Symposium 14 (S14): Berry Crop Breeding, Production and Utilization for a New Century

Monday · August 12

Location: Metro Toronto Convention Centre, Room 201EF

1100–1140
S14–O–1
ENJOY A PHYTOCHEMICAL FRUIT COCKTAIL

Willy Kalt*

Agriculture and Agri-Food Canada, Atlantic Food and Hort. Res. Centre, 32 Main Street, Kentville, Nova Scotia, Canada, B4N 1J5

Public and scientific interest abounds in the health-promoting benefits of fruits and vegetables. Epidemiological evidence, in vitro studies and more and more in vivo data support a role for fruits and vegetables in reducing the risk of gastrointestinal and other cancers, cardiovascular disease and neurodegeneration associated with aging and illness. Many classes of phytochemicals are being examined, both in foods and in isolated forms. Among the popular North American small fruit crops—blueberries, strawberries, raspberries, blackberries and currants—the most notable phytochemicals are the polyphenolics. Also important are vitamin C and dietary fiber. Small fruits are rich in flavonoid polyphenolics including anthocyanin pigments, proanthocyanidins and flavonol glycosides. Also abundant in fruit are non-flavonoid polyphenolics such as the hydroxycinnamate derivative chlorogenicacid. The reputed human health-promoting properties of polyphenolics, especially the flavonoids, lie in their antioxidant, anti-inflammatory and immunomodulating activities. Other biological activities have also been reported. Recent results on the health promoting properties of small fruit crops will be reviewed in this presentation.

1140–1200
S14–O–2
ALTERING FLAVONOID GLYCOSYLATION FOR INCREASED BIOAVAILABILITY IN CRANBERRY THROUGH INTERSPECIFIC HYBRIDIZATION

Nicholi Vorsa*, James Polashock

P.E. Marucci Center, Rutgers Univ., 125A Lake Oswego Road, Chatsworth, NJ, USA, 8019

Various flavonoids, including anthocyanins, differ in antioxidant potential and bioavailability, as a function of their carbohydrate moiety. Bioavailability studies of flavonoids indicate glucosides may be the most bioavailable flavonoid conjugates. The fruit of the American cranberry, *Vaccinium macrocarpon* Ait., is recognized as having anthocyanins composed mostly of 3-O-galactosides (about 70%), followed by 3-O-arabinosides (22–33%), and to much lesser amount (5–6%), 3-O-glucosides of the aglycones cyanidin and peonidin. Fruit of another cranberry species *V. oxycoccus* has been found to contain predominately glucoside anthocyanins (60–70%), followed by arabinosides (about 25%), and less than 7% galactosides. We have successfully hybridized *V. macrocarpon* with *V. oxycoccus* L. (2n = 2x = 24). The *V. macrocarpon* x *V. oxycoccus* hybrids were intermediate in their fruit anthocyanin profiles having from 31 to 39 percent anthocyanin 3-O-galactosides, 36 to 49 percent anthocyanin 3-O-glucosides, and 17 to 23 percent anthocyanin 3-O-arabinosides. *V. macrocarpon* x *V. oxycoccus* hybrids are fertile in both self-pollinations and in backcrosses to *V. macrocarpon. V. oxycoccus* offers genes for increasing the glucosylated anthocyanins for greater bioavailability in American cranberry.

1200–1220
S14–O–3
BLUEBERRY POLYPHENOLICS PROTECT CULTURED NEURONS AGAINST DAMAGE DUE TO HYPOXIA AND OXIDATIVE STRESS

W. Kalt*[1], M.I. Sweeney[2], K.J. Clark[2], S.L. MacKinnon[3], K.T. Gottschall-Pass[4]

[1]Agriculture and Agri-Food Canada, Kentville Research Centre, 32 Main St., Kentville, Nova Scotia, Canada, B4N 1J5; [2]Dept. of Biology, Univ. of Prince Edward Island, Charlottetown, PE, Canada; [3]National Research Council, Halifax, NS, Canada; [4]Dept. of Family and Nutritional Science , Univ. of Prince Edward Island, Charlottetown, PE, Canada

Dietary supplementation with aqueous extract of lowbush blueberries (*Vaccinium angustifolium* Aiton) has recently been demonstrated to reduce neuronal damage after surgically-induced stroke in rats. Blueberry-enriched diets have also been shown to reverse age-related declines in motor and cognitive function in rats. The mechanistic basis and the compounds responsible for this in vivo protection are examined here. Neurons were isolated from the cerebellum of neonatal rats, then grown in 97% pure primary cultures, and challenged with a 6hr incubation of oxygen-glucose deprived medium (OGD), to simulate a stroke, or 100 μM hydrogen peroxide, to induce oxidative stress. During both challenges, neurons were treated with either a mixture of lowbush blueberry polyphenolics or an enriched fraction of blueberry anthocyanins, and the resulting cell death was quantified compared to controls. In this model, hypoxia- or peroxide-induced damage is indicated by extracellular lactate dehydrogenase (LDH) activity, reflecting disruption of the plasma membrane (necrosis), while induction of caspase-3 activity reflects apoptosis. A blueberry polyphenolic mixture (30–1000 ng/mL) reduced both OGD- and hydrogen peroxide–induced necrotic cell death, which was apparent by a 33–79% decline in extracellular LDH. Phenolic mixtures also provided protection against apoptotic neuronal death, apparent by a 66–96% lower induction of caspase-3 activity. Protection by blueberry phenolics against necrotic and apoptotic neuronal cell death was both potent (EC_{50} = 40–50 ng/mL and 9–10 ng/mL, against necrosis and apoptosis, respectively) and efficacious (maximum 98% reductions). An anthocyanin-enriched fraction also provided protection to neuronal cells, blocking apoptosis by up to 94% (EC_{50} = 20 ng/mL). However anthocyanins were less potent and less efficacious than the polyphenolic mixture in reducing necrosis (EC_{50} = 300-500 ng/mL; maximum 49-67% reduction). These results indicate that lowbush blueberry polyphenolics, including anthocyanins, can protect neurons against damage induced by hypoxia or reactive oxygen species. In this case a combination of polyphenolic groups was more effective than a single group. The effect of proanthocyanin-rich fractions from blueberries are still being investigated.

1220–1240
S14–O–4
PRELIMINARY OBSERVATIONS ON ADAPTATION AND NUTRICEUTICAL VALUES OF BLUE HONEYSUCKLE (*LONICERA CAERULEA* L.) IN OREGON, USA

Maxine Thompson*, Arusa Chaovanalikit

Dept. of Horticulture, 4017 Ag & Life Sciences Bldg, Oregon State Univ., Corvallis, OR, USA 97331

Blue honeysuckle is a commercial berry crop in Russia and Japan and is also widely harvested from wild plants in regions of China, Japan, and Russia where plants are native. However, this species is virtually unknown in North America as an edible berry. To investigate the possibility of establishing this northern, severe climate species as a successful new crop in the relatively mild climate of the Pacific Northwest, a broad array of germplasm has been assembled, including 27 Russian cultivars/selections and representatives of the six subspecies used for cultivar development in Asia. Because of the extremely wide geographic range and diversity of this polymorphic species, there is good potential to select individuals adapted to our environment. Herein are reported the first 3 years' observations of Russian cultivars and about ,000 seedlings from several sources in Russia, China, and Japan. Records have been made on seed germination, growth of seedlings, length of juvenile period, and phenological traits such as dates of leafing out, flowering, fruit maturity, second flowering, summer leaf senesence, and leaf fall. Yields of 1- to 3-year-old plants have been recorded and berries evaluated. The development of successful cultivars will provide not only a new, unique-flavored, edible berry but also an excellent source of nutriceutical preparations. The relatively high values of total anthocyanin pigments and antioxidant properties as a measure of Oxygen Radical Absorbing Capacity (ORAC) discovered in initial analyses of several representative samples, and reported here, indicate that this species is worthy of more extensive investigation for these valuable compounds.

1340–1440
S14–P–5
PREHARVEST TEMPERATURE AFFECTS ANTIOXIDANT CAPACITY IN STRAWBERRY

Shiow Y. Wang*, W. Zheng

Fruit Laboratory, Bldg 010A, U.S. Dept. of Agriculture, 10300 Baltimore Ave.,

Beltsville, MD, USA, 20705-2350

The influence of four day/night growing temperature combinations (18/12, 25/12, 25/22, 30/22 °C) on phenolic acid, flavonol, and anthocyanin content and antioxidant activities in fruit juice of strawberry (*Fragaria xananassa* Duch.) was studied. Pelargonidin-based anthocyanins such as pelargonidin 3-glucoside, pelargonidin 3-rutinoside, and pelargonidin 3-glucoside-succinate were the predominant anthocyanins in strawberry fruit juice. The content of cyanidin-based anthocyanins, cyanidin 3-glucoside and cyanidin 3-glucoside-succinate, were much lower than pelargonidin-based anthocyanins. Strawberry growth in high temperature conditions significantly enhanced p-coumaroylglucose, dihydroflavonol, quercetin 3-glucoside, quercetin 3-glucuronide, kaempferol 3-glucoside, kaempferol 3-glucuronide, cyanidin 3-glucoside, pelargonidin 3-glucoside, pelargonidin 3-rutinoside, cyanidin 3-glucoside-succinate and pelargonidin 3-glucoside-succinate content in strawberry juice. Plants grown in the cool day and night temperature condition (18/12 °C) generally had the lowest phenolic acid, flavonol, and anthocyanin content. An increase in night temperature from12 to 22 °C, with the day temperature kept constant at 25 °C, resulted in a significant increase in phenolic acid, flavonol, and anthocyanin content. An increase in night temperature from 12 to 22 °C, with the day temperature kept constant at 25 °C, also resulted in a significant increase in antioxidant capacity. The highest day/night temperature (30/22 °C) yielded fruit with the highest phenolic content as well as free radical absorbance capacity.

1340–1440

S14–P–6

ANTIOXIDANTS IN OHIO BERRIES

Richard C. Funt*

Dept. of Horticulture & Crop Scienc, The Ohio State Univ., 2001 Fyffe Court, Columbus, OH, USA, 43210-1096

Increasing the level of antioxidants in the human body has shown a number of possible human health benefits. Research at The Ohio State Univ. James Cancer Research Hospital has indicated that strawberries and raspberries, which are high in antioxidants, can reduce the risk of cancer in rats. Recent observations indicate that more than one component within berries is responsible for reduced levels of cancer. Ellagic acid, total phenolics, ORAC analysis, anthocyanin and other components will be discussed. This preliminary research is to discover how these components are different among cultivars and growing conditions.

1340–1440

S14–P–7

BERRIES FROM DOMESTIC RESOURCES FOR THE FRUIT PROCESSING INDUSTRY IN GERMANY: POSSIBILITIES AND CONSTRAINTS

Erich Schmidt*, Kai Maack

Institute Economics in Horticulture, Chair, Market Analysis & Ag. Policy, Herrenhaeuser Str. 2, Hannover, Niedersachsen (Lower Saxonie), Germany, D-30419

German production of canned fruits, jam and fruit preparation for the dairy industry highly depend on berries as charge material–mainly strawberries, raspberries, but also black and red currents, blueberries and gooseberries. On average, 45% of the berry based final products in terms of quantity is raw material, and–depending on the price for the primary products—25% to 45% of the ex factory unit values goes to the cost for berries. For years the fruits have been almost exclusively imported from the co-called Middle and Eastern European Countries. During the ongoing transition process of these economies, supplies and the price of berries fluctuate heavily. The main reasons are lower production capacities, higher production variability, the lack of market transparency due to the elimination of the former state trading organisations, and—last but not least–gradually tightened protectionism of the Common Agricultural Policy (complicate and complex systems of import quotas, minimum import prices and import duties, different for different berries and aggregates and for different origin). The negative changes in berry scarcities and prices gave rise to look for safeguarding the supplies of raw materials. The obvious thing to do is to check opportunities to take up or increase domestic berry production for processing. Calculations have been undertaken to assess production costs and margins for strawberries, raspberries, black currents, blueberries and gooseberries. The evaluation of economic efficiency shows that due to high labour cost, German berry production is feasible in special situations only. In any case, however, one indispensable prerequisite for domestic production are contractual agreements on a well-balanced distribution of risks and risk premiums between farmers and processors. The reason is that berry production is characterized by high initial investment, unproductive first year(s) of cultivation, and long pay-off periods.

1340–1440

S14–P–8

EFFECTS OF ETHREL APPLICATION ON RABBITEYE BLUEBERRY FRUIT RIPENING

Mihoko Kugishima*[1], Takuya Ban[1], Tsuneo Ogata[2]

[1]Faculty of Life and Environmental Science, Shimane Univ., Kamihonjo 2059, Matsue, Shimane, 690-1102, Japan; [3]Graduate School of Agriculture and Biological Sciences, Osaka Prefecture Univ., Gakuencho1-1, Sakai, Osaka, 599-8531, Japan

It has been reported that Ethrel (2-Chloroethylphosphonic acid) would stimulate blueberry fruit ripening. However, its effect on other fruit quality factors have not been clarified. In this study, we investigated the effects of Ethrel application on fruit size, total soluble solids, titratable acidity and anthocyanin content of rabbiteye blueberry. Ethrel at 200, 300 and 500 ppm were applied to rabbiteye blueberry fruit ('Homebell') with a hand-sprayer exactly four days before the initiation of fruit coloration. Ripe-fruit (fully blue-colored visibly) were harvested at three-day intervals from July 23 to August 13, 2001. Each berry was weighed and analyzed for total soluble solids, titratable acidity and anthocyanin content. Ethrel accelerated fruit coloring and shortened the period to harvest, resulting in that approximately 90% of the fruits could be harvested by the second harvesting. Compared to the controls, Ethrel increased marketable fruit number and titratable acid content; it reduced fruit size and total soluble solids of the harvested fruit from the first and second harvesting. Our results showed that Ethrel would stimulate the accumulation of anthocyanin in blueberry fruit, but did not promote the other factors related to fruit ripening such as increment in total soluble solids and decrement in titratable acidity.

1340–1440

S14–P–9

ROLE OF CHALCONE SYNTHASE AND DIHYDROFLAVONOL REDUCTASE IN LIGHT DEPENDENT ACCUMULATION OF ANTHOCYANINS IN 'TOYONOKA' STRAWBERRY FRUITS

Yuhua Li*[1], Ryozo Sakiyama[2], Saneyuki Kawabata[2]

[1]Research Institute of Flower Biotechnology, College of Landscape Architecture, Northeast Forestry Univ., P.O.Box 333, No. 26, Hexing-Lu, Harbin 150040, China; [2]Laboratory of Horticultural Science, Graduate School of Agricultural and Life Sciences, Univ. of Tokyo, Bunkyo-ku, Tokyo 113-8657, Japan

The pigmentation of 'Toyonoka' strawberry fruits, which have an excellent taste and flavor, is known to be sensitive to light conditions. Due to this characteristics, this cultivar requires additional labor to make the fruit evenly pigmented. Fruits of 'Nyoho', which is one of the most popular strawberry cultivar in Japan, pigment well even under low light intensities. The effects of light intensity received by the fruit surface on anthocyanin biosynthesis were compared between these two cultivars. Fruits of 'Toyonoka' were collected at green fruit stage (GF; 2 weeks after anthesis), white fruit stage (WF; about 3 weeks after anthesis), the onset of pigmentation (OP; 1-2 days after white fruit stage), pink fruit stage (PF; 3-4 days after white fruit stage), and full pigmentation stage (FP; 8 days after white fruit stage). The expression of chalcone synthase (CHS) gene was highest at GF stage, declined at OP stage, and then remained constant during all pigmentation stages. The expression of dihyroflavonol reductase (DFR) gene was low at OP stage and then increased as fruit pigmented. This suggested that DFR but not CHS was involved in the developmental regulation of anthocyanin biosynthesis. When fruits of 'Toyonoka' were shaded by wrapping with aluminum foil after WF or OP stage, the accumulation of anthocyanins was remarkably reduced. The shading of 'Nyoho' fruits after WF stage also reduced the accumulation of anthocyanins, but the content was not lower than that of unshaded 'Toyonoka' fruits. Northern blot analysis showed that the expression of both genes was not affected by fruit shading. It suggested that both CHS and DFR were not involved in light dependent biosynthesis of anthocyanins in 'Toyonoka' strawberry fruits.

1340–1440

S14–P–10

VARIATION IN FLAVONOL CONTENT AMONG BERRY CULTIVARS GROWN UNDER NORTHERN CONDITIONS

A. Hukkanen*, M. Anttonen, H. Kokko, S. Kärenlampi, R. Karjalainen

Univ. of Kuopio, Ecol Env Sci, POBox 1627, FIN-70211 Kuopio, Finland

Flavonoids are a large and diverse group of over 4000 secondary plant products, comprising anthocyanins, flavonols, flavones, catechins and flavanones. Flavonoid-derived plant compounds are known to act as protective nutrients possessing antioxidant and free radical scavenging activity in foods. The HPLC-based quantitative procedure with improved extraction and hydrolysis was used to analyze the content of flavonols, quercetin, kaempferol and myricetin in black currant, raspberry and strawberry cultivars grown under northern conditions. Myricetin was the most abundant flavonol in black currant, followed by quercetin and kaempferol. High variability in flavonol contents among black currant cultivars was found. In strawberry, quercetin was the most abundant flavonol, but its amount was 5 times smaller than that in black currant cultivars. The kaempferol levels in strawberry were similar to those in black currant. The levels of quercetin and kaempferol varied greatly among strawberry cultivars. Quercetin was the only flavonol found in raspberry, and its content varied widely among cultivars. Flavonols were also analyzed from black currant and strawberry cultivars grown in organic and conventional ways, but no consistent differences were found. The high variability in the levels of flavonols in different berry cultivars offers possible avenues for identifying and selecting cultivars rich in certain flavonols for the special production of berries for industrial use.

1340–1440

S14–P–11

SUGAR, ORGANIC ACID LEVELS AND COLOR TRAITS IN STRAWBERRY FRUITS

Ebru Kafkas[1], Sevgi Paydas*[1], Mine Kosar[2], Ibrahim Tayfun Agar[1], Kazim Husnu Baser[2]

[1]Univ. of Cukurova, Faculty of Agriculture, Dept. of Horticulture, Adana, Turkey, 1330; [2]Univ. of Anadolu, Faculty of Pharmacy and Medicinal Plant and Drug Research Center (TBAM), 26470 Eskisehir, Turkey

The major soluble constituents of ripe strawberries are soluble sugars and organic acids. Sugar accumulation which is a very important physiological process, determines the fruit quality of sweet strawberries . Organic acids are responsible for the tartness of the fruit. The sugar/organic acid ratio is a major parameter of strawberry taste and flavor. Fruit color is also an important character that attracts consumers. Anthocyanidins are responsible for attractive fruit colors. Such pigments are one of the most important aesthetic components being natural indicators of fruit ripeness. The objective of present study is to characterize 16 strawberry progenies and their parents with regard to their fruit sugar and organic acid levels and colors. Soluble sugars and organic acids were separated, identified and quantified using High Performance Liquid Chromatography with refractive index and Photo diode array detections, respectively. Ranges for external (skin) and internal (flesh) L*, h and C* values of strawberry genotypes were determined using Minolta chromometer. Considerable variation in the soluble sugars and organic acids contents and color rates were determined among 20 genotypes. The details of the result will be discussed in the poster.

1340–1440

S14–P–12

THE EXPRESSION OF ANTHOCYANIN BIOSYNTHETIC PATHWAY GENES IN RABBITEYE BLUEBERRY FRUIT

Takuya Ban*[1], Megumi Ishimaru[2], Shozo Kobayashi[3]

[1]Faculty of Life and Environmental Science, Shimane Univ., Kamihonjo, Matsue, Shimane, 690-1102, Japan; [2]Graduate School of Agriculture and Biological Sciences, Osaka Prefecture Univ., Gakuencho1-1, Sakai, Osaka, 599-8531, Japan; [3]Dept. of Grape and Persimmon Research, National Institute of Fruit Tree Science, Akitsu, Hiroshima, 729-2494, Japan

The expression of anthocyanin biosynthetic pathway genes in rabbiteye blueberry is still unknown. In this study, using two blueberry cultivars ('Bluebelle'and'Tifblue'), we investigated the expression of anthocyanin biosynthetic pathway genes(phenylalanine ammonia lyase [PAL], chalcone synthase [CHS], flavanone-3-hydroxylase [F3H], dihydroflavonol-4-reductase [DFR], leucoanthocyanin dioxygenase [LDOX], UDP glcose-flavonoid 3-o-glucosyl transferase [UFGT]) in five different developmental stages(immature, mature green, just beginning to color, fully colored red, fully colored blue-purple). Northern blot analysis showed that the six anthocyanin biosynthetic pathway genes were expressed in immature berries. The expression of all genes examined except UFGT were reduced in mature green berries. In contrast, the UFGT gene was highly expressed in mature green 'Bluebelle' berries. All genes were expressed again in berries that had just begun to color, and the expression was continued through to the fully colored red berry stage. In fully colored blue-purple berries, the expression was slight. Boss et al(1996) reported that the major control point to anthocyanin biosynthesis in grape skin is UFGT, and this control point is later in the pathway than has been observed in studies with maize, petunia and snapdragon anthocyanin biosynthesis. In this study, we investigated the expression of anthocyanin biosynthetic genes in blueberries. Our result showed that, the control point of anthocyanin biosynthesis in blueberry is different from that of grape, maize, petunia and snapdragon.

1340–1440

S14–P–13

MODIFIED ATMOSPHERE STORAGE AND ETHYLENE ABSORBENT ENABLES PROLONGED STORAGE OF 'HAYWARD' KIWIFRUITS

M. Pekmezci*, M. Erkan, H. Gubbuk, I. Uzun, I. Karasahin

Dept. of Horticulture, Faculty of Agriculture, Akdeniz Univ., Antalya, Turkey, 07058

In this study, the effects of modified atmosphere storage and ethylene absorbent on flesh firmness, titratable acids, soluble solids, ascorbic acid, chilling injury and percentage of decay of 'Hayward' kiwifruit were evaluated. The experiments were performed at 0 °C and 90% relative humidity using 50 x 70 cm polyethylene bags. Fruits stored in modified atmosphere with ethylene absorbent during storage were firmer, had higher titratable acids, ascorbic acid and lower weight loss than the control fruits. After a 6 month storage period, the highest percentage of marketable kiwifruits was obtained from the fruits kept in modified atmosphere with ethylene absorbent. In modified atmosphere conditions, the percentage of O_2 concentration decreased to 6–8% and CO_2 percentage increased to 7–9% at the end of 6 month storage.

1440–1500

S14–O–14

PHENOLIC COMPONENTS IN CULTIVATED AND WILD STRAWBERRIES OF CANADA AS SOURCES FOR ANTIOXIDANT NUTRACEUTICALS

Rong Tsao*[1], Adam Dale[2]

[1]Food Research Program, Agriculture and Agri-Food Canada, 93 Stone Road West, Guelph, Ontario, Canada N1G 5C9; [1]Dept. of Plant Agriculture, Horticultural Research Institute of Ontario, Univ. of Guelph, P.O. Box 587, Simcoe, Ontario, Canada N3Y 4N5

Strawberries are one of the richest antioxidant sources among commonly consumed fruits and vegetables. The antioxidant activity of strawberries has been attributed to the phenolic compounds. However, the phenolic content of strawberry could vary significantly depending on the cultivar, state of ripeness, harvesting time, and geographical location. In Canada dozens of different cultivated and wild strawberry varieties exist. We have examined 26 cultivated and 26 Canadian wild strawberry varieties for their total phenolic contents and antioxidant activities. We found that the total phenolic contents (TPC) varied markedly among both cultivated and wild varieties, ranging from 284-768 mg/mL gallic acid equivalent (GAE) for the former and 420-820 mg/mL GAE for the latter. Total anthocyanin contents (TAC) also varied significantly, with 111-455 mg/mL Pelargonidin-3-glucoside equivalent (PGE) and 88-479 mg/mL PGE, respectively. The TPC and TAC in the cultivated varieties correlated positively ($R = 0.65$), however, the two did not correlate in the wild varieties ($R = 0.31$). We concluded that in cultivated varieties, anthocyanins may be a major contributor to the TPC, however in wild strawberries, phenolic compounds other than anthocyanins may have affected more significantly on the TPC. This may also explain why a greater difference in the TPC was seen between the cultivated and wild strawberries, i.e. 475 and 600 mg/mL GAE, respectively, and only a small difference was seen in the TAC, 278 and 241 mg/mL PGE, respectively. The antioxidant activity was found positively correlated to both TPC and TAC in cultivated strawberries, but the same cannot be said for the wild strawberries. These and further information from our studies on the antioxidant capacity of individual phytochemicals such as phenolic acids and polyphenols are to be incorporated into the breeding program for breading antioxidant-rich, high quality varieties. Such strawberry variety, when processed into nutraceuticals or developed into functional foods, will add additional values to this delicious fruit.

1500–1520
S14–O–15
L'AUTHENTIQUE ORLÉANS: A NEW STRAWBERRY CULTIVAR WITH HIGH LEVELS OF ANTIOXIDANTS

Shahrokh Khanizadeh*[1], Johanne Cousineau[1], Louis Gauthier[2], Deborah Buszard[3]

[1]Agriculture and Agri-Food Canada, HRDC,430 Gouin Blvd., St-Jean-sur-Richelieu, QC, Canada, J3B 3E6; [2]Les Fraises de l' Île d'Orléans Inc., St-Laurent, Île d'Orléans, QC, Canada, G0A 3Z0; [3]Dept. of Plant Science, McGill Univ., Ste-Anne-de-Bellevue, QC, Canada, H9X 1C0

A new project was started in 1996 by Agriculture and Agri-Food Canada, Les Fraises de l'Île d'Orleans Inc. and McGill Univ. to develop firm strawberry cultivars with a long shelf life suitable for transportation. Initially, five selections (FIO-9623-55, FIO-9524-74, FIO-968-1, FIO-9624-11, FIO-9623-40) were retained and entered into advanced trials. FIO-9623-55 was re-selected for its good shelf life and high yields of firm, large fruit. Chemical analysis of the fruit revealed high levels of proanthocyanidins. In a separate project, proanthocyanidins were shown to enhance fruit preservation because of their antifungal properties and a correlation was found between the level of proanthocyanidins in cultivars and shelf life. Selection FIO-9623-55 is being released under the name 'L'Authentique Orléans'. It is a June-bearing strawberry cultivar (*Fragaria x ananassa* Duch.) bred for Eastern Central Canada and more specifically for Île d'Orleans growing conditions. 'L'Authentique Orléans' is a progeny resulting from a cross between two recently released cultivars from our station, 'AC-L'Acadie' and 'AC-Joliette, made by S. Khanizadeh. 'L'Authentique Orléans' has been tested at the Agriculture and Agri-Food Canada substation in L'Acadie, Quebec and at Île d'Orleans, Quebec, since 1997. It outyielded 'Annapolis' and 'Kent' in both trials and had the highest levels of the antioxidants ellagic acid, gallic acid, catechin and epicatechin compared to 23 other strawberry cultivars tested including 'Kent' and 'Annapolis'. Additional information on this new cultivar can be obtained from Les Fraises de l' Île d'Orleans Inc. (LG) or from Agriculture and Agri-Food Canada (SK).

1520–1540
S14–O–16
EFFECT OF MATURITY LEVEL AND HARVEST DATE ON SOLUBLE SOLIDS AND TITRATABLE ACIDITY IN FRUIT OF STRAWBERRY GROWN IN A WINTER, ANNUAL HILL PRODUCTION SYSTEM

Craig K. Chandler*[1], Mark E. Herrington[2], Ann Slade[2]

[1]Gulf Coast Research & Education Center, Univ. of Florida, 13138 Lewis Gallagher Road, Dover, FL 33527 USA; [2]Maroochy Research Station, Queensland Horticulture Institute, PO Box 5083 SCMC, Nambour, QLD 4560 Australia

Six strawberry cultivars (Camarosa, Selva, Kabarla, Joy, Flame, and Sweet Charlie) were grown in a raised bed, annual hill production system at Nambour, Queensland (26º S. latitude) in 2000. Four replications of each cultivar were arranged in a randomized complete block design. Fruit of five different maturities, from red (M1) to fully ripe (M5), were harvested from each plot, four to seven times over a three month period (June – August), and analyzed for soluble solids (SS) and titratable acidity (TA). There was a positive relationship between maturity level and SS and a negative one between maturity level and TA. Within harvest date, cultivar rankings for SS and TA based on M1 fruit data were essentially the same as rankings based on M5 fruit data. Between harvest dates, cultivar rankings shifted somewhat for SS, but not for TA. 'Sweet Charlie' and 'Joy' had the lowest TA; 'Camarosa' and 'Selva' were intermediate; and 'Kabarla' and 'Flame' had the highest TA. These data suggest that to identify genotypes with high SS, fruit samples should be collected and analyzed several times over the course of the season, whereas to identify genotypes with low TA, data from a single harvest may be sufficient.

1540–1600
S14–O–17
COMPARISON OF CELL WALL COMPONENTS BETWEEN COMPARISON OF CELL WALL COMPONENTS BETWEEN *FRAGARIA* X *ANANASSA* AND *FRAGARIA CHILOENSIS* GROWN IN CHILE

Takashi Nishizawa[1], Sayuri Nagasawa[1], Jorge B. Retamales*[2], Arturo Lavín[3], Yoshie Motomura[4]

[1]Faculty of Agriculture Yamagata Univ. Tsuruoka Yamagata, 997-8555 Japan; [2]Facultad de Ciencias Agrarias Univesidad de Talca Casilla 747, Talca, Chile; [3]Centro Experimental Cauquenes Instituto de Investigaciones Agropecuarias Casilla 165 Cauquenes, Chile; [4]Faculty of Agriculture and Life Sciences, Hirosaki Univ. Hirosaki 036-8561, Japan

Fruit firmness and cell wall composition were compared among five cultivars of *F.* x *ananassa* ('Chandler', 'Seascape', 'Tudla', 'Hokowase' and 'Reiko') and two land races of *F. chiloensis* (94BAU1A and 97PUR1A) that were grown near the coastal town of Chovellen, Maule Region, Chile (Lat. 35°56'S). Fruit size of *F. chiloensis* was smaller than *F.* x *ananassa*. Firmness of the epidermal tissue did not differ significantly between *F.* x *ananassa* and *F. chiloensis*. But firmness of the cortical tissue was significantly lower in *F. chiloensis*, and as a result, difference in firmness between epidermal and cortical tissues was significantly greater in *F. chiloensis* than in *F.* x *ananassa*. Receptacle calcium concentration was significantly lower in 'Reiko' and ' Hokowase' than the rest of the *F.* x *ananassa* varieties used in this study; and land races of *F. chiloensis* had intermediate levels between these two groups. Total uronic acids in the cell wall fraction were significantly higher in *F. chiloensis* than in *F.* x *ananassa*, mainly due to their high concentration in the water-soluble fraction. Non-cellulosic neutral sugars, especially arabinose in water CDTA-, and Na2CO3-, and KOH-soluble fractions, was significantly lower in *F. chiloensis* than in *F.* x *ananassa*. Moreover, cellulose concentration of *F. chiloensis* was significantly lower than that of *F.* x *ananassa*.

1600–1620
S14–O–18
EFFECTS OF GROWTH ENVIRONMENTS ON STRAWBERRY FRUIT FLAVOUR COMPONENTS

T. McBurney*[1], C.J. Wright[2], R. Watson[2]

[1]ADAS Rosemaund Preston Wynne Hereford HR1 3PG UK; Univ. of Nottiingham School of Biological Sciences Sutton Boningtton Campus Loughborough Leicestershire LE12 5RD UK

The characteristic flavour of fresh strawberry fruit is a complex interaction between a large number of volatile and non-volatile chemicals. For reasons that are not fully understood, there is considerable variation in the chemical profile of fruit of the same cultivar harvested at different locations, seasons, and even within a single harvest period of the same crop. This variation is thought to account for consumer disappointment with some crops. Two experiments were conducted on strawberries cv Elsanta raised in glasshouses in peat bags and irrigated continuously with a dilute nutrient solution. In each case, fruits were regularly sampled and analysed using Atmospheric Pressure Chemical Ionisation (APCI) and LC-MS techniques for 15 volatiles and 3 non-volatiles, sucrose, glucose and citric acid implicated in strawberry flavour. In the first experiment, water stress treatments were imposed at the onset of fruit ripening in May. Irrigation was withheld until volumetric moisture content of the peat media had reached 35% or 20% (after 5d and 6d respectively) then irrigation was restored to that of control plants maintained at 60%. In the second experiment, plants were subjected to three shading levels (0%, 25%, 47%) for two weeks prior to first fruit ripening in June. In both experiments the concentration of fruit flavour components varied predominantly with harvest date. For successive harvests in May/June (first experiment) non-volatiles increased and volatiles decreased. For harvests in June/July (second experiment) non-volatiles decreased and volatiles were variable. Water stress treatments decreased yields and volatile concentrations, but non-volatiles were unaffected (in contrast with preliminary trials where sugars increased with water stress). Shading treatments reduced yields and concentrations of both volatile and non-volatiles. We discuss the implications of these results for the potential manipulation fruit flavour quality using growth environments.

1620–1640
S14–O–18–A
TO BE ANNOUNCED

1640–1700
S14–O–18–B
TO BE ANNOUNCED

Tuesday · August 13

1100–1140
S14–O–19
BERRY BREEDING'S CHALLENGE FOR THE NEW CENTURY: CONSUMER SAFETY AND SATISFACTION, THE EXAMPLE OF THE STRAWBERRY

Phillipe Roudeillac*

Centre Interrégional de Recherche Expérimentation Fraise (CIREF), LANXADE, F24130, Prigonrieux., France

If the agricultural challenge of the 20th Century was to feed a rapidly expanding world population following two world wars, then our efforts in the 21st Century will be increasingly focussed on food quality and safety. In berry crops genetic improvement for fruit quality often occurs at the expense of productivity, a theme that is well illustrated by the strawberry. This presentation examines the expectations of consumers with respect to fruit quality and safety and the expectations of growers with respect to plant productivity and reasonable financial returns. Using the strawberry as a model, we will examine how plant breeders are addressing these often conflicting demands through a combination of genetic improvement and innovative crop management systems.

i

1140–1200
S14–O–20
DEVELOPMENT OF A SCAR MARKER LINKED TO THE GENE AN2 CONFERRING RESISTANCE TO COLLETOTRICHUM ACUTATUM IN STRAWBERRY (*FRAGARIA* X *ANANASSA*)

Estelle Lerceteau-Köhler[1], Guy Guérin[2], Philippe Roudeillac[1], Frédéric Laigret*[2], Béatrice Denoyes-Rothan[2]

[1]Centre Interrégional de Recherche et d'Expérimentation de la Fraise (Ciref), Lanxade, 24130, Prigonrieux, France; [2]Institut National de la Recherche Agronomique (INRA). Unité de Recherche sur les Espèces Fruitières et la Vigne, BP 81, 33883, Villenave d'Ornon Cedex, France

In the southwestern area of France, the main disease of the cultivated strawberry is anthracnose, caused by Colletotrichum acutatum. Two pathogenicity groups have been characterised. Resistance to pathogenicity group 2 is controlled by one dominant gene (An2) while resistance to pathogenicity group 1 seems quantitative and polygenic. In parallel to a strategy dealing with the mapping of QTLs associated with the complex resistance, bulk segregant analysis (BSA) combined with the AFLP markers has been carried out for the detection of markers linked to the dominant gene. A full-sib family originating from a cross between a heterozygous and a recessive homozygous parent for the resistance gene has been used from which four DNA bulks (resistant and susceptible) were developed. One hundred and ten AFLP primer combinations were analysed generating 6260 markers. Among them four markers were found linked to the dominant gene with a recombination percentage ranging from 0 to 18.1% based on 78 individuals. The closest markers have been converted into SCAR (Sequence Characterised Amplified Regions) and tested on several varieties both resistant and susceptible to the disease in order to study their efficiency at the variety level. The association between the presence of the SCARs and the genotype of the variety at the resistance gene will be discussed as well as the possible integration of the SCARs in a breeding program.

1200–1220
S14–O–21
ENHANCEMENT OF FREEZING TOLERANCE OF STRAWBERRY BY HETEROLOGOUS EXPRESSION OF CBF1

Christopher L. Owens*, Amy F. Iezzoni, James F. Hancock

Dept. of Horticulture, Michgian State Univ., East Lansing, MI 48824 USA

Many rosaceous fruit crops suffer yield reductions due to early season freezes during or just prior to bloom. Fruit cultivars with improved floral freezing tolerance would be one approach to alleviate this problem. In model plant systems, researchers have been able to identify genes that play a role in freezing tolerance by identifying proteins regulated in response to cold temperature. Even though freezing tolerance is a complexly inherited trait, manipulation of just one gene, CBF1, a cold-induced transcription factor important in the cold acclimation response, has been shown to improve the whole plant freezing tolerance of Arabidopsis. In order to help determine if the CBF1 and the CBF1 regulon are conserved in the Rosaceae, the effect of CBF1 over-expression on strawberry freezing tolerance was determined. Agrobacterium-mediated transformation of a CaMV35S-CBF1 construct was conducted on *Fragaria* x *ananassa* 'Honeoye' crown discs. Two transgenic lines were regenerated that expressed the transgene at low levels in both leaves and receptacles with pistils. Receptacles with attached pistils of the transgenic lines showed no significant change in freezing tolerance when compared to wild type plants. However, the temperature at which 50% electrolyte leakage occurred in detached leaf-discs from the two transgenic lines was -8.2 °C and -10.3 °C, respectively. These freezing tolerance values were significantly greater than the value for the wild-type 'Honeoye' leaf discs of -6.4 °C.

1220–1240
S14–O–22
RESISTANCE TO BLACK ROOT ROT AMONG WILD CLONES OF STRAWBERRY, *FRAGARIA VIRGINIANA* AND *F. CHILOENSIS*

Chad Osborn*, James Hancock

Dept of Horticulture, Plant and Soil Science Building, Michigan State Univ., East Lansing, MI, USA, 48823

Black Root Rot (BRR) is a devastating root disease that affects all strawberry cultivars and is thought to be caused by a complex of pathogens that include root lesion nematode, *Pratylenchus penetrans*, and two soil fungi, *Rhyzoctonia* spp. and *Pythium ultimum*. Soil fumigation with methyl bromide is standard practice to combat BRR in annual strawberry production and is recommended for perennial matted row culture; however, methyl bromide is a known ozone depletor and will to be phased out of production by 2005. To facilitate the breeding of resistant cultivars, we have begun screening native germplasm for their resistance to BRR. Our specific goals are to i) identify pathogens involved in BRR and monitor their levels in strawberry fields across MI, ii) screen wild genotypes for tolerance and/or resistance to identified pathogens, and iii) determine if resistance to soil-borne pathogens is narrow or broad. In 1999, 38 native strawberry clones of *F. virginiana* and *F. chiloensis* were evaluated on a site with a history of BRR symptoms in Michigan. Seven genotypes were selected whose runner production and yield were least affected by the absence of fumigation. These seven wild clones, along with three susceptible cultivars, were planted September 1999 in four fields across MI using a split plot factorial design with two replications, fumigation vs. no fumigation. The roots from soil cores were measured, weighed and segments from the lesioned areas were incubated on V-8 agar. Over 70% of the root samples were infected with Pythium ultimum. Roots from non-fumigated soil averaged 3.4 *P. ultimum* spores/mm of root, while roots from fumigation averaged 0.6 spores/mm of root. Genotype performance was evaluated in the 2000 and 2001 seasons by measuring several horticultural related traits. Three clones showed high vigor on non-fumigated soils, with FRA 368, a *F. chiloensis* clone from Alaska, displaying the highest level of genetic resistance.

1340–1440
S14–P–23
'AC-SAINT-PIERRE' STRAWBERRY

Shahrokh Khanizadeh*[1], Johanne Cousineau[1], Martine Deschênes[2], Audrey Levasseur[3], Odile Carisse[4], Jennifer DeEll, Louis Gauthier, Alan Sullivan

[1]Agriculture and Agri-food Canada, Horticultural Research and Development Centre, 430 Gouin Blvd., St-Jean-sur-Richelieu, Quebec, J3B 3E6, Canada; [2]Ontario Ministry of Agriculture, Food and Rural Affairs, 4890 Victoria Ave N, Box 8000 Vineland Station, ON, Canada, L0R 2E0; [3]Les Fraises de l' Île d'Orléans Inc., St-Laurent, Île d'Orléans, QC, Canada, G0A 3Z0; [4]Univ. of Guelph, Dept. of Plant Agriculture, Edmund C. Bovey Bldg., Guelph, ON, Canada, N1G 2W1

'AC-Saint-Pierre' is a new June bearing strawberry cultivar (*Fragaria* x *ananassa* Duch.) bred for Eastern Central Canada and climates similar to Quebec conditions. 'AC-Saint-Pierre' was released because of its very large, firm light red coloured fruit and its keeping quality lasting several days after harvesting or maturing in the field. The fruit colour does not darken during storage and has a similar level of antioxi-

dants (Gallic Acid, Protocatecuic A., Catechin, P-hydroxybenzoic A., Epicatechin, and Ellagic Acid) as others with good shelf life. It is ideal for growers who need to store fruit for several days before marketing. The Prefix 'AC' in the name is the abbreviation for 'Agriculture and Agri-Food Canada' and 'Saint-Pierre' is a village located in Ile d'Orléans, Quebec. The area is well known for its production of horticultural crops, including strawberries. 'Saint-Pierre' was first licensed to "Les Fraises de l'Ile d'Orléans Inc.", located in Saint-Pierre.

1340–1440

S14–P–24

BREEDING OF FUSARIUM WILT-RESISTANT STRAWBERRY CULTIVAR SUITABLE FOR OPEN CULTURE IN NORTHERN JAPAN

H. Takahashi*, Y. Yoshida, H. Kanda, H. Furuya, T. Matsumoto

Dept. of Biological Production, Akita Prefectural College of Agriculture, Ohgatamura, Akita, Japan

Fusarium wilt of strawberry, which is caused by *Fusarium oxysporum* f. sp. fragariae, is a very serious soilborne disease in cooler regions of Akita Prefecture in Northern Japan. The initial infestation of susceptible cultivar Morioka-16 and Pajaro with the disease in Akita Prefecture was noted at minimum air and soil temperature of ca. 15 °C in the end of May. As the time advanced to the high temperature season (the beginning to the middle of July) the numbers of the disease plant increased rapidly and died. Effective control of this disease has yet to be found. Breeding for new resistance strawberry cultivars suitable for open culture of cooler regions was conducted. A thousand and six F_1 seedlings obtained from the crossing with cv. Pajaro (susceptible resistance) and cv. Belle Rouge (intermediate resistance) were grown in artificially infested potting mixtures (with isolate 91-40) and three resistant lines were selected. The lines, WB-A15, WB-B22 and WB-B33, were not damaged by the disease when they were cultured in an open field naturally and heavily infested with *Fusarium oxysporum* f. sp. fragariae for three consecutive years (1999 to 2001). The results demonstrated that the lines were resistant to *Fusarium* wilt enough to grow them under practical conditions in the regions. We are now attempting to survey the vegetative and fruit characteristics of these lines and their adaptability to open culture in Akita Prefecture.

1340–1440

S14–P–25

DEVELOPMENT OF CHAETISIPHON FRAGAEFOLII ON DIFFERENT STRAWBERRY GENOTYPES

Miloljub Stanisavljevic*, Slobodan Milenkovic

ARI 'SERBIA', Fruit andGrape Research Centre, KRALJA PETRA I 9, CACAK, Yugoslavia, 32000

Development of the population of strawberry aphid *Chaetosiphon fragaefolii* (Homoptera, Aphididae) was studied on 652 hybrids *Fragaria ananassa* x *Fragaria chiloensis* clone Del Norte and on 12 standard cultivars. The parameters recorded in order to determine the suitability of strawberry genotypes for development of aphid population were as follows: survival and fertility of individuals in a five-day test, fertility achieved and longevity, morphometric characters of the females reared on different genotypes and honeydew secretion.The highest parameters concerning development of the population *Chaetosiphon fragaefolii* were recorded with highly sensitive selection, Cacanska Rana, as well as with cvs. Totem, Hood, Homeoye, Cacanska Krupna, Belrubi. In terms of the stated cultivars, longevity of a female on average ranged from 35.1 to 42.8 days, average fertility varied from 35.2 to 38.2 larvae/female. Average longevity on moderately sensitive hybrids ranged from 24.8 to 26.8 days, average ahieved fertility varying from 10.2 to 12.3 larvae/female. In terms of survival and progeny density, a five-day survival test revealed significant differences among the individuals reared on sensitive and moderately resistant strawberry genotypes. The intensity of honeydew secretion was determined through the number and diameter of drops using filter paper with bromine cresol green.The secretion intensity was significantly higher on sensitive genotypes. Drop diameter on Cacanska Rana selection totaled 3.05 mm, and 0.27 mm on moderately resistant hybrids. It accounted for 0.14 mm on resistant clone Del Norte. Strawberry genotype also affects the morphometric characters of parthenogenetic females of strawberry aphid. The lowest dimensions of the body and the apical segment of the rostrum were recorded with the females reared on Del Norte and moderately resistant hybrids.

1340–1440

S14–P–26

DISCRIMINATION OF RUBUS CULTIVARS USING RAPD MARKERS AND PEDIGREE ANALYSIS

Eric T. Stafne*, John R. Clark, Matthew C. Pelto

Dept. of Horticulture, Univ. of Arkansas, 316 Plant Science, Fayetteville, Arkansas, USA, 72701

The utilization of RAPD (random amplified polymorphic DNA) markers are an important tool in the discrimination of Rubus cultivars. However, few studies using RAPD markers have focused on blackberry cultivars. In this study we attempted to differentiate several blackberry and raspberry cultivars for genetic identification. Differences were realized among the cultivars from the genetic similarity matrix for both RAPD markers and pedigree analysis. The raspberry cultivars included in this study participated as the outlier group and were identified as such in relation to the blackberry cultivars. Differences among the blackberry cultivars were evident as well, however similarity distances indicate low genetic diversity in most cases.

1340–1440

S14–P–27

DEVELOPMENT OF SPECIFIC PRIMERS FOR CLASSIFICATION OF *ACTINIDIA* SPP. AND THE SELECTION OF CULTIVAR-SPECIFIC MARKER

Seong-Cheol Kim*, Chun-Hwan Kim, Doo-young Moon, Seung-Jong Chun, Kong-Ho Kim

Jeju Agricultural Experiment Station, Rural Development Administration 1696, O-Deung dong, Jeju, Korea, 690-150

The genus Actinidia has about 60 known species in the world. Kiwifruit (*Actinidia deliciosa* Planch 'Hayward') has been commercially cultivated in the 1980s in Korea. But there is only one variety in most of the countries in the world. From the early 1990s, many countries have tried to breed new high quality varieties with large size and high vitamin content. We have been carrying out the breeding program which consists of cross-breeding among the wild species and molecular work since 1996 in Jeju Island, Korea. Nine species and twenty three varieties of native eastern Asia were examined using 19-20 base-length primers obtained from kiwifruit specific repeated DNA. We analyzed the phylogenetic relationship of the genus Actinidia and selected cultivar specific bands with these primers. We think that these primers are powerful tools for elucidating phylogenetic relationship and selection of specific marker in the kiwifruit breeding program.

1340–1440

S14–P–28

OUTSTANDING STRAWBERRY SELECTIONS FROM ITALIAN BREEDING ACTIVITY

Walther Faedi*[1], Gianluca Baruzzi[1], Pierluigi Lucchi[2]

[1]Istituto Sperimentale per la Frutticoltura–Sezione di Forlì–Forlì–Italy; [2]Centro Ricerche Produzioni Vegetali (CRPV)–Cesena–Italy

The strawberry breeding program for Po Valley (Italy) began in 1978 and has produced several varieties of commercial importance for northern areas. Since 1993 this breeding activity has been included in the Italian National Project "Frutticoltura". Essentially we are breeding strawberry for wide areas as southern regions, Po Valley and North mountain areas, characterized by different environmental conditions and cultivation techniques. Breeding objectives reflect current industry trends of strawberry. The imminent phase out of methil bromide has increased breeding emphasis on resistance to soil borne pathogens. More than in the past the program aims to obtain improved varieties for fruit quality (good balance of sweetness and acidity, flavor and juiciness) and recently to offer to the growers the option of extending their production season, in particular for the fall culture that is a double (autumn-spring) cropping system from a single planting. Extra-large cold stored plants (A+, WB, TP) are set (about 80,000 plants/hectare) in August-early September and protected by plastic tunnels. During the blooming (no later than mid-October). Berries are harvested from October through December. In autumn, 10-15 t per hectare can be produced and than 20-25 t in the following spring. In this paper only the recent progress of the breeding activity for the northern areas will be discuss. In 2000, 40 advanced selections, were evaluated in Cesena and Verona areas in comparison to the traditional varieties. Some

of them, as 94.568.2, 95.42.03, 96.58.02, 97.64.05, have notable traits.

1340–1440

S14–P–29

COMPARISON OF STRAWBERRY PLUGS FROM DORMANT PLANTS TO CANADIAN TIP CUTTINGS

Peter R. Probasco*[1], Stephen A. Garrison[2]

[1]Salem County Agricultural Agent, 51 Cheney Road, Suite #1, Woodstown, New Jersey, Salem, 8098; [2]Rutgers Research Farm 121 Northville Road Bridgeton, NJ 08302

New Jersey strawberry fields on plastic mulch are normally planted with plug plants from Canadian tip culture in the month of September. In order to utilize new varieties, we evaluated the technique of growing plug plants from dormant plants out of cold storage (28 F). These plants were dug in April and placed in storage until mid-July. The dormant plants were transplanted into a 36-cell tray containing a peat-lite mix and grown over the summer months outdoors in full sunlight. Blooms were removed from the dormant plugs twice during August before planting. Runner tips from Canada were grown in a 50-cell tray containing a peat-lite mix during August in a nearby greenhouse and set out on September 9 in the field alongside the dormant plug plants in a randomized block design. The varieties Chandler, Northeastern, Seneca, and Sweet Charlie were included in this study. Marketable yield of the dormant plants was 11,231 lbs/A as compared to 13,406 lbs/A from the Canadian tip plugs. Fruit size was 17.2 g/berry for the dormant plugs vs 17.6 g/berry for the tip cuttings. Each variety from Canadian tip cuttings out yielded the dormant plant plugs. Chandler was the highest yielding variety at 16,558 lbs/A and remains the standard variety for commercial growers in New Jersey. Fruit size was not affected by the plug technique, but tip cuttings produced significantly higher marketable yields than dormant plug plants.

1340–1440

S14–P–30

MANIPULATING TRANSPLANT MORPHOLOGY TO ADVANCE AND ENHANCE FRUIT YIELD IN STRAWBERRY

Julia Y. Reekie*[1], Peter R. Hicklenton[1], John Duval[2], Craig Chandler[2], Paul Struik[3]

[1]Atlantic Food and Horticulture Research Centre, 32, Main Street, Kentville, Nova Scotia, Canada , B4N 1J5; [2]Univ. of Florida, GCREC, 13138 Lewis Gallagher Road, Dover, Florida, U.S.A. 33527; [3]Leerstoelgroep Gewas- en Onkruidecologie, Univ. of Wageningen ,Bode 98, Postbus 430, 6700 AK Wageningen, NL

Strawberry plants are vegetatively propagated in the northern nurseries for use in fruit production in southern United States. Digging actively growing plants in the fall from northern nurseries, and transplanting them into the southern fields at a time of extreme heat makes it difficult for transplants to re-establish successfully. Tall transplants are prone to leaf damage during shipping, and excessive leaf area causes wilting leading to plant death in the southern fields. Improving strawberry plant morphology in the northern nurseries can potentially lead to more robust transplant growth and early production in the southern fruiting fields. Experiments to alter plant morphology used two methods: mechanical leaf removal by way of mowing, and chemical control using a growth regulator (Prohexadione-Calcium). Two southern-adapted strawberry cultivars, 'Sweet Charlie' and 'Camarosa' were mowed in a nursery field in Nova Scotia (45º26' N, 63º27' W), on one of four dates (Aug. 22, Sept. 7, Sept. 22 and Oct. 5) during the growing season in 2000. Plants were dug on October 5, and transplanted in Dover, Florida (28 ºN, 82º22' W). Fruits were collected twice weekly from late November, 2000 to mid-February, 2001. Mowing reduced plant height and total leaf area. At time of digging, plants which were mowed later were shorter than those mowed earlier. Compared to unmowed plants, 'Camarosa' from the Sept. 7 mowing produced 50.6% more fruit by weight by the end of December, and total yield was increased by 20%. Similarly, plants of 'Sweet Charlie' treated with Prohexadione-Calcium on Sept. 7 in Nova Scotia were more compact, and in turn produced 28.8% more fruit by weight by the end of December, and increased total fruit yield relative to non-treated transplants in Florida.

1340–1440

S14–P–31

PRE-PLANT WINTER COVER CROPS FOR WEED SUPPRESSION IN A LOW-INPUT STRAWBERRY PRODUCTION SYSTEM

B.L. Black*[1], J.M. Enns[1], H.J. Swartz[2]

[1]USDA-ARS Fruit Lab, Beltsville Agricultural Research Center, Beltsville, Maryland, USA; [2]Dept. of Natural Resource Science and Landscape Architecture, Univ. of Maryland, College Park, Maryland, USA

Weed control is the major management issue in establishing matted-row strawberry plantings. The advanced matted row (AMR) strawberry production system utilizes the residue of a winter cover crop to suppress weeds during the establishment year. A combination of Hairy Vetch (*Vicia villosa*), Crimson Clover (*Trifolium incarnatum*) and Rye (*Secale cereale*) is used as a winter cover. Over the past three years, we have tested 18 alternative cover crops for compatibility with the AMR production system. Candidate cover crops were fall-planted in replicated plots. In April, each plot was divided into non-herbicide treated and glyphosate-treated sub-plots. Two weeks after herbicide application, all sub-plots were mowed, and 'Allstar' strawberry plants were placed through the resulting crop residue. Cover crops were compared to the vetch-clover-rye combination for: germination, establishment, weed suppression, and compatibility with strawberry growth. Most cover crops tested had inconsistent stand establishment and/or poor weed suppression. In all of the herbicide treated sub-plots, either the cover crop was not affected by glyphosate, or there was little weed suppression by the crop residue. In the non-herbicide sub-plots, Creeping Bentgrass (*Agrostis stolonifera*), Creeping Red Fescue (*Festuca rubra*), Meadow Foxtail (Alopecurus pratensis), Red Top (*Agrostis alba*), and Tall Fescue (*Festuca arundinacea* 'Kentucky 31') all showed good weed suppression, but also inhibited growth and establishment of the strawberry plants. Annual Ryegrass (*Lolium multiflorum*) and Little Barley (*Hordeum possilum*) show the most promise, as weed growth was inhibited but strawberry growth continued. The effects of these cover crops on subsequent strawberry fruit yield will be discussed.

1340–1440

S14–P–32

SALINITY LEVELS OF NUTRIENT SOLUTION AFFECTING GROWTH, YIELD AND QUALITY OF STRAWBERRY CV. NYOHO GROWN IN PEAT BAGS

Yuichi Yoshida*, Tanjuro Goto*, Masaharu Masuda*

Fac. Agriculture, Okayama Univ., Tsushima-naka 1-1-1, Okayama, Japan, 700-8530

Substrate culture for strawberry is developing in Japan. In the coastal area, only saline water is obtainable for fertigation, and in some other regions, water contains small amount of Na or Cl, and high amount of other ions including Ca or Mg. Effect of NaCl added to the nutrient solution was determined for strawberry grown in peat bags. Concentration of nutrients in the standard solution were; NO3-N:8, NH4-N:0.85, P:0.85, K:3.8, Ca:2.05 and Mg:0.93 mM. Nutrient solutions were prepared with tap water (EC 15 mS/m) containing Na:0.35 and Cl:0.29 mM. NaCl (0, 4, 8, 12 mM) was added to the solutions and EC values were 130, 180, 230 and 280 mS/m, respectively. Only for the mineral elements, not for NaCl, the strength was changed according to the seasons, ranging from 50 to 100% of the standard solution. Tray plants of 'Nyoho' were planted in peat bags (8 plants in 80 x 28 cm bags containing 18L of medium) on 20 September. Area of the newly expanding leaf decreased with increase in NaCl concentration. Concentration of Na and Cl in petiole increased with increase in light intensity and temperature (April and May), and in the concentration of NaCl. Severe tip burn occurred in the calyx of the primary flower in the plants supplied with12 mM of NaCl. The symptom was observed in 60-70% of the 1st and 2nd inflorescence in 12 mM of NaCl, whereas only in 3-10% of the inflorescences in 0 or 4 mM of NaCl. Average fruit weight and total yield were significantly lower in 12 mM of NaCl compared to the other three treatments. Total soluble solids and titratable acidity were highest in the control, but the concentration of NaCl did not affect significantly. The occurrence of tip burn was stimulated by 8 mM of NaCl, but it affected little on the yield. When EC value of the obtainable water containing NaCl and/or other ions is lower than 100 mS/m, the water may be suitable for strawberry production with peat-based substrate.

1340–1440

S14–P–33

CHARACTERISTICS OF ROOT AND RHIZOME DEVELOPMENT IN COMPARISON WITH THEIR TISSUE STRUCTURE IN STRAWBERRY VARIETY ELSANTA

J. Papp*[1], P. Gracza[2]

[1]Dept. of Pomology, SZENT ISTVÁN Univ. H-1118. Budapest Villányi út 35-

43. Hungary; [2]Dept. of Biology EÖTVÖS LORÁND Univ. H-1055. Budapest, Hungary

During germination, the little germ root emerging from the achene lengthens and the lateral roots appear on its surface. After 3-4 weeks, the root axis becomes stronger and the hypocotyl and epicotyl become thicker forming the vertical rhizome, which develops bigger shoots toward the shoot tip. New leaves of bigger size emerge from the apical part of the rhizome. At the same time, the rhizome becomes thicker and develops new, thick roots. At the apical part of the stolon on the mature strawberry plant a single reduced leaf appears at first. After a further 5-6 cm of growth of the stolon, little leaves come into existence. However, in contrast with the plant developing from seed, the development of leaves precedes the development of the roots which emerge from the lower part of the horizontal shoot tip. The wide root apex develops thick roots. The size of leaves increases and the upper part of the shoot forms rhizome. In the beginning, the position of the rhizome is inclined but later it turns to a vertical position due to the effect of the growing new roots. The tissues of the roots of the little germ plant are markedly narrower than that of the roots emerging from the rhizome. Later, the rhizome develops from the hypocotyl and epicotyl over the main root. The shoot-originated roots coming from the rhizome are thicker. These roots have wider primary bark and stele. The vascular tissue consists of 5-6 xylem and phloem bundles. The roots of shoot origin generally do not thicken. The thickening of the transport tissues was found, and this has not described in the literature before. Parallel with the aging of the roots, the wall of the pith tissue cells begin to thicken spirally. Tracheae develop by this process and the xylem becomes thicker at the expense of the pith tissue. At the same time, paracambium develops from pericambium forming cork tissue of 6-8 cell rows.

1340–1440
S14–P–34
EFFECT OF POLYETHYLENE MULCHES AND COVERS ON EARLY PRODUCTION, TOTAL YIELD, AND FRUIT QUALITY OF DAY-NEUTRAL STRAWBERRY CROP

E. Carpentier*[1], S. Khanizadeh[2], L. Gauthier[3], A. Gosselin[1]

[1]Horticultural Research Centre, Laval Univ., Qc, Canada, G1K 7P4; [2]Horticultural Research and Development Centre, Agriculture and Agri-Food Canada, 430 Blvd Gouin, St-Jean-Richelieu, Qc, Canada, J3b 3E6; [3]Fraise de l'Île d'Orléans Inc., 2035 ch.Royal Île d'Orléans, Qc, Canada, G0A 3Z0

The objectives of this study were to increase early production, maximize total yield, and improve fruit quality of day-neutral strawberry crop using three types of polyethylene mulch and two types of cover. During the three years of this experiment (1999, 2000, 2001), we cultivated the day-neutral strawberry cultivar "Seascape" on raised beds at a density of 72 000 plants/ha. Treatments consisted of black, photoselective green, and silver on black mulches, as main plots and of floating row covers (clear perforated polyethylene mulch), small tunnels (clear perforated polyethylene mulch), as sub-plots. For each harvest, total yield, marketable yield, and mean fruit weight were measured. Also, for the last summer (2001), soil and air temperatures were monitored. Our preliminary results indicated no significant difference between mulches on total yield, marketable yield, and mean fruit weight. However, first-year strawberry plants produced higher total and marketable yields on silver plastic mulch than on black or green mulches. On the contrary, green mulches were the best with two-year-old strawberry plants. Secondly, our results showed that one-year-old strawberry plants and two-year-old strawberry plants did not respond in the same way to the covering treatments. For the first year, no cover (control) seemed to be the best treatment. For the second year, strawberry plants under row covers gave the best early and total yield. However, the mean fruit weight was less than the control. Small tunnels did not allow higher early yield, total yield, and mean fruit weight.

1340–1440
S14–P–35
AN ECONOMIC ASSESSMENT OF THE RETURNS TO IRRIGATION INVESTMENT FOR WILD BLUEBERRIES

Timothy J. Dalton, Andrew Files, David E. Yarborough*

Maine Agricultural Center Univ. of Maine Orono, ME 04469 USA

Wild blueberry growers in Maine have increased their average crop yield from 10,000 to 38,000 metric tons per year over the past 20 years by adopting improved management practices. Highly variable and insufficient rainfall patterns have prompted farmers to consider irrigation as a method to further improve crop productivity and reduce risk of crop failure due to drought. Currently, approximately 4,000 of the 26,000 ha in wild blueberry production are irrigated. An understanding of the costs of and potential returns to irrigation provides growers better information to use in determining whether to make the large investment decision. Four irrigation systems: 1) a handline moveable large gun, 2) a hose reel large gun, 3) a handline small sprinkler and 4) a permanent set small sprinkler were evaluated on 10, 20 or 40 ha fields. This study focused on an economic analysis of irrigation costs, both ownership and operating, using partial cost budgets of each irrigation system and operation size. Using this cost analysis a modified breakeven analysis and earliest possible pay off period were derived. The study highlights key differences in system design, cost and input requirements to provide farmers with the background to choose a system that gives the best returns for their operation.

1340–1440
S14–P–36
THE INDUCTION AND REGENERATION OF RABBITEYE BLUEBERRY BUDS

Yadong Li*, Shuying Liu*, Zhidong Zhang*, Lin Wu*

Small Fruit Research Institute, Dept. of Horticulture, Jilin Agricultural Univ., Changchun, 130118, P. R. China

Several factors affecting bud induction, differentiation and plant regeneration in rabbiteye blueberry were studied. The results indicated that supplementing the subculture medium with NAA and 2ip benefited the induction of blueberry buds, and 2ip maintained the ability of differentiation in rabbiteye blueberry. Plant source, especially genotype, had no effects on bud differentiation of long-term culture. Different hormones (NAA,2ip and ZT etc.) affected bud differentiation frequency. Among them, 2ip increased the frequency of bud formation. In the autumn, the explant which was pre-handled by low-temperature could enhance bud differentiation frequency. In the subculture stage, we found that 4300 and 5000 lux light intensity gave good results. Supplementing the root medium with IBA or NAA increased the formation of root, and IBA was better than NAA.

1440–1500
S14–O–37
GENETIC IMPROVEMENT OF THE BEACH STRAWBERRY, FRAGARIA CHILOENSIS

James F. Hancock, Peter W. Callow, Chrislyn Drake*, Sedat Serce

A349 PSSB, Dept. of Horticulture, Michigan State Univ., East Lansing, MI, USA, 48824

The beach or Chilean strawberry, *Fragaria chiloensis* L., is a mostly wild strawberry found in South America (primarily in Chile) and in coastal North America from California to Alaska. The Mapuche Indians of Chile appreciated the large, fragrant fruit, and domesticated it over 1000 years ago. The existing landraces are very large fruited, but they are low yielding and the fruits are mostly white. The North American types of *F. chiloensis* were not domesticated, and their fruit tends to be smaller than their South American counterparts, but they are better colored and more numerous. We crossed elite wild and domesticated clones from South and North America in the winter of 1999, in hopes of creating new large, red-fruited cultivars with high fruit numbers. The South American parents were the landraces BRA 1A (PI 612316), NAH 3 (PI 612318), CFRA 372 (PI 551736), CFRA 24 (PI 236579), and the wild selection MAR 1A (PI 602567). The North America parents were HM1 (PI 612489), Pigeon Point (PI 551728), RCP 37 (PI 551445), and Scotts Creek (PI 612490). Progeny from the crosses were grown in a greenhouse, hand pollinated and data were collected on flowering and fruiting season, peduncle length, fruit size, color and soluble solids, and number of fruit, crowns and runners. Significant differences were observed across families for all of the traits, and most of the observed variation appeared additive. NAH-5 and Pigeon Point transmitted the largest fruit size. Scotts Creek and MAR1A were the best parents for fruit color. HM1 produced progeny with the highest flower numbers. Progeny of MAR 1A and BRA1A were the latest fruiting. The cross Scotts Creek x NAH 3 yielded the highest number of selections with large fruit, excellent color, good yields and high soluble solids as well.

1500–1520
S14–O–38
ANALYSIS OF STRAWBERRY PROTEIN EXPRESSION DURING FRUIT RIPENING

C. Gerardi*[1], A Leone[1], B. Laddomada[1], L. Leo[1], C. Bisson[2], S. Valentini[2], G. Zacheo[1]

[1]Istituto di Scienze delle Produzioni Alimentari, Sezione di Lecce, CNR, via Prov.le Lecce-Monteroni, 73100-Lecce; [2]Istituto di Scienze delle Produzioni Alimentari, Sezione di Torino, CNR c/o Bioindustry Park Canavese, via Ribes 5, 10010 Colleretto Giacosa (TO)

Strawberry fruits are widely grown throughout the temperate regions of the world and are a commercially important non-climacteric soft fruit. Here we present the results of a funded project aimed to study the events occurring during ripening of strawberry fruits. This study was conducted using chemical, molecular and biochemical methods in an attempt to find biomarkers (genes, proteins and metabolites) related to quality traits in some strawberry ecotypes. To gain insight into the molecular determinants associated with fruit ripening, we examined mRNA populations in different cultivar and wild ecotype of strawberry fruits at different ripening stages (green, pink and red) using AFPL fingerprinting. In order to better understand the biochemical basis of the ripening process, we analysed protein expression by proteoma methods, lipoxygenases (LOX) and hydroperoxidelyase (HPL) enzymatic activities and aroma compounds in green, pink and red fruits. The 2DE map matching revealed an increased protein expression in ripe fruits compared to unripe fruits, confirming existing data on gene expression during strawberry ripening. From 2DE map analysis we observed a shifting of more expressed protein molecular masses from 35 kDa in unripe fruits to 45 kDa in ripe fruits. LOX and HPL are involved in the biogenesis of the major constituent of "green odour" in strawberry fruits; spectrophotometrically assays of these enzymes showed a high activity at the green and pink stages and a LOX activity decrease in mature fruits. LOX and HPL specific activities resulted higher in membranes than in soluble fractions. These results together with N-terminal amino acid sequencing and identification of ripening induced proteins should provide a powerful tool for biotechnological improvement of strawberry quality and productivity.

1520–1540
S14–O–39
CYTOGENETICS OF VACCINIUM DARROWI X V. ARBOREUM HYBRIDS AND THEIR OPEN-POLLINATED DERIVATIVES

Paul Lyrene*[1], Jose San Martin[2]

[1]Horticultural Sciences Dept., P.O. Box 110690 Gainesville, Florida 32611; [2]INIA, Osorno, Chile

Vaccinium darrowi, a low-growing, evergreen blueberry native in the southeastern United States, is the species that was crossed with northern highbush blueberry cultivars to produce "southern highbush" cultivars. *Vaccinium arboreum*, the sparkleberry, also native in the southeastern United States, is a small tree that can reach 8 m height. Unlike highbush blueberry, sparkleberry can tolerate soils that are prone to drought, contain little organic matter, and have pH as high as 6.0. More than 100 *V. darrowi* x *V. arboreum* F_1 hybrids (both parents diploid) were grown for five years in a field that also contained tetraploid V. corymbosum and hexaploid *V. ashei* cultivars. Meiotic studies of the F_1 hybrids showed that they were diploid and that univalents normally outnumbered bivalents during Metaphase I. There were lagging chromosomes and chromatin bridges at Anaphase I. The F_1 hybrids flowered abundantly but were very low in pollen staining and in production of open-pollinated seed. Of eight open-pollinated progeny that were studied, seven were tetraploid and one was pentaploid. Although fertility and chromosome pairing were higher in the open-pollinated progeny than in their F_1 parents, meiosis still revealed some univalent chromosomes, lagging chromosomes, and chromatin bridges. Despite chromosome pairing problems, introgression of *V. arboreum* genes into highbush cultivars could be useful, especially where higher vigor, increased tolerance for upland soils, and later ripening are desirable.

1540–1600
S14–O–40
BUD HARDINESS AND DEACCLIMATION IN BLUEBERRY CULTIVARS WITH VARYING SPECIES ANCESTRY : FLOWERING TIME MAY NOT BE A GOOD INDICATOR OF DEACCLIMATION

M.K. Ehlenfeldt*[1], L.J. Rowland[2], R. Arora[3]

[2]USDA-ARS, Fruit Laboratory, Beltsville, Maryland, 20705, USA; [3]Dept. of Horticulture, Iowa State Univ., Ames, Iowa

Detached shoots of blueberry cultivars with varying percentages of species ancestry (*V. corymbosum* L., *V. angustifolium* Ait., *V. ashei* Reade, *V. darrowi* Camp) were assayed in mid-February to determine initial bud hardiness, and rates of deacclimation under constant temperature conditions. The LT_{50} of field-grown shoots of 'Weymouth', 'Bluecrop', 'Legacy', 'Ozarkblue', and 'Tifblue' were initially evaluated by controlled freezing in a glycol bath at temperatures from -1 °C to -28 °C, followed by visual evaluation after a 24 h incubation at 23 °C. Similar shoots were deacclimated at a constant temperature of 20 °C and batches were evaluated daily for 6 days. Cultivars with any amount of southern germplasm (*V. ashei* or *V. darrowi*) were less hardy (LT_{50} -20 to -21 °C) than northern highbush cultivars (LT_{50} -24 °C) which are composed primarily of *V. corymbosum* with small percentages of V. angustifolium. Cultivars with greater amounts of southern germplasm deacclimated more quickly and to a slightly less hardy level (LT_{50} -12 to-14 °C) than did northern-adapted cultivars (LT_{50} -15 °). By 6 days, deacclimation appeared to plateau for all cultivars. 'Ozarkblue' is extremely late-flowering, and because of this would seem to be adaptable to northern climates, yet the data suggest bud swell and flowering time are poor measures of deacclimation. Deacclimation under fluctuating field conditions is currently being evaluated.

1600–1620
S14–O–41
KARAKA BLACK: ANOTHER "MAMMOTH" BLACKBERRY FROM CROSSING EASTERN AND WESTERN USA BLACKBERRIES

Harvey K. Hall*, L.R. Brewer*, M.J. Stephens*, C.J. Stanley

HortResearch, Nelson Region, PO Box 220 Motueka, New Zealand, 7161

The 'Mammoth' blackberry is said to have been produced in the second generation of a cross between 'Aughinbaugh', (a female 8x *Rubus ursinus* West Coast USA blackberry) and 'Crandall' (an Eastern USA upright blackberry). In New Zealand a similar cross was made between 'Aurora' (~8x-derived from *R. ursinus*) and 'Comanche' (an Arkansas upright blackberry cultivar derived from Eastern USA blackberries) in 1982 and about 1500 seedlings were planted. In these seedlings there was great variability, from small to very large fruit, from soft to very firm fruit, from prostrate to upright canes and from almost spineless, smooth and shiny canes to very spiny, very hairy canes. Two selections from this cross, one with very large fruit and another with very firm fruit were subsequently inter-crossed and a population of about 200 seedlings planted. Several selections were chosen including 8627N8-6, which had exceptionally large firm fruit and a long harvest season. This selection had less vigorous canes than the other selections but was retained for trials because of its other attributes. 8627N8-6 was trialed at Lincoln by Geoff Langford, a HortResearch berry scientist, and finding it of high quality he "dubbed" it "Cracker Black" in a media interview. Subsequently Cracker Black was changed to 'Karaka Black' to give it a more distinctive and New Zealand name (Karaka is the Maori name for a New Zealand native tree).

1620–1640
S14–O–41–A
TO BE ANNOUNCED

1640–1700
S14–O–41–B
TO BE ANNOUNCED

Thursday · August 15

1100–1140
S14–O–42
DISEASE MANAGEMENT PROGRAMS FOR BERRY CROPS IN THE 21ST CENTURY

Michael A. Ellis*

Dept. of Plant Pathology, The Ohio State Univ./OARDC, 1680 Madison Av-

enue, Wooster, OH, USA, 44691

Despite the many recent advances in the production of most berry crops, diseases will continue to be a major constraint to berry production in the 21st century. Although fungicides will probably remain an important part of future disease management programs, their use will be highly regulated and scrutinized by regulatory agencies as well as the general public. In order to minimize the use of pesticides, the development and implementation of truly integrated disease management programs must be emphasized. The objective of integrated disease management is to provide a commercially acceptable level of disease control on a consistent (year-to-year) basis with minimal fungicide use. Developing a program that integrates all available control methods can meet this objective. An effective disease management program for berry crops must emphasize the integrated use of specific cultural practices, knowledge of the pathogen and disease biology, disease resistant cultivars, biological control and timely applications of fungicides, when needed. In order to reduce the use of fungicides to an absolute minimum, the use of disease resistance cultivars and appropriate cultural practices will need to be strongly emphasized. This symposium will discuss various components of an integrated disease management program, as well as recent developments in disease management for berry crops.

1140–1200
S14–O–43
INCIDENCE AND DEVELOPMENT OF ANTHRACNOSE FRUIT ROT IN SEVEN STRAWBERRY GENOTYPES INOCULATED WITH FIVE CONCENTRATIONS OF *COLLETOTRICHUM ACUTATUM*

Joel Shuman*[1], Jim Ballington[2]

Virginia Tech, Horticulture Dept., 301 Saunders Hall, Blacksburg, VA, USA, 24061

Anthracnose fruit rot (AFR) can cause considerable economic damage on strawberries in the humid Southeastern US. Differences in both the incidence and the amount of AFR among strawberry genotypes in the field indicate that there may be differences in susceptibility to AFR. Based upon field observations under natural inoculation conditions, 'Pelican', 'Sweet Charlie', and NCR 95-08 have consistently appeared to be resistant to AFR. This has not been the case for 'Apollo' or NCH 95-173 for which observations range from resistant to moderately susceptible. 'Camarosa' and 'Chandler' are susceptible. Fruit of these seven strawberry genotypes (Gen) were inoculated with five concentrations of *Colletotrichum acutatum conidia* (Inoc). The experimental design was a split plot with Inoc (0, 1x103, 1x104, 1x105, and 1x106 conidia mL^{-1}) as the whole plot. The Gen were the subplot and were arranged in a randomized complete block with three replicates. The experiment was conducted three times within a growth chamber. Green to fully ripe fruit were inoculated. Data on lesion length and width, incubation period (IP), and fruit age were collected. For most genotypes, the most dramatic increase in percentage lesions was observed from 1x104 to 1x105 conidia mL^{-1}. The largest range of mean percent lesions among Gen was observed at 1x105 conidia mL^{-1}. Logistic regression revealed that fruit age at inoculation was a significant explanatory variable for predicting probability of lesion formation among the seven Gen: probability of lesion formation generally is low at young fruit age, increases at median age, and then rapidly decreases at older ages (i.e. over-ripe). This response curve was not consistent among Gen. IP was not different among Gen or the Gen x Inoc concentration interaction. Rate of AFR lesion diameter increase was different among Inoc, Gen, and the Inoc x Gen interaction. The most susceptible 'Camarosa' and 'Chandler' had the largest rates of lesion diameter increase, 'Sweet Charlie' and NCR 95-08 had much lower rates, and 'Pelican' had the lowest rate. These results suggest that fruit age and rate-limiting resistance are two components of resistance to AFR.

1200–1220
S14–O–44
IDENTIFICATION OF SOURCES OF RESISTANCE TO BACTERIAL ANGULAR LEAFSPOT DISEASE OF STRAWBERRY

John Hartung*[1], Cristina Gouin[1], Stan Hokanson[2], John Maas[1]

USDA ARS Fruit Laboratory, 10300 Baltimore Avenue, Building 010-A Room 238 BARC-West, Beltsville, Maryland, USA, 20705

Bacterial angular leafspot disease (BALD) of cultivated strawberry, caused by the bacterium *Xanthomonas fragariae*, has become an increasingly serious disease problem. It is of particular concern because it is readily transmitted through asymptomatic nursery plants. Until now, there have been no sources of resistance to this pathogen identified in either commercial varieties or germplasm. We have characterized the population structure of *Xanthomonas fragariae*, and have used this knowledge to screen 81 *Fragariae* genotypes, including both diploid and octoploid accessions, for resistance to this pathogen. Two genotypes, a native *F. virginiana* from Minnesota and a cultivated *F. virginiana* X *F. ananassa* hybrid from Georgia were found to be resistant to all four genotypes of this pathogen after leaf infiltration assays. Following infiltration of these genotypes, symptoms of the disease including localized necrosis, leaf collapse, bacterial ooze or systemic spread of the pathogen were not observed. Plants of 'Sweet Charlie', used as the susceptible standard showed all of these symptoms. The two resistant genotypes, designated US 4808 and US 4809 have been made available to the public as germplasm releases. Controlled crosses were also made between US 4808 and US4809 and the susceptible variety 'Sweet Charlie'. Resistance to *X. fragariae* was transmitted to 8-12% of the progeny of the US4808 cross and to 4-18% of the progeny of the US4809 cross. Data from these experiments is being analyzed to establish the mode of inheritance. Hypersensitive resistance, characterized by rapid collapse of the tissue at the inoculation site followed by death of the bacterium (single gene dominant) was not observed. Further experiments are planned to better understand the nature of the observed disease resistance.

1220–1240
S14–O–45
VEGETATIVE AND FLORAL CHARACTERISTICS OF SIX STRAWBERRY CULTIVARS ASSOCIATED WITH FRUIT SIZE, YIELD AND SUSCEPTIBILITY TO TARNISHED PLANT BUG INJURY

D.T. Handley*, J.F. Dill

Univ. of Maine, P.O. Box 179, Highmoor Farm, Monmouth, Maine, USA, 04259-0179

Strawberry cultivars can differ in their susceptibility to tarnished plant bug injury, but the mechanisms for these differences have not been determined. Isolating such mechanisms could allow breeders to develop significant insect resistance in commercial strawberry cultivars. Selected vegetative and floral characteristics were measured in six strawberry cultivars grown in a perennial matted row system and compared to the yield data and levels of tarnished plant bug injury. "Mira" and "Mesabe" had the highest marketable yields, followed by "Jewel" and "Sable". "Cabot" and "Northeaster" had the lowest yields. "Cabot" had the largest fruit size, followed by "Jewel", "Mira", "Northeaster", "Sable" and "Mesabe". Naturally occurring levels of tarnished plant bug injury were lower than expected, but some significant differences were observed between the six cultivars. "Mira", "Northeaster" and "Cabot" had the highest levels of tarnished plant bug injury. "Jewel", "Mesabe" and "Sable" had lower levels of injury. There were no significant correlation between yield and levels of tarnished plant bug injury, reflecting the low levels of injury in this experiment. Of the floral parameters evaluated, only high pollen levels were significantly correlated with higher levels of tarnished plant bug injury. Flower size, flower number, pedicel length, peduncle length and number of stamens were not significantly correlated with injury. Primary flower diameter and flower dry weight was positively correlated with average fruit size. For the vegetative characteristics, neither petiole length nor hairiness was significantly correlated to tarnished plant bug injury.

1340–1440
S14–P–46
BASTA 150 SL USE IN STRAWBERRIES IN ESTONIAN CONDITIONS

Kersti Kahu*

Polli Horticultural Institute of the Estonian Agricultural Univ., Karksi-Nuia 69104, Viljandimaa, Estonia

This experiment was carried out in the strawberry plantations at the Polli Horticultural Institute during two years, 2000-2001. 'Bounty' was the strawberry cultivar studied. The objective of this experiment was to evaluate the effectiveness of the herbicide Basta 150 SL on problem weeds and strawberry daughter plants. The strawberry plants were set in the spring of 1999 and black plastic mulch was used. The plot size was 30 m^2 (2 m x 15 m) and the planting scheme was 1.2 m x 0.3 m in the experiment. The following treatment variants were used: 1. Untreated (control); 2. Basta 150 SL 3 L/ha; 3. Basta 150 SL 5 L/ha. Each variant was represented with 4 replications. The herbicide was applied with a backpack sprayer twice; in May before blooming and in August when new weeds had grown. The results of experiment indicated that Basta 150 SL decreased weed infestation in strawberry plantation by 90-96%, and strawberry daughter plants were practically destroyed 100%

by Basta 150 SL. The results also showed that Basta 150 SL did not cause damage to the strawberry plants ot the berries. To eliminate perennial weeds such as *Taraxacum officinalis, Cirsium arvense,* and *Viola arvensis*, Basta 150 SL at the rate of 5 L/ha was necessary, otherwise a rate of 3 L/ha is sufficient to eradicate most weeds in the orchard.

1340–1440

S14–P–47

INCREASING WINTER-STRAWBERRY PRODUCTION IN NORTH-CENTRAL FLORIDA USING PASSIVE VENTILATED GREENHOUSES AND HIGH PLANT DENSITIES

Ashwin Paranjpe*[1], Daniel J. Cantliffe[1], Elizabeth M. Lamb[2], Peter J. Stoffella[2], Charles Powell[2]

[1]Horticultural Sciences Dept. Univ. of Florida 1251 Fifield Hal Gainesville, FL 32611-0690; [2]Indian River Research and Education Center Univ. of Florida Institute of Food and Agricultural Sciences 2199 South Rock Road Ft. Pierce FL 34945-3138

In the United States, soil-less strawberry production under protective structures is still being researched and is yet to be adopted on a commercial scale. Previous studies done in North-central Florida have shown that winter-strawberry production can be increased by growing strawberries under passive ventilated greenhouses using bags or troughs filled with soil-less substrates like perlite, peat and pinebark (Paranjpe et. al., 2001). The plant density used in these greenhouse studies (7.5 plants/m^2) was approximately two times higher than the density used for field production (4.3 plants/m^2). For protected strawberry cultivation to be profitable, the plant density needs to be increased. It is possible to increase the plant density from 7.5 plants per m^2 to 22 plants/m^2 by reducing the between-row and within-row spacings. The objective of this trial was to test the performance of eight different plant densities (22, 20, 18.3, 16.9, 14, 12.7, 11.7, 10.8 plants/m^2) of the cultivar Sweet Charlie for early yields and total yields from November to March. The eight densities were derived by having four between-row spacings (50, 55, 60 and 65 cm center-to-center) and two within-row spacings (17.5 cm and 35 cm plant-to-plant). Strawberry plants were grown in ëPolygal Hanging Bed-Packí troughs (10 cm bottom width, 12 cm wall height and 60 mm planting hole diameter) that were suspended 1.8 m above the ground level. Troughs were filled with locally available pinebark (2.5 cm^2 sieved) and plants were irrigated with drip tape (5 cm emitter spacing and 9.45 mL min^{-1} emitter-1discharge). Average berry size was 20 g and more than 80% of the early yield was marketable. Marketable yield/m^2 increased linearly with plant density throughout the season. A cost threshold was developed comparing higher early yields when prices are higher to increased cost of plants.

1340–1440

S14–P–48

OUT OF SEASON PRODUCTION OF STRAWBERRIES: THE EFFECT OF A SHORT-DAY TREATMENT IN SUMMER

Atsushi Yamasaki*, Takayoshi Yano, Hidekazu Sasaki

Dept. of Vegetable and Floricultural Science, National Agriculture Research Center for Tohoku Region, Shimo-Kuriyagawa, Morioka, 020-0123 Japan

Japanese strawberries tend to be in short supply in the summer and autumn because it is difficult to promote flower initiation when the temperatures are high. However, the demand from confectionery makers for fresh strawberries remains high in the summer and autumn. Strawberry production may be possible in northern Japan because the summer temperatures are relatively cool. Therefore, the effects of a short-day treatment in the summer on the flower initiation in three varieties of strawberry plants were investigated. Daughter plants of three Japanese forcing varieties, 'Nyoho,' 'Sachinoka,' and 'Kita-no-Kagayaki', were grown under the following conditions: short-day (8 hr photoperiod) for one month in July using tunnel covering with a shading film. Flower buds were successfully induced by the short-day treatment in 'Nyoho' and 'Sachinoka' in spite of high daytime temperatures; however, the flower initiation of 'Kita-no-Kagayaki' was ten days behind that of the other two varieties. The effect of nitrogen level was also observed: a high nitrogen level delayed flower initiation in the three varieties.

1340–1440

S14–P–49

OUT-OF-SEASON STRAWBERRY PRODUCTION IN THE EASTERN UNITED STATES

Fumiomi Takeda*

USDA-ARS, Appalachian Fruit Research Station, 45 Wiltshire Road, Kearneysville, WV 25430

In the Middle Atlantic coast region (latitude 39º N), hydroponic strawberry cropping systems research has demonstrated that high yields can be obtained under protected cultivation during 8-month harvest duration that starts as early as October. In July and August 2000, 'frigo' plants were transplanted into ~0.9 L pots. Container plants were transferred in Oct. to a hydroponic system under natural photoperiod. Plants were placed 30-cm apart in 15-cm x 15-cm (HxW) gutters filled with perlite and fertigated intermittently with recirculating nutrient solution through a dripper line laid on top of the substrate. The solution volume was kept constant by addition of daily make-up water. Thermostats were set at 18-20 ºC during day and 12-14 ºC at night. HPS lamps provided supplemental lighting on overcast days. Harvest commenced in late October for day-neutral and everbearing strawberries and in November for short-day cultivars. Seasonal yield (average of 6 plants per plot) ranged from ~7.2 kg for 'Camarosa' to 3.5 kg for 'Selva'. Fruit size averaged > 40g at the beginning and gradually declined to < 15 g in June. For the season, the mean berry weight ranged from 21 g for 'DIAMANTE' to ~12 g for 'Selva' and 'Everest'. When flower removal was extended until mid October, yield was increased 0.4 kg per plant and berry weight increased 0.5 g. Yield per plant was highly variable in 'DIAMANTE' strawberry and it may be associated with its crown being "loose". However, the 'DIAMANTE' plant is compact and it produces fruit on short, stiff peduncles.

1340–1440

S14–P–50

SUGAR CHANGE IN SHOOT APEX OF STRAWBERRY UNDER FLOWER BUD INDUCTIVE CONDITION

M. Hamano*, H. Yamazaki, H. Miura

National Institute of Vegetable and Tea Science 360 Kusawa, Ano, Mie, 514-2392, Japan

Flower induction in June-bearing strawberry (*Fragaria* x *ananassa*) is controlled by photoperiod and temperature, and a period of time of inductive conditions is required. During inductive condition, biochemical or physiological changes occur in shoot apex before morphological change is recognized. One of the possible change that might occur is sugar contents, so in this study, sugar (sucrose, glucose and fructose) contents in shoot apex of strawberry (cv. Nyoho) under flower bud inductive condition were measured. Runner plants were rooted directly in 10.5 cm plastic pots in June and kept under a canopy with natural daylength and ventilation over 25 ºC. For flower bud induction, plants were transferred into the green house set at 25/15 °C (day/night) with eight hours daylength in August until the flower bud differentiation was observed by microscopic inspection. Control plants were kept under the canopy as mentioned above. With three weeks of induction treatment flower bud differentiation was recognized. Shoot apices including unexpanded leaves were collected every three days and sugars were extracted with 80% ethanol. Sucrose, glucose and fructose were measured enzymatically. Most abundant sugar was sucrose (50-58% of total) followed by glucose (34-42% of total) and fructose content was much lesser than sucrose and glucose (5-10% of total). Glucose content in shoot apex decreased after the plants were transferred to the inductive condition, then increased gradually. Sucrose content decreased at the beginning of the induction treatment, but increased soon to the level of control plant. When flower bud differentiation was recognized, sucrose content in shoot apex was lower than before. Fructose was higher in treatment plants than in control plant.

1340–1440

S14–P–51

EFFECT OF PLANT DENSITY ON GROWTH, DEVELOPMENT AND YIELD IN STRAWBERRY CULTIVARS 'ELSANTA' AND 'BOLERO' IN A DOUBLE-ROW BED SYSTEM THROUGH THE SEASON

M.E. Pérez de Camacaro*[1], G.J. Camacaro[2], P. Hadley[2], J.G. Carew[2], N.H. Battey[2]

[1]Nucleo Universitario Dr. Juan Agustin de la Torre. Universidad Centroccidental Lisandro Alvarado (UCLA), Apto. 400, Barquisimeto–Estado Lara, Venezuela; [2]The Univ. of Reading, Reading RG6 6AS, UK

In order to evaluate the effects of plant spacing on vegetative growth, reproductive development and yield in strawberry (*Fragaria* x *ananassa* Duch.) cultivars 'Elsanta' and 'Bolero', single crowned cold stored A+ graded plants were established on 15 March 2000 in an area of 124.10 m^2. The research was con-

ducted on the experimental grounds of the School of Plant Sciences at The Univ. of Reading, U.K. The experiment was arranged as a factorial (2x3) design with three randomised blocks, six treatments and 30 plants per plot per treatment in which each plot had two rows of plants. The plants were established in double-rows in flat beds covered with black polyethylene mulch. The factors were cultivar ('Elsanta' and 'Bolero') and density (25 plants m-_ (20 cm spacing); 16 plants m-_ (25 cm spacing) and 11 plants m-_ (30cm spacing)). Plant spacing became more important in determining the vegetative growth and reproductive development in cultivars 'Elsanta' and 'Bolero' after the first pick and principally at last pick. Growth and development increased as the density decreased and this effect was shown more clearly in 'Bolero'. The highest yield per area and the lowest yield per plant were found at closest spacings in both cultivars. At closer spacings the ratio of the total dry matter produced to the corresponding PAR was absorbed (RUE) was greater, indicating that the PAR was used more efficiently. Harvest index did not differ significantly between plant spacing in a double-row bed sytem. Furthermore, the cultivar 'Bolero' obtained the greatest conversion of dry matter into the fruit.

1340–1440

S14–P–52

USE OF ROW COVERS AND POST HARVEST STORAGE TECHNIQUES TO ALTER MATURITY AND MARKETING PERIOD FOR HIGHBUSH BLUEBERRIES

Peter Hicklenton*, Charles Forney, Carolyn Domytrak

Agriculture and Agri-Food Canada Atlantic Food and Horticulture Research Centre 32 Main Street Kentville Nova Scotia B4N 1J5

Storage technology and rapid distribution networks have enabled extended season marketing of highbush blueberries. Fitting fruit availability to market demand, however, may require greater flexibility than is provided by storage alone. Often control of fruit maturity in the field must be linked with appropriate storage methods to meet a specific market opportunity. A 2-year study conducted in northeastern Canada has investigated the effects of row coverings on fruit maturation in three highbush blueberry cultivars, and the impact of these field treatments on pre- and post-storage fruit quality. In the first year, 50% shade covering plants of 'Briggita' and 'Bluegold' caused fruit to mature about 2.5 weeks later than controls. Neither fruit firmness, average weight or titratable acidity were affected by shading, but yield declined by between 11 and 25%. Fruit quality after 6 weeks of controlled atmosphere (CA) storage (10% CO_2, 16% O_2, 0EC) was similar in both field-shaded and control treatments and showed a very low incidence of decay, but after 9 weeks decay increased in both treatments. In a parallel study a removable tunnel covered with 6 mil polyethylene was installed in early May over 4-year-old plants of 'Elliot'. Half of the plants were uncovered following petal drop; the tunnel remained in place on the others until the end of fruit harvest. Full season and partial season covering advanced fruit maturity by about 14, and 10 days, respectively, as compared with the controls. First year yields were increased by 25% by either covering treatment. Covered fruit was initially softer and smaller than that of the control plants, but firmness increased to equal that of controls after 6 weeks in CA storage. Quality was high (90% marketability) in fruit from all treatments even after 9 weeks of CA storage. The results indicate the potential for integrating field maturity control strategies with CA storage to modify the marketing period for highbush blueberries.

1340–1440

S14–P–53

N AND P FERTILIZERS, SOME GROWTH VARIABLES, AND MYCORRHIZAE IN WILD BLUEBERRY (*VACCINIUM ANGUSTIFOLIUM* AIT.)

E.A. Jeliazkova*, D.C. Percival

Dept. of Environmental Science, Nova Scotia Agricultural College, PO Box 550, Truro, Nova Scotia, Canada, B2N 5E3

N and P are among the fertilizers widely used by wild blueberry producers to improve growth and yield. Although extensive research has been done on fertilizers applications to wild blueberry fields, no conclusive evidence could be found regarding whether or not fertilizers do improve wild blueberry growth. The mycorrhizal associations are a substantial component of the blueberry ecosystem and may benefit growth and nutrition of the wild blueberry, but very little is known about the fertilizers effect on the mycorrhizal associations. The purpose of this study was to investigate the effects of N and P on some morphological variables of wild blueberry and associated ericoid mycorrhizae. N and P, singly and in combination, were applied to wild blueberry field in the vegetative phase of production in spring 2001. A factorial combination of the treatments in five replications (N, 0 and 35 kg N/ha in the form of urea 46-0-0; P, 0 and 60 kg P205/ha in the form of triple superphosphate 0-46-0) was used. Plots were arranged in randomized block design with a plot size of 5 x 10 m. Whole plant samples (squares of 16 x 16 cm and depth of 10 cm) were collected in July and August and mycorrhizal infection, stem density, stem dry weight, stem length, rhizome dry weight, root dry weight, and vegetative nodes were recorded. No significant effect of any of the treatments on any of the studied variables was noted. Consequently, the results of this experiment indicated that N and P, supplied as fertilizers in the form of urea and triple superphosphate at the specified rates, had no impact on the measured morphological variables and the associated ericoid mycorrhizae in the wild blueberry.

1340–1440

S14–P–54

EVALUATION OF BLUEBERRY SPECIES TO DIFFERENT SOIL AND CLIMATES OF JILIN PROVINCE OF CHINA

Yadong Li*, Lin Wu*, Zhidong Zhang*

Small Fruit Research Institute, Dept. of Horticulture, Jilin Agricultural Univ.,Changchun 130118, P.R.China

In 1998, three sites representing 3 natural soil and climate (acid, organic soil type, high rainfall and humidity) of the Changbai Mountain Area, and one site in Changchun City representing a large area of soil and climate in the Jilin province (high pH mineral soil, low rainfall and humidity) were selected. Nineteen blueberry species including 13 higbush, 4 half-high highbush and 2 lowbush species were cultured to evaluate the yield potential of blueberry species in different soil types and climates (soil was amended by sulfur and sawdust in the Changchun area). Plant growth, yield, fruit characters and cold-tolerance were studied from 1998 to 2001. The results indicated that lowbush blueberry and half-high highbush blueberry species showed high tolerance to cold and had high yield in the Changbai Mountain and Changchun Area. The average yield of 'Northland', 'Northblue' and 'Northcountry' reached 2.56 to 3.03 kg/plant; and 'Blomidon' reached 1.15 kg/plant in 2000. The winter damage was small and almost had no influence on yield. However, most highbush blueberry species had low tolerance to cold and low in yield, making them unsuitable to grow in the Chang Bai Mountain. Some highbush species such as 'Bluecrop', 'Patriot', 'Nelson', and 'Bluejay' had good growth and high yield in the Changchun area. The average yield reached over 2.95 kg/plant in 2000, 'Bluecrop' yield excellently, reaching 3.81 kg/plant, which is the highest yield in all 13 highbush species. From the experimental results, we recommend 'Northblue', 'Northland', 'Northcountry' and 'Blomidon' be used as the main juice and frozen fruit processing species for the commercial blueberry cultivation in the Changbai mountain Area; and 'Bluecrop', 'Patriot', 'Northblue' and 'Northland' be used as the main fresh fruit species for the commercial blueberry cultivation in the Changchun Area.

1340–1440

S14–P–55

COMPARISON OF SPRING FROST TOLERANCE AMONG DIFFERENT HIGHBUSH BLUEBERRY (*VACCINIUM CORYMBOSUM* L.) CULTIVARS

Lin Wu*[1], Kazimierz Pliszka[2]

[1]Dept. of Horticulture, Jilin Agricultural Univ., Changchun 130118, P.R.China; [2]Dept. of Pomology, Warsaw Agricultural Univ., Warsaw, Poland

Observations were carried out in the blueberry field station of Warsaw Agricultural Univ., Central Poland. Fifteen-year-old highbush blueberry plants were used. In the spring of 2000, central Poland was warmer than in previous years. Highbush blueberry plants began to bloom in the last 10 days of April. Before May 2, some cultivars were in full blossom. In the morning of May 3, from 3 to 6 am, there was a heavy frost. Temperature decreased to -6 °C and stayed there for 3 hours. Investigation of damaged flowers was carried out two days later. Most of the blueberry flowers were injured after the spring frost, especially the early-season cultivars 'Patriot', 'Darrow' and 'Earliblue'. Percent of injured flowers were 84.69%, 82.98%, and 72.95%, respectively, much higher than the mid-season cultivars 'Bluecrop', 'Berkeley', 'Blueray', and 'Spartan'. The late-season cultivar 'Lateblue' can avoid the frost injury because of its late blossom. Percent of injured flowers was only 10.77%. There were differences in frost susceptibility among

the three early-season cultivars 'Patriot', 'Darrow' and 'Earliblue' . 'Patriot' showed more injured flowers but a high fruit set rate and many berries formed. Most of the berries were quite small and had no seeds. 'Darrow' showed high flower injury and low fruit set rate and few berries formed. 'Earliblue' showed high flower injury, medium fruit set rate and few final berries. During berry development, 41.27% berries dropped. Symptoms of frost injury on flowers also showed on berries during their development (degree 0, 1, 2). Some injured berries can develop and ripen, but most of them are quite small and have no seeds inside. This frost almost had no influence on fruit set rate and the number of final berries on the late-season cultivar 'Lateblue'.

1340–1440

S14–P–56

CAN LOWBUSH BLUEBERRY SOIL PH BE TOO LOW?

J.M. Smagula*, W. Litten

Horticulture Program, 416 Deering Hall, Univ. of Maine, Orono, ME, U.S.A, 04469-5722

A soil pH of 4.8 is often cited as being optimal for wild lowbush blueberry (*Vaccinium angustifolium* Ait), but commercial fields have a range from 3.9 to 5.3. To determine if soil pH below the optimum is detrimental, two 2.4 x 4.8 m treatment plots within each of eight clones were established in a commercial field in Lamoine, ME in 1994. One plot was randomly selected to receive 784 kg of sulphur per ha to create an extremely low soil pH of 4.0. Pretreatment 1994 yield data verified comparable fruit production of the two plots. Soil pH was significantly lower in sulphur-treated plots compared to control plots in 1995, 1997, 1998 and 1999. In 1998 the control pH was 4.6 and the sulphur treated plots were 4.0. Despite this difference in soil pH, there were no differences between treatment plots in stem density (number of stems/m^2), stem length, branching, or flower buds/stem and only minor increases in leaf N, P and K concentrations and minor decreases in leaf Ca and B concentrations in 1997 samples. There were no differences in normal alternate-year yield of control or sulphur-treated plots in 1996, 1998, or 2000. Soil pH as low as 4.0 does not adversely affect growth or yield of lowbush blueberry.

1340–1440

S14–P–57

REGIONAL, SPATIAL AND TEMPORAL VARIABILITY OF CRANBERRY SOIL PH

Joan R. Davenport*[1], Carolyn J. DeMoranville[1], Saratha Kumudini[1], Teryl R. Roper[1], Art Poole[1], John Hart

[1]Washington State Univ. 24106 N. Bunn Road Prosser, WA 99350 USA; [2]UMASS Cranberry Experiment Station 1 State Bog Road E. Wareham, MA 02538 USA; [3]Rutgers Bluberry Cranberry Research Center, Oswego Road Chatsworth, NJ 08019 USA; [4]Univ. of Wisconsin 1575 Linden Drive Madison, WI 53706 USA; [5]Oregon State Univ. 290 N. Central Blvd Coquille, OR 97423 USA

Soil pH is an important factor impacting plant nutrient availability and the activity of soil borne pathogens. Therefore, the careful monitoring of soil pH characteristics is critical to plant productivity. This is especially significant to the perennial crop cranberry (*Vaccinium macrocarpon* Ait.) which is periodically flooded and, as a typical Ericiaceous plant, requires an acidic soil. Temporal and spatial variability in pH can impact plant vigor during much of its active growth. Typically in cranberry production systems soil samples are collected from multiple locations in a field, composited, and analyzed for soil pH. The sampling is generally conducted in the spring or fall to a depth of 15 cm, which is the deep end of cranberry root growth. We hypothesized that cranberry soil pH varies not only from region to region and field to field but within field (spatially) and throughout the growing season (temporally). To test this, a minimum of 4 fields were identified in the five principal US cranberry growing regions–Massachusetts, New Jersey, Oregon, Washington, and Wisconsin. Samples were collected from 0–15 cm depth in a 1 m sampling radius at twelve georeferenced sample points within each field. Samples were collected at monthly intervals throughout the growing season to evaluate temporal variability. In several of the growing regions samples were also collected at 2 depths–0–6 cm and 0–15 cm–to determine if the shallow soil might be a better indicator of soil pH in the concentrated root zone. Preliminary data suggest that the greatest variability in soil pH is from field to field although both spatial and temporal variability occurs within a field.

1340–1440

S14–P–58

MANUAL HARVESTING OF BLACKBERRIES IS FASTER ON SINGLE-SIDED SHIFT-TRELLIS THAN STATIC-I TRELLIS

Herbert Stiles*

Extension Horticulturist, Southern Piedmont AREC, VPI&SU, 2375 Darvills Road, Blackstone, Virginia, USA, 23824-3020

Virginia's blackberry industry primarily consists of small enterprises that dispose of their crops through fresh-fruit marketing channels. High levels of consumer demand, recent fresh-fruit prices and proximity to large population centers tend to reinforce the industry's reliance on fresh markets. Although progress toward mechanical harvesting of fresh-market brambles has been reported, manual harvesting remains essential for extended shelf-life in such products. Single-Sided Shift-Trellising systems have been derived to manipulate blackberry fruiting zones and vegetative canopies so that manual harvesting is accelerated and berries are protected from sunscald. Whole-plant harvests of marketable 'Navaho' and 'Chester' berries were more than twice as fast on Single-Sided Shift-Trellis than Static-I Trellis in a split-plot experiment during 1999 at Blackstone, Virginia. Observational procedures were changed during 2000 to harvest only those fruit located within 2 meters of the soil surface. Although this change eliminated "ladder time" for accessing of berries at the tops of vertically oriented Static-I Trellis canopies, the mean harvesting rate (number of berries per minute) remained 46% higher on Single-Sided Shift-Trellis.

1340–1440

S14–P–59

PATHOGENIC ORGANISMS AS THE STRESSFUL FACTOR FOR FRUIT AND SMALL FRUIT CROPS

Marina Keldish*[1], Yury Pomaskov[2], Olga Chervyakova[1], Irina Papko[1]

[1]Main Botanical Garden of Russian Academy of Sciences, Botanicheskaya Str., 4 127276 Moscow, Russia; [2]Univ. of Friendship People, Mikluho-Maklaya Str., 8 Moscow, Russia

Pathogenic organisms, infecting fruit and small fruit plants are obligatory components in ecosystems. Result of their activity is not only immediate damage–the reduction of crop yield, but also changes in the correlation of species in biocenoses. A biogenic stress, the reaction of plants to pathogenic activity of microorganisms, exerts an important influence on productivity and can vary between resistance–susceptibility. During virus infection monitoring in various ecosystems it is shown that fruit and small fruit plants are affected by a complex of viruses. These plants show a high level of adaptation to viruses of many types. The study of the role of viruses in disease shows the high infectious potential of these agents. Associations of nematodes, typically found in the rhizosphere of garden plants, can be virus vectors. There are usually not less than 3-5 kinds of nematodes in the rhizosphere. Under stress conditions plants seem to be more susceptible to nematode infestation. On the infected plants virus vector nematode population numbers increase. The process of infection is aided by the presence of a mixed population of viruses. There is an additive effect on plant susceptibility. There are numerous associations of viruses in the rhizosphere of fruit plants. The occurrence of complex infections promotes an expansion of the number of vectors and methods of transfer within the rhizosphere. The importance of this virus/vector interaction as it affects the productivity of small fruit crops cannot be understimated.

1340–1440

S14–P–60

KAOLIN CLAY AS A REPELLENT TO FLOWER THRIPS FEEDING ON RABBITEYE BLUEBERRY (*VACCINIUM ASHEI* READE)

James D. Spiers*[1], Frank B. Matta[2], Blair Sampson[3], John B. Braswell[4]

[1]26 Lindbergh Blvd Starkville, MS 39759; [2]Dept. of Plant and Soil Sciences Box 9555 117 Dorman Hall Mississippi State, MS 39762; [3]USDA Small Fruit Research Station P.O. Box 287 Poplarville, MS 39470; [4]South MS Research and Extension Center Poplarville, MS 39470

Kaolin clay emulsion applied to mature rabbiteye blueberry (*Vaccinium ashei* Reade) plants dried to form a reflective white film repellent to polyphagous flower thrips (*Frankliniella* spp.). Kaolin formulated as a wettable powder (Surround WP at 60 g/L) was applied to 18 blueberry plants until leaf run-off. Treat-

ments were applied during peak bloom, early fruit set, and 2 weeks before harvest. The experimental design was a Latin square with six replications, three rabbiteye cultivars (Delite, Tifblue, Woodard), and two treatments per cultivar (kaolin-treated plants and unsprayed plants). The number of thrips captured per yellow sticky trap (450 cm_) over a 7-day period was used to assess thrips abundance within the canopies of the blueberry plants. Kaolin clay reduced the number of thrips by 41% during flowering and 42% during the fruiting period. Kaolin did not influence yield, and no adverse effects were observed. Results show that kaolin can be a safe product for improving blueberry crop protection against flower and fruit feeding thrips.

1340–1440

S14–P–61

VIRUS IDENTIFICATION AND DISTRIBUTION IN TWELVE GENOTYPES OF BLACKBERRIES IN THE SOUTHEASTERN UNITED STATES

Tania Guzman*, Gina Fernandez, Zvezdana Pesic-VanEsbroeck

Dept. of Horticultural Science, North Carolina State Univ., Raleigh, NC 27695

Reports of virus diseases and virus-like symptoms have increased in blackberry cultivars in southeastern U.S. over the past five years (North Carolina State Univ. Insect and Disease Clinic). However, the characterization of these blackberry viruses was unknown. A survey was conducted to determine the presence and distribution of four viruses known to occur in blackberry. These viruses included: tobacco ringspot nepovirus (TRSV), tomato ringspot nepovirus (ToRSV), tobacco streak ilarvirus (TSV), and raspberry bushy dwarf idaeovirus (RBDV). Symptomatic leaf samples were collected from Apache, Chickasaw, Arapaho, Choctaw, Kiowa, Navaho, Shawnee, Chester, Rosborough, Triple Crown, Illini Hardy, and Brazos plantings. The collections were taken from nine grower locations and university research stations in North Carolina, South Carolina and Virginia. Leaves were tested by enzyme-linked immunosorbent assay (ELISA) using ELISA kits obtained from Agdia, Inc. (Elkhart, IN, USA). TRSV, ToRSV and RBDV were detected in leaf samples from different locations and varied by genotype. TSV was not detected in any of the samples tested. Despite of the expression of virus-like symptoms on the leaves, some of the samples tested negative for the above four viruses; this could be due to the time of the year that the samples were collected (low virus concentration), or the presence of virus(es) other than those tested for in this study.

1340–1440

S14–P–62

SUSCEPTIBILITY OF STRAWBERRY VARIETIES TO CROWN ROT (*PHYTOPHTHORA CACTORUM*) IN GREENHOUSE TESTS

P. Parikka*

MTT Agrifood Research Finland, Plant Protection, FIN-31600 Jokioinen, Finland

Crown rot (*Phytophthora cactorum* Lebert & Cohn) J. Schroet. was first observed in the summer of 1990 to cause severe wilting and destruction of strawberry plants in Finland. The popular variety Jonsok suffered the greatest damage. To be able to recommend strawberry varieties and disease control measures for growers, varietal resistance to crown rot was tested at MTT Plant Protection using crown inoculation with Finnish isolates of *Phytophthora cactorum*. During the past eight years more than 50 strawberry varieties and some *Fragaria vesca* hybrids have been used in greenhouse tests to determine their susceptibility to crown rot. Runner plants originating from micropropagated material were used in the tests. There were great differences in susceptibility to Phytophthora cactorum between varieties and the only resistant ones were 'Senga Sengana', 'Bounty', 'Sara' (*Fragaria vescana*) and 'Minja' (*Fragaria vesca*). The test results varied depending on the time the plants were infected. The age of the runner plants used was always the same and the temperature in greenhouse was fixed, but the light conditions varied. In the summer the very long photoperiod made most of the varieties more susceptible to crown rot than in the winter. The variety 'Senga Sengana', which is usually considered to be quite resistant, was moderately susceptible when tested during June-July. On the other hand, varieties like 'Elsanta' did not show such variation in test results. The Phytophthora cactorum isolates used in the inoculations originated from strawberry crowns. The age of the isolate might affect the pathogenicity but isolates of the same age also showed differences. Inoculation with fungal mycelium is an effective but laborious method in testing disease resistance. There is a demand for an easy method to evaluate plant material coming from the strawberry breeding programs.

1340–1440

S14–P–63

INITIAL SHOOT GROWTH AND DEVELOPMENT OF MICROPROPAGATED BLUEBERRY PLANTLETS FOLLOWING INOCULATION WITH AN ERICOID MYCORRHIZAL ISOLATE

Mark C. Starrett*

Univ. of Vermont, Dept. of Plant and Soil Science, Hills Science Bldg., Burlington, VT 05405-0082

Microshoots of blueberry (*Vaccinum corybosum* 'Bluecrop') were rooted directly in Jiffy-7 Peat Pellets containing established cultures of one of five different isolates of the ericoid mycorrhizal fungus, *Hymenoscyphus ericae* (Read) Korf and Kernan or remained non-inoculated. Microshoots were grown for 2 months under aseptic conditions in a growth chamber and then transferred to a greenhouse for 4 months. At harvest the following were recorded: shoot length, shoot number, leaf number, leaf area and shoot dry weight. In general, all shoot growth measurements were greater for inoculated microshoots than those which were not inoculated.

1440–1500

S14–O–64

INVESTIGATION OF STRAWBERRY PROANTHOCYANIDINS: IDENTIFICATION OF ANTAGONISTS TO BOTRYTIS CINEREA

Claire Hebert*[1], Louis Gauthier[2], Andre Gosselin[3], Yves Desjardins[3], Shahrokh Khanizadeh[4]

[1]Departement des sciences des aliments et de nutrition, Centre de Recherche en Horticulture, Pavillon de l'Envirotron, Universite Laval, G1K 7P4 Canada; [2]Les Fraises de l'Ile d'Orleans Inc., St-Laurent, Ile d'Orleans, Qc, GOA 3ZO, Canada; [3]Departement de phytologie, Centre de Recherche en Horticulture, Pavillon de l'Envirotron, Universite Laval, G1K 7P4 Canada; [4]Agriculture and Agri-Food Canada, Horticultural Research and Development Center, 430 Gouin Blvd., St-Jean-sur-Richelieu, Qc., J3B 3E6, Canada

Proanthocyanidins (PA) were evaluated as markers for *Botrytis cinerea* resistance of strawberry. These phenolic compounds (flavan-3-ols dimers and oligomers) consist of a mixture of basic units, e.g. catechin, epicatechin, gallate. They may serve as a chemical barrier to invading fruit pathogens, while their antioxidant potential may further improve quality preservation and extend shelf-life. Strawberry susceptibility to *Botrytis* rot varies among cultivars and may be explained in part by PA content. We previously showed that strawberry PA extract inhibited *Botrytis* growth in solid and liquid media, in correlation with fruit preservation. The aim of the research was to determine whether PA content could be used as indicator of disease resistance, and whether grey mold resistance correlated with PA oligomers or their basic units. Proanthocyanidins (PA) were extracted from six strawberry lines and assessed for their ability to control growth of *Botrytis* on solid medium. Catechin, epicatechin and gallic acid concentrations were assayed after hydrolysis, individually and combined. Polymerized catechins identity and content were also determined for these lines by LC-MS and HPLC; structure elucidation was assessed by mass spectroscopy. Cultivars rich in PA were more resistant to grey mold, in correlation with content in free and bound catechin > epicatechin and > gallic acid. The importance of characteristic catechin oligomers for resistance to grey mold will be discussed with respect to content proportions and interactions.

1500–1520

S14–O–65

EFFECTS OF BIOLOGICAL SPRAYS, MULCHING MATERIALS AND IRRIGATION METHODS ON GREY MOULD IN ORGANIC STRAWBERRY PRODUCTION

S. Prokkola*[1], P. Kivijärvi[2], P. Parikka[3]

[1]MTT, North Ostrobothnia Research Station, Tutkimusasemantie 15, FIN-92400 Ruukki, Finland; [2]MTT, Ecological Production, Karilantie 2 A, FIN-50600 Mikkeli, Finland; [3]MTT, Plant Production Research, FIN-31600 Jokioinen, Finland

A project to study different mulches and plant protection techniques in organic strawberry production is being carried out at MTT (Agrifood Research Fin-

land) in 2000-2003. Grey mould (*Botrytis cinerea*) is the disease which causes the most severe losses in strawberry production in Finland. Weeds are usually controlled with plastic covers, but more suitable materials for organic production are being sought. The effects of mulches, biological sprays and irrigation methods on the incidence of grey mould in the field and on the shelf-life of the harvested fruit are being evaluated in separate field trials. Mulching materials were black plastic, greenmass, straw, buckwheat husks, flax fibre mat and wood chips from deciduous and coniferous trees. The biological sprays used were seaweed, garlic and compost extracts, silicon, Trichoderma sp. and Gliocladium catenulatum sprays. The spraying treatments were started about two weeks before flowering and continued 4-5 times weekly during the growing season in 2001. The experiments were established at two MTT research stations, in Mikkeli and Ruukki. The effects of drip irrigation and sprinkle irrigation on grey mould were studied at Jokioinen. Yield losses caused by grey mould were calculated and a method for predicting the shelf-life of berries was developed. Marketable berries were placed individually into separate wells of plastic minipots and kept at room temperature and high humidity. Each tray was examined daily and berries with visible rotting were discarded over a week. In 2001 the incidence of grey mould in the field was low and the shelf-life of ripened berries short. The effects of different biological sprays and irrigation methods on the incidence of grey mould and the self-life of the berries were insignificant. Different mulching materials had more obvious effects due mainly to differences in the vegetative growth of the plants.

1520–1540
S14–O–66
BENZOTHIADIAZOLE INDUCES DEFENCE RESPONSES IN BERRY CROPS

R. Karjalainen*[1,2], A. Hukkanen[2], M. Anttonen[2], K. Tiilikkala[1]

[1]AgriFood Research in Finland, 31600 Jokioinen, Finland; 2Univ. of Kuopio, Dept. Ecology and Environmental Sciences, 70211 Kuopio, Finland

Plants have developed multiple protection strategies during evolution to respond to invading pathogens and environmental stresses. Strawberry contains a variety of phenolic compounds implicated in protective function against plant diseases and health-promoting activities in human nutrition. Defence mechanisms in plants can be activated by biotic or abiotic elicitors, which trigger a defence pathway leading to the expression of several defence genes and the accumulation of antifungal compounds, which eventually leads to the inhibition of the development of fungal growth. Benzothiadiadiazole (BTH), is a well characterized synthetic plant activator (salicylic acid derivate), known to give protection against a wide range of pathogens. We have tested the ability of BTH to induce resistance to powdery mildew in strawberry. Powdery mildew has currently become a serious disease in strawberry grown under plastic and greenhouses in many parts of the world. As chemical control is a difficult task due to the rapid development of fungicide insensitive strains, alternative mildew control strategies are needed. We found that foliar applications of BTH (0,6-1,2 g/L) on young strawberry leaves provided effective mildew control in greenhouses. The flavonol glycoside content of BTH treated leaves were also analyzed by HPLC and ESI-MS method, but no clear differences were detected between BTH treated and control plants. However, the levels of two flavonols, quercetin and kaempferol in berries were increased in response to foliar treatments under field conditions. The results suggest that BTH and related resistance elicitors may become a realistic alternative for chemical control against powdery mildew in strawberries grown in greenhouses and plastic tunnels.

1540–1600
S14–O–67
DOUBLE-CROP SYSTEM IN OUT-OF-SEASON STRAWBERRY PRODUCTION

Timo Hytönen*, Pauliina Palonen, Katriina Mouhu

Univ. of Helsinki, Dept. of Applied Biology, Horticulture, P.O.Box 27, FIN-00014 Univ. of Helsinki, Finland

There are few greenhouse strawberry producers in Finland. They obtain a maximum of two crops in a year, in the spring and in the fall. To increase productivity, a new cultivation technique is needed. The aim of this study was to develop a new plant production technique for greenhouse strawberry production. Plants of cultivar 'Korona' were exposed to two successive short day (SD) treatments followed by cold storage in order to obtain two successive crops during forcing and give four crops in a year. Furthermore, different SD treatments were studied in order to optimize flowering in 'Korona'. Pot-grown plants were subjected to three different daylength treatments: 1) 3 weeks SD + 2 weeks LD (long day) + 3 weeks SD; 2) 3 weeks SD + 4 weeks LD + 3 weeks SD; 3) 10 weeks SD. Daylengths in SD and LD were 12 h and 18 h, respectively. Temperatures of 15 °C (SD) and 20 °C (LD) were maintained during treatments. After the treatments, plants were packed in plastic bags and stored at -1 °C. After 6 to 10 weeks of storage, plants were forced in a greenhouse. The numbers of flowers and trusses were recorded, and marketable yield was weighed. To find an optimal SD treatment for 'Korona', plants were subjected to 10 different daylength treatments. After the treatments, half of the plants were stored for 6 weeks as described above and then forced in a greenhouse. The other half was forced immediately after the treatments. Numbers of flowers and trusses were recorded during forcing. Vegetative growth was observed by measuring petiole length. In addition, a number of flower initials at different developmental stages were recorded using a dissecting microscope. Day length treatments were carried out during the fall in 2001 and observations made during the following winter and spring. The treatment effects on vegetative and reproductive characteristics of strawberry are discussed.

1600–1620
S14–O–68
SCHEDULING PRIMOCANE FRUITING RASPBERRIES FOR YEAR-ROUND PRODUCTION IN GREENHOUSES.

Adam Dale*[1], Angela Gilley[2], Elizabeth M. Kent[3]

[1]Dept. of Plant Agriculture, Univ. of Guelph, Box 587, Simcoe, Ontario N3Y 4S4, Canada; [2]Performance Plants Inc., Queens Univ., Kingston, Ontario K7L 3N6, Canada; [3]Laboratory Services Division, Univ. of Guelph, Guelph, Ontario N1H 8J7, Canada

In Ontario, raspberries have the potential to be grown year-round in greenhouses. Initial research has shown that primocane fruiting raspberries can fruit for several years without a cold period, although in the winter production ceased. Since primocane raspberries can also fruit on overwintered canes, a duplicate set of experiments, one in 1998 and one in 1999, were set up to schedule fruit production throughout the year. Potted plants of two primocane fruiting cultivars 'Autumn Britten' and 'Polana' grown in the greenhouse and in the first year, plants either had their canes cut to 30 cm or left uncut. In December the plants were either left in the greenhouse or subjected to 6 weeks below 7 °C . In the first year, the plants with cut canes yielded less than the uncut plants and produced about one month later. In the second year, the plants that had been chilled, fruited sequentially on their floricanes and primocanes from late March onwards. Those plants that were not chilled fruited on their primocanes from May onwards and had lower annual yields than those that were chilled. These results are discussed together with their implications for year-round production.

1620–1640
S14–O–69
UTILIZATION OF DIFFERENT COMPOSTS TO INCREASE SOIL QUALITY AND BERRY PRODUCTION

Richard C. Funt*[1], Michael A. Ellis[2], Joseph C. Scheerens[3]

[1]Dept. of Horticulture and Crop Science, The Ohio State Univ., Columbus, Ohio 43210-1096 USA; [2]Dept. of Plant Pathology, The Ohio State Univ., Wooster, Ohio 44691 USA; [3]Dept. of Horticulture and Crop Science, The Ohio State Univ., Wooster, Ohio 44691 USA

Several studies exploring compost amended soils report increased organic matter, cation exchange capacity, decreases in bulk density and increases in water holding capacity. Within soils that are low in pH, and organic matter and high in bulk density, the physical and chemical soil improvements from compost may be of benefit for berry crops. Improving soil conditions can improve the number of good roots. Adding composts to soils can affect the nutrient content of the fruit, which can aid in human health. It is important to understand how soil amendments affect fruit elemental content and ultimately affecting the health of the general population.

1640–1700
S14–O–69–A
TO BE ANNOUNCED

Friday · August 16

0800–0900
S14–P–70
CHANGES IN FREEZING TOLERANCE AND PROTEIN CONSTITUENT OF *LONICERA CAERULEA* DURING COLD ACCLIMATION

H. Imanishi*[1], K. Takada[2], K. Masuda[2], T. Suzuki[2], T. Harada[2]

[1]Experimental Farm, Akita Prefectural College of Agriculture, Ogata, Akita, Japan 010-0451; [2]Hokkaido Univ., Sapporo, Japan 060-8589

Lonicera caerulea var. emphyllocalyx is a deciduous shrub native to the northern areas of Japan and eastern Russia. It bears purple, sour-sweet fruits in the summer. For the purposes of domestication, the extension of its culturing area, and the elucidation of the molecular events underlying cold acclimation were used to examine the relationship between habitat and freezing tolerance. We also examined freezing tolerance in different tissues, and verified freezing tolerance and protein constituents using the callus culture system. We evaluated the freezing tolerance of twigs by the bud sproutings that developed from October to March in Hokkaido, Japan. Differences in freezing tolerance of twigs were recorded between two habitats in February, and may be caused by the differences in air temperature and the depth of snow in the study areas. As evaluated by the TTC reduction test, time to develop freezing tolerance was earlier and longer in buds than in stems. There were remarkably no differences in the freezing tolerance between buds and stems throughout the winter, when both tissues had a high freezing tolerance. In the period of decreasing freezing tolerance from winter to spring, buds showed more tolerance than did stems. The calli exposed to low temperature of 5 °C increased their cold tolerance after 8 treatment days, reaching a plateau on day 12. The cold-treated calli lost their freezing tolerance within 2 days of incubation at 25 °C. The proteins extracted from these calli were analyzed by two-dimensional polyacrylamide gel electrophoresis. Results showed an abundant accumulations of a 42 kDa (pI 5.4) protein during cold acclimation. This protein decreased by incubation at 25 °C. Manipulating the level of the 42 kDa (pI 5.4) protein through breeding may contribute to the development of freezing tolerance in Lonicera caerulea var. emphyllocalyx.

0800–0900
S14–P–71
AUTUMN OLIVE: A POTENTIAL ALTERNATIVE CROP

Ingrid Fordham*, Beverly A. Clevidence, Richard H. Zimmerman, Brent L Black

U.S. Deaprtment of Agriculture, Beltsville, Maryland, USA, 20705-2350

Autumn olive (*Elaeagnus umbellata* Thunb.) was introduced into North America from Asia around 1830 as an ornamental shrub. It was also used to attract wildlife, and due to its disease and drought resistance, ability to fix nitrogen, and thrive on poor soil, it has been planted in distressed areas, along steep banks, highway intersections and median strips to prevent soil erosion. The abundant, deep red fruit has a good, sweet-tart flavor, but has hardly been used for human consumption in this country. However, recent studies at the USDA Beltsville Phytonutrient laboratory have shown that the fruit of Autumn olive is exceptionally high in the antioxidant carotenoid lycopene, together with other carotenoids and flavonoids. Lycopene has been associated with prevention properties of certain cancers and other chronic diseases. With the current interest in phytonutrients, Autumn olive may become a viable alternative crop. Unfortunately, due to seed dispersal by birds, Autumn olive has become a pest in some areas of the Eastern United States, and is listed as an invasive, alien plant. Since Autumn olive has not been grown as a fruit crop, selection for horticultural characteristics is needed, together with information about harvesting and processing the fruit on a commercial scale.

0800–0900
S14–P–72
INSECT VISITORS AND POTENTIAL POLLINATORS OF LINGONBERRIES, VACCINIUM VITIS-IDAEA SUBSP. MINUS IN SUBARCTIC ALASKA

A.N. Davis*, P.S. Holloway, J.J. Kruse

Univ. of Alaska Fairbanks, Georgeson Botanical Garden, P.O. Box 757200, Fairbanks, Alaska, USA, 99775

Flowers of lingonberries were observed at four locations in the Tanana Valley floodplain, Alaska in June and early July. Insect visitors were captured, identified and examined for pollen loads. Nine different insect types visited lingonberry flowers during anthesis from six families. They included *Apis mellifera*, Psithyrus sp., *Dolichovespula arenaria*, *D. norvegicoides*, Andrena sp., *Bombus sandersonii, B. flavifrons flavifrons, B. terrestris, B. mixtus, B. frigidus*, Dialictus? (Halictidae), ten specimens of Syrphidae, and two Geometridae: Lepidoptera. All visitors except two specimens of Syrphidae and the Geometridae carried lingonberry pollen. Specimens with the greatest lingonberry pollen load (>1000 pollen tetrads per insect) were *Apis mellifera, Bombus terrestris, B. sylvicola, B. flavifrons flavifrons, Andrena* sp. and *Dialictus?* (Halictidae). Three hives of *Apis mellifera* and two of Bombus terrestris were established in five woodland locations in the Tanana River floodplain. Flowering stems were tagged along two to four transects extending up to 150 m from the hives at each location to learn if honeybees or bumblebees aid in pollination. There was no correlation between fruit set, fruit diameter, filled seed per fruit and hive distance for all transects. This may indicate honeybee and bumblebee colonies do not improve fruit production in wild stands of lingonberries even though they visited flowers and carried lingonberry pollen. Native insect populations may be adequate for pollination. This project must be repeated over several seasons to verify these results.

0800–0900
S14–P–73
A NEW APPROACH FOR PROPAGATION OF KIWIFRUIT CV. HAYWARD: DIRECT ROOTING OF IN VITRO GROWN MICRO-CUTTINGS IN THE GLASSHOUSE

Temel Yalçin*, Buruhan Erenoglu, Masum Burak

Ataturk Central Horticultural Research Institute, Yalova, Turkey 77100

Micro cuttings grown in vitro were quick dipped in different IBA solutions, transferred into lattice pots holding different aggregate medium, and kept under mist in the glasshouse for 6 weeks. The highest rooting rate (94.7%), highest root number (32.8), and longest root (38.6 mm) were obtained from the peat:perlite (1:1 v:v) rooting mixture, after treating the micro-cutting with 400 mg/L IBA solution for 5 seconds.

0800–0900
S14–P–74
STUDIES ON THE DIAGNOSIS OF NUTRITIONAL STATE OF KIWIFRUIT 'HAYWARD' IN CHEJU ISLAND

Chun-Hwan Kim*, Doo-Young Moon, Seong-Cheol Kim, Seung-Jong Jun, Kong-Ho Kim

Jeju Agri. Experiment Station 1696 O-Deung dong Jeju, Koera

For the diagnosis of nutritional state of kiwifruit in Cheju, 110 orchards were selected and leaves and petioles of kiwifruit were analyzed from 1994 to 1996. The results obtained are summarized as follows: 1) The most suitable time for sampling of leaves of kiwifruits was from July 20 to August 20 when the concentration of macro-nutrient elements was least variable. 2) The average contents of N, P, K, Ca and Mg in the leaves of 'Hayward' kiwifruit were 2.74, 0.20, 1.91, 1.91, 0.51%, respectively, while those of Fe, Mn and Zn were 147.0, 160.1 and 54.0 ug/g, respectively. 3) The estimated critical levels in 'Hayward' kiwifruit leaves for macro-nutrients such as N, P, K, Ca and Mg were 2.5-3.0, 0.16-0.24, 1.80-2.44,1.95-2.63, and 0.39-0.63%, respectively. 5) The chemical properties of soil in kiwifruit 'Hayward' orchards were: pH 5.46, OM 9.69%, available P2O5 220.7 ppm, K 1.1, Ca 4.91, Mg1.48, CEC 16.18 me/100 g. 6) Correlation coefficients between N-content in leaf and leaf color was highest on August 5 ($r = 0.77$).

0800–0900
S14–P–75
STUDIES ON PARTHENOCARPY IN KIWIFRUIT

J. Hakimi Rezaei*[1], Y. Agayev[2]

[1]Agricultural Research Center of West Azarbaijan, Iran; [2]Dept. of Agronomy and Plant Breeding, Faculty of Agriculture, Tabriz Univ., Tabriz, Iran

Karyotype study is of great importance in cytogenetics. It is significant from systematic, evolutionary and breeding viewpoints. Reasons for parthenocarpy in kiwifruit cultivar. Monty, were investigated by studying root tips from both parthenocarpic and normal kiwifruits. A number of different methods of squash techniques are used for this purpose. In this study aceto-iron-hematoxylin stain technique is reported. The advantage of this method is: chromosomes keep their natural structures. We used an Olympus microscope Model BH2 to obtain the chromosome numbers in metaphase. Results revealed that chromosome numbers in both normal and parthenocarpic kiwifruits varied between 167-177, and it seemed that there was no difference between the 2 samples. In another preliminary study gibberellic acid (GA3) was sprayed in 3 doses (30, 45 and 60 ppm) 3 times to prevent or decrease fruit drop, because parthenocarpic fruits may drop after fruit set due to lack of seeds. Results revealed that 3 times GA_3 application at the dose of 60 ppm had significant effect in preventing fruit drop.

0800–0900
S14–P–76
PERFORMANCE OF CHOKEBERRY (ARONIA MELANOCARPA) IN OREGON, USA

Bernadine Strik*[1], Chad Finn[2], Ron Wrolstad[3], Gloria Murray[4]

[1]Dept. of Horticulture Oregon State Univ. 4017 ALS Corvallis, OR 97331-7304; [2]Hort Crops Research Laboratory 3420 NW Orchard Ave. Corvallis, OR 97330; [3]Dept. Food Sci. and Tech. Wiegand hall Oregon State Univ. Corvallis, OR 97331; [4]North Willamette Research and Extension Center 15210 NE. Miley Rd. Aurora, OR 97002

Chokeberry [*Aronia melanocarpa* (Michx.) Elliott] has become an increasingly popular fruit product in the USA where it is marketed as Aroniaberry juice. While this species is native to Eastern North America and is a diploid (24=34), significant breeding efforts in Germany and Russia have produced cultivars that are tetraploid (24=68) and have sometimes been designated as A. mitschurini Skvortsov et Majjtulina. In Eastern Europe, many health benefits are ascribed to Aronia and there is extensive commercial production of this crop for juice. However, there is presently little commercial hectarage in North America. We established a planting of chokeberry cultivars in 1997, using rooted cuttings, at the North Willamette Research and Extension Center in Aurora, Oregon. The cultivars being evaluated are 'Albigowa', 'Darbrowice', 'Egerta', 'Kutno', 'Nero', and 'Nowa Wies'. All cultivars grew vigorously in the planting year. In 1998, there was no fruit harvest due to bird depredation; the plot was netted from 1999-01. Yield in 1999 ranged from 4.4 to 12.4 kg/plant with 'Egerta' producing the lowest yield and 'Nero' the highest. Production in 1999 ranged from 13.0 ('Egerta') to 22.1 ('Kutno') kg/plant. 'Kutno', 'Albigowa' and 'Nowa Wies' did not differ significantly in yield in 2000. Plants were pruned for the first time in winter 2000/01. In 2001, 'Nero' produced the highest yield (24.1 kg/plant) and 'Egerta' the lowest (13.1 kg/plant). Berry weight ranged from 2.0 to 2.8 g in 2001, considerably larger than in 1999 and 2000. Percent soluble solids at harvest in 2001 ranged from 15.6 to 17.6 percent. Berries were found to have high sorbitol and anthocyanin content. Fruit quality data including total anthocyanins, total phenolics, sugar and acid profiles, and antioxidant properties will be presented. Our findings show that this crop is easy to grow in Oregon. No disease or insect pressure was observed during this study. Plants are very precocious, but cultivars do differ significantly in yield.

0900–0940
S14–O–77
COMMERCIAL POTENTIAL AND DEVELOPMENT OF NEW BERRY CROPS: AN OVERVIEW

J. Gilbert*, L. Gardner

Northwoods Wholesale Nursery 28696 S. Cramer Rd. Molalla, OR 97038 USA

The development of new berry crops with commercial potential will benefit from adopting a world perspective both in terms of selection and production techinques. The choices of potential new berry crops for northern growing regions have expanded thanks to the availability of plant material and information from the former Soviet Union. The commercial development of berry crops which are virtually unknown outside their areas of origin presents significant challenges. Potential growers of new berry crops will require information regarding production, harvesting and post-harvest handling. These growers will benefit by learning from the examples of those in other countries who have already invested much time and resources developing these crops. In addition, growers should consider borrowing ideas from existing cropping systems, when applicable. A commitment to exchange information and resources among growers can also assist the development of a new berry crop industry. In particular, growers should work together from the outset to establish a plan that defines quality standards and balances marketing of their new product with supply. Examples ofpotential new berry crops which offer opportunities to practice this approach include sea buckthorn (*Hippophae rhamnoides*), hardy kiwi (*Actinidia arguta*), and edible honeysuckle (*Lonicera kamtschatica*).

0940–1000
S14–O–78
NATIVE PLANT DEVELOPMENT PROGRAM

H. Rousseau*[1], D. Bergeron[2]

[1]Research and Development Institute for the Agri-Environment (IRDA)2700, Einstein, Sainte-Foy, Quebec, Canada G1P 3W8; [2]Quebec Ministry of Agriculture, Food and Fisheries,1665, boul Wilfrid-Hamel, Quebec, Canada G1N 3Y7

Throughout the province of Quebec, Canada, there are more than 40 native plant species producing edible fruits. From these species, it appears that some have the potential to be grown on a commercial basis. In 1996, many cultivators specialized in different horticultural crops, expressed their interest in diversifying their enterprises. To fulfill the needs of these cultivators, the Research and Development Institute for the Agri-Environment (IRDA), along with Quebec Ministry of Agriculture, Food and Fisheries, began to work on a native fruit development program. Since then, the plants that are being studied include the native species of the genus Rubus, Amelanchier, Viburnum and Aronia, respectively called blackberries, juneberries, cranberry-tree and black chokeberry. The objectives of the program are to select individual plant species in the wild that display interesting agronomic characteristics and to evaluate their performance as fruit crops; to develop plant production schemes; to determine cultural requirements; to identify major pests and diseases and develop integrated pest management programs; to transform these fruits into different high-value products and to carry out market research. The touristic aspect also represents an important part of the project. Six plantings, each designed by a landscape specialist, have been carried out on six farms in the Quebec city area. Eleven different types of blackberries and seven different types of juneberries were also evaluated at the IRDA's Research Farm. The work accomplished to date is, of course, a first step in developing native fruit crops. Valuable cultivars of blackberries and juneberries have been released on a small scale. However, research will continue to improve the quality of these cultivars. Extensive pests and diseases surveys have also been conducted. Plant production schemes are available and high-value products have been developed. A production guide will soon be available.

1000–1020
S14–O–79
LINGONBERRY YIELD TRIAL FOR THE PACIFIC NORTHWEST

Ross H. Penhallegon*

Oregon State Univ. Lane County Extension Service 950 W. 13 Avenue Eugene, OR 97402 USA

In the last five years, there has been a significant drop in small fruit acreage, mainly strawberries due to market demand and imports from out of state. In an effort to keep Oregon and Washington growers growing viable small fruits, lingonberries were looked at as a possible new crop for the Pacific Northwest. Lingonberries are primarily grown in the Scandinavia and European countries of Norway, Sweden, Finland, Estonia, and Russia. In north America, the berries are found in Alaska, eastern United States and eastern Canada. There have been two classifications of lingonberries found: the wild lingonberries, *Vaccinium vitis-idaea L. minus* Lodd and the European varieties used in commercial production, *Vaccinium vitis-idaea*. Lingonberries have been grown in the Pacific Northwest for four years as a new potential crop for berry growers. Yield trials have been conducted for the last four years looking at size, period of ripening, per cent of berries ripe and over all yield per acre. The yield per picking is being looked at since there are two distinct picking seasons; one the first week of August and the second, the last week of October. Seventeen different varieties are being looked at across Oregon and Washington at nine different sites.

1020–1040
S14–O–79–A
TO BE ANNOUNCED

1400–1420
S14–O–80
RELIABILITY OF RUSSIAN SEA BUCKTHORN VARIETIES IN NORTH OSTROBOTHNIA, FINLAND

Soile Prokkola*

MTT, North Ostrobothnia Research Station, Tutkimusasemantie 15, FIN-92400 Ruukki, Finland

The cultivation area of sea buckthorn (*Hippophae rhamnoides*) has increased rapidly during recent years in Finland. In 2000, sea buckthorn was cultivated over a total area of 116 ha, most of which was planted recently. One of the problems limiting cultivation is the lack of cultivars that are reliable to grow under local cultivation conditions. In Finland, Russian cultivars have been marketed before any research on the reliability of these cultivars under Finland's climatic conditions was undertaken. Siberian cultivars were marketed in the early 1990s, but they did not adapt to a maritime climate. The reliability of five sea buckthorn cultivars from the botanical gardens of Moscow State Univ., marketed during recent years, had been studied at the North Ostrobothnia Research Station of MTT (Agrifood Research Finland) in 1997-2001. The sea buckthorn cultivars studied were 'Avgustinka', 'Botanicheskaja', 'Botanicheskaja Ljubitelskaja', 'Gidrid Pertsika' (synonym Hybrid Pertsika) and 'Trofimovskaja'. Five plants per plot and four replicates were planted in June 1997. Black plastic was used as soil mulch. The saplings were planted at a 2-m distance within rows and 4 m between rows. Two pollinizers bred at the botanical gardens of Moscow State Univ. were planted within replicates. The cultivars proved to be very susceptible to stem canker disease, which resulted in the death of the stems and the entire bushes. The yields produced in 2000 and 2001 were very low. Possible reasons for the severity of stem canker disease are discussed.

1420–1440
S14–O–81
ISOLATION OF QUERCETIN GLYCOSIDES FROM LEAVES OF SEABUCKTHORN (*HIPPOPHAE RHAMNOIDES* SSP. MONGOLICA)

Leonid Akhov*, Branka Barl

Dept. of Plant Sciences, Univ. of Saskatchewan, Saskatoon, Saskatchewan S7N 5A8 Canada

Seabuckthorn (*Hippophae* spp.) has been used extensively in folk medicine of several Asian and European countries for hundreds of years. Being an excellent source of unsaturated fatty acids, vitamins C and E, carotenoids, phytosterols, and flavonoids, it has become the most sought after medicinal shrub in Western Canada. The Hippophae rhamnoides ssp. mongolica, introduced to the Canadian prairies from Siberia in the 1930s, was used as a parent material for the development of a cultivar named 'Indian Summe.' In contrast to seabuckthorn berries and seeds, very limited studies on natural compounds, notably flavonoids, from leaves have been conducted to date. Our earlier research has revealed that the leaves are a slightly richer source of flavonoids than the berries, and that 'Indian-Summer' biotype R-C4 contained consistantly the highest amount of flavonoids (1.8 to 2.0%). Flavonoids were separated from a crude 30% methanol extract of dry R-C4 leaves using a RP-C18 chromatographic cartridge, and then further fractionated by LP-LC on a LiChroprep RP-18 column using gradient elution. Three pure flavonol glycosides with quercetin as the aglycone were isolated, namely quercetin 3,7-O-diglucoside (MW 626), quercetin 3-O-glucoside-7-O-rhamnoside (MW 610), and a quercetin glycoside with 4 sugar units (2 hexoses and 2-deoxy-hexoses) in the side-chain (MW 918). Quercetin 3,7-O-diglucoside is the dominant flavonol in the leaves and accounts for ca. 24% flavonoids, followed by quercetin 3-O-glucoside -7-O-rhamnoside ca. 14% flavonoids. The chemical structures of two quercetin glycosides were determined using negative-ion FAB-MS, 1H-NMR,13C-NMR, UV spectra, bathochromic shifts after addition of a diagnostic reagent, and by comparison of our data with literature information. Presence of quercetin as the aglycone was also confirmed by acid hydrolysis of isolated compounds followed by HPLC analysis of hydrolysis products using quercetin as a reference standard.

1440–1500
S14–O–82
FLAVONOID CONTENT AND COMPOSITION IN LEAVES AND BERRIES OF SEABUCKTHORN (*HIPPOPHAE* SPP.) OF DIFFERENT ORIGINS

Branka Barl*, Leonid Akhov, Donna Dunlop, W.R. Schroeder, Sahti Jana

Dept. of Plant Sciences, Univ. of Saskatchewan, 51 Campus Drive, Saskatoon, SK S7N 5A8 Canada

Seabuckthorn (*Hippophae* spp.) is a rich source of natural health products and is actively cultivated in Canada. Berries, seed, and leaves are marketed in form of food and dermatological products, and dietary supplements worldwide. Flavonoids, one of several important constituents of seabuckthorn, are well documented to exhibit a variety of activities beneficial to human health: antinflammatory, antioxidative, antiviral, adaptogenic, antitumor, and immunostimulatory. For that reason, it is worth including flavonoid content as a desirable trait in future selections and breeding of seabuckthorn. The objective of this study was to determine total flavonoid content and flavonoid profile in leaves and berries of Hippophae species originating from China, Russia, Finland and Canada, sampled from the seabuckthorn germplasm collection at the PFRA Shelterbelt Centre in Indian Head, Saskatchewan. Four species (*H. rhamnoides*, *H. gyantensis*, *H. neurocarpa*, *H. mongolica*) and four subspecies of *H. rhamnoides: rhamnoides, sinensis, turkestanica* and *mongolica* (cultivar 'Indian Summer') were investigated. Results from a two-year study of 98 leaf and 51 berry samples indicated that flavonoid content, expressed as isorhamnetin equivalents, ranged from 0.92% to 1.89% for air-dried leaves, and 0.18% to 0.41% for lyophilized berry flesh. Two selections of 'Indian Summer' contained consistently the highest amount of flavonoids in leaves (1.7% to 2.0%) and berries (0.38% to 0.49%). The H. rhamnoides ssp. rhamnoides contained the least amount of flavonoids in leaves, but not in berries. On dry weight basis, leaves are in general slightly richer source of flavonoids than berries. The investigation of the flavonoid profile by RP-HPLC revealed that berries and leaves contain at least 19 and 13 distinct compounds, respectively. Flavonoid composition differs at the species and subspecies level and is both genetically and environmentally controlled.

1500–1520
S14–O–83
EFFECT OF AGE OF VINE, HAND THINNING AND PLANT GROWTH REGULATORS: THIADIAZURON, CARBARYL AND ETHREL ON FRUIT SIZE, YIELD AND QUALITY OF KIWIFRUIT (*ACTINIDIA DELICIOSA* CHEV.) CV. ALLISON

K.K. Jindal*, V.P. Kanan, P. Sharma

Dept. of Pomology, Univ. of Horticulture and, Forestry, Nauni, Solan, Himachal Pradesh, India, 173230

Kiwifruit has gained wide popularity in India in the recent past. This fruit is recommended for commercial cultivation in the low and mid hills. Cultivar 'Allison' is commercially grown but is prone to the problem of excessive fruiting, which results in small-sized fruits. Therefore, fruit thinning is necessary to improve the size and quality of fruits. A trial was carried out using plant growth regulator treatments with thiadizuron, carbaryl and ethrel with or without hand thinning at petal fall stage. At harvest, thiadiazuron treated fruits were 65 to 74 percent heavier than the control, depending on the concentrations used. It also increased fruit length from 14 to 23 percent, and diameter from 23 to 29 percent over the control. As a result, the yield per vine was about 27 to 43 percent higher than the control. Carbaryl application did not have positive effects on fruit size, weight and yield. Both grade 'A' and 'B' fruits were increased by thiadiazuron, while carbaryl increased grade 'B' and 'C' fruits. Thiadiazuron treated fruits had higher total soluble solute (TSS), TSS:acid ratio and lower fruit acidity, tannins and firmness than the carbaryl treatment and the control. Total sugars, total carbohydrates, ascorbic acid and soluble proteins level in the fruits also increased by thiadiazuron treatments. Ethrel spray followed by fruit dipping caused maximum fruit thinning when using concentration of 600 ppm, followed by 800 ppm, 400 ppm and 200 ppm. Significant fruit thinning by ethrel spray alone was also obtained at concentration of 600 ppm. A comparison of fruit thinning in old and young vines showed that maximum fruit thinning in old vines at 800 ppm ethrel spray. These studies were also compared with hand thinning. The fruits thinned by ethrel or hand thinning im-

proved the size of fruits significantly.

1520–1540
S14–O–84
IMPACT OF MULTIPLE FERTILIZER APPLICATIONS ON PLANT GROWTH, DEVELOPMENT, AND YIELD OF WILD BLUEBERRY (*VACCINIUM ANGUSTIFOLIUM* AIT.)

D.C. Percival, D.E. Stevens, D.E. Janes*

Dept. of Environmental Sciences, Nova Scotia Agricultural College, P.O. Box 550, Truro, Nova Scotia, Canada, B2N 5E3

An experiment examining the influence of multiple fertilizer applications throughout the two-year wild blueberry production cycle was examined at two commercial blueberry fields in Nova Scotia and Prince Edward Island during 2000 and 2001. A randomized complete block experimental design with nine treatments, five replications, and a plot size of 6 x 8 m was used. The treatments used consisted of (1) no fertilizer application, (2) an initial fertilizer application of 200 $kg{\cdot}ha^{-1}$ of 14-14-14 ($N:P_2O5:K_2O$) in the vegetative year of production (IFA), (3) IFA + 10 $kg{\cdot}ha^{-1}$ N prior to floral initiation of the vegetative year of production (FI), (4) IFA + 10 $kg{\cdot}ha^{-1}$ N prior to dormancy of the vegetative year of production (PD), (5) IFA + 10 $kg{\cdot}ha^{-1}$ N prior to bloom of the reproductive or "cropping" year of production (PB), (6) IFA + FI + PD, (7) IFI + FI + PB, (8) IFI + PD + PB, and (9) IFI + FI + PD + PB. Multiple fertilizer applications significantly increased stem density, leaf tissue N and P, individual stem dry weight, number of set fruit per stem, and harvestable yield ($g{\cdot}m^{-2}$) at both locations. Results from this study also indicated that the C:N ratio of the shoot may be an important factor regulating the yield potential. Therefore, results from this preliminary investigation indicate that multiple fertilizer applications can improve the nutrient status, growth, development, and harvestable yield of wild blueberries, and may be worth including in commercial cultural management practices.

1540–1600
S14–O–85
FIELD PERFORMANCE OF LOWBUSH BLUEBERRY PROPAGATED BY SEED, STEM CUTTINGS, AND MICROPROPAGATION

A.R. Jamieson*, N.L. Nickerson

Agriculture and Agri-Food Canada, Atlantic Food and Hort. Res. Centre, 32 Main Street, Kentville, Nova Scotia, Canada, B4N 1J5

Field plantings of improved Vaccinium angustifolium Aiton clones have had limited success due to reduced rhizome formation in plants propagated by stem cuttings. This study was designed to evaluate the field performance of the lowbush blueberry when propagated by alternative methods. A field plot was established in 1985 from plants that were either propagated by stem cuttings, by micropropagation, or grown from open-pollinated seeds. The three blueberry genotypes selected for this study were known to vary in yield of fruit and proclivity to produce rhizomes. When propagated by cuttings, K206 produced many rhizomes but few fruit, K74-13 produced many fruit but few rhizomes, and ME3 produced many fruit and moderate numbers of rhizomes. After 16 years, the greatest row widths were in the plots grown from seedlings. These were 2 to 3-fold wider than plots grown from cuttings. Rows from micropropagated plants were nearly as wide as the seedlings. The enhanced rhizome production of the micropropagated and seedling plants did not always lead to a greater fruit production.