow-rooted crop with very fine, fibrous roots. Recently, we installed minirhizotrons (root observation tubes) in a conventional and an organic blueberry planting in western Oregon, USA. We wanted to know exactly when and where new roots were being produced and to determine whether different fertilizer and weed management practices were affecting root production and turnover. At both sites, root production peaked once in mid- to late May, about a month prior to harvest, and again in September, about a month before dormancy each year. Most roots were located < 30 cm deep and averaged only 20–75 µm in diameter. In general, plants produced more roots in raised beds than in flat ground, with sawdust mulch than with weed mat, with granular fertilizer than with fertigation, and with no or lower rates than with higher rates of fertilizer. Plants on raised beds and grown with no or low rates of fertilizer also produced deeper roots.** The average median lifespan of the fine roots was 115–135 d, but roots survived an average of 60 d longer with fertigation than with granular fertilizer. Overall, timing of root production in blueberry appears to be highly dependent on temperature, shoot growth, and fruit development, while total root production and lifespan are mostly affected by availability of soil water and nutrients. Practices such as raised beds, sawdust mulch, and reduced fertilizer rates can be used to increase root production, while fertigation may reduce plant carbon costs associated with root turnover.

PLANT PATHOLOGY SESSION

Wednesday, April 13, 2016

8:00am - 9:30am

Management of *Exobasidium* Leaf and Fruit Spot Disease of Blueberry in the Southeastern United States

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The southeastern states currently account for more than one-third of the cultivated blueberry production area in the United States. The increase in acreage and production intensity in the region has been accompanied by the emergence of new fungal, bacterial, and viral diseases. For example, Exobasidium leaf and fruit spot, caused by*Exobasidium maculosum*, only rarely affected blueberries in the past, but has now become a common problem in the Southeast. This fungal disease causes green or white lesions on the fruit, rendering them unmarketable. Symptomatic fruit are not easily detected on the packing line, slowing down the packing process and sometimes causing fruit loads to be rejected or downgraded. Management options for this disease were unknown. In 2012, an initial fungicide timing trial was conducted to determine the efficacy of early (pre-bloom and bloom), mid-season (petal fall and early cover), late (during fruit maturation), or full (all three periods combined) spray programs. Early and full fungicide schedules provided the best control, whereas mid-season applications provided some disease suppression and late applications did not reduce disease; this indicated an early-infection period by the fungus. Captan provided the best efficacy of the materials tested. In 2013, an additional trial further supported the early use of fungicides, and a single late-dormant application of calcium polysulfide was determined to be equivalent to multiple applications of Captan in-season. Calcium polysulfide efficacy when applied at the late-dormant stage was further confirmed as a critical management tool in 2014 multi-county fungicide trials. It is now recommended that Exobasidium-active fungicides be applied during late-dormant and bloom, followed by two to three applications post-bloom in conditions of high disease pressure to further reduce disease levels. These management recommendations have been rapidly adopted by blueberry producers throughout the Southeast, and Exobasidium incidence has been reduced significantly as a result.

Blueberry Fruit Drop Disease Associated with a Novel Member of the *Caulimoviridae*

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Recently, a nearly 100% fruit drop symptom has been observed in several fields of cv. Bluecrop, in the Fraser Valley in Washington, U.S.A. and British Columbia, Canada. Also, it was observed that young leaves showed a transient red coloration of the veins during the bloom period and the corolla of the flowers exhibited some red striping. After bloom the plants appear normal until about three weeks prior to harvest, when the fruit drops. Prior to harvest, affected bushes can be identified easily since they stand upright. Using Rolling Circle Amplification, enzymatic digestion, cloning and primer walking, a novel virus was isolated and sequenced from samples showing symptoms described above. Using BLAST, it was found that the obtained sequence had a high degree of homology with *Dahlia mosaic virus* and *Cauliflower mosaic virus*, both viruses belonging to the family *Caulimoviridae*. The new virus (provisionally named Blueberry fruit drop associated virus) had a genome of 9850 bp, which is the largest caulimovirus known. The genome codes for a single ORF that shares 50% amino acid sequence identity with *Strawberry vein banding virus* over 24% of the ORF. Detection primers were designed based the on virus sequence, which amplified a 350 bp amplicon and confirmed the presence of the virus from symptomatic plants but not from healthy plants. In field tests of 66 plants, 31/31 symptomless plants tested negative for the virus and 35/35 plants with fruit drop symptoms were positive for the virus, which demonstrates a good correlation between symptoms and infection with this virus. The impact of this virus in cultivars other than 'Bluecrop' is unknown.

Potential Global Distribution of Blueberry Twig Blight (*Phomopsis vaccinii*) Predicted by Two Species Distribution Modeling Approaches

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Blueberry twig blight, caused by *Phomopsis vaccinii* (teleomorph *Diaporthe vaccinii*) is a severe endemic disease in the Eastern and Northwestern USA. It has also been found at a few locations in Europe, Canada, and one location in Chili and China. In the latter two countries and most of Europe, the pathogen was eradicated after being found, except for Latvia. Publications on its occurrence in the USA and Canada would indicate that this is a cool-season pathogen. Models on the potential spread of *P. vaccinii* have not been published. The data base of the National Plant Diagnostic Network (NPDN) could possibly be used to predict the potential spread of this pathogen. Published data on worldwide occurrence were inventoried and supplemented with NPDN data. GPS coordinates were estimated at the county level. Occurrence data and long-term climate data from the Worldclim website were entered in the species distribution models MaxEnt and Multi-Model Framework (with 9 models). The models predicted that the climate in central and eastern USA (down to North Florida) and the west coast of the USA and Canada would be conducive to blueberry twig blight. Large areas in Europe, Eastern Australia and New Zealand, and smaller areas in South America and East Asia would be conducive too. All locations where twig blight had been identified were correctly predicted to be conducive. Precipitation in the driest quarter contributed most to the prediction, followed by mean annual temperature. The models indicated that *P. vaccinii* is not necessarily limited to cool climates, although the optimal annual average temperature is 10°C according to the MaxEnt model. Thus, the NPDN database can be an important source of information for the prediction of the potential global spread of a plant pathogen.

Diagnosis and Management of New and Re-Emerging Diseases of Highbush Blueberries in Michigan

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Blueberries are an important commodity in Michigan and disease management is crucial for production of high-quality fruit. Over the past 6 years, a number of new and re-emerging diseases have been diagnosed in the state. In 2009, Blueberry scorch virus (BlScV) and Blueberry shock virus (BlShV) were detected in several fields, leading to a statewide survey and eradication effort to safeguard the blueberry industry. Around the same time, a new syndrome characterized by brownish, cupped leaves and plant decline ("bronze leaf curl") was observed in multiple older blueberry fields. While initially attributed to herbicide injury, a closterovirus similar to Blueberry virus A was found in affected bushes. The role of this virus in the disease is currently being investigated. Blueberry leaf rust is a sporadic problem that became prevalent in 2010 and 2011 after several particularly rainy summers. The pathogen was identified as *Thekopsora minima* whose alternate host is eastern hemlock (*Tsuga canadensis*). Fungicide efficacy trials showed that Pristine (pyraclostrobin + boscalid) was the most effective, followed by Indar (fenbuconazole) and Quash (metconazole). The organic fungicide Serenade (*Bacillus subtilis*) was moderately effective. The recent expansion of blueberry cultivation into previously wooded areas has led to localized outbreaks of Armillaria root rot, caused by *Armillaria mellea.* This soilborne fungus continues to kill many relatively young bushes in affected fields. There are currently no management tools available other than to remove infected plants. While root rots are relatively uncommon in Michigan blueberry fields, declining 'Jersey' plants were observed in a poorly drained field in 2009. A pathogenic oomycete, *Pythium sterilum,* was identified as the causal organism. Changes in cultivars, production practices or climatic conditions may lead to new disease outbreaks. Regular disease monitoring and use of virus-tested planting stock are recommended as well as a rapid response when exotic pathogens are detected.

National Blueberry Certification Scheme in the United States

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Pilot studies to evaluate the feasibility and effectiveness of the proposed National Blueberry Certification Scheme are underway in three states with a tradition in blueberry propagation (Michigan, Oregon and Washington). The guidelines describe propagation, testing and maintenance procedures at four generation stages (G-levels) in the certification scheme. Plants are tested for different sets of viruses based on the G-level and geographic location of the certified nursery. Guidelines for best management practices have been developed based on scientific knowledge and experience of state regulatory agencies and the nursery industry. The ultimate goal of this project it to provide an effective certification scheme that will allow for the interstate movement of blueberry propagation material and reduce constraints on exports.

Managing Blueberry Rust under an Evergreen System

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Blueberry rust caused by the fungus *Thekospora minima,* is a significant disease of evergreen blueberry production, costing the Australian blueberry industry tens of millions of dollars each year in lost production and control. Leaf symptoms appear as yellow-brown lesions on the upper surface. Orange coloured pustules containing urediniospores develop on the underside of the leaf. Severe rust infections can cause leaves to drop with the potential for severe defoliation. Defoliation of southern highbush varieties under an evergreen system is undesirable, as maintaining healthy leaves from the previous season is important to produce fruit for the early season high priced market. Cultural and chemical management is required to prevent defoliation from rust in this system.

Six fungicides from four chemical groups were evaluated for efficacy against blueberry rust in NSW, Australia. A randomised block design trial with five replications of nine plants per treatment block was established. Fungicides tested included azoxystrobin, azoxstrobin+cyproconazole, dithianon, fenbuconazole, tebuconazole and mancozeb. Disease severity was assessed fortnightly on 20 leaves from each plant in each treatment. Assessments were made using a diagrammatic scale based on the leaf percentage affected. Blueberry rust was present prior to starting treatments.

All chemicals tested in this trial significantly reduced blueberry rust incidence when compared with the untreated control. Fenbuconazole and dithianon were the most effective in reducing severity of blueberry rust over the 12 week trial. Dithianon is a broad spectrum, multi-site activity fungicide and its mode of action prevents spore germination. Fenbuconazole provides protective, curative and limited eradicant properties.

When fungicides are applied after symptoms appear, the lesions they are applied to are present over a range of developmental stages. This is significant because fungicide application timing may affect the success of rust to produce viable urediniospores and reinfect the host plant. For blueberry rust this requires further investigation.

POSTHARVEST SESSION

Wednesday, April 13, 2016

10:30am - 12:00pm

Solar Dehydration of Blueberries (*Vaccinium corymbosum* L.)

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To know the effect of pre-treatment of blanching on the quality of blueberries (*Vaccinium corymbosum* L.) variety "Biloxi", grown in San Andrés Yucuita, Nochixtlán, Oaxaca, Mexico, area of low chill level, subject to solar dehydration, the fruits was collected in commercial maturity. Blueberries were washed with 25 ppm chlorine and selected by size (9.0 ± 1.0 mm of diameter) and colour (H ° 295 ± 5). The fruits were separated in two batches: the first was dehydrated directly and the second was blanching at 95° C for 20 seconds and then dehydrated. Each lot was placed in room trays of 0.0625 m^2 with an equivalent of 2.00 kg of fruit/m^2 and last to a solar drier by natural convection with air velocities among 0.6-0.8 m/s and temperature of 68.0 ± 3.0 ° C. The quality parameters evaluated were: total solids, soluble solids, titratable acidity, total reducing sugars, total phenolics, total anthocyanins and antioxidant activity. The results indicate that the blanching fruits required 11.5 h to reach levels of humidity between 12.5%, while the not treated fruits reached the same moisture the 13.0 h. Fruits with blanching presented greater response to rehydration compared with those who did not receive this treatment; both lots had light browning by dehydration, and moderate losses of phenolic compounds and antioxidant activity.

A New Non-destructive Approach to Assess Bruises of Blueberries Using Hyperspectral Imaging

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A major limitation of current blueberry firmness measurements is that the firmness cannot be measured for the same object overtime due to the destructive nature of the measuring approaches. The goal of this study was to develop a new approach based on hyperspectral imaging to accurately detect and assess bruises of blueberries. A total of 1000 samples of two northern highbush cultivars were collected and equally divided into one control treatment and three bruise treatments. Hyperspectral reflectance images of the samples were acquired in the wavelengths ranging from 950 to 1650 nm. Average spectra of individual samples were extracted from masked hyperspectral images generated by a thresholding method, whereas pixel spectra of healthy and bruised tissue were extracted from manually selected ROIs. The fruit spectra with measured firmness were used to train a partial least square (PLS) model to predict fruit firmness, while the pixel spectra were used to train a support vector machine (SVM) classifier to generate classification map by classifying the hyperspectral images at pixel level. The classification map was used to calculate bruise ratio of individual samples. The PLS model showed poor prediction accuracy and R^2, but the SVM achieved an accuracy of 97%. Statistical tests were conducted to compare the bruise assessment effectiveness of the predicted firmness, bruise ratio, and measured firmness. The results showed that the bruise ratio was equivalent to measured firmness in terms of keeping statistical significance among various treatments. The predicted firmness did not show statistical significance for most treatments. Therefore, the bruise ratio calculated by the proposed method could be an effective index to accurately and non-destructively assess blueberry bruises.

Evaluation of Sulfur Dioxide-Generating Pads and Modified Atmosphere Packaging for Control of Postharvest Diseases in Blueberries

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Postharvest diseases are a limiting factor of storage and shelf life of blueberries. Gray mold caused by *Botrytis cinerea* is one of the most important postharvest diseases in blueberries grown in California. In this study, we evaluated the effects of sulfur dioxide (SO_2)-generating pads (designated as Dual or Slow release pads) alone or in combination with modified atmosphere packaging (MAP) on gray mold and other diseases and fruit quality. Freshly harvested fruit were placed in clamshells in cardboard boxes. In each box, 6 clamshells in which one single fruit pre-inoculated with *B. cinerea* was placed in the center of the clamshell were used to evaluate the treatment effects on the fruit-to-fruit spread of gray mold, and the remaining 6 clamshells without pre-inoculated berries were used to examine natural infection. All clamshells together in each box were then wrapped with either a regular liner or MAP bag. There were three replicates for each pad and bag combination. Fruit were stored at 1°C for 5 weeks. On the fruit treated with the Dual pad, no gray mold was observed on the inoculated fruit, thus no spread of gray mold. Although gray mold developed on the inoculated fruit treated with Slow pad or MAP bag alone, gray mold spread was significantly reduced compared to the control. Incidence of decayed fruit was significantly reduced with either Dual or Slow pad, especially in combination with MAP bag, compared to the control. However, more than 20% of blueberries treated with Dual pad exhibited bleaching due to SO_2 injuries. Our results suggested that the combination of Slow release pad and MAP bag is a promising method for control of fruit decay while maintaining blueberry fruit quality during storage.

Prevalence and Incidence of Postharvest Diseases of Blueberries in California

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Recent establishment of low-chill southern highbush blueberry cultivars in California's warm climate has significantly increased the acreage of blueberry production in the Central Valley of California, which is now a major southern highbush blueberry production region in the United States. The vast majority of blueberries grown in California are destined for the fresh market. As the production continues to grow, the blueberry industry has a need to prolong the storage life of blueberry in order to extend marketing period. However, the postharvest life of blueberry fruit is limited by fruit rots caused by fungal pathogens. To determine what are the major postharvest diseases affecting blueberries in the region, blueberry fruit were collected at harvest from 42 (27 conventional and 15 organic) and 62 grower lots (49 conventional and 13 organic) in 2013 and 2014, respectively; stored at 0-2C for 5 weeks; and then evaluated for the presence of fruit rots. Causal agents of rots were isolated from decayed fruit and identified. Incidence of decay ranged from 23 to 74% in 2013 and from 3 to 74% in 2014. One or more than one fungi were isolated from each decayed fruit. On average, *Botrytis* spp. (mainly *B. cinerea*), *Cladosporium* spp., *Alternaria*spp. (mainly *A. alternata* and *A. arborescens*), *Aureobasidium pullulans*, *Rhizopus stolonifer,* and *Penicillium* spp. were isolated from 21-46%, 6-13%, 25-38%, 12-29%, 2-26% and 2-8% of the decayed fruit sampled from conventional grower lots, respectively; and from 20-73%, 5-18%, 11-46%, 7-19%, 5-25%, and 3-4% of the decayed fruit sampled from organic grower lots, respectively. Our results indicated that *B. cinerea*, *Alternaria* spp., *Aureobasidium pullulans*and *Cladosporium* spp. were the major pathogens as they were consistently isolated from decayed fruit from most grower lots during the 2-year survey and that control measures should target these pathogens.

Effects of Prior Freezing Conditions on the Performance in Freeze Drying Process of Blueberry

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The freeze drying involves the following three steps: the freezing step, the primary drying step and the secondary drying step. Freezing agricultural product is a very important step because the freezing speed influences on the structure of the frozen product which decides whether the product can be freeze-dried with high quality or not. In the freeze drying process of blueberry, the prior freezing operation is an essential process to go forward the drying operation smoothly. The prior freezing influences on the total drying time, product quality and specific energy and costs. The experiments were carried out changing the cooling speed of blueberry in the prior freezing. Rabbiteye blueberry cultivar 'Tifblue' fruits harvested in the university orchard (Fuchu, Tokyo) were used as test material. The cooling speed was selected by changing the chilling tray temperature at -20 ºC – -80 ºC of a small size freezer. The changes in the material temperature were measured with 0.1 mm T-type thermocouple in the data logger during the cooling and freezing process. Primary and secondary drying was done by using a transparent vacuum desiccator connected to a vacuum pump through a vapor cooling trap. Trapped vapors were analyzed with GC-MS to identify and quantify the flavor component of blueberry such as benzaldehyde during the sublimation of water. The relationships among the cooling speed, the drying performance and the quality on the flavor disappearance of the dried fruit were discussed to find the better cooling speed in the prior freezing step.

Semi-mechanical Harvesting Platform for Harvesting Blueberries with Fresh-market Quality

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Over-the-row (OTR) mechanical harvesters are capable of harvesting >500 kg of blueberries per hour and have been used to harvest blueberries that are packed for fresh market. As promising as it seems, there are several major issues related to harvesting blueberries with OTR harvesters. First, the quality of the fruit harvested by OTR machines is generally low compared to hand harvested fruit. Machine-harvested blueberries have more internal bruise and usually soften rapidly in cold storage and have lower pack-out yield because immature fruit is shaken off by the machine and ~25% of detached fruit fall onto the ground.

The objective of this study was to evaluate the fruit quality and several harvest parameters of highbush blueberries harvested by hand, hand-held (HH) olive shaker and OTR blueberry harvester. Mature 'Aurora', 'Draper', 'Legacy', and 'Liberty' blueberry plants were harvested either by hand and with an olive shaker with two different lengths of nylon tines and operated at 45 psi (310 KPa) and 65 psi (454 KPa), with detached fruit collected on a net surface attached to a portable catch frame. In addition, 'Legacy' blueberry was harvested with a Littau harvester operated with ground speed and shaker frequency selected by grower operator. For each plant, the weight of total detached and green/red fruit, fruit firmness, internal bruise, Brix (%), pH, and titratable acidity was determined. In addition, fruit was sampled for weight loss, firmness and internal bruise after 1 day at room temperature (RT); and 1, 2, 3, and 4 weeks in cold storage, plus 1 day at RT.

HH shaker removed 3.5 to 15 times more fruit (g/min) than by hand harvesting. All samples lost weight (1 to 5%) in cold storage, but the difference between harvest methods was small. In all cultivars, Brix was lower and TA was higher in fruit harvested with HH shaker than by hand or OTR harvester. Fruit firmness was higher in fruit harvested by hand compared to HH shaker harvested in 'Liberty', same in 'Aurora' and 'Legacy', and lower in 'Draper'. 'Legacy' fruit harvested with OTR harvester had a significantly less firmness compared to hand HH shaker harvested fruit. The operating pressure and tine length has little or no effect on none of measured fruit quality parameters. The percentage bruised area and percentage of fruit with >19% bruised was less in 'Aurora' and 'Draper' than in ''Legacy' and 'Liberty'. There was a slight differences in bruising due to shaking parameters, but the bruise was less than 8% in hand and HH shaker harvested fruit compared to >25% in 'Legacy' fruit harvested by OTR harvester. These results indicate a good potential for harvesting fresh-market quality blueberries using hand-held shakers and portable fruit catch frame.

HORTICULTURE/PRODUCTION SESSION

Wednesday, April 13, 2016

1:00pm - 3:00pm

Shoot Orientation and Flushes of Shoot Growth Affects Flower Bud Differentiation and Fruit Quality in ´Jewel´ and ´Star´

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Blueberry fruit quality is affected by several factors such as cultivar, growing conditions, water status, soil types, and also internal plant factors. On this study we wanted to test the hypothesis that floral bud locations in the plant and time of differentiation have also an effect on fruit size and quality. Our objective were to determine the effect of shoots orientation (horizontal or vertical), flushes of growth and time of vegetative growth cessation on floral bud formation and fruit quality of two blueberry cultivars 'Jewel' and ' Star' planted in Curacaví, Chile. In both cultivars we found that growth cessation occur first in horizontally oriented shoots with 1 and 2 flush of growth than in vertically oriented shoots. In 'Jewel' bud differentiation occurs first in horizontal and then in verticals shoots, and this was related to time of shoot growth cessation. Flower buds on shoots with one flush of growth were heaviest independent of orientation. In both cultivars, bloom, fruit set and fruit ripening occur first in horizontal shoots of one flush of growth. The following spring fruits size was larger on vertical shoots of one flush. No significant differences among treatments were found in fruit firmness, sugar content or acidity. Time of shoot growth cessation in 'Jewel' and 'Star' planted in the Curacaví, did affect the time of flower bud development and also the different phenological stages. Horizontal shoots that stop earlier and grow less had earlier flower bud development, bloom, set fruit and ripen earlier than shoot that stop later. Fruit size seems to be more related to shoots vigor than to time of flower bud formation.

Evaluating Tensiometers and Moisture Sensors for Cranberry Irrigation

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Irrigation scheduling continues to be a major challenge in cranberry (*Vaccinium marcrocarpon* Ait.) production. Many growers tend to rely on the 25 mm per week "rule" from rain and irrigation despite evidence that in most years this results in some weeks with inadequate water and others with excess. This project tested wireless tensiometers and farmer practice for irrigation management on six cranberry bogs of southeastern Massachusetts. When the tensiometer was used to decide when to water, irrigation was initiated only when the tension reading was -5 kPa and stopped at -2kPa. The grower method of 25 mm per week was used as control. In each method, volumetric moisture sensor readings were taken and canopy temperatures were continuously monitored using a data logger. Cranberry plant density and yield components were measured. The results showed that the grower practice had tension readings of -2 kPa or less and consistently wetter than the tensiometer method. On average, the volumetric water content of grower practice was 26 gkg^{-1} and 17 gkg^{-1} with the tensiometer method. Fruit rot was 7% higher and yield was 24% lower under the grower practice relative to the tensiometer method. It is highly likely that irrigation based on detecting available moisture in the soil and irrigating only when the moisture is inadequate to support plant growth results in better cranberry yield and less fruit rot.

Mastering Subtropical Central Florida Blueberry Challenges

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Management of blueberries in subtropical Central Florida requires a very different pest control program than management of blueberries in warm temperature areas such as South Georgia, USA. Some major blueberry diseases of warm temperate areas such as mummy berry, *Monilinia vaccinii-corymbosi*, and septoria leaf spot, *Septoria albopunctanta*, are absent or nearly absent. Other diseases which are minor problems or rare in warm temperate areas such as blueberry rust, *Pucciniastrum vaccinii*, phylosticta leaf spot, *Phyllosticta vaccinii*, and algal stem blotch, *Cephaleuros virescens*, are major problems in central Florida. Slime mold in pine bark beds is another unusual problem for some C. Fla.growers. Some major arthropod pests such as blueberry maggot,*Rhagoletis mendax*, are absent in C. Florida. Other arthropod pests which are rare or absent in warm temperate blueberry areas are major problems in subtropical central Florida. These include citrus root weevils, *Pachnaeus litus* and *Diaprepes abbreviates*, chilli thrips, *Scirtothrips* spp., and spider mites,*Tetranychus urticae* and *Oligonychus ilicis.* The use of hydrogen cyanamide for breaking dormancy in C. Fla. deciduous blueberry production is important, but must be based on a knowledge of cultivars, plant phenology and spray conditions.

Field Trials of Bilberries *(Vaccinium myrtillus* L.) in Norwegian Forest Fields

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Effects of different environmental factors (origin, climate, fertilization and soil properties) on berry nutritional quality and plant growth were studied in forest fields of bilberry (*Vaccinium myrtillus*) in Northern-, Mid- and Southern Norway. Effect of fertilization on plant growth was examined. The fields that performed best had O-layers close to 7 cm or thicker. The C/N ratios indicated that N was not easily available in any field, and addition of mineral fertilizer increased elongation of long shoots and number of developed nodes (Mid Norway). Organic fertilization by adding composted wood chips or wood chips alone increased tiller growth (Northern Norway). The results suggest that by improving growth conditions, especially by securing a thick natural O-layer and adjusting soil macro nutrient composition, growth conditions could be improved. No clear trend was found between locations on nutritional quality, but untargeted multivariate analysis of metabolite profiles revealed clear segregation patterns between locations. Contents of anthocyanin, phenolics and titratable acidity were significantly affected by mineral fertilization (Mid-Norway), while organic fertilization did not show any significant effects (Northern Norway). Chemical composition of bilberry was affected by harvest time, where content of phytochemicals where higher when harvesting at mid or towards the end of the production season (Southern Norway). Regional and annual climate had the strongest impact on both plant growth and the nutritious content of bilberries.

Use of Pine Bark in Soil Management of Southern Highbush Blueberries

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Southern highbush blueberries (SHB) (*Vaccinium corymbosum* hybrid) require acidic, well-drained soils that have high organic matter content. Pine bark is commonly used as a soil amendment in the southeast U.S. because its physical and chemical characteristics are suitable for blueberry production. These include low pH, relatively low C/N ratio, and high porosity and aeration. Southern highbush blueberries are commonly planted on pine bark beds approximately 15 to18 cm deep, or in pine bark amended soil by mixing equal parts of bark and native soil into the top 15 to 18 cm of soil. Pine bark beds represent a significant establishment cost that can exceed $9,000/ha. The pine bark incorporation method potentially reduces pine bark inputs by 50% compared to bark beds. The purpose of this research was to determine the effects of pine bark placement (beds vs. incorporated) on early growth and yield of SHB. Treatments consisted of 1) Non-amended soil; 2)8 cm of pine bark incorporated into the top15 cm of soil; 3) 8 cm of pine bark incorporated plus 8 cm of surface applied pine bark mulch; and 4)15 cm deep pine bark beds applied to the soil surface. Vegetative (plant canopy and pruning dry weights) and reproductive (yield and mean berry weight) growth were similar for all pine bark amended treatments during the study, but plants in the non-amended treatment were smaller, less vigorous, and had lower yields of smaller fruit. Incorporating pine bark into the soil required only half the amount of bark and resulted in similar plant size and yield compared to pine bark beds during the first four years following planting. These results suggests that pine bark inputs can be reduced during establishment without affecting plant growth or yield by incorporating pine bark as opposed to using pine bark beds.

Maine Wild Blueberry Systems Analysis

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We conducted a multi-disciplinary large-scale study covering 3 production cycles (2 year crop cycle) from 2010 to 2015 on four cropping input systems: Organic, Low input, Medium input, and High input; that fit along gradients of capital inputs and potential environmental effects to quantify system effects on pollination, yield, weed, pest and pathogen communities, plant health, and the economic effects of inputs. The goal of the project was to provide growers with information on how different management systems affect the crop, its environment, and the ecological and economical sustainability of wild blueberry production. An issue concerning growers is how to optimize increasingly expensive inputs to achieve economically and environmentally sustainable yields. In the 2010 to 2011 cycle we established two fields per cropping input system for a total of eight fields, and in 2012 to 2013 four fields per cropping system for a total of 16 fields, in 2014 to 2015 some fields were changed to provide a better geographical distribution and a more diverse cooperator input. This paper will discuss the significant findings in weed, insects, and disease by system and use a path system model of each production system to quantify the major dynamics to represent the relative importance of system input effects on yield so that a holistic view may be visualized and the inputs relative significance can be quantified. Path coefficients can then be compared by system to determine the relative value of inputs in each system and allow growers to make the most efficient investments to improve productivity and efficiency. It will also allow growers to evaluate the relative merits of each of the production strategies to determine which one is the best for their operation.

Water Footprint in Cultivated Blueberries with Drip Irrigation Systems in Concordia, Argentina

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The production of blueberry crops (*Vaccinium Corymbosum L*.) is very important in Concordia area, in Entre Rios province, Argentina. There are more than 1.000 has producing around 10.000 tons basically destined to the northern hemisphere markets, aiming at supplying consumers after their local production is finished. This activity generates 350.000 labor days for manual harvesting of the fruit, 30.000 labor days to pack the fruit, and 400 fixed positions for field maintenance during the year. To produce in the early spring, anti frost irrigation systems are required to avoid the damages of low temperatures during winter and the beginning of spring. In addition to the 1.413 mm annual average rainfall, drip irrigation systems are used as supplementary irrigation. Blueberries have a very superficial root system and are planted in sandy soils with slopes of around 2%, low water retention capacity, and high hydric erosion susceptibility. This fact and the high sensitivity of blueberries to soil water potential, oblige irrigation designers to provide highly efficient drip systems and farmers to follow strictly water management and irrigation schedule. Soil water potential is followed with tensiometers, reference evapotranspiration is measured following Penman-Monteith equation, crop coefficient is calculated according to the shaded area of the crop. In this trial we analyzed the design uniformity of the system installed, we calculated the total distribution efficiency coefficient of the system after five years work, we measured the "*recession phase time and volume in drip irrigation*" generated by the slopes of the area. More over, we measured the water footprint of blueberry production under the mentioned conditions, arriving to values of 135 liters of water per kg of fresh fruit produced.

Cane Productivity is Affected by Cane Diameter and Location in Highbush Blueberry

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In blueberries, it has been reported that cane productivity can be affected by their diameter, but the effect of spatial location is unknown. This is important to consider when deciding pruning strategies. Thus, the objective of this study was to assess the effect of cane diameter and location on yield in mature highbush blueberry fields cv. O'Neal and Brigitta (*Vaccinium corymbosum* L.) in Romeral-Chile (34º58'00"S; 71º08'00"W), over two growing seasons. Cane diameter was measured at 10 cm from the cane base. Canes were then grouped into three diameter ranges: 0-0.9; 1-1.9 and 2-2.9 cm. In every bush, the cane spatial location was defined as external (E), located within 25 cm from the canopy periphery, or internal (I) those growing in the canopy center. Fruit were harvested every 5 d from each individual cane and fruit number and yield were determined. Photosynthetically active radiation (PAR) was measured for internal and external cane positions and every 30 cm from the top to the base of the canopy and expressed as percentage of full sun (%FS). External canes had higher yield (70%) and fruit number (50%) than internal canes. Yield increased as cane diameter increased and this was due mainly to fruit number per cane. The correlation between fruit number and yield per cane was high for both varieties and seasons ($r^2 \geq 0.94$). The %FS received by external canes was significantly higher (43% FS) than internal ones (27% FS). In both varieties, % FS was reduced as the distance from the canopy edge increased. The productive zone was significantly higher for external canes (>30%). As in the canopy center the availability of radiation was lower, this would have affected floral bud initiation, which reduced the extent of the productive zone, and generated a lower fruit number which ended up generating a lower yield.

PHYSIOLOGY SESSION

Wednesday, April 13, 2016

3:30pm - 5:00pm

Influence of Light and Temperature Conditions on Anthocyanin Accumulation in *Vaccinium* spp. Berries

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Anthocyanins are the main pigments in the *Vaccinium* berries. Besides contributing the characteristic bluish to reddish colors of the berries, anthocyanins are also recognized as potential health beneficial compounds. The biosynthesis of anthocyanins is well understood and the key regulators have been characterized in many plant species. The final anthocyanin composition in ripe berries is regulated both by developmental and environmental factors, determined by the genetic background. We have studied the role of different light and temperature conditions on accumulation of anthocyanins in wild bilberries (*V. myrtillus*) and cultivated highbush blueberries(*V. corymbosum*), both in controlled and in field experiments. These experiments include specific growth conditions and clones from northern and southern latitudes in addition to different altitudes. The results show complicated interactions both in the levels and qualitative composition of anthocyanins as response to light and temperature conditions. For instance, lower temperature and specific light wavelengths induced accumulation of delphinidin glycosides in bilberries. However, high species-specific variation in response to different treatments or growth conditions was detected.

Technical Improvement of a New Bioreactor for Large Scale Micropropagation of Blueberries and other Horticultural Crops

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Conventional micropropagation is expensive and labour intensive. Until now few laboratories have been truly profitable. However with development of a new biological pathway using temporary immersion system in bioreactors it is now possible that micropropagation become cost-effective. We have developed a commercially attractive bioreactor for large scale in vitro plant production as well as for basic research. The bioreactor has been designed in a way that is easy to handle, it has low weight, it is transparent and it is autoclavable. Nutrient supply and gas exchange can be controlled using air pumps and timers. The units can be placed above each other saving place in the climate chamber. Blueberries and a number of horticultural plants have been tested resulting in high quality plants, faster growth and better survival after transfer to soil.

Comparison of Nonstructural Carbohydrates across Cranberry Cultivars

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Carbohydrate competition within reproductive (fruiting) uprights has been proposed to explain low fruit set and biennial bearing tendencies of cranberry (*Vaccinium macrocarpon*). Yet, comparisons of nonstructural carbohydrate concentrations during critical phenological stages across cultivars that differ in biennial bearing tendencies and return bloom potential are lacking. This study sought to address this deficiency by comparing total nonstructural carbohydrates (TNSC), soluble sugars (SS), and starch concentrations across cultivars that reportedly differ in biennial bearing tendencies and return bloom potential. Plant material representing 'Gryglesky Hybrid 1' ('GH1'), 'Stevens', and 'HyRed' were collected from a commercial cranberry marsh located in central Wisconsin. Concentrations of sucrose, glucose, fructose, and starch were determined via high-performance liquid chromatography. Patterns of carbohydrate changes were similar to previous reports. Vegetative uprights generally had greater concentrations of carbohydrates relative to reproductive uprights, while roots had the lowest concentration across all cultivars. Concentrations of TNSC and SS in reproductive uprights were lowest on 30 July, which corresponds to late bloom/early fruit set and terminal bud development. 'Stevens' and 'HyRed' TNSC and SS concentrations subsequently increased after this period, whereas concentrations remained low in 'GH1'. Return bloom potential was lower in 'GH1' relative to 'Stevens' and 'HyRed'. These findings support the explanation that carbohydrate limitation in reproductive uprights may contribute to biennial bearing by reducing the potential for return bloom.

Emulsions of Long-chain Fatty Acids as Fruit Sizing and Ripening Agents for Gibberellin-A3-treated Rabbiteye Blueberries (*Vaccinium virgatum* Aiton syn. *V. ashei)*

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Some rabbiteye blueberry cultivars (*Vaccinium virgatum* Aiton syn*. ashei*) lose ≤67% of their berries to a floral polymorphism (*z1-5)*, which by deforming corollas, stamens, and pistils reduces male and female function. These deformities give flowers and reproductive organs an asymmetric shape, and in extreme cases, cause sterility. Overcoming sterility and expected fruit loss in 'Premier' flowers was possible with two applications of an exogenous plant growth regulator (PGR), 250 ppm gibberellin-A_3 (GA). Interestingly, 0.5% coconut oil soap chosen as a dual emulsifier and surfactant for our GA dips behaved like a PGR by advancing ovule growth far enough along to produce small hard intact seeds. Resulting berries were 20% - 25% heavier and matured 7 – 14 d earlier. Fruit sets as high as 80% to 90% stemmed from the emulsion's GA ingredient. Yet, the heaviest seed-rich berries either resulted from cross-pollinated flowers or from unpollinated blooms treated with GA/coconut oil soap emulsion. A second greenhouse experiment was set up and incorporated chemical dips containing four concentrations of coconut oil soap, five component medium- and long-chain fatty acids (C_{10} – C_{18}), and three new cultivars. Again, these replicated trials achieved similar results. GA stimulated high fruit set, while coconut oil soap plus its component long-chained fatty acids produced heavier faster growing berries for unpollinated blooms of 'Austin', and 'Prince'. 'Tifblue' flowers however yielded seedless fruit, indicating genotypic sensitivities to exogenous GA. The soap's component fatty acids appear to promote embryony and, in effect, mimic cross-pollination.

Chilling Effect on Three Highbush Blueberry Cultivars

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In recent years blueberry production has increase in areas with mild winter climate where chilling is one of the major problems concerning plant productivity. Breeders and nurseries normally provide just approximate values of the chilling requirements for specific cultivars. Thus growers in different areas have to cope with a lack of knowledge about cultivar behavior in their region. Portugal has a diverse climate with 400 chilling hours in the south of the country and more than 1200 hours in the north. In order to evaluate the effect of chilling hours on three blueberry cultivars, Legacy, Duke and Elizabeth a trial was set up with five chilling treatments (955, 1123, 1267, 1417 and 1520 chilling hours) and a control (natural cold, 501 chilling hours). Plants were grown in substrate for three years until the setup of the experiment. Depending on the cultivar, plant production varied with chilling treatments. 'Legacy' had a negative response to chilling and the control treatment resulted in the highest yield (5.0 kg per plant). 'Duke' presented an exponential response to chilling with the highest value at 1200 chilling hours. 'Elizabeth' showed a positive response towards chilling but with no clear tendency. Since plants from all treatments left the cold chamber on the same date (11 March), growing degree days were equal for all treatments and no effect on phenological dates was registered. 'Legacy' was the first cultivar to begin harvest (29 May) and 'Elizabeth' the last (25 June). With this experiment we can state that 'Legacy' can be grown in the south, 'Duke' in places where plants can achieve 1200 chilling hours and Elizabeth in places where occur at least 1000 chilling hours.

SOIL/NUTRIENT MANAGEMENT SESSION

Thursday, April 14, 2016

8:00am - 9:30am

Biochar and Compost Soil Amendments Affect Soil Carbon and Greenhouse Gas Emissions

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Australian blueberry production in the sub tropics is commonly based on mounded soil with a surface mulch of plastic weedmat, woody mulches or groundcover plant clippings from the interrow. This research examines the soil amendments compost and biochar, for their ability to improve soil fertility, increase soil carbon, lower greenhouse gas emissions, modify soil moisture and temperature. Biochar is a charcoal like substance created through the thermal conversion of organic biomass under low oxygen conditions. It is a more stable carbon based material than the parent feedstock, and in pilot trials, has produced an increase in soil C, a liming effect and a reduction in the production of the greenhouse gas nitrous oxide (N_2O). Compost has also been shown to increase soil C over time but its influence on greenhouse gases is less well defined.

A new planting of Southern Highbush *Vaccinium corymbosum* L. hybrid (Opi) was amended with 4 T carbon /ha to a Ferralsol, with either biochar, compost or a combination. Soil is monitored for total C, N, P, pH, CEC, microbial activity, microbial biomass C, bulk density, aggregate stability, moisture, temperature, plant growth, berry yield (when mature) and soil flux of N_2O, CH_4 and CO_2. Established in March 2015, the preliminary results show that biochar and compost increased soil C by 12-14%, in the 0 - 100 mm layer. The amendments increased pH from 5.10 to 5.60 – 5.75, a benefit in this acidic soil type, and increased CEC by 26 – 53%. There was no change in bulk density or total N. There is a trend showing lowered N_2O emissions from biochar amended soil. Plant growth will continue to be monitored every 6 weeks and soil moisture logged with capacitance sensors in each plot. These inputs are showing some soil improvements while contributing positively to climate change mitigation.

Physical and Chemical Characterization of Pine Bark for the Production of Blueberry (*Vaccinium corymbosum* L.), in Containers

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Pine bark (PB), a product of *Pinus oaxacana Mirov,* is an abundant organic waste in the state of Oaxaca, México. In the last 18 years about 72,000 tons have been generated annually. In Mexico, composted pine bark has not yet been used to make organic substrates. Due to the volume of waste generated, pine bark could be used as a substrate or component of alternative substrate. This work analyzes PB as a sustainable organic substrate for blueberry production in containers. PB was subjected to a controlled composting process for 241 days. The final compost obtained served as the basis for the formulation of four different mixtures that were characterized by analyzing their physical and chemical properties, based on the UNE EN. The mixtures CPTAEV2, CPTAEV3, and CPSSC have recommended values of total porosity, aeration capacity and moisture retention capacity, physical properties important to assess the quality of a substrate. CPTAEV1, CPTAEV2, and CPSSC mixtures have a proper balance of water and air. Regarding AFD and AR parameters, CPTAEV2 and CPTAEV3 mixtures have very appropriate values. Regarding pH, CPTAEV2, CPTAEV3, and CPSSC mixtures have acid values, as required for blueberry cultivation. In regard to EC, CPTAEV3 and CPSC mixtures have values lower than 1 dS m-1, also suitable for cultivation. The C.I.C of CPTAEV2, CPTAEV3, CPSSC and CPT mixtures all have values in the recommended range. The MO has low values and C / N ratio is suitable. Overall, compost and mixtures made from *Pinus oaxacana Mirov,* exhibit physical and chemical characteristics that meet the conditions for use as growth substrate for production of blueberries in container.

Assessing Soil Health in Organic Blueberry with the SOLVITA® CO_2 Respiration Test

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Measurement of carbon dioxiderelease from microbial respiration in the soil is a potentially important tool to predict availability of mineralized nitrogen; an essential element estimated but not measured in routine soil tests. A three-year field study assessed soil fertility and health in four commercial highbush blueberry fields (Vaccinium corymbosum) in Central New Jersey. Carbon dioxide production from microbial life in the rhizosphere was measured with the Solvita CO_2 aerobic respiration test.

Average annual CO_2 values from 2013-2015 for all four organic blueberry fields was 49.7, 53.8, 58.6 and 61.8 CO_2 ppm CO_2 -C ppm per 40 gram dried sample, respectively. These values are categorized as 4.0 on a 0-5 scale with 4 being the best and 5 excessive. These soils were characterized as having medium to ideal fertility compared to marginal to moderate ratings for annual crops soils that reached only 14.1 CO_2 ppm CO_2 -C ppm. The main distinction of organic perennial cropping was no tillage which left soil undisturbed along with standard practices of applying composted amendments and excluding synthetic pesticides.

The Solvita system is a rapid, high-tech soil and compost test that provided a simple, quantitative and inexpensive means to assess an important indicator of soil health, compost quality or changing farming practices over time. Measuring this biological source of nutrient availability has the potential for growers with healthier soils to reduce the amount of fertilizer application and advisors to reduce N rates; yet expect the same yield, reduce expenses and avoid excessive nutrient runoff. To be able to accurately credit nitrogen from natural organic matter mineralization against the estimated total nitrogen recommendation may be a valuable contribution to economical and sustainable farming.

Comparison of Liquid, Granulated, and Controlled Release Fertilizer in Blueberry on Fruit Quality and Growth

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Southern highbush blueberry (SHB; *Vaccinium corymbosum* **L. hybrids) are acid-loving plants that thrive at soil pH levels of 4.0-5.5. Under the acidic soil conditions, ammoniacal nitrogen (**NH_3-N) fertilization is applied for plant nitrogen. Most fertilizer formulations contain some level of nitrate (NO_3^-); however, for blueberry, NO_3^- **in the fertilizer formulation is suggested not to exceed 25%. Fertigation and controlled release fertilization (CRF) are being adopted by growers for convenience. However, some liquid and CRF formulations can contain levels of nitrate above 25%. In 2014 and 2015 at the University of Georgia blueberry farm in Alapaha, GA, USA, five treatments with three replications per treatment of SHB 'Star' were fertilized at the rate of 112 kg ha-1 nitrogen (N) with 1) Granular 10-10-10 (GF; 95%** NH_3-N, 5% NO_3^-), 2) Liquid 10-5-5 (LF; 63.5% NH_3-N, 36.5% NO_3^-), 3-5) CRF 18-6-12 (55.5% NH_3-N, 44.4% NO_3^-) as 3 (CRF3), 6 (CRF6), and 12 (CRF12) month controlled release. Leaf tissue N (LTN) and NO_3^- **concentration, plant growth (shoot length and number), and fruit firmness, color, total acidity, and sugars were assessed. In 2014, significant differences were seen in shoot length and firmness but not in nitrogen, shoot number, or other fruit quality measurements. The CRF12 had 29% longer shoots with 10% firmer fruit than GF. In 2015, differences were noted but with different treatments. The CRF6 measured 22% longer shoots but had 31% fewer shoots than the LF. In both years, the** NO_3^- **leaf tissue level was ≤ 0.02% for all treatments. This work shows that in SHB 'Star' applying either CRF at 55.5%** NH_3-N or LF at 63.5% NH_3-N will produce adequate plant growth and fruit quality.

Nitrogen Effectiveness on Blueberry Yield and Quality

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Research on mineral nutrition for high-bush blueberries in Latvia is at a very early stage. Our studies was devoted to nitrogen – plant nutrient with high mobility and significant impact on vegetative growth and yield formation. The field experiment was started in 2012 in plantation established 3 years before. Experimental plots with blueberry cultivar 'Chippewa' were arranged on gently slope with mineral soil developed from moraine. Original topsoil's reaction was pH KCl – 6.41, organic matter content 20 g kg^{-1}. Before planting strips under bushes was conditioned using acid sphagnum peat. Five experimental plots each of them consisting from 8 bushes was set up. The objective of research was to determinate the effect of different fertilizer treatments (0; 40; 80; 120 and 160 kg ha^{-1} N) on biochemical contents in the berries and the yield, as well as on the chemical composition of leaves. Soil reaction was determined potentiometrically, organic matter in mineral soil according to the Tyurin's method, in organic materials – by dry combustion, total nitrogen using Kjeldahl method. Samples of leaves were taken during the vegetation for NPK and Mn, B and Mo analysis. Research showed that different nitrogen fertilizer rates did not significantly influenced blueberry yield, but changed biochemical composition of berries. In 2014 the highest phenol content in berries was around 80 kg N ha-1, while both the 2013 and the 2015 results show a different picture. The highest content of anthocyanin in blueberries was N 0 and N 160. This could be due plant's response to stress, resulting in plants enhanced formation of secondary metabolites.

BREEDING/GENETICS/EVALUATION SESSION

Thursday, April 14, 2016

11:00am - 12:30pm

Molecular Markers to Identify Morphological and Biochemical Variations in Micropropagated *Vaccinium* Species

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Significant advances in *Vaccinium* micropropagation has been achieved along with the tremendous progress of plant tissue culture techniques and their acceptance globally by commercial growers. Bioreactor micropropagation in liquid media has been evolved as an alternative to conventional micropropagation on semi-solid gelled media, for cut down of propagation cost. However, optimal propagation rate is dependent on biochemical and physiological factors responsible for culture growth in a liquid culture system. Enhanced vegetative growth and change in biochemical components are common in in vitro propagated *Vaccinium* plants. Somaclonal variation, either genetic, epigenetic or combination of both, can affect the scaling up of any micropropagation protocol. DNA-based markers can be used in tissue culture propagated *Vaccinium* species to monitor clonal fidelity in micropropagated plants. This review describes the progress in-depth of various aspects of *Vaccinium* culture in vitro, the variation in micropropagated *Vaccinium* plants and the use of molecular markers to identify these variations.

Dissecting the Blueberry Soil Microbiome to Assess Soil Health

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The plant rhizosphere is made up of not only soil, but a myriad of living organisms; these living organisms can both contribute to, and be indicators of, soil health. We explored the possibility of assaying the soil microbiome in areas where blueberry fields are declining, as compared to healthy fields in an effort to extract clues as to what might be causing the decline. To assay the microbiome, soil samples were collected from representative fields and total DNA was extracted. The DNA was amplified using 16S primers for bacteria and ITS primers for fungi. Primers were also designed and tested for nematodes. Then resulting amplicons were purified and used to prepare DNA libraries by following the Illumina TruSeq DNA library preparation protocol. Sequencing was performed on the MiSeq next-generation sequencing platform. Sequences were joined and depleted of barcodes. Sequences that failed quality control parameters were deleted. Operational taxonomic units (OTUs) were defined by clustering at 3% divergence (97% similarity). Final OTUs were taxonomically classified using BLASTn against a curated database derived from GreenGenes, RDPII and NCBI. These data are being compared to see if there is a biological 'signature' associated with poor soils. The ultimate goal is to use these data to develop plans for remediation using, for example, cover crops. However, it is likely that the problem varies from location to location and customized plans will need to be implemented.

Performance of Recently Released Rabbiteye Blueberry (*Vaccinium ashei*) Cultivars in Alabama

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Blueberries are a high value fruit crop that is becoming increasingly popular worldwide. Alabama's blueberry farm gate value has increased by approximately 13% in the last decade. Proper cultivar selection is one of the first and perhaps the most important decision a grower can make when planting blueberries. The University of Georgia Blueberry Breeding Program has accelerated development of blueberry varieties in the past 15 years to facilitate commercial and home garden demands for new varieties. A new large-fruited rabbiteye blueberry cultivar named 'Titan' with was developed and released in 2010. Rooted plants from 'Titan', 'Alapaha', 'Brightwell', 'Vernon', and selections '03-06', 'T-611', 'T-743', 'T-957', 'T-965', each represented by 5 plants were introduced to Alabama in 2011 to study the plant development and productivity at the specific growing conditions. Blueberries were planted at the North Alabama Horticulture Research Center (NAHRC), Cullman, in 2011 in a RCBD. Our results suggest selection '03-06' had the highest cumulative (2013-2015) yield of 16.1 kg/plant, followed by 'Titan' (13.2 kg), and 'T-743' (12.8 kg) . 'Titan' and selections 'T-965' had the largest fruit size during the period of study. Berries of 'T-965' matured very early in the season. During the initial years of establishment cultivars 'Titan', 'Brightwell', 'Vernon', and selections 'T-965', and 'T-957' were highly productive.

U.S. Consumer Preference for Blueberry Attributes

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This study investigates U.S. consumer preferences for blueberry attributes using an online survey. We included search attributes (color, size), experience attributes (sweetness, tartness, firmness) and credence attributes (organic, local, non-GMO). The results show consumer preferences for blueberry attributes are heterogeneous and are influenced by consumer demographic background and geographic location. This information has important marketing implications for blueberry suppliers such as growers and retailers in adopting market segmentation, target market selection and promotional strategies.

Blueprints for Blueberry: An Update on the Assembly and Annotation of the Blueberry Genome

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We report on the current state of the blueberry genome and highlight the currently available genomic resources. While many plant sequencing efforts are underway across the plant kingdom, the Ericaceae family is under represented. The goal in sequencing the blueberry is to anchor this part of the evolutionary tree and to generate a genome reference will act as a backbone for linkage mapping and association studies. Gene annotation and marker alignments have been undertaken. We will highlight the current status of assembly, the available resources to the blueberry community and future directions for the blueberry genome project.

A Botanical Survey of Two Forest Fields, Dominated by European Blueberry (*Vaccinium myrtillus* L.), was made to Examine Changes in Botanical Diversity and Cover Percentage of Species

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In a project focusing on semi cultivation of European blueberry (*V. myrtillus* L.) running from 2008 to 2011, a botanical survey was undertaken in two experimental fields respectively in the municipalities Snåsa (300 m asl) and Lierne (410 m asl) in the county of North-Trøndelag, Norway. Each of the fields consisted of three plots of 1*1 m^2randomly distributed within a block of 15*15 m^2, with five replications. The prehistory of the fields was different; both the Snåsa- and Lierne- fields were clear-cut, but respectively 25 and five years ahead of the survey. During establishing of the experimental fields, bushes and trees were cut to the ground. Number of species of a plot, percentage of covering, height of field layer in cm, thickness of stray layer in cm and percentage covering of the plot were recorded. Twenty-four species were present in the fields and the article discusses changes of botanical diversity, especially focusing on the parameters of European blueberry. Suggestions are made of how the growth of European blueberry could be strengthened and subsequently how the competitors could be weakened.

POSTER SESSION ABSTRACTS

Abstracts are arranged alphabetically by presenter's last name within each topic.

POSTER SESSION 1

Monday, April 11, 2016
2:30pm - 3:30pm

Breeding/Genetics/Evaluation

Entomology

Physiology

Soil/Nutrient Management

POSTER SESSION 2

Wednesday, April 13, 2016
9:30am - 10:30am

Horticulture/Production

Plant Pathology

Postharvest

BREEDING/GENETICS/EVALUATION SESSION

Poster Session 1

Monday, April 11, 2016

2:30pm - 3:30pm

Abstracts are arranged alphabetically by presenter's last name

Performance of Rabbiteye and Southern Highbush Blueberries in the Low to Moderate Chill Region of North Florida

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The range of chill hour accumulation in north Florida is 400 to 750 hours of temperatures below 45 F (7.2 C). Although too warm to for the culture of highbush blueberries (*Vaccinium corymbosum* L.), rabbiteye blueberries (*Vaccinium virgatum* Aiton) are native to this region and have been grown for over 70 years. In addition, blueberry breeding programs in Florida and elsewhere have developed and patented many cultivars of southern highbush blueberries (*Vaccinium corymbosum* L. x *Vaccinium darrowi* L.) that are adapted to low- to moderate-chill locations throughout the world. In Florida, the advantage of Southern highbush blueberries over rabbiteye blueberries is mainly early fruit ripening, and the higher fruit prices associated with an early market window. Consequently, the southern highbush blueberry industry has moved progressively further south into very low chill regions of Florida. Currently, the most profitable blueberry ripening period is late March to mid-April. North Florida cannot target this early market window without the use of high tunnels, which are extremely expensive. The advantages of rabbiteye blueberries over southern highbush blueberries in north Florida includes much higher yield, much longer life span, better resistance to insects and diseases, no requirement for pine bark or overhead irrigation for freeze protection, and consequently, much lower establishment costs. In this paper we report the performance of rabbiteye and southern highbush at the North Florida Research and Education Center in Quincy, Florida. The ten rabbiteye cultivars evaluated were 'Alapaha', 'Austin', 'Brightwell', 'Climax', 'Ira', 'Ochlocknee', 'Powderblue', 'Premier', Savory' and 'Yadkin'. The eight southern highbush cultivars were 'Bluecrisp', Emerald', 'Jewel', 'Millennia', 'Misty', 'O'Neal', 'Sharpblue' and 'Star'. Preliminary observations of the southern highbush cultivars, 'Farthing', 'Indigocrisp', 'Meadowlark', 'Rebel', 'Suziblue', 'Sweetcrisp', and 'Ventura' are also reported.

An Economical DNA Test for Genetic Identity Confirmation in Blueberry

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Blueberry (*Vaccinium sp.*) cultivation began in the early 20th Century in the U.S. Since then it has become a major crop in North America, South America, Europe, China, Japan, Australia and New Zealand. The United States Department of Agriculture (USDA) National Clonal Germplasm Repository (NCGR) in Corvallis, OR, USA preserves genetic diversity of this important genus and maintains a national collection of >1,750 accessions representing 71 species from 39 countries. Reliable identification of the plants in this collection is critical and must be ensured for scientific, commercial and public needs. DNA analysis allows efficient genetic conservation through the reduction of clonal redundancy and can eliminate identification inaccuracies. The objective of this study was to develop an efficient and economical DNA fingerprinting set that consists of reliable primer pairs that can be combined into a single reaction and differentiate genetic variants. Seventeen microsatellite or simple sequence repeat (SSR) primer pairs flanking core repeats of three nucleotides were screened for polymorphism and ease of scoring in seven diverse blueberry cultivars. Five out of these 17 primer pairs were selected to make up a single multiplex set and were evaluated in 287 highly requested blueberry plants preserved at the NCGR. These 287 plants consisted of 126 accessions that exist as replicate clones of the same name in addition to 8 accessions that were present as a single plant, for an expected total of 134 unique genetic profiles. Five of the 126 replicated blueberries had a different genetic profile from other plant(s) with the same name while six pairs of 134 unique accessions could not be differentiated. When 13 additional SSRs were used to confirm genetic similarity among these six pairs, only the closely related 'Lateblue' and 'Berkeley' were different. We describe the use of this fingerprinting set to confirm identity of these accessions, eliminate incorrectly labeled clones and ways to improve discrimination power of this DNA test.

Towards Genomic Resources for the Molecular Breeding of Enhanced Blueberry Flavor: The Oxylipin Volatile Biosynthetic Pathway as a Test Case for a New Gene-Identification Methodology

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For most breeding programs of commercial fruit crops, improved flavor is seen as an extremely desirable yet often elusive breeding goal. In blueberry, several recent studies have correlated human perception of the characteristic 'blueberry flavor' to a subset of volatile compounds commonly found in blueberry fruit. Targeted breeding strategies utilizing genomic data to select for genetic elements responsible for reduced or enhanced flavor volatile biosynthesis present novel routes to modulating blueberry fruit flavor for better alignment with consumer preferences. In order to collect usable genomic information for blueberry, we developed a gene identification pipeline that begins with identifying a volatile compound of interest, searching the scientific data for genes putatively involved in its biosynthesis, designing gene-specific PCR primers off of those candidate sequences, cloning and sequencing the homologous gene from blueberry, validating the catalytic activity of the specific gene product utilizing a petunia protoplast recombinant protein expression system and finally confirming the gene's role in flavor volatile biosynthesis *in vivo* using RNAi transgenic blueberry constructs. Our lab successfully applied this methodology to several candidate genes of the *Vaccinium corymbosum* oxylipin biosynthetic pathway, the source pathway for several short chain compounds implicated as major players in blueberry flavor. Although full confirmation of the identities of the genes investigated must await maturation of the transgenic blueberry plants, these preliminary results indicate that we have developed a robust pipeline for the thorough and efficient identification of genes involved in blueberry flavor volatile biosynthesis. It is our hope this methodology can be successfully used to characterize the relevant biosynthetic genes for the myriad of flavor volatiles present in blueberry, thus furthering the collection of genomic information that may one day prove useful towards efforts aimed at improving blueberry flavor via molecular breeding.

Agronomical Behaviour of 35 Blueberry Cultivars in Central Italy

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Rising demand for blueberries for fresh consumption and the need to reduce transportation costs of the product trigger the extension of sustainable and cost-efficient production systems.

This study analyses the adaptability of old and new cultivars to new cultivation areas in Central Italy.

The evaluation of 35 blueberry cultivars (Northern highbush, Southern highbush, Rabbiteye) was carried out at the experimental fields of CREA-FRU in Central Italy, under Mediterranean climatic conditions.

Two different cultivation systems were compared: 1. traditionally in the field (TF) with acid peat and a specific fertirrigation programme, and 2. cultivation in plastic containers (CS) with a specific acid substrate. In both systems, drip irrigation was used.

In TF, after an initially good growth during the first year, in the following two years the plants reduced vegetative and productive activity, probably due to unfavourable pH of the soil, despite a constant acidification of irrigation water.

Yields differed widely among cultivars within all observed species, with a minimum of slightly more than 150 g and a maximum of 1.500 g per plant. Average fruit weight was also variable, with a minimum and a maximum of 0,90 g 2,8g respectively.

In the CS system, the plants resulted more vigorous with a very intense vegetative renewal, which lead to an increased unitary yield to a maximum of 9.000 g, but slightly reduced the average fruit weight.

In conclusion, CS cultivation can be considered a good solution for new areas where the chemical soil proprieties do not match the requirements of blueberry plants: compared to traditionally cultivation, the CS method significantly increases the yield per plant and is also advantageous from an economic point of view: in spite of the initial cost of containers, production costs will be lower due to easy management of irrigation and fertilization, higher efficiency of manpower.

Wild Germplasm in *Vaccinium* Species Improvement

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The significant decrease of *Vaccinium* crop biodiversity that leads to genetic erosion at intraspecific and species levels, are due to environmental and human drivers. Cranberry, blueberry and lingonberry are three commercially important members of *Vaccinium* species. Maintenance of their germplasm will be helpful for the conservation of these crop plants and their wild relatives in the biodiversity. The locally adapted diverse germplasm is required for the future viability of *Vaccinium* production under changed environment. Genetic diversity analysis in cranberry, blueberry and lingonberry germplasm will facilitate reliable genotypes classification and identification of accessions with possible use in a breeding program. This review describes the progress in blueberry, lingonberry and cranberry wild germplasm collection and their characterization al morphological, molecular and chemical levels.

Oryzalin-induced Chromosome Doubling in *Vaccinium* Species

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Within *Vaccinium*, there is a wide array of diploid (2*n* = 2*x*) germplasm with potential benefit to blueberry breeders, but which has received little attention, in part, because of low crossability. To cross this material with cultivated highbush blueberry germplasm (tetraploid, 2*n* = 4*x*), breeders must either rely on the natural production of unreduced gametes in selections of interest or induce chromosome doubling prior to crossing. Traditionally, colchicine has been used to induce chromosome doubling in a wide range of crop plants, including *Vaccinium*, by inhibiting the polymerization of tubulin and thereby the formation of spindle apparatus during mitosis. More recently, dinitroaniline herbicides, which have a similar mode of action but cause less phytotoxicity and are safer to use, have been successfully used for tetraploid conversion in many crops. Using seedlings of *Vaccinium ovatum* and *Vaccinium pallidum*, we tested two published methods of tetraploid conversion from other plant species using the herbicide Surflan (oryzalin): 1. Soaking seedlings at the cotyledon stage in a 10 µm solution for 24 hours, and 2. Misting seedlings in the greenhouse to runoff with a 100 µm solution daily for 21 days. Surviving seedlings were evaluated for potential chromosome doubling in the L1 meristematic layer by measuring stomatal aperture and density as well as leaf shape and comparing to untreated seedlings. The first method achieved excellent results with good seedling survival (70% in *V. ovatum*, 63% in *V. pallidum*) as well as relatively high rates of apparent 4*x* seedlings (22% in *V. ovatum*, 56% in *V. pallidum*), while the second method resulted in 100% mortality. Apparent sectoral chimeras were identified in both groups as plants that showed enlarged stomata on leaves of some but not all shoots from which measurements were taken. Seedlings will be monitored in future years for flower and pollen size as an indication of potential doubling in the L2 meristematic layer and future crossing with tetraploid germplasm.

Furthering the Utilization of *V. constablaei* and *V. virgatum* Germplasm in Cultivar Development

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An ongoing project has pursued the goal of incorporating the cold-hardiness and late bloom of *V. constablaei* into a form suitable for northern growers. Past research has shown that combining *V. constablaei* with *V. virgatum* allows many of the best aspects of both of these germplasms to be combined into a usable form. Such hybrids derive late bloom and cold-hardiness from *V. constablaei* as expected, and many aspects of vigor from rabbiteye (RE), but additional characters from both parents must be optimized to produce cultivar-quality material. The first commercial product in the USDA program of this introgression is the variety 'Nocturne', which achieves the majority of the goals desired in combining these germplasms, but is dark-fruited and is unlikely to achieve success as a mainstream cultivar. A range of strategies are being implemented to enhance the recovery of commercially acceptable types, among them: 1) 'Nocturne' (and 'Nocturne' sibling, US 1057) × 4*x* HB cultivars 'Duke'/'Elliott', 2) 'Nocturne'/US 1057 × 6*x* RE, 3) next-gen 5*x* F_1 × 4*x* HB cultivars and next-gen 5*x* F_1 × 6*x* RE cultivars, and 5) 'Nocturne' × 6*x* HB/RE. Season of ripening, bush form, cold hardiness, fertility, and fruit quality are among the numerous issues involved in furthering the use of this material.

Identifying Blueberry Germplasm that is Slow to get Blueberry Shock Virus in the Pacific Northwest United States

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Blueberry shock virus (BlShV) is a serious problem in production in the Pacific Northwest region of North America. Infection occurs during bloom and the virus moves into other parts of the plant in an uneven but steady manner and may take several years to become fully systemic in mature bushes. In the year after infection, emerging flower and leaf tissues die rapidly at full bloom followed by regrowth. Once symptoms have been exhibited in all parts of the plant, the plant remains asymptomatic in subsequent years. Infection in young plants of some cultivars can stunt the plant for the remainder of its life, however, more typically production is lost for one year. While there appears to be no immunity as tested by grafting, it has been recognized that the rate of infection varies among genotypes. Plants in the HCRU breeding program and at the NCGR, have been tested regularly by ELISA BlShV, in some cases for nearly 20 years, and germplasm that is particularly slow to become infected has been identified. At Oregon State University, North Willamette Research and Extension Center (NWREC), 'Legacy' (25 yrs.), 'Toro' (25), 'Bluecrop' (19), 'Baby Blues' (14), 'Darrow' (11) and all rabbiteye cultivars (11) have tested negative for BlShV for over 10 years while growing among many known positive plants. On the other extreme, 'Berkeley', 'Bluegold', 'Brigitta Blue', 'Nui' and 'Spartan' tested positive in the year following their 1st bloom. At the NCGR, 'Bladen', 'Harding', 'Lateblue', 'Legacy', 'Razz', US 612, US 693, US 845 and US 847 all tested negative after 20 years in the field. 'Toro' and 'Bluecrop', which had tested negative after 20+ years at NWREC, were positive at the NCGR. Crosses have been made among genotypes that are slow to test positive for BlShV to try to develop this trait in cultivars.

Rapid Characterization of Blueberry Aroma by FastGC Proton-Transfer Reaction-Time-of-Flight-Mass Spectrometry

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Because of its impact on marketability, blueberry aroma profile should be better investigated and considered in breeding programs. Breeders need more information and precise analytical tools to facilitate selection for complex multigenic traits such as flavor quality. This task is greatly facilitated by the availability of new rapid and accurate methods to assess fruit flavor.

In this study, the volatile compounds emitted by 13 *Vaccinium* accessions (at full ripe stage) were analyzed by two solvent-free headspace methods: proton-transfer reaction time-of-flight mass spectrometry (PTR-ToF-MS) direct injection and PTR-ToF-MS coupled with a FastGC system that allows a rapid (120 s) chromatographic separation of the sample. The combination of these two analytic strategies allows the simultaneous unsupervised (direct injection) and supervised (FastGC) analysis of aroma compounds of blueberry in few minutes. Multivariate statistics (Principal Component Analysis and Cluster Analysis) of the results allows an unambiguous separation among genotypes based on their aroma fingerprinting.

These results show that PTR-ToF-MS is suitable to monitor at high sensitivity the emission of a large number of volatiles that precisely describe the blueberry aroma profile. This technology can easily monitor and quantify compounds related to ripening and/or senescence so that it can be used to improve the breeding process in order to modify the volatile compound profile.

Optimum Transformation and Expression of Transgenic Constructs for the Molecular Breeding of Enhanced Blueberry Flavor

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Since 1970, blueberry consumption in the United States has increased exponentially. Previous research using consumer-assisted selection of blueberry fruit quality traits has made it apparent that blueberry consumers are interested in enhancing flavor (Gilbert et al., 2014). Short chain volatile aldehydes emitted by blueberry have been found to have a direct impact on flavor perception in humans. With the use of tissue culture and transformation systems that were initiated through productive collaborations at the University of Florida, a yellow fluorescent protein (YFP) confirmed preliminary transgenic events in Vaccinium corymbosum. By using tissue culture and molecular cloning techniques we can ensure that the YFP is present in the genomic DNA, RNA, and in crude protein extracts. Preliminary results indicate the presence of YFP-coding mRNA and gDNA sequences. This shows the generation of stable transformants based on this blueberry plant line. Using data on likely oxylipin candidate genes gathered by another undergraduate researcher in our lab, a pipeline of RNAi constructs have been made to reduce endogenous expression and used during a transformation event with these blueberry plants. To assay this endogenous transcript, these plants will be continually screened and grown up. Screening of the volatile compounds of our transgenic plants also allows us to see if we have reduced C6 volatiles as hypothesized. By understanding what genes are responsible for making C6 volatiles in blueberry tissue we can then appropriately transform these plants into creating a sweeter, more well–liked berry. With our research we will then be able to provide breeders with the molecular marker to ultimately create the best tasting blueberry.

Global Diversity of *Vaccinium*: A Future of Possibilities

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The United States Department of Agriculture (USDA) Agricultural Research Service, National Clonal Germplasm Repository (NCGR) in Corvallis, Oregon, preserves genetic resources of *Vaccinium* including > 1,750 accessions from 39 countries. In addition to 300 cultivars and selections of cultivated blueberries the genebank preserves representatives from 29 sections and more than 80 species of *Vaccinium*. During the early 20th century, the first for blueberry breeding, commercial production expanded greatly by utilizing only the genetic diversity of Eastern North American section *Cyanococcus*. The global diversity of *Vaccinium* found in temperate, subtropical, and tropical regions represents untapped potential to further develop blueberry production. The germplasm resources maintained at NCGR and the ease of crossability within the genus, provide direct opportunities to enrich blueberry cultivars with novel characteristics such as stress-tolerance (high pH, heavy soils, and salinity), morphology (inflorescence type, fruit color, fruit shape, and plant habit), and physiology (fruit flavor, chilling, and disease resistance). The objective of this study is to summarize key descriptor character states of NCGR genebank accessions to demonstrate the diversity of the global *Vaccinium* gene pool for potential use by breeders. Cultivated fruit production using a “steady state” approach encouraging simultaneous stem growth, flowering, and fruiting, similar to natural subtropical *Vaccinium* could be an innovative goal for low and no chill growing production regions.

Molecular Cloning and Expression Analysis of the Transcription Factor Gene *Sabzip78* from *Vaccinium corymbosum* L

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The bzip78 (basic leucine zipper) genes are an important family of transcription factors in plants, encoding transcriptional regulators with a variety of functions involved in developmental and physiological processes. In this study, the conserved domain of the bzip78 gene in Vaccinium corymbosum L. was cloned using two degenerate primers, and the 5'terminal and 3'terminal of the gene were amplified by using rapid amplification of cDNA ends (RACE) methods. The complete cDNA sequence termed as *Sabzip78* **was obtained and the sequence was submitted to GenBank. Sequence analysis showed that the nucleotide sequence of** *Sabzip78* **was 1451 bp, containing an open reading frame (ORF) of 1077 bp and encoding a protein with 358 amino acids. The alignment analysis indicated that the predicted protein sequence contained two typical Leucine zipper structure domain and basic domain DNA-binding domain**. Homology analysis showed that the Sabzip78 protein had 58% and 56% homology with bzip78 from *Corylus heterophylla* **and** *Medicago sativa* **respectively. And its hydrophobicity/hydrophilic**, physico-chemical properties, phylogenetic tree, and main functional domains were predicted. Real-time quantitative polymerase chain reaction (Real-Time PCR) analysis was performed for *Sabzip78* **treated with a low-temperature of 4**°C. The results showed that *Sabzip78* **gene expression was increased 2 h after being cold induced and reached a peak after 8 h, and then decreased.** *Sabzip78* **might play a key role during the development of cold resistant molecular mechanisms in** *Vaccinium corymbosum* **L.**

New Southern Highbush Blueberry Varieties from the University of Georgia

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The University of Georgia has released three new southern highbush blueberry (*Vaccinium corymbosum* L.) varieties, part of the new "Southern Misses" series, targeting the major growing season with some production and fruit quality improvements. 'Miss Alice Mae™', flowers a few days later than 'Star', but ripens during the current peak of southern highbush season in south Georgia. 'Miss Alice Mae™' yields are very good, and berry firmness, flavor, and quality are excellent. 'Miss Jackie™' is a later season variety, flowering and ripening with 'Camellia'. This variety could be used in production systems without frost protection. 'Miss Jackie™' fruit are high quality, and the bush is easier to manage than the overly vigorous 'Camellia'. Finally, 'Miss Lilly™' is expected to offer growers fruit that ripens in the early to main season, but without the requirement of frost protection. This new variety flowers 12 to 15 days after 'Star', yet ripens at a similar time. 'Miss Lilly™' per plant yields are less than 'Star', but the narrow, upright growing habit of the new variety facilitates higher density plantings to help maintain yields per unit land area. Regardless, there are a number of growers looking for an easier to manage, early ripening southern highbush that does not require frost protection. 'Miss Lilly™' offers this, with high quality fruit and large berry size. Together, this new group of "Southern Misses" offers growers of low to mid chill blueberries (400 to 600 hours < 7 C) novel varieties to help develop more reliable production strategies of high quality fruit. Patents for these new varieties have been applied for and propagation rights are controlled by University of Georgia, Innovation Gateway, GSRC Boyd Bldg, Athens, Ga. 30602-7411 (gateway@uga.edu ; 706-542-1401).

Characterization of Backcross Blueberry Populations created to Introgress *Vaccinium arboreum* Traits into Southern Highbush Blueberry

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Southern highbush blueberry (SHB) cultivars resulted from crosses among wild *Vaccinium* species in section Cyanococcus native to the southeastern U.S. and *Vaccinium corymbosum* (VC) cultivars. One of the most recent wild species to be used in crosses with SHB germplasm is *Vaccinium arboreum* (VA). Unlike the previous crosses, VA belongs to the section Batodendron. VA has several adaptive characteristics of interest for blueberry production, such as single trunk architecture, open racemes, deeper root systems, and higher fruit soluble solids. Two half-sib first generation pseudo-backcrosses (BC) were selected for study and twenty-five vegetative, reproductive, and postharvest parameters were measured. Phenotypic data were collected during 2012 and 2013 on two and three-year old BC plants, respectively. Results indicated that vegetative, reproductive, and postharvest traits have been successfully introgressed from VA into SHB. For example, the low adventitious rooting from softwood cuttings of VA was observed, with one of the BC populations segregating from zero to 100 percent rooting. The longer pedicel and peduncle from VA (average of 8.5 mm and 61.6 mm, respectively) in comparison with SHB (average of 5.1 mm and 10.3 mm, respectively) were also observed in the BC individuals where there was a range from 2.8 to 8.3 mm for pedicel length and from 3.9 to 21.9 mm for peduncle length. Fruit firmness was improved by introgression from VA, with both BC population means significantly higher ($P < 0.05$) than SHB. However, stringent selection must be applied in early generations to retain desirable traits and eliminate negative traits.

Genetic Control of Anthocyanin Glycosylation in a Cranberry Hybrid

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Anthocyanins are important antioxidants in cranberry. The American cranberry (*Vaccinium macrocarpon* Ait.) and small-fruited cranberry (*V. oxycoccos* L.) have different anthocyanin glycosylation patterns. *V. macrocarpon* contains mainly galactosides and arabinosides of the aglycones, cyanidin and peonidin, with less than 8% glucosides. In contrast, small-fruited cranberry contains mostly glucose conjugates. Since the sugar moiety can mediate bioavailability, we are interested in the genetic modification the of glycosylation pattern. We successfully hybridized *V. macrocarpon* and *V. oxycoccos*. The F1 hybrid phenotype was intermediate, while the F2 segregated for glycosylation pattern. The structural gene controlling glycosylation is presumed to be the 3-O-glycosyltransferase. We amplified the anythocyanidin 3-O-glycosyltransferase from both cranberry species using primers based on comparison of other published plant species sequences with the cranberry genome sequence as a reference. The deduced amino acid sequence suggested the proteins encoded by these genes differ in the plant secondary product glycosyltransferase (PSPG) box, which is involved in binding to the UDP moiety of the sugar donor, making this region of particular interest. We are sequencing this region from representative F2 hybrids, for which the anthocyanin phenotype has been determined to confirm the amino acid differences impacting glycosylation specificity.

Physicochemical Characteristics of Half-highbush Blueberry Fruits Dependent on Genotype and Cultivation Conditions

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Blueberry cultivation has been developing more in northern regions where effective managing can be assured primarily suitable cultivars and growing conditions. The aim of this study was to find out the influence of endogenous and exogenous factors on the physical parameters and chemical composition of blueberry fruits. The experimental plantations were established in 2010 with two-year-old micropropagated plants. In trials six half-highbush blueberry clones were present concurrently in mineral (*Enti-Umbric Albeluvisol*, sandy texture, pH 5.7) and peat soil (*Fibri–Dystric Histosol*, pH 2.6) areas. The blueberry clones were originally the seedlings of half-highbush blueberries (*V. corymbosum* × *V. angustifolium*) and seeds were collected from selected plants in 1997 and 2000. A peat soil experimental site was located on an abandoned peat production field. In mineral soil experiment each plant received 10 litre peat into the growing substrate and plastic mulch was applied before planting. Blueberry clones No 20/02, 8/05, 12/02, and 29/03 had bigger berries compared to 8/04 and 20/00. In peat soil condition the average berry mass was 54% bigger than in mineral soil condition. At the same time the water content was 2% higher in berries grown on abandoned peat field. The berries of clones 20/00 and 20/02 had sweet taste due to low organic acid presence. The pH value of mashed fruits was significantly lower of the berries from a peat soil plantation. The content of total phenols was higher in the berries of clone 29/03 and it appeared in both soil conditions. The blueberries picked from a mineral soil plantation had significantly higher total phenolsconcentration. However, anthocyanins and ascorbic acid content was lower compared to peat soil. In the experiment the half-highbush blueberry clone 20/02 was distinguished by abundance of bioactive component as ascorbic acid, phenols and anthocyanins.

Variation in Flavonoid Content in American Cranberry (*Vaccinium macrocarpon*) Cultivars

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Cranberry flavonoids include anthocyanins, flavonols, and proanthocyanidins (PACs). These phenolic compounds occur at high levels in cranberry and are associated with anti-oxidant, anti-cancer and anti-inflammatory activities, as well as cardiovascular health benefits. Cranberry anthocyanins and flavonols occur mainly as glycosides, while PACs occur as oligomers and polymers of flavan-3-ols. The objective of this study was to assess phenolic quantitative and qualitative variation in eight cranberry cultivars representing various genetic backgrounds: native selections Ben Lear (BL), Early Black (EB) and Howes (HO); 1st breeding cycle cultivars Stevens (ST) and #35; and 2nd breeding cycle cultivars Demoranville (DM), Crimson Queen (CQ) and Mullica Queen (MQ). Mature fruit were sampled from a replicated field trial and analyzed using spectrophotometry, HPLC and APCI-MS/MS. Cultivars varied significantly for anthocyanin; BL had high levels, as did BL offspring DM and CQ; while HO, and HO offspring #35 and MQ were lower in anthocyanins. Genetic effects were evident with PAC as well, with HO, #35 and MQ having significantly higher total PAC (458, 443, and 448mg/100g fruit, respectively), while BL, DM and CQ had the lowest total PACs (249, 270, 307mg/100g). Similar differences were also found for individual PAC's, with HO, #35, and MQ having higher levels at most degree-of-polymerization (DP). The most abundant PACs were polymers having DP≥11 with 49% of total PAC, and DP-4 with 16%. Eight flavonol glycosides were quantified, with quercetin-3-galactoside and myricetin-3-galactoside being the most abundant overall (35% and 26%, respectively), and the most abundant for each cultivar. EB had the lowest total flavonol at 35mg/100g fruit, compared to ST and DM with the highest level (49mg/100g), but the differences were not statistically significant. Myricetin-3-arabinofuranoside was the only flavonol with significant cultivar variation, with EB having the lowest level. Environmental effects were also evident as CV values were all over 15%.

Breeding Northern Highbush Blueberry for Fresh Market Machine-Harvestability and Self-Fertility

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Rutgers University's highbush blueberry breeding program is focused on developing machine-harvestable varieties for the fresh market. In the last 15 years, 323 crosses have been made among advanced selections and cultivars. Over 14,000 progeny have been evaluated for machine harvestability traits (fruit firmness, ease of pedicel disarticulation, small fruit scar, tolerance to bruising, and uniform ripening), as well as yield and flavor. Over 300 advanced selections have been planted in replicated evaluation trials. However, another important trait in any potential new variety is self-fertility or self-fruitfulness. In large commercial blueberry fields, the majority of ovule fertilizations are from self-pollination. Therefore, self-fertility is essential, both in terms of fruit set and full fruit development. Unfortunately, due to typically high diversity in blueberry breeding program blocks, virtually all breeding programs measure fruitfulness in a highly cross-pollinated environment. In 2013, we evaluated 30 advanced blueberry selections for self-fertility. Flower clusters were either self or cross-pollinated in the greenhouse and evaluated for fruit set, berry size and days to ripening. A few blueberry selections were highly self-fertile, with no differences between cross and self-pollinated flowers. A machine-harvest trial was planted with these 30 selections, 15 plant plots, to be evaluated under mechanical harvesting conditions. In 2014 and 2015, 19 additional selections were evaluated for self-fertility, as determined with seed counts. All selections had lower developed seed set in the self-pollinated fruit. When the means of the 2015 self vs. cross pollinated flowers are compared, self-pollinations had 10% lower fruit set (72% vs 81%), ripening period increased by 2 days (52 vs 49), had 0.2 grams smaller fruit (1.6 vs 1.8), and one-third the number of seeds (11 vs. 33). A positive relationship was found between berry weight and seeds/berry ($R^2 = 0.44$), indicating that seed number impacts yield.

Fine Mapping of Fruit Rot-resistance and Organic Acid QTL in the American Cranberry

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Broad spectrum fungicides are commonly used on cranberry (*Vaccinium macrocarpon* Aiton) to control a fungal complex that incites cranberry fruit rot, a major threat to cranberry production in NJ, MA and increasingly in other growing areas. Environmental and ecological impacts (e.g. bee colony collapse disorder) of fungicide treatments, particularly during pollination, are a major concern. Enhancing fruit rot resistance (FRR) through breeding and selection offers to reduce reliance on fungicides for fruit rot management. Previous studies have identified four diverse FRR accessions in our cranberry germplasm, and shown that FRR is a quantitative trait that has been linked to several loci. FRR may be associated with organic acids levels during certain fruit development stages. Four principal organic acids found in cranberry fruit are quinic acid (QA), benzoic acid (BA), citric acid (CA), and malic acid (MA). CA and MA are common in other fruit species and contribute to the tart taste of cranberries, while QA and BA are quite unique to cranberry and, in our studies, were found at higher levels in FRR accessions. These FRR accessions were used in biparental crosses to produce segregating populations. The progeny were screened for FRR in field plots, under severe fruit rot pressure, for three years. Levels of QA and BA in progeny were quantified at various stages of fruit development using HPLC. High density genetic maps were then developed through the use of Genotyping-By-Sequencing (GBS). Putative FRR, QA and BA QTL were identified and will be used for candidate gene discovery and pyramiding of FRR QTL into elite horticultural backgrounds.

`Winterbell´, A New Southern Highbush Blueberry for Warm Climates

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'Winterbell' is a selection from open pollinated seedlings of FL 95-174 (non-patented) planted in 2008 near Winter Haven, FL . It was selected in 2009 and has been evaluated for five years. Plant growth is upright and spreading. Fruit shape is round with a very slight bell shape. Fruit size averages 2 grams. Flavor is slightly tart when it first turns blue, similar to 'Jewel', but sweetens with maturity. 'Winterbell' has a low winter chilling requirement (less than 200 hours) and performs well under evergreen culture. Leaves are easily retained during the winter under a moderate spray program with fertilization. Season of ripening is very early, about the same as 'Springhigh'. Yield potential is very high with second leaf plants in 2015 producing two kilograms per plant, 39% harvested before 1 Apr. A plant patent has been applied for and interested parties can contact the author for additional information.

ENTOMOLOGY

Poster Session 1

Monday, April 11, 2016

2:30pm - 3:30pm

Abstracts are arranged alphabetically by presenter's last name

Spotted Wing Drosophila, Trapping and Baiting

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Spotted wing drosophila (SWD), Drosophila suzukii, is a new fruit fly species that has become a serious threat to fruit crops. Using a prominent and serrated ovipositor, the female SWD pierces and inserts her eggs inside healthy ripening fruit leading to rapid infestation of an entire farm. SWD causes significant damage to a wide range of hosts but is especially damaging to berry crops. Using traps, farmers monitor for the presence of SWD to determine when to spray pesticides. The current gold standard bait for SWD monitoring is apple cider vinegar (ACV). SWD can be readily distinguished from non-SWD fruit flies by several distinctive anatomic markings. The purpose of this study is to discover what bait is most effective in trapping SWD.

This study tested the effectiveness of different baits for trapping SWD on a blueberry farm. The different baits included distilled water, ACV, newly fermented blueberry wine made on the farm, blueberry wine+ ACV, red grape wine, red grape wine + ACV, and commercially available SWD pheromone bait (Pherocon)+ ACV.

This study showed "new blueberry wine" to be the most effective, most specific, most inexpensive, and most cost effective bait for trapping SWD. Blueberry wine trapped 27.5% of all the SWD, whereas ACV, the gold standard, only caught 4%. Pherocon + ACV only trapped 13.6% of all the SWD, and its effectiveness decreased significantly after the first week despite being advertised to last 7-8 weeks. Blueberry wine was also the most cost effective bait with 35 SWD trapped/dollar spent versus 4 SWD trapped/dollar with ACV, 3 SWD trapped/dollar with Pherocon + ACV, and 2-3 SWD/dollar with red grape wine. Blueberry wine preferentially traps female over male SWD (65% vs. 35%).

A Screening Method for Evaluating Resistance to the Spotted Wing Drosophila (*Drosophila suzukii*)

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The objective of the study was to develop an effective screening method for evaluating resistance to the Spotted Wing Drosophilla (SWD, and to locate resistance in southern adapted blueberry germplasm including the hexaploid rabbiteye (*Vaccinium asheii* Reade = *V*. *virgatum* Aiton) and the tetraploid southern highbush (*V. corymbosum* L. complex hybrid. One hundred berries were sampled from 88 blueberry genotypes were examined for the presence or absence of SWD feeding damage or egg laying. In laboratory bioassays using no-choice arenas, clutch size for SWD (number of eggs per fruit) as well as total brood per fruit were assessed after 3 days and these counts correlated with berry quality attributes that were independently recorded for each variety or accession before SWD infestation [berry weight, percentage soluble solids (Brix^{o}), and harvest seasonality (early-, mid-, and late-season harvest)]. No antibiosis could be detected among blueberry or blackberry hosts tested in our experiments; SWD flies within 3 days lay anywhere from 5 to 10 viable eggs per host fruit. SWD fecundity (viable eggs) and total brood production was strongly associated with sugar levels in blueberry fruit.

PHYSIOLOGY

Poster Session 1

Monday, April 11, 2016

2:30pm - 3:30pm

Abstracts are arranged alphabetically by presenter's last name

Delaying Blueberry Harvest with Cold Treated Plants

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Blueberry production is increasing worldwide and in Europe there is a growing demand for fresh fruit all year round. The strong seasonal characteristic of European production led to a significant fruit value increase in the off-season market. This fact opens the opportunity for regions with mild winter climate to commercial fill the gap between European and southern hemisphere production. The current increase in blueberry substrate production allows growers to manipulate the growth cycle for an early or late harvest. In order to delay harvest to mid-September a trial was set up in a greenhouse with three highbush cultivars, Legacy, Elizabeth and Duke and four chilling treatments with two control treatments. All plants were placed in the cold chamber on 14 January and sequentially left the chamber on 15 May, 1 June, 15 June and 30 June. Plants grown outside and under plastic were the two control treatments. The highest yield (2.6 kg per plant) was obtain for 'Legacy' and 'Duke' in the first date. 'Elizabeth' gave significant lower yields with 1.4 kg per plant also for the first date. All plants kept until 30 June (4008 chilling hours) did not produce any fruits. The differences in production responses to chilling treatments were related to their chilling requirements. The use of cold chamber to delay blueberry harvest needs to be better tested and several improvements to this technique can be added, as follows: later in-chamber date, later cultivars and possibly the use of shade nets will better postpone harvest without the negative cumulative effect of chilling.

Photosynthetic Characteristics of Southern Highbush and Rabbiteye Blueberries at High Temperatures

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To document the acclimation mechanism of rabbiteye (RB) and southern highbush (SH) blueberries to heat stress, we measured leaf gas exchange of container grown RB ('Brightwell' and 'Woodard') and SH ('Misty' and O'neal) blueberries in response to a temperature range between 33°C and 42°C in a temperature controlled environment. Maximum net photosynthesis (P_n) of 'Woodard' was recorded at leaf temperature (T_L) between 36-39°C, and 'Brightwell' and 'O'neal' at 33-36°C, while as P_n of 'Misty' reduced when T_L > 33°C. Leaf stomatal conductance (g_s) of both 'O'neal' and 'Woodard' in response to high temperature followed a trend similar to P_n, except in 'Brightwell' in which g_s continued to increase with temperatures. Intercellular CO_2 concentration and transpiration increased with temperature in all tested cultivars. Overall, RB cultivars had better photosynthetic performances at high temperatures than SH cultivars. In SH cultivars, 'O'neal' adapted better at high temperatures than 'Misty' with a higher max. P_n and better water use efficiency.

Extraction optimization of Oleanolic and Ursolic Acids from blueberry (*Vaccinium corymbosum* L.) Fruit

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Ursolic acid and oleanolic acid are the main active components in fruit of Vaccinium corymbosum L, and possess anticancer, antimutagenic, anti-inflammatory, antioxidative and antiprotozoal activities. In this study, An ecofriendly ultrasonic-assisted extraction (UAE) technique was developed for rapid extraction of bioactive compounds oleanolic and ursolic acids from blueberry fruits. Several different influential extraction parameters, such as ultrasonic power, extraction time, solvent type, aqueous ethanol concentration, loading ratio and extraction temperature, were investigated. The optimum extraction conditions were 90% ethanol solution as solvent, ultrasoundpower 150 W, the liquid:material ratio of 20:1 (v/w) and extraction for 50 min at 40◦C. In order to understand the variation of ursolic acid and oleanolic acid levels by genotype, 20 various blueberry samples were analyzed for ursolic acid (UA) and oleanolic acid (OA) content. UA and OA content of blueberry were found to vary greatly among different genotypes. OA content of the 'Northcountry' cultivar reach 11.37 mg/100g. FW, UA content of the 'M5'cultivar reach 12.54 mg/100g. FW.

(New abstract and presented in Wednesday's poster session.)

Hydraulic Conductivity in *V. corymbosum* and *V. arboreum* Grafting Impacts Drought Responses

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The high pH soils and the strong drought suffered lately in California have impacted blueberry *(Vacciniuim corymbosum)* production. To mitigate the problem, the potential use of a deep rooting, and possibly drought tolerant rootstock (*Vaccinium arboreum*) motivated the present research. The first season of the experiment was carried at Kearney Agricultural Research and Extension Center, in the San Joaquin Valley in a previously established trial consisting on three treatments: grafting of *V. corymbosum* onto *V. arboreum*, *V. corymbosum* non-grafted, and large *V. arboreum* sprouts from the rootstock. Treatments were subjected to two contrasting levels of irrigation during two weeks where stem water potential (ψ_{stem}) and stomatal conductance (g_{st}) were measured. Preliminary results showed that after 14 days without irrigation there was no significant differences on (g_{st}) between grafted (0.06±0.04 *mol* m^{-2} s^{-1}) and non-grafted (0.04±0.03 *mol* m^{-2} s^{-1}) blueberry plants, nor between them and *V. arboreum* (0.07±0.05 *mol* m^{-2} s^{-1}). In contrast, (Ψ_{stem}) in *V. arboreum* was significantly more negative (-2.3±0.76 MPa), than *V. corymbosum* (p-value < 0.01); either grafted (-1.52±0.44 MPa) and non-grafted (-1.57±0.03 MPa). The fact that these two species are showing contrasting results despite being part of the same plant and sharing the same roots, led us to suspect a higher hydraulic resistance in *V. arboreum* shoots than in *V. corymbosum*. Pressure volume curves illustrated that the turgor loss point (TLP) in *V. corymbosum* was -2.5±0.39 MPa, similar to *V. arboreum* (–2.3±0.14 MPa). However, even under drought, blueberry did not get such negative values, whereas *V. arboreum* did, which may be indicating that blueberry plants are more conservative in terms of their stomatal closure.

Temperature and Photon Flux Density Effects on Carbon Assimilation in Cranberry

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Photosynthetic CO_2 assimilation tends to increase linearly as the photon flux density is increased until it is equal to CO_2 released by mitochondrial respiration. The rate at which this light compensation point is reached varies with species and developmental conditions. Increasing the photon flux above the light compensation point results in a proportional increase in photosynthesis rate. When C3 plants such as cranberry (*Vaccinium marcrocarpon* Ait.) are exposed to optimal temperature and saturating light, the rate of net CO_2 assimilation is almost always limited by Rubisco due to the tendency for photorespiration. It is not clear whether new cranberry cultivars, whose fruit yields are greater than those of older cultivars, support the increased fruit load by the minimization of photorespiration or by having a larger photosynthetic capacity. This project evaluated the effect of temperature and photon flux density on net CO_2assimilation in two old cultivars ('Early Black' and 'Stevens') and two new cultivars ('Crimson Queen' and 'Mullica Queen'). Gas exchanges of upright shoots were measured with an infrared gas analyzer (CIRAS-2, PP systems Inc., Amesbury, MA) fitted with an automatic conifer cuvette [PLC5(C), PP Systems Inc.]. Data for all cultivars were taken at two cuvette temperature regimes (15 and 30˚C). Dark respiration ranged from -10.57 mmol $m^{-2}s^{-1}$ at 30˚C to 10.86mmol $m^{-2}s^{-1}$ at 15˚C in 'Stevens' and -6.55mmol $m^{-2}s^{-1}$ at 30˚C to 24.06mmol $m^{-2}s^{-1}$ at 15˚C in 'Crimson Queen'. The highest light compensation point was 65.09mmol $m^{-2}s^{-1}$ with 'Early Black' and the lowest was 15.92mmol $m^{-2}s^{-1}$ with 'Mullica Queen' at 30˚C. The fact that both new cultivars reached a higher asymptote compared to the old cultivars indicates they have a higher quantum yield and can capitalize on existing light microclimates in the field. In a crowded canopy these differences could be significant with respect to net CO_2 assimilation.

Physiological Effects of Artificial Shading on Leaf Gas Exchange, Growth and Yield in Rabbiteye Blueberry

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Temporarily wilting of young shoot tips often occurs on rabbiteye blueberry bushes (*Vaccinium ashei* Reade) during the midday summer heat in lowland Taiwan. We hypothesized that reducing irradiance by artificial shading could avoid overload of solar energy and thus improving photosynthesis activity, growth, and yield. Container grown 3-year-old 'Tifblue' rabbiteye blueberries were lightly (LS) or moderately (MS) shaded with transmissible polypropylene shade cloth to reduce solar exposure from July 18 to October 5, 2014, and their responses were compared with the unshaded control. On hot sunny days, the mid-day photosynthetic photon flux densities (PPFD) under the LS and MS treatments were 21% and 36%, respectively, lower than the control. Leaf temperatures were reduced by 1.3 and 2.6°C, and leaf-to-air vapor pressure deficit ($VPD_{L\text{-}air}$) reduced by 0.62 and 1.17 KPa, respectively, under LS and MS. The dark-adapted photosystem II efficiency (F_v/F_m) and quantum efficiency of photosystem II electron transport (Φ_{PSII}) of mature exposed leaves slightly decreased in midday but were undistinguishable among treatments, indicating no severe photoinhibition. The lower T_L and smaller $VPD_{L\text{-}air}$ under the MS treatment improved leaf net assimilation rate (A_n) and stomatal conductance (g_s) by 30% higher than those of the control. Water use efficiency (*WUE*) was promoted by shading although transpiration rate (*E*) was not affected. However, the positive physiological effects of shading was only obvious at conditions with high light intensity and air temperature > 35°C. Therefore, the benefits of shading did not reflect on vegetative growth and yield of rabbiteye blueberries grown in lowland Taiwan with a hot but frequently cloudy weather condition in the summer.

Development of a Hydroponic Screening Method for pH Tolerance in Rabbiteye (*Vaccinium virgatum*) and Southern Highbush (*Vaccinium corymbosum*) Blueberries

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Blueberries (*Vaccinium* spp.) have a specific set of criteria for optimal growth and production. They require a pH range of 4.5 to 5.3, good drainage and aeration, and consistent but moderate supply of soil of moisture. Germplasm or cultivars toleratant to higher pH ranges could be utilized to incorporate this trait into new cultivars capable of thriving in more basic soils. Many buffering agents used to stabilize pH in hydroponics have several disadvantages, but the buffering agent 2(N-Morpholino) ethanesulfonic acid (MES) appears to be biologically inert and does not interact significantly with other ions in solution. The objectives of this study were to 1) Utilize three MES levels (0, 5, and 10 mM) to determine whether MES can be used as a buffering agent in hydroponics for pH tolerance in blueberries; and 2) Evaluate pH tolerance of 5 rabbiteye (RE) and 5 southern highbush (SHB) blueberry cultivars and crosses growing at four pH levels ranging from 5.5 to 8.5. Parameters used for pH tolerance evaluation include SPAD reading, root weight, stem weight, leaf weight, and visual rating. The pH of the solution showed greater stability when buffered by 10 mM MES. At pH 7.5, RE blueberries showed greater tolerance for higher pH by exhibiting higher leaf and stem weights. At pH 8.5, RE also had higher stem weight, but SH had higher root weights. Although no differences in root weight were detected among RE cultivars grown in the pH 7.5 treatment, the SHB cultivars Summit and Legacy had higher root weight than Cape Fear and Georgiagem. This hydroponic system can be used in screening for other abiotic stresses such as salt tolerance in blueberries or other crop species.

The Influence of Flooding Stress on the Growth and Gas Exchange Characteristics of Young Rabbiteye Blueberry (*Vaccinium ashei* Reade)

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Potted, one-year-old seedlings of rabbiteye blueberry (*Vaccinium ashei* Reade) 'Brightwell' and 'Gardenblue' were flooded over a 14-day period and then transferred to normal condition for 30 days. The growth property and gas exchange characteristics of stressed plants and stress-recovered plants were compared to well-watered control. The leaf net photosynthetic rate (Pn), stomatal conductance (Gs), intercellular CO_2 concentration (Ci), and transpiration rate (Tr) were measured during stress and after 7 days of recovery. Root, stem, and leaf dry weights were recorded after flooding stress and after 30 days of recovery. Data indicate: 1) Pn in stressed plants of both cultivars declined gradually with prolonging of stress time. The Pn of plants flooded for 14 day decreased significantly as compared to control plants in both blueberry cultivars. The trend in Gs, Ci, and Tr in plants flooded for 3-5 days was not associated with Pn; however, for longer duration of flooding, their decline coincided with the decline in Pn, and the extent of decrease increasing with the duration of flooding; 2) Flooding 14 days significantly decreased the dry weight of root and shoot, relative growth rate of both cultivars as compared to controls; 3) After recovering for 7 days, the Pn, Gs, Ci, Tr in stressed plants of 'Brightwell' reversed back to control levels, while the Pn, Gs, Tr in stressed plants of 'Gardenblue' still significantly lower than those in the control. After a 30-day recovery, the dry weight of root and shoot in stressed plants of both cultivars were still lower than the control, but the relative growth rate was at par with the control. Overall, flooding reduced photosynthesis mainly via a decrease in stomatal conductance and causes a decrease in growth of the plant. The photosynthetic characteristics and growth parameters recovered to different extents after releasing of flooding stress, and the recovery rate and recovery level were different due to genotype.

The Response of Antioxidants of Blueberry Leaves to Aluminum

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Aluminum (Al) toxicity is a primary limitation to plant growth on acid soils. It has been reported different genotypes of blueberry showed different physiological and biochemical response to Al, although blueberry is an acidophilic plant. However, the response of antioxidants of blueberry was still unclear. Therefore, rabbiteye blueberry 'Brightwell' and highbush blueberry 'Bluegold' were cultivated in Hoagland's solution without or with $Al_2(SO_4)_3$ (100 µmol L^{-1}) for 5 month, and total contents of phenolics (TPC), flavonoids (TFC) and anthocyanidins (TAC) of blueberry leaf were determined. It was showed that TPC, TFC and TAC for 'Brightwell' and 'Bluegold' were 47.07 and 39.17 mg gallic g^{-1} DW, 13.91 12.67 mg quercetin g^{-1} DW, 52.05 and 111.4 mg catechin g^{-1} DW with Al free treatment, respectively. Compared to Al free treatment, TPC for 'Brightwell' and 'Bluegold' were significantly increased by 13.77% and 41.8%, TFC were significantly decreased by 14.87% and 18.63%, respectively; while TAC for both cultivars were not affected with 100 µmol L^{-1} Al treatment. Overall, Al showed stimulation on TPC, inhibition on TFC and no impact on TAC for both cultivars in this study.

SOIL/NUTRIENT MANAGEMENT

Poster Session 1

Monday, April 11, 2016

2:30pm - 3:30pm

Abstracts are arranged alphabetically by presenter's last name

Ericoid Mycorrhizal Inoculation of Blueberry Cultivars under Nursery Conditions

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Under natural conditions, blueberries form mycorrhizal symbiosis with ericoid mycorrhizal fungi (EMF). Mycorrhizal colonization, however, has often been observed to be lower in commercial blueberry fields and nurseries than in natural habitats. Hence, inoculation with mycorrhizal fungi during plant propagation might be desirable to improve plantlet growth and nutrient uptake. We have tested the influence of mycorrhizal inoculation, substrate composition and nitrogen fertilization on the growth of micropropagated blueberry plantlets of *Vaccinium corymbosum* cv. "Reka" and "Duke" and the half-high hybrid "Northblue" (*V. angustifolium* x *V. corymbosum*). The plantlets were inoculated with commercial EMF inocula after transfer from *in vitro*-conditions to a peat-based substrate. Substrates containing sawdust showed lower nitrogen but higher manganese concentrations. Addition of fresh sawdust to the peat-based substrate generally reduced plant growth. The effect of EMF inoculation at the plantlet stage on the growth of two-year old container-grown blueberry plants depended on the cultivar, but also on nitrogen fertilization and substrate composition.

Ericoid Mycorrhizal Ioculation of Organically Grown Highbush Blueberries

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In Sweden, commercial blueberry production has expanded during recent years. At the same time, consumer demand for organically produced fruits and berries has increased. As a part of a project aiming at optimizing organic production of blueberries in a Nordic climate, we have examined the influence of ericoid mycorrhizal inoculation on the growth and nutrient uptake of highbush blueberry plants fertilized with organic residues. Two commercial mycorrhizal inocula and two fertilizers based on organic residues were tested for the *V. corymbosum* varieties 'Duke' and 'Reka' in a pot experiment. Differences in plant growth were small for plants grown with a meat- and bonemeal based fertilizer or with a fertilizer based on residues from cellulose-production. Leaf mineral nutrient concentrations were within the normal range for blueberries, with the exception of boron which was below recommended values. The mycorrhizal treatments had no significant effects on plant height in the pot experiment or one year after transplanting the plants into the field.

Calcium Effects on Nitrate and Iron Acquisition in *Vaccinium* Species

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High levels of calcium and bicarbonates in soil or irrigation water have been reported to negatively impact growth of most cultivated *Vaccinium* species. Irrigation sources in many areas, including Florida, southern California, and the southwest region of the U.S. contain high levels of calcium. Although the negative effects of high calcium on cultivated *Vaccinium* may be ameliorated by addition of organic soil amendments, these are costly. A wild species, *V. arboreum*, grows naturally in areas of the southern U.S. with high calcium in the soil. This adaptation of *V. arboreum* to high calcium soils may be related to the ability to assimilate iron and/or nitrate more efficiently than the cultivated blueberry. We investigated responses of the cultivated southern highbush blueberry (SHB) and *V. arboreum* to calcium in a hydroponic system using nitrate as the nitrogen source in a complete nutrient solution. Root ferric chelate reductase (FCR) activity in both species decreased in response to 10 mM calcium in the nutrient solution. However, the rate of iron uptake was greater in *V. arboreum* compared with SHB when grown in calcium-containing nutrient solution. Nitrate reductase activity and nitrate uptake rates were also greater in *V. arboreum* compared with SHB when grown in the presence of calcium. The greater uptake of iron and nitrogen under high calcium conditions exhibited by *V. arboreum* may play a role in the ability of this *Vaccinium* speciesto tolerate higher calcium soils compared with the SHB.

Comparison of Controlled Release and Soluble Granular Fertilizers on Cranberry Growth, Yield, and Soil Nutrients

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Cranberry growers are looking for ways to reduce off-site movement of nitrogen (N) and phosphorus (P). One approach is to use controlled-release fertilizers (CRF), potentially increasing nutrient uptake efficiency and decreasing potential for leaching or moving laterally into drainage. Data showing that less N and P are in cranberry soil water in the months following fertilizer application were lacking. Further, if CRF is more efficiently supplying N and P to the root zone, application rates of those elements might effectively be reduced with CRF compared to other materials. This has not been tested in cranberry. We compared four CRF to an all soluble forms protocol on a new cranberry planting and measured N and P concentrations in lysimeter water and in tile drains within the experimental units. All treatments with the exception of one CRF had similar plant growth but rate of N release into the soil water varied. One CRF formulation gave good plant growth and had the least lateral and vertical movement of nutrients in the soil. In the subsequent two years, that formulation, with a low P ratio, was tested against a higher-P CRF and an all soluble protocol on a producing bed. In the first year, N rate in the CRF treatments was reduced by 8% compared to the soluble treatment (grower practice); the next year the N rate in the CRF treatments was reduced by 24%. Crop yield was not statistically different (p=0.05) among the treatments. The two CRF treatments had more new growth per unit weight of old tissue and a higher proportion of uprights flowering compared to the soluble (grower practice) treatment, but the differences were not significant. At this site, CRF applied at a reduced N rate was as effective as the grower-practice soluble fertilizer in supporting crop yield and plant growth.

Effect of Soil pH on the Growth, Chlorophyll Fluorescence and Leaf Mineral Elements of Blueberry

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Soil pH is a key factor affecting the growth of blueberry, and most of the soil in China is difficult to grow blueberry because of the high pH. Therefore, studies on the reaction mechanism of blueberry to different soil pH are beneficial to breeding the new varieties to adapt different soil with extensive pH. A research was conducted to study the effect of different soil pH (4.5, 5.3, and 6.0) on the plant growth, chlorophyll fluorescence, and leaf mineral elements content in two bluebrerries, *Vaccinium ashei*'Climax' and *V. corymbosum 'A119', an* excellent seedling progeny from southern blueberry variety 'Southmoon'. Plant height, diameter of main stem, branching number, leaf dry weight, stem dry weight, root dry weight, total plant dry weight, chlorophyll content index, PSII maximum photochemical efficiency and effective light quantum yield showed decreasing trends with increased soil pH in two blueberries. But lower reduction was found in 'A119' than 'Climax', especially in pH 5.3 treatment. Leaf P, Mg, Mn, Cu, and Zn contents were decreased when soil pH was increased, but leaf K content was increased in two blueberries. Ca content of upper leaves for 'Climax' was not significant difference among soil pH treatment, however, that was decreased with the increase of soil pH for 'A119'. Ca contents of lower leaves in two blueberries were significantly lower in soil pH 5.3 treatment than other two soil pH treatments. Fe contents in upper or lower leaves were lower with pH 5.3 treatment than other two treatments for 'Climax', but they were not significantly affected in different soil pH treatments for 'A119'. In total, 'A119' had stronger high pH tolerance than 'Climax', and the disorder of leaf mineral elements content could be a key factor to inhibit the growth of blueberry when the soil pH was increased.

Effects of Nitrogen Source and Rate on Growth, Flowering, Fruit Quality, and Yield of `Duke´ Highbush Blueberry Plants

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The objective of this study was to determine the effect of N source and rate on the vegetative and reproductive growth, fruit characteristics, yield of 'Duke' highbush blueberry (*Vaccinium corymbosum* L.) plants over two years. The trees were fertigated with one of $(NH_4)_2SO_4$, NH_4NO_3, NH_4Cl, and $NH_4H_2PO_4$ at three rates (42 $mg \cdot L^{-1}$ N for low, 85 $mg \cdot L^{-1}$ N for medium, and 127 $mg \cdot L^{-1}$ N for high), at 2 to 4 week-intervals from late April to mid August. Each tree received 1.27, 2.54, and 3.81 g of N for the low, medium, and high rate, respectively, in 2012, while in 2013 the amount was halved. The plant height was increased with increasing rates of N for NH_4Cl, while the medium rate was best for $(NH_4)_2SO_4$, NH_4NO_3, and $NH_4H_2PO_4$. Overall the plant height growth was highest with the medium rate of the $(NH_4)_2SO_4$ and the high rate of NH_4Cl. Leaf size (length and width) was increased with increasing rates of N for all sources. Except for NH_4NO_3, SPAD values were increased with increasing N rate. The highest SPAD value occurred in the high rate of $(NH_4)_2SO_4$. The number of floral buds formed in the second year was highest with the medium rate of NH_4NO_3. The time of flower opening and full bloom was unaffected. The yield was highest with the low rate of $(NH_4)_2SO_4$, and regardless of N sources, low and medium rates generally produced a higher yield than high rate, which was related to the reduced size of berry in the high rate. Fruit firmness was increased with increasing application rate for all N sources. Total soluble solids and titratable acidity of juice were not influenced. The measurement of the chemical properties of the media in which the plants were grown showed that pH was reduced from 4.6 to 3.3-4.2 over two seasons of N application and that the reduction of pH was faster in the high rate of $(NH_4)_2SO_4$, NH_4Cl, and $NH_4H_2PO_4$ than that of NH_4NO_3. Total N, Ca, Mg, and K concentrations were unaffected, while P concentration was substantially increased by $NH_4H_2PO_4$treatments, especially with its high rate.

Leaf Nutrient Levels in Blueberries - Does One Size Fit All?

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Leaf tissue testing is commonly used in modern agricultural systems to portray plant nutrient profiles. However, for leaf analyses to be useful there needs to be an optimal or desired range for each nutrient. Whilst nutrient standards are available for blueberry and are updated occasionally, much of the data is based on older varieties and is not necessarily applicable to all growing regions. Moreover, only rarely has there been a distinction made between nutrient profiles of highbush HB (*Vaccinium corymbosum*) and rabbiteye RE (*Vaccinium virgatum*) types.

In this study, nutrient profiles for two blueberry varieties selected from the New Zealand Plant and Food Research breeding programme: 'Sunset Blue' (HB) and 'Centra Blue' (RE) were measured and compared between mid-spring and mid-summer. Significant differences were found between varieties in levels of potassium, iron and copper, indicating that nutrient standards for blueberry varieties grown in New Zealand may need to be updated and changed to better reflect varietal differences. Compositional data analysis using isometric log ratios (ILR) is discussed in relation to plant-based bio-fortification, with the aim of increasing plant mineral levels in blueberry and enhanced bioavailability.

Ericoid Mycorrhizal Fungi and Soil Nutrient Uptake of Two Rabbiteye Blueberry Cultivars

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Ericoid mycorrhizal fungi (EMF) increase plant access to nutrients via a symbiotic relationship with the root system. EMF have been used previously in nursery production of blueberry plants and were shown to be beneficial. Field studies, using highbush blueberry (*Vaccinium corymbosum*), were less conclusive. In the present study, three-year old rabbiteye (*Vaccinium virgatum*) cultivars Tifblue and Climax were inoculated with EMF species (*Oidcodendron maius* (OM) and *Pezizella ericae* (PE)) in Mississippi to determine soil nutrient uptake. Nutrient uptake response was cultivar dependent; however, in some cases, EMF enhanced mineral uptake by the blueberry plants, especially OM. Iron uptake was found to be enhanced over the control in 'Tifblue' but not in 'Climax'. Combining OM and PE appeared to suppress Fe uptake when compared to independent treatments as well as the control. There were few negative effects seen from the EMF treatments and several potentially positive benefits. More work should be done to expand the scope of using EMF in blueberry production and fully identify any economic benefits to using these mycorrhizal fungi species over conventional production practices.

HORTICULTURE/PRODUCTION

Poster Session 2

Wednesday, April 13, 2016

9:30am - 10:30am

Abstracts are arranged alphabetically by presenter's last name

Blueberries in Romania: Past, Present and Future Perspective

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The first blueberry research plantation in Romania was established in 1968. In the next two decades, between 1975 and 1989 were planted more than 250 hectars. After 1989 due to the property regime change, most of the blueberry lands have been abandoned or cutting down, total surface became less than 30 hectars. Since 2004, the attention and interest in setting up new blueberries orchards steadily increased. In 2012, blueberry plantations ocupies 280 hectars and in 2015 exceeded 600 ha. The fast upward trend of blueberry establishments in Romania is motivated by the growing market demand for fresh fruits consumption and the incentive profit comparing with other fruits produced in the orchards. With the entry into force of the new National Rural Development Programme 2014-2020 and allocation of European funds for the Pomiculture sector within the programme, the blueberry crop outlook becomes even better. We expect that the number of blueberry orchards in the upcoming years to grow and the total production to increase as fast as the investments materializes.

Climate Change Affects Blueberry Production in Romania

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Research conducted over time in different experimental blueberry fields located in the submontane region of Romania revealed that between 1968 and 1990, extreme weather phenomena have insignificantly influenced blueberry production. After this period, however, climate change becomes more evident, particularly by prolonged droughts, extreme cold in winter and increase of hail frequency. Drought recorded in the autumn of 1991 continued with lower temperatures in winter has led to substantial losses of production in the following year. Losses caused in Muscel area by water stress registered in 1999 and 2012 and hail occurred in recent years (2014-2015) have significantly marked blueberry production in the affected area. In this context of climate changes that occur in these regions with favorable rainfall and temperature regime, blueberry culture increasingly demand irrigation and hail protection nets to secure the annual production.

Differentiation-Pruning: A Novel Strategy to Induce and Advance Floral Buds Development in Blueberries

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Pruning is a key management tool in blueberries to produce quality fruit, to balance vegetative and reproductive growth and to keep plants young and active. Several pruning methods, strategies and timing have been developed for blueberries, both in traditional northern areas and in more warm or southern climates. A novel strategy to increase and advance floral buds in vigorous vertical shoots, a differentiation D-Pruning is under development in the central part of Chile. Treatment consisted in the partial removal of the vigorous current-season-shoot at different timing from mid-summer to mid-fall from Feb to May, 2014 (dates for southern hemisphere). We were able to induce floral buds below the pruning cut in the majority of the treated shoot from mid-February to early April. May pruning result only in vegetative buds below the cut indicating that the time for induction and differentiation was over. Percent bud break, floral buds count, number of flowers per bud, fruit size and harvest curve was measured for each treatment and compare to the unpruned shoots. Differences in the dormancy stage of the buds affect the response to pruning. Early Feb treatment induces short laterals in the majority (85%) of the shoots with 3 to 5 floral buds each. This was reduced to 46% buds with laterals in mid- Feb and 0% laterals from March to April. Bud number below the cut range from 3 to 6 for the Feb and March treatment, mainly directly under the cut. Number of flowers per bud and fruit size was larger the following spring for the Feb and March treatments and they were also more concentrated than the control that produce later and smaller fruits. D-pruning can be used to concentrate harvest, induce floral buds below the cut and to produce larger blueberry.

Effect of Substrate Type and Pot Size on Blueberry Growth and Yield, First Year Results

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Blueberry substrate production is increasing worldwide specially in regions with mild winter climate. This is a new production system that needs to be studied since little information is available. Growers normally use large pots and stable substrates in order maintain plants in the same pot for a long period in order to reduce labor and costs. A trial was setup in 2013 in order to study the influence of different substrate and pot sizes on growth and yield of Southern highbush blueberry plants of cultivar Paloma, grown under protected cultivation. One-year-old plants were planted in two sized pots (32x24cm/15L and 33x33cm/25L) and two substrate types with different densities (200 and 140 $g.dm^{-3}$) for one year. Plants were winter pruned and all flowers removed in spring. All plant biomass was determined in three sampling dates, beginning, middle and end of the growth cycle. Yield per plant was recorded the following spring. The experiment showed that plants thrived well in both substrate and pot sizes with an increase of 800 g in their dry matter with no significant differences regarding substrates or volumes. Yield in 2015 was not significantly different for all treatments with an average yield of 1.4 kg per plant. Since pot size and substrate were similar in this first year the prolongation of the study is crucial in order to determine the long term effect of root volume and the stability of the substrate in fruit production.

Use of Continuous and Cyclic Irrigation with Micro-Sprinklers for Reducing Fruit Temperature during Warm Weather Events in a Field of Northern Highbush Blueberry

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Northern highbush blueberry (*Vaccinium corymbosum* L.) is sensitive to high temperatures above 30 °C. When high temperatures coincide with fruit ripening, damage and reductions in fruit quality (softness, wrinkling, red-coloring) are often reported. Overhead sprinklers can be used to cool blueberry fields during hot temperatures, but most new blueberry fields are irrigated by drip. Options for reducing heat damage in drip-irrigated fields are currently limited. A few growers are trying low-flow micro-sprinkler systems to cool the fruit, but questions remain such as the critical temperatures at which cooling is needed, the amount time and frequency the systems should be run, and whether it has an effect on fruit quality or plant diseases. Therefore, a study was conducted in 2014 and 2015 to evaluate the efficacy of micro-sprinklers at reducing berry temperature in a commercial field of 'Aurora' blueberry located in western OR, USA. Four treatments were applied, including continuous cooling, cyclic cooling at 1-h intervals or at 20-min intervals, and no cooling. During warm weather, continuous and cyclic cooling reduced berry temperature from as high as 49 °C to < 27 °C within 25 min. As a result, cooling eliminated any heat damage in the sun-exposed fruit. Cooling also resulted in 20% greater fruit firmness than no cooling. Cyclic cooling was as effective as continuous cooling, but it used 50% less water, led to fewer slug problems, and resulted in drier fruit that were immediately ready for harvest the following morning. There was little difference in berry temperature and no difference in water use between the cycling treatments, indicating the time between cycling intervals was flexible.

Determination of Blueberry Acreage and Soil Type in North Carolina Using Web-based Resources

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An accurate estimate of commercial blueberry acreage and blueberry farm soil type in North Carolina was achieved through the use of web-based tools that overlay existing soil maps onto user-defined areas of interest. Blueberry sites known to the authors were mapped first, then other, previously unknown blueberry sites were discovered and mapped, using publicly-available satellite imagery. A total of 102 fields, farm units or contiguous blocks were mapped in the Fall of 2015. Unplanted areas within farm boundaries (roads, ditches, headlands) averaged 17.2% of the total mapped acres, and these areas were excluded from the planted acreage estimate of 9,756 acres in southeastern NC. Predominant soils (those representing five hundred acres or more of the total) were Leon fine sand (40%), Lynn Haven fine sand (19%), Murville fine sand and Murville muck (7%), and other muck soils (12%). Acres recorded by county included Bladen (5,859), Pender (2,092), Sampson (1,012), Duplin (501), Columbus (165) and Craven (127).

Foliar Applications of Boron and Calcium for Improved Fruit Set and Berry Quality in Washington Blueberry

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Pollination of highbush blueberry (Vaccinium corymbosum) relies almost exclusively on honeybees (Apis mellifera) in the Pacific Northwest. Inclement weather can reduce honeybee activity and suppress pollination. Blueberry typically has a short pollination window (five to seven days), resulting in periods of bad weather being the primary causal factor for decreased fruit set and yields. Increased pollen viability would lengthen the pollination window, thereby increasing the potential for successful fertilization, fruit set, and increased fruit size. Boron and calcium are micronutrients that can be important for germination of pollen, lengthening of pollen tubes, and berry quality. To increase the window of pollen viability and improve fruit quality, applications of boron (125 and 250 ppm), calcium (750 and 1500 ppm), and a combination product (matched ppm values) were applied to 'Draper' and 'Bluecrop' blueberries at four field sites in western Washington in 2015. Chemical fertilizers were applied at the 'pink tip' stage and continued to be applied at seven to ten day intervals until six applications had been administered. Weather conditions were uncharacteristically warm and clear for the duration of the bloom period. Resultant fruit set was not significantly altered by treatment, however, the average fruit set across sites was 10-15% higher than previously recorded averages. No significant differences were observed in yield component analyses, fruit size, or post-harvest fruit firmness. Nutrient analysis of leaf and fruit tissues showed elevated boron in the leaves, demonstrating absorption and mobility, but calcium levels remained unchanged.

Effectiveness of Living and Biodegradable Mulches for Weed Control in Pacific Northwest Highbush Blueberry

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When managed properly, living mulches can effectively suppress annual weed growth while not negatively affecting crop productivity. Biodegradable mulches (BDM) also show promise for weed control in many crops, and are currently being investigated for usefulness in berry production systems. In a newly-transplanted blueberry trial, 'Draper' plants were transplanted from 3.8-L pots into the field in March 2015. Greenhouse-grown living mulch plants, creeping buttercup (*Ranunculus arvensis*) and sweet woodruff (*Galium odoratum*), were transplanted to a density of 10.8 plants m^{-2} at the same time as blueberry. Other plots were treated with 5 cm of sawdust or by BDM (black spunbond polylactic acid plastic) to cover all bare soil. Soil in the fifth treatment was left bare. BDM provided good to excellent weed control, reducing weeding time 97% in May and 82% in July compared to bare ground plots. Sawdust also reduced weeding time by 70 and 66% in May and July, respectively, compared to bare ground plots. Living mulch did not reduce weeding time in May of the establishment year compared to bare ground plots, but weeding time was reduced by about 70% in July. In a separate trial in well-established 'Duke', creeping buttercup and sweet woodruff were transplanted as described above in March 2015 and their effects on weeds and blueberry were compared to those from sawdust mulch. Living mulches did not affect hand-weeding time, fifty-berry weight, or berry yield in July of the living mulch establishment year. Blueberry growth and meadow vole (*Microtis* spp.) activity in both trials will be recorded during winter 2015-16. Both trials will be maintained through the 2016 growing season to determine if fully-established creeping buttercup or sweet woodruff negatively affect blueberry growth or yield, and whether BDM will continue to provide weed suppressive ability after two years in the field.

Applications of Foliar Calcium Products to Fruit Had No Impact on Firmness and Shelf-life of Blueberry Cultivars

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Foliar calcium (Ca) products are applied to some crops to enhance fruit quality and shelf-life. The objectives of this study were to determine if various Ca products or formulations could be applied to blueberry fruit during development to increase fruit Ca concentration and improve fruit quality. In our first trial, done at two grower sites, various formulations of Ca (Ca chloride, Ca chloride + boron, Ca silicate, Ca chelate, and Ca acetate) were applied to 'Spartan', 'Liberty', and 'Draper' at a rate of 0.05% and 0.09% (Ca chloride only) using a backpack sprayer (748 $l \cdot ha^{-1}$ water). In our second trial, Ca chloride was applied using a backpack sprayer (0.05% Ca) or an electrostatic sprayer (0.16% Ca using 215 $l \cdot ha^{-1}$ of water) to 'Draper' and 'Legacy'. The rate of Ca applied was chosen to stay within product label rates while applying an equal concentration of Ca. Water was applied as a control in both trials. Foliar applications began at late bloom/early green berry stage and were repeated 3–4 times every other week, depending on cultivar. Fruit were hand harvested at a commercial stage of ripeness 1–4 weeks after the final application of Ca. Data collected included berry weight, fruit appearance, flavor after rinsing, and leaf and fruit Ca concentration after rinsing in deionized water. Fruit were cold-stored (at approximately 1.7 °C) in clamshells for 0 to 20 days and evaluated for effects on percent decay, weight loss, firmness, skin toughness, and percent soluble solids. There was no effect of Ca on fruit or leaf Ca concentration and fruit quality regardless of formulation, rate or method of application. Cultivars differed in quality parameters during storage with 'Draper' exhibiting highest firmness values as well as skin toughness after at least 10 days in storage.

Wetland versus Upland Cranberry Fields: The Role of Organic Peat and Subsurface Drainage in Cranberry Production

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The origin of the cranberry industry is firmly rooted in the peat bogs of Massachusetts, USA. Although peat facilitates flooding of farms and impedes leaching of pesticides, it may cause poor drainage that diminishes plant productivity and enhances fruit rot. Consequently, new constructions of cranberry farms are emerging on upland soils, where geologic peat is absent and subsurface drainage is rapid. Given the inherent connection between cranberry farms and peat bogs, we sought to elucidate the role of peat in the production of cranberries, as well as the effect of subsurface tile drainage in cranberry farms. Soil tension and fruit yield were measured in two cranberry fields with contrasting geology and soil drainage: a wetland field with peat and an upland field without peat. The wetland field was planted with 'Stevens' and renovated in 2013, when tile drains were installed at two depths: 20 and 30 cm from ground surface to the bottom of the tile drain. The upland field was also planted with 'Stevens' and constructed in 2010, with tile drains installed at a depth of 30 cm. During the summer of 2015, mean soil tension was uniformly -1.1 kPa across the wetland field, not varying with tile drain depth. By comparison, the upland soils were about three times drier than the wetland soils, with a mean soil tension of -3.2 kPa. The wetland field yielded 16440 kg ha^{-1} of fruit, whereas the upland field produced 40530 kg ha^{-1} of fruit. These results suggest that (1) subsurface tile drainage may enhance rapid drainage in cranberry fields, but does not represent a universal solution to poor drainage in wetland cranberry fields, and (2) poorly-drained peat bogs may produce low yielding crops compared to well-drained upland farms.

Evaluation of Potting Media for Soilless Cultivation of Southern Highbush Blueberry

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Growing blueberry plants in containers for fruit production allows producers to overcome issues with poor soil quality, such as high pH and salinity, and enables blueberry production in more diverse climates. The objective of the present study was to test various soilless substrates for container blueberry production. Plugs (70 mL) of 'Snowchaser' southern highbush blueberry (*Vaccinium* sp. hybrid) were transplanted in Mar. 2015 into 4.4-L containers filled with one of 10 substrates, each with different proportions of sphagnum peat moss, coco coir, and aged douglas fir (*Pseudotsuga menziesii*) bark. Perlite (10% by volume) was added to each mix for drainage. Additionally, a calcinated clay substrate (Turface), containing no organic matter, and a commercial nursery substrate were evaluated. Plants were grown in a greenhouse with supplemental lighting for 4 months and fertigated, as needed, with a modified Johnson's nutrient solution. Each fertigation was followed by irrigation with clean water to achieve a goal of 25% drain (by volume). The electrical conductivity of the drain solution ranged from 0.093 to 1.73 $dS \cdot m^{-1}$ over the course of the study, depending on treatment. Total plant biomass was similar among the treatments at 2 months after planting but was greater in substrates containing 60% to 90% peat moss or coir (by volume) than in those with 60% to 90% bark at 4 months after planting. Plants grown in Turface and the nursery substrate performed similar to plants in the best treatments containing coir and peat moss. Treatments containing high proportions of bark performed poorly. Additionally, there were no differences in plant biomass observed between peat moss and coir, suggesting both may be suitable substrates for soilless production of 'Snowchaser'.

Patterns of Winter Injury in Michigan Blueberries

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Severe cold in the winters of 2014 and 2015 caused several different types of winter injury in northern highbush blueberry (*Vaccinium corymbosum* L.) plantings in Michigan. Temperatures fell to near -30 C several times during the winter in growing regions away from Lake Michigan. Temperatures only fell to about -20 C closer to the Lake and damage was much less severe. Injury patterns were similar in both years. Young shoots (which grew the previous season) were often killed to the snow line or had a severe damage near the snowline. Young canes (2 to 5 years old) with good terminal and lateral growth (15 cm or more) had damage to the flower buds located at the shoot tips and vegetative shoot buds generally grew well during the spring and summer. Older canes with poorer growth showed good bloom but poor growth from the vegetative buds. Older canes grew poorly. There was vigorous growth from the base of all bushes. Aggressive growers pruned heavily in the fall of 2014 to remove older damaged canes. These heavily pruned fields often expressed more severe winter injury (cane collapse) in 2015 than those which were not pruned. This indicated that winter hardiness was reduced by heavy fall pruning. Non-pruned fields were generally old bushes (30 years or older) that had minimal management in 2014 due to the light crop and poor growth. In 2015, these fields leafed out slowly and generally had a light bloom and crop, many of these fields were only harvested once or not harvested. Varietal differences were minor compared to the impact of site location and grower management.

A Suggestion of How the European Blueberry (*Vaccinium myrtillus* L.) Could Be Cultivated in Outlying Fields and on Agricultural Land

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In the Nordic states there have been an increasing interest in the native wild blueberry (*V. myrtillus* L.) for the last two decades. This has happened mainly because of the high dietetic value highlighted in the literature and media, but also because it is traditional in the Nordic diet. These values have become increasingly appreciated in the modern society, because of a wave created by nostalgia, and the focus on human health of berries in general and especially the wild blueberry. This interest has risen the question if the berries could be cultivated and if this could be rental. Research on the European blueberry till 2010 has been previously reviewed, and together with newer research there are leads to suggest how the wild blueberry of Europe could be semi cultivated in outlying fields and fully cultivated on agricultural land. This include deforesting, leveling of terrain, fertilization, humus, compost, mulch and pollination, etc.

Cane Diameter and Location do not Affect Fruit Quality in Highbush Blueberry

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We have shown that cane diameter and location influence fruit yield in highbush blueberry. Growers want to increase blueberry fruit yield without affecting fruit quality. In this context, the objective of this study was to assess the effect of cane diameter and location on fruit quality. For that purpose we selected mature highbush blueberry fields cv. O'Neal and Brigitta (*Vaccinium corymbosum* L.) in Romeral-Chile (34º58'00"S; 71º08'00"W). Cane diameter was measured at 10 cm from the base of the cane. Canes were then grouped into three diameter ranges (cm): 0-0.9; 1-1.9 and 2-2.9. In every bush, the cane spatial location was defined either as external (E), located within 25 cm from the canopy periphery, or internal (I) those growing in the canopy center. Fruit with at least 80% blue coverage were harvested every 5 d from each individual cane. Soluble solids, firmness and fruit diameter were not affected by cane position or diameter in cv. O'Neal. In cv. Brigitta, external canes had fruit with lower soluble solids (13.1ºBrix) that internal ones (14.4ºBrix). Fruit diameter in Brigitta was significantly higher in canes with diameters greater than 1 cm. Cane diameter and location did not affect fruit weight loss after 40 days of storage (0ºC and at 95% relative humidity) in cv. O'Neal. In cv. Brigitta, fruit weight loss was higher in smaller cane diameters (0-0.9 cm) than in canes of intermediate diameters (2-2.9 cm). The proportions of undamaged, soft and decay fruits did not show significant differences for cane position and diameter in both cultivars. For these varieties and cane diameters, growers could postpone pruning canes of larger diameters, since this would generate higher yields without affecting the quality and postharvest life of the fruit.

The Effect of Three Different Irrigation Systems on the Activation of the Herbicide Flumioxazin in Blueberry (*Vaccinium* spp.)

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Preemergence herbicides (PH) require approximately 1.27 to 2.54 cm of precipitation to activate the herbicide. In the absence of rain, overhead irrigation is the best option; however, many growers depend on drip irrigation. A study was designed at the University of Georgia's blueberry farm in Alapaha, GA, USA to determine if the form of irrigation would affect herbicide activity at two levels of pine bark mulching. Southern highbush blueberries (*V. corymbosum* L. **hybrids) 'Suziblue' and 'Camellia' where evaluated. The two levels of pine bark used were: 1) 11,200 kg ha^{-1} of pine bark incorporated into the soil before planting (no-mulch), and 2) 11,200 kg ha^{-1} of pine bark incorporated with 7.62 cm surface applied to the bed (mulch). Three irrigation treatments were evaluated: 1) single drip tape, 2) double drip tape, 3) and a micro-emitter. Chateau (flumioxazin) herbicide was applied at the rate of 702 g ha^{-1} using a CO_2 backpack sprayer calibrated to deliver 187 L ha^{-1}.** No-mulch and mulch where considered separate experiments, but where applied simultaneously. Herbicide was applied over the bed as a directed spray to both sides of the plant. The herbicide band was 1.8 m x 3.66 m in length and incorporated three plants. In both mulch and no-mulch, four replications per irrigation treatment were made with applications on Aug. 20, 2014 and Apr. 8, 2015. Overall control, weed counts, and percent weed cover where taken at 4, 8, and 12 weeks after treatment (WAT), and weed fresh weight was taken at 12 WAT. Significant differences where seen within no mulch treatments with % weed cover and weed fresh weight in 2014, and weed count and fresh weight in 2015. There were no significant differences seen in overall weed control between irrigation treatments in either mulch or no mulch.

Difference in Fruit Quality between the Wild `Albino´ and Blue Bilberry (*Vaccinium myrtillus* L.)

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Bilberry (*Vaccinium myrtillus* L.), also called European blueberry, is one of the most important wild berries in Europe, because of its high potential benefits for human health. They contain particularly high levels of anthocyanins, which are responsible for intensive blue coloration of the fruits. Suppressed expression of the anthocyanin biosynthetic genes, which encode the enzymes, causes pale color of the albino mutant as opposed to the typical blue type of wild bilberries. Wild albino and blue bilberry fruit growing on the same location were analyzed to compare different fruit characteristics linked to the composition of primary and secondary metabolites. Compounds were determined using HPLC-MS and standard quality parameters were additionally determined. The fruits of albino berries were significantly smaller, accumulated less water and were characterized by 23% higher dry weight. Soluble solids content and pH value were higher in albino bilberry, their surface was lighter and yellow pigmented with small blue spots compared to the blue form. Composition of sugars and organic acids was comparable between both types; however, the albino form had 33% higher content of total sugars and 9% higher content of total organic acids. Fifteen anthocyanins have been identified in both forms, but in albino bilberries individual components have only been detected in traces. Blue bilberry contained higher levels of flavanols, flavonols, hydroxycinnamic acid derivatives and consequently higher total phenolic content. Our findings represent an interesting source for further investigations and place albino bilberries in focus of breeders and consumers, because of their unusual color and distinctive fruit appearance.

Preliminary Study of Mulching Rabbiteye Blueberry Plants in Taiwan

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Mulching with pine bark is a standard operation procedure for commercial blueberry production in the USA. However, it is not economically practical in Taiwan. Alternatives with benefit similar to pine bark should be identified. Field grown 'Blueshower' 'Powderblue' rabbiteye blueberries (*Vaccinium ashei*) were mulched with pine bark, rice hull, or silver-black plastic film, or not mulched as the control. In clear summer days, soil under pine bark had the lowest mid-day temperature (29.3°C), followed by soil under rice hull (30. °C), plastic film (30.6°C), and the control (31.1°C). Soil moisture content was highest with pine bark (19.16%), followed by rice hull (15.06%), plastic film (18.57%) and the control (8.58%). Lengths and diameters of the first flush after planting were similar in both cultivars among mulching treatments. Pine bark and rice hull mulch improved shoot length for the second and third flushes. Total leaf area by the end of the second flushing cycle in 'Blueshower' mulched with rice hull (6858.23 cm^2) wassignificantly higher than the control (5080.81 cm^2)but not different from pine bark (5709.04 cm^2) and plastic film (5559.17 cm^2). Overall, rice hull performs well and can be an economic substitute of pine bark mulch in Taiwan.

Wild Blueberry Systems Approach Economic and Risk Analysis

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We conducted a multi-disciplinary large-scale study from 2010 to 2015 on four wild blueberry cropping input systems; Organic, Low input, Medium input and High input that fit along gradients of capital inputs and potential environmental effects to quantify system effects on yield, fruit quality, pest communities, the environment, and economic effects of inputs. The goal of the project is to provide growers with information on how different management systems affect the crop, its environment and the ecological and economical sustainability of wild blueberry production. A critical issue affecting growers is how to optimize increasingly expensive inputs to achieve economically and environmentally sustainable yields. In the 2010 to 2011 production cycle we established two fields per cropping input system for a total of eight fields, and in 2012 to 2013 four fields per cropping system for a total of 16 fields; in 2014 to 2015 fields were substituted to provide a better geographical distribution and more diverse cooperator inputs. This paper will evaluate the grower inputs and returns using a partial budget analysis comparing the four input systems over the three crop production cycles and 16 locations in order to determine the relative profitability. In comparison with the partial budgets of previous production cycles, a representative budget of each input system for the most recent production cycle will be included with our updated estimates of fixed costs. A risk analysis of all the fields over the recent three production cycles will identify the underlying risk, cost and return of changing management practices across the four production management systems that Maine wild blueberry growers may practice, which will allow wild blueberry growers to be able to evaluate the risks of production and to choose a cost-effective management plan that balances risk with efficiency in a world that is changing economically and ecologically.

Vinegar Residue: A New Soil Conditioner to Improve Blueberry Antioxidant Activity

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Vinegar residue (VR), byproduct of vinegar processing, was high of organic material. We found that soil application of VR could improve the growth of blueberry in pot and field experiments (not published) recent years. While, effect of VR on blueberry antioxidant activity hasn't been studied, so total contents of phenolics (TPC), flavonoids (TFC) and anthocyanidins (TAC) of blueberry leaf was investigated after soil application of VR. There were 6 treatments as follows (Soil:VR, v/v): T1, 100:0, T2, 75:25, T3, 50:50, T4, 25:75, T5, 0:100, and pot experiment was conducted with one-year old 'Brightwell' in 2014-2015. Results showed that the TPC, TFC and TAC of blueberry leaf in T1 was 52.37 mg gallic g^{-1} DW, 15.61 mg quercetin g^{-1} DW and 78.03 mg catechin g^{-1} DW respectively. There showed no significance difference of TPC and TFC between VR treatment (T2-T5) and T1. While TAC was increased significantly in VR treatment, it was 101.54 mg catechin g^{-1} DW in T2, 30.05% more than it in T1. But with the increasing of VR amount added, the increment of TAC was decreasing slowly. As a conclusion, application of VR could improve blueberry antioxidant activity, especially TAC, and soil application of VR by 20% in volume is appropriate according to the results. Further research about the influence of VR on blueberry fruit is needed to value the effect of VR on blueberry quality.

PLANT PATHOLOGY

Poster Session 2

Wednesday, April 13, 2016

9:30am - 10:30am

Abstracts are arranged alphabetically by presenter's last name

The Effect of *Trichoderma* spp. in the control of Root Rot caused by *Phytophthora Cinnamomi* in Blueberries in Peru

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This experiment was conducted at the National Agrarian University La Molina, Peru. The objective of the work was to evaluate the effect of different strains of*Trichoderma spp* to control Root rot caused by *Phytophthora cinnamomi* under laboratory and greenhouse conditions. Under laboratory conditions, five strains of *Trichoderma* were evaluated in a medium of Potato Dextrose Agar (PDA): T1= *Trichoderma sp*. 1 (LM01); T2= *Trichoderma sp*. 2 (Chav02), T3=*Trichoderma harzianum* (Chav01), T4= *Trichoderma harzianum* (LM02) and T5= *Trichoderma viride* (LM03), along with *Phytophthora cinnamomi* isolations. It was determined that all strains inhibited the development of *Phytophthora* in vitro conditions. Under greenhouse conditions plants of blueberries Biloxi cultivars, were planted in bags of 3 kg with sterile sand, these were inoculated with five isolates of *Trichoderma* (tested in laboratory*)*, the treatments were performed 3 times every 15 days with 150 ml of solution with a concentration of 10^8 conidia/ml. Inoculation of *P. cinnamomi* was performed, in the same substrate, by incorporating wheat colonized with the pathogen at the proportion of 2.5 g of wheat per 1 kg of ground. 60 days after inoculation of *P. cinnamomi*, the following assessments were performed: Plant Height, Diameter of Stem, Fresh Weight of Leaf, Dry Weight of Leaf, Fresh Weight of Root, Dry Matter of Root, Root Length, and Percent of Diseased Roots. In general, all treatments inoculated with *Trichoderm*a showed statistical differences with the control, but the treatment T4= *Trichoderma harzianum* (LM02) showed the highest values in percentage of Diseased Root and Root Length (significance level $\alpha = 0.05$ Tukey).

Occurrence of *Vaccinium* Viruses in Blacksea Region of Turkey

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The Black Sea Region of Turkey, northeastern part of Anatolia, is one of the main germplasm centers of several Vaccinium and Ericaceous plant species. Caucasian whortleberry (*Vaccinium arctostaphylos*), bilberry (*Vaccinium myrtillus*) and lingonberry (*Vaccinium vitis-idea*) have been naturally grown in the forests and plateaus over the centuries. However commercial blueberry production by using northern high bush blueberries (*Vaccinium corymbosum*) started in the 2000s in the country. The presence of blueberry viruses in Turkey has not been studied up to now. The aim of this study is to detect and characterize of some important viruses in *Vaccinium* species such as *Blueberry mosaic associated virus* (BlMaV), *Blueberry leaf mottle virus* (BLMoV), *Blueberry scorch virus* (BlScV), *Blueberry shock virus* (BlShV) and *Blueberry shoestring virus* (BSSV) by ELISA and/or RT-PCR analysis. Blueberry samples were collected from Samsun, Giresun, Rize, Trabzon and Artvin provinces located in the Black Sea Region in 2014. The most common symptoms were observed as leaf crinkling, reddening, ringspots and mosaics on the blueberry leaves. The infection rates for BlScV and BlShV in tested samples were found as 2.0% and 3.0%, respectively. BLMoV and BSSV were never found in all tested samples. Three samples out of ten collected from Rize province was found positive for BlMaV by RT-PCR and part of the movement protein gene was successfully amplified. Amplification products of three samples were directly sequenced. The sequences of Turkish isolates were identical. To each other and showed 96% similarity with the isolate deposited in NCBI GenBank (Acc. No KJ704367). Our results confirm the presence of BlMaV in Turkey. Further molecular characterization of Turkish BlMaV isolates is under investigation.

Xylella fastidiosa is Associated with Reduced Yield and Altered Fruit Quality in a Rabbiteye Blueberry Orchard in Louisiana but does not Appear to Spread Rapidly

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Xylella fastidiosa is a bacterial pathogen that causes diseases such as Pierce's disease of grape, bacterial leaf scorch of shade trees, and citrus variegated chlorosis. Work by researchers in Georgia and Florida has shown that it is the cause of bacterial leaf scorch of Southern highbush blueberries (*Vaccinium corymbosum* interspecific hybrids), as well, but a greenhouse experiment in Georgia suggested that it was not a major cause for concern in rabbiteye blueberry (*Vaccinium ashei*). In Louisiana, fruit was harvested for two years (2013 – 2014) from forty established 'Tifblue' rabbiteye blueberry plants. Total yield differed significantly between those in which *X. fastidiosa* was (5.2 kg, n = 9) and was not (12.8 kg, n = 31) detected. A marginally significant difference in average berry weight, calculated from 25 berry samples taken at each harvest, was found. Fruits sampled from one harvest date in 2014 differed in soluble solids concentration, according to a non-parametric analysis, with those from *X. fastidiosa*-positive plants having a higher mean soluble solids concentration (11.5%) than *X. fastidiosa*-negative plants (10.1%). Foliar symptoms were not always observed in association with infected plants but sometimes included early "fall" colors or, less commonly, marginal leaf necrosis. Among forty plants sampled annually, no new infections were detected in 2014 or 2015, among the 31 plants that tested negative in 2013. In repeated sampling of plants in which *X. fastidiosa* was detected at least once, the bacterium was detected more consistently in root sap by real-time PCR than (a) in single stem sap by real-time PCR or (b) by ELISA, in tissue from multiple petioles/midribs or most recent shoot growth (sampled when leaves were not available). Detection of *X. fastidiosa* by ELISA using tissue from petioles/midribs or most recent shoots seems most reliable in summer (June – September) and least reliable in April.

First Detection of Silverleaf (*Chondrostereum purpureum*) on Rabbiteye Blueberry (*Vaccinium ashei*) and Disease Damages

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Silver leaf of blueberry was described for the first time in *Vaccinium corymbosum*, cv. Brigitta Blue, in 2005 season, in the southern area of Chile. The disease is caused by the fungus *Chondrostereum purpureum* **and the symptoms are silvering of the foliage, necrosis of the wood center and plant dead. From the first detection, every year a new cultivar was detected susceptible to this disease. Thus, the annual sequence was Brigitta Blue, Bluecrop, Duke, Misty, Elliot, Liberty, Blueheaven, Draper, Rocio and Corona. However, during the 2014 season silverleaf was detected for the first time on rabbiteye blueberry, cv. Brithwell, near to affected Brigitta plants. The objective was to describe the disease, the damage on the plant and fruit, and the causing agent. Koch postulate were performed by isolating the fungus from wood necrotic tissue collected from plants with silver leaves. On PDA the fungus developed white and cottony colonies covering a 9-cm Petri plate in 7 days. The inoculation test was done on potted 3 years old healthy rabbiteye blueberry cv. Brithwell. Five plants were inoculated by pruned one of their stem and placing a 10-mm-diameter inoculum plug, taken from the border of the fungal colony, and covered with parafilm. Disease assessment was performed along the year, and after silver leaf symptoms was observed the stems were split in half to observe the wood necrosis. Symptomatic chips were collected from the necrotic area and cultured on PDA, producing the same fungus that was originally isolated. Pure mycelium was used for DNA extraction and sequence analysis of the ITS 4 and 5 regions, besides the APN1 marker for specie identification. The fungus was identified as***Chondrostereum purpureum***. Furthermore, the disease reduce photosynthesis, calcium content and fruit hardiness, important factors for plant production and fruit quality.

Symptomology and Epidemiology of *Exobasidium* Leaf and Fruit Spot of Blueberry

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With an area of cultivation of more than 11,500 hectares in 2014, the state of Georgia has advanced to be one of the largest producers of cultivated blueberries in the United States. As production has expanded and intensified, several new blueberry diseases of economic importance have emerged, the most recent of which is Exobasidium leaf and fruit spot caused by the novel fungal plant pathogen *Exobasidium maculosum*. The disease primarily affects rabbiteye (*Vaccinium ashei*) and southern highbush cultivars, causing leaf spotting early in the season as well as unripened spots on fruit that can result in the rejection of the fruit at the packinghouse. The pathogen has only recently been recognized as a distinct species; therefore, and because of the emerging nature of the disease caused by *E. maculosum*, limited information is currently available on aspects of the pathogen life cycle such as its overwintering biology and sources of primary and secondary infection. To fill these knowledge gaps, epidemiological field studies have been initiated in 2014 that include the use of trap plants, shoot demographic surveys, spore trapping, and other means of pathogen detection. Detailed disease monitoring has revealed a previously unrecognized symptom, the formation of lesions on young, expanding shoots that typically leads to shoot girdling and subsequent blighting. Initial results from pathogen population monitoring suggests that *E. maculosum* is capable of overwintering epiphytically on all blueberry tissues tested during dormancy. However, within and end-of-season epiphytic populations of the pathogenare dramatically lower than during plant dormancy. Shoot demography and trap plant data collected in 2015 suggest that primary infection is not the result of blueberry buds being infected the previous season. This information leads us to believe that there is a yet to be identified site on the plant that serves as the source of primary inoculum.

Use of Biofungicides to Address Conventional *Botrytis* Blight Control Challenges in Wild Blueberry Production

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Botrytis blossom blight has become the most widespread and damaging disease affecting wild blueberries in Atlantic Canada with over 20% crop losses reported. Field trials were conducted during 2015 to reduce the dependency upon conventional fungicides through the incorporation of biofungicides into a floral blight management program. Fungicides including Fracture® (Blande de Lupinus Albus Doce, BLAD) and Serenade Max® (*Bacillus subtilis*) were evaluated alone and in rotation with Switch® against Botrytis blossom blight in June, 2015. Three applications (3 Fracture®, 3 Serenade Max®, Fracture®-Switch®-Fracture®, Serenade Max®-Switch®-Serenade Max®, Fontelis®-Switch®-Pristine®) of the products were made at 7-10 days intervals. Biofungicide applications at the onset and end of the Botrytis blossom blight infection window period combined with an application of the conventional fungicide Switch®during peak Botrytis pressures controlled Botrytis blossom blight as well as the conventional fungicide program. Using Fracture® in this rotational pattern also provided control of Septoria leaf spot. There were no significant differences in harvestable berry yield between the conventional fungicide control program and the Fracture® and Serenade Max® fungicide treatments that were applied in rotation with Switch®. Therefore, results from this study have indicated that Botrytis blossom blights can be adequately controlled and fungicide usage reduced when biofungicides are integrated and used in tandem with conventional fungicides.

Integration of Laboratory Sensitivity Analysis into *Monilinia* Blight Management Technologies for Wild Blueberry Production

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Demethlyation inhibitors (DMIs) are systemic and site-specific fungicides that have medium risk of developing resistance by a target fungal pathogen after prolonged, repeated applications. Propiconazole (the active ingredient in the fungicides Tilt®, Mission®, etc.) has been extensively used throughout the wild blueberry industry for Monilinia control over the past 20 years with multiple fungicide applications typically having to be made during the cropping year of production. Given the apparent loss of Monilinia blight control observed in field research trials and also in commercial fields, concerns were raised that the natural population of *Monilinia* sp. (causing fungal agent of Monilinia blight in wild blueberries) was becoming less sensitive to propiconazole. Combined with this was uncertainty of the sensitivity of the *Monilinia* sp. population found in wild blueberry fields to other fungicides applied prior to bloom in the cropping phase of production. Given this, laboratory sensitivity analysis of *Monilinia* sp. single-spore isolates to propiconaozle, difenoconazole, prothioconaozle-dethio, boscalid, penthipyrad, and cyprodinil was completed through the use of a mycelium growth assay. A significant shift toward reduced sensitivity to propiconazole in population of *Monilinia* sp. was not detected. EC_{50} values (effective concentration that inhibit the growth of mycelium by 50%) ranged from 0.007 to 0.036 $\mu g \cdot mL^{-1}$ with mean value of 0.015 $\mu g \cdot mL^{-1}$. Prothioconazole-dethio was the most effective active ingredient examined with respect to its ability to inhibit mycelium growth of *Monilinia* sp. on agar medium. By contrast, cyprodinil was the least effective active ingredient. Therefore, results from this study have confirmed that propiconazole is still an effective fungicide for Monilinia control, new fungicides including prothioconaozle-dethio and difenoconazole are also effective, and the use of laboratory growth medium sensitivity analysis is an important tool in determining effective disease control.

Sustainable Approaches to Blueberry Disease Management in Michigan

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Highbush blueberries (*Vaccinium corymbosum*) in Michigan are affected by a number of fungal diseases, including mummy berry (*Monilinia vaccinii-corymbosi*), Phomopsis canker and twig blight (*Phomopsis vaccinii*), anthracnose fruit rot (*Colletotrichum acutatum*) and leaf rust (*Thekopsora minima*). While conventional disease management relies mostly on preventative applications of synthetic fungicides, our goal has been to optimize fungicide use and to identify "softer" alternatives that also may be appropriate for organic production. Among "reduced-risk" fungicides, azoxystrobin (Abound), fluazinam (Omega) and potassium silicate (Silmatrix) have shown good efficacy against anthracnose fruit rot. The biocontrol agents *Bacillus subtilis* (Serenade), *Bacillus amyloliquefaciens* (Double Nickel 55), and giant knotweed extract (Regalia) have been effective alone or in combination against mummy berry. Sprays of lime sulfur and Sulforix (an improved formulation of lime sulfur) during the dormant season (late fall and/or early spring) have reduced disease pressure of mummy berry, anthracnose fruit rot and Phomopsis twig blight. Cultural control methods, such as mulching and pruning have also been evaluated but tend to be moderately effective and may need repeated application to observed results. These methods compliment the use of fungicides and also facilitate fungicide resistance management. For mummy berry, field scouting to observe apothecial development is important for optimal timing of fungicide sprays. Mummy berry "nurseries" have been helpful in observing the different stages of apothecial development. Over the last decade, many growers have adopted the use of dormant sprays and disease monitoring is provided by trained scouts. Disease prediction models are being validated for anthracnose fruit rot and mummy berry in order to optimize fungicide applications and improve fruit quality.

Botryosphaeria Stem Blight on Blueberries: Effect of *Vaccinium* Cultivar, *Botryosphaeriaceae* Species and Temperature

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Botryosphaeria stem blight is a destructive disease of blueberries grown in the southern United States. Historically stem blight has been reported to be caused by the fungus *Botryosphaeria dothidea.* Recently, other genera in the *Botryosphaeriaceae* family have been identified as causal pathogens of this disease. A detached stem assay was used to compare the effect of temperature on lesion development of one highbush, two southern highbush and two rabbiteye blueberry cultivars following inoculation byisolates of three *Botryosphaeriaceae* genera. Partially-hardened, terminal stems were wounded; inoculated with an isolate of *B. dothidea, Neofusicoccum ribis,* or *Diplodia seriata;* and incubated at 10, 15, 20, 25, 30, and 35°C. Lesions developed fastest on stems of the southern highbush cultivar Star. Stems inoculated with *B. dothidea* developed lesions at a faster rate than stems inoculated with the other two isolates. Lesion development was faster on stems incubated at higher temperatures than on stems incubated at lower temperatures. The effect of temperature on growth rates of these isolates in culture was also determined by growing each isolate on acid potato dextrose agar in the dark in growth chambers at 10, 15, 20, 25, 30, and 35°C. After 5 days the average colony diameter of each of isolate was least when incubated at 10°C. *B. dothidea* colony diameter was greatest at the three higher temperatures, *D. seriata* colony diameter was greatest at 25°C, and *N. ribis* colony diameter was greatest at 30°C. The optimum growth temperature for each isolate in culture was not the same as the optimum temperature for lesion development for each isolate.

Effect of Cultural Practices and Fungicide Treatments on the Severity of *Phytophthora* Root Rot of Blueberries Grown in Mississippi

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Phytophthora root rot is an important disease of blueberries especially when grown in areas with poor drainage. Reliable management strategies are needed for this disease. Two studies were conducted to evaluate the effects of cultural practices and fungicide treatments on Phytophthora root rot severity of blueberries planted in *Phytophthora cinnamomi* infested soil. Plants of one-year-old 'Star' or two-year-old 'Legacy' were transplanted into flat or raised beds (whole plots) fertilized with 0.5x, 1x, or 2x levels of nitrogen as urea (subplots). Within subplot treatments were soil amendments (pine bark, peat, none) or fungicide treatments [Agrifos® (phosphorous acid) foliar, Aliette® (aluminium tris) foliar and drench, Ridomil Gold® (mefenoxam) drench]. Plant vigor was rated twice a year and top and root weights were recorded at the conclusion of each study. Plants in the 'Star' study were grown for four years and those in the 'Legacy' study were grown for two years. 'Star' plants grown for two years on raised beds were more vigorous and had a greater percentage living plants than those grown on flat beds, but there was not a significant difference in vigor or percentage living plants due to nitrogen level. After four years 'Star' plants in the Agrifos foliar, Aliette foliar and drench, Ridomil Gold drench, and bark treatments had the highest top and root weights and vigor scores, but there was no significant difference in vigor or top weight of plants due to bed height or nitrogen level. After two years plants in the 'Legacy' study that were fertilized with urea at the 2x rate had the greatest top weight. Those treated with Agrifos foliar, Aliette foliar, and Ridomil drench had the highest vigor scores and top weights. There were no significant differences in vigor or top weight due to bed height.

Effect of Nitrogen Fertilization and Fungicides on *Botryosphaeria* Stem Blight Lesion Development on Detached Stems

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Botryosphaeria stem blight is a destructive disease of blueberries. Field observations indicate stem blight is more severe on vigorous plants than on slower growing plants. Two studies compared the effect of two types of fertilizers applied at four rates and nine fungicides on lesion development following inoculation of detached stems from two-year old potted plants of the rabbiteye cultivar, Tifblue. Partially-hardened stems were wounded, inoculated with*Botryosphaeriaceae* isolates, and incubated for 10 to 21 days in a growth chamber. Plants in the fertilizer study were inoculated with a virulent isolate of*Botryosphaeria dothidea* and those in the fungicide study were inoculated with the same isolate plus three other *Botryosphaeriaceae* isolates. Results of the fertilizer study showed no differences in lesion length 10 days after inoculation on stems from plants receiving 1, 2, 4, and 8 times the recommended levels of liquid or slow release fertilizers. Lesions were longer on stems from plants receiving these fertilizer treatments compared to those from plants that were not fertilized. In the fungicide study, plants were sprayed with nine fungicides or with water. Stems were wounded either immediately before or 24 hr after fungicide application, collected 24 hr after fungicide application, and inoculated within 6 hours. Twenty-one days after inoculation among stems wounded before fungicide application, those treated with pyraclostrobin, fosetyl aluminium, or pyraclostrobin + boscalid had the shortest lesions; among those wounded after fungicide application, there were no differences in lesion length between the untreated control and any fungicide treatment. Two *B. dothidea* and two*Neofusicoccum* sp. isolates were grown for 4 days on agar amended with the same nine fungicides at a range of concentrations. Growth of each isolate was significantly reduced on agar amended with azoxystrobin, pyraclostrobin, tebuconazole, propiconazole, pyraclostrobin + boscalid or cyprodinil + fludioxonil at concentrations above 0.1 mg/L.

Effects of *Phytophthora cinnamomi* Isolate, Inoculum Delivery Method, Flood, and Drought on Vigor, Disease Severity and Mortality of Blueberry Plants

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Four studies evaluated the effects of cultivar, inoculum delivery method, flood, and drought on plant vigor, disease severity, and mortality of blueberry plants grown in pots in the greenhouse. *Phytophthora cinnamomi* isolates were obtained from the root zone of blueberry plants displaying symptoms of Phytophthora root rot. 'Tifblue', 'Star', and 'Biloxi' plants were inoculated with 11 *P. cinnamomi* isolates using inoculum delivered as a mycelial slurry, zoospore suspension, or grown on rice grains or vermiculite. Flood conditions were evaluated by submerging pots in water for 0, 24, or 48 hr every 3 or 6 weeks. To evaluate drought conditions, plants were watered 4 or 7 days a week. In each study, there were significant differences among isolates in plant vigor, mortality and disease ratings; and inoculated plants were less vigorous, received higher disease ratings and had a higher mortality rate than plants that were not inoculated. 'Biloxi', a southern highbush cultivar, was less vigorous, received higher disease ratings, and had a higher mortality rate than 'Tifblue', a rabbiteye cultivar, or 'Star', a southern highbush cultivar. The drought conditions evaluated resulted in high mortality rates in both inoculated and not inoculated plants. Based on the results of these four studies, we determined that inoculating rooted cuttings of 'Biloxi' with a virulent *P. cinnamomi* isolate grown on rice grains and subjecting the plants to either a 24 or 48 hr flood every 6 weeks provided the best protocol for future studies evaluating chemical and biological root rot controls or studying environmental effects on the development of Phytophthora root rot on blueberries.

Discovery of an *Ampelovirus* and a *Vitivirus* in *Vaccinium*

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Blueberry and cranberry plants with atypical virus-like symptoms were subjected to large scale sequencing using as template degenerate oligonucleotide reverse transcription from infected material. VirFind, a virus discovery pipeline identified two new viruses; one in cranberry, an amplelovirus related to little cherry virus 2 and one in blueberry, a vitivirus related to grapevine virus A. Detection assays verified the presence of the viruses in several symptomatic plants, although no clear association viruses and symptoms could be established. Surveys for the viruses in major blueberry and cranberry production areas in the United States are underway.

Plans for a Pest Risk Assessment of *Diaporthe vaccinii* in the European Union by the Plant Health Panel of the European Food Safety Authority

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The fungus *Diaporthe vaccinii* (anamorph *Phomopsis vaccinii*), the causal agent of blueberry twig blight and fruit rot, was detected in some European countries in the past, but was eradicated in all but one, Latvia, where it is present with a restricted distribution and under official quarantine control. An extensive survey in the EU member states will be carried out in 2016. Outside the EU, the pathogen is endemic in Canada and the USA, and has been reported in Chile, China, Belarus and Russia. Suitable climatic conditions for *D. vaccinii* are present in most of Europe, especially in Central and Eastern Europe, and the organism can be spread by natural and human-assisted means. The movement of contaminated but symptomless plants for planting could be a major pathway for introduction and spread, next to the natural spread from areas where the pathogen is currently established. Information on the potential impact of *D. vaccinii* in the EU, as well as on the potential spread to native *Vaccinium* species, is limited. A two-step approach was devised for a fit for purpose risk assessment of *D. vaccinii* and other pestsin the EU: 1) a pest categorization was prepared and published by EFSA, and following the feedback by risk managers, 2) a pest risk assessment including risk reduction options is currently under development. A quantitative risk assessment methodology is being proposed by the EFSA PLH Panel to assess the risk of introduction, establishment and spread along the pathways, as well as the potential impact, and the efficacy of risk reduction measures. The new approach is based on measurable variables and probability judgement. Data on the distribution and the impact of *D. vaccinii* in its native range are needed for this assessment.

POSTHARVEST

Poster Session 2

Wednesday, April 13, 2016

9:30am - 10:30am

Abstracts are arranged alphabetically by presenter's last name

Quantitative Evaluation of Blueberry Packing Line in Chile Using Miniature Instrumented Sphere

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Fruit bruising induced by mechanical impacts has caused great economic losses to blueberry industry. The issue exists not only in the United States, but also in Chile which has became an important supplier of off-season fresh blueberry to the northern atmosphere. To quantitatively measure the mechanical impacts, we developed a miniature instrument sphere, known as the Berry Impact Recording Device (BIRD). During the harvest season in 2014, we tested nine packing lines in Chile using the BIRD sensor. Six lines were tested with fruit, one line was tested both with and without fruit, and on empty line and one line with fruit were tested with and without padding. The BIRD sensor recorded the impacts larger than 18 ***g*** and generated two parameters for each impact -peakG and velocity change - to indicate the magnitude of the impact. We also collected fruit samples at various locations of the packing lines to evaluate the fruit bruising caused by the lines. Fruit bruising was evaluated after 24 hours of the sample collection and after 45 days in the blueberry storage. The impact recorded by the sensor showed most of the impacts happened when sensor transferred from one component to another. The fruit had no effect on the sensor readings except when the sensor transferred to the hopper at the end of the line. The paddings were shown to be helpful in reducing the impacts. The fruit bruising data showed no significant difference in fruit bruising among different samples after 24 hours of sample collection but showed significant difference after 45 days storage and the average bruising was consistent with the impacts occurred from the start of the line to the sample location.

Studies on Quality of Two Southern Highbush Blueberry Cultivars: Effects of Pulp Temperature, Impact and Hydrocooling

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Production of southern highbush blueberries continues to increase in mild temperate and subtropical climates such as Florida and southern Georgia. Growers with small acreage commonly pack at a larger grower's facilities; however, they are constantly challenged to maintain fruit quality following harvest. Commercial cultivars 'Windsor' and 'Farthing' were harvested in May 2015 directly into rigid, hinged "clamshell" containers (0.45 kg capacity) and returned to the laboratory. There was no difference in mass (n=3 clamshells) loss during 3 hr at 22°C (30°C). In a separate test these cultivars were equilibrated to 10 or 20°C (45 min) and dropped 60 cm onto a solid surface. After 4 d at 4°C, 'Windsor' fruit dropped at 20°C lost significantly more mass (62%) than undropped; 'Farthing' dropped at 20°C lost 26% more mass. There was no difference at 10°C or in firmness or sugar/acid ratio at either temperature due to impact. In another test, both cultivars were equilibrated to 30, 10 or 5°C, then dropped as above. Both responded similarly: when dropped at 30°C, the respiration rate was >2.5 times higher than undropped; there was no significant difference in respiration due to impact for fruit at 10°C or 5°C. 'Windsor' also demonstrated propensity to lose more mass than 'Farthing' during storage at 1°C following hydrocooling. The former had 100% shrivel and almost 5% decay after 14 d of storage, while the latter had only 35% shrivel and no decay. These results demonstrate that significant differences exist between cultivars that must be taken into account in order to reduce postharvest losses.

NOTES

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