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Central Valley POSTHARVEST newsletter

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CT PRODUCT AND GAS PENETRATION AFTER CONTAINER FUMIGATION OF TABLE GRAPES WITH REDUCED DOSES OF SULFUR DIOXIDE

Carlos H. Crisosto, **Lluís Palou**, **David Garner**, Dept. of Pomology, University of California, Davis, Kearney Agricultural Center, Parlier, CA; and **Donald A. Armson**, Gerawan Farming Inc., Reedley, CA

Reduced doses of sulfur dioxide (SO_2) were evaluated for the fumigation of marine containers with respect to the concentration per time (CT) product and gas penetration. Two commercial export containers were loaded at 0ºC with 20 metric pallets (40 x 48 inch) comprised of 72 expanded polystyrene foam boxes of table grapes (12 tiers, 6 boxes per tier) and fumigated with 1.0 and 0.5 lb SO_2, respectively. A third marine container was loaded with 20 metric pallets (40 x 48 inch) comprised of 84 plastic boxes of table grapes (14 tiers, 6 boxes per tier) and fumigated with 0.25 lb SO_2. The boxes contained 16 lb of table grapes distributed in nine polyethylene cluster bags enclosed in a perforated polyethylene box liner. Fumigations were performed through the bottom seal of the rear door from pre-weighed compressed SO_2 cylinders. CT product was calculated after taking samples of the atmosphere in the container every 5-10 min and measuring the ambient SO_2 concentration with a gas sampling pump and colorimetric dosimeter tubes. Gas pallet and box penetration

was assessed by placing passive colorimetric SO_2 dosimeters inside the cluster bags in boxes located in both the third and ninth center box from the top of pallets located in the front, center, and rear of the load. Fumigations with 1.0, 0.5, and 0.25 lb SO_2, with calculated CT products at 0ºC of 925, 360, and 40 ppm-h, respectively, were found to provide excessive, adequate, and insufficient SO_2 doses for the purposes of the treatment.

EFFECTS OF CONTINUOUS 0.3 PPM OZONE EXPOSURE ON DECAY DEVELOPMENT AND PHYSIOLOGICAL RESPONSES OF PEACHES AND TABLE GRAPES IN COLD STORAGE

Lluís Palou, **Carlos H. Crisosto**, Dept. of Pomology, University of California, Davis, Kearney Agricultural Center, Parlier, CA; **Joseph L. Smilanick**, Horticultural Crops Research Lab, USDA-ARS, Fresno, CA; **James E. Adaskaveg**, Dept. of Plant Pathology, University of California, Riverside, CA; and **Juan P. Zoffoli**, Facultad de Agronomía, Pontificia Universidad Católica de Chile, Santiago, Chile

Continuous ozone exposure at 0.3 ppm (v/v) (US-OSHA Threshold Limit Value for short term exposure) inhibited aerial mycelial growth and sporulation on 'Elegant Lady' peaches wound inoculated with *Monilinia fructicola*, *Botrytis cinerea*, *Mucor piriformis*, or *Penicillium expansum* and stored for 4 weeks at 5ºC and 90% relative humidity (RH). Aerial growth and sporulation, however, resumed afterward in ambient atmospheres. Ozone exposure did not significantly reduce the incidence and severity of decay caused by these fungi with the exception of brown rot. Gray mold nesting among 'Thompson Seedless' table grapes was completely inhibited under 0.3 ppm ozone when fruit were stored for 7 weeks at 5ºC. Gray mold incidence, however, was not significantly reduced in spray inoculated fruit. Continuous ozone exposure at 0.3 ppm increased water loss after 5 weeks of storage at 5ºC and 90% RH in 'Zee Lady' peaches but not after 4 weeks of storage in 'Flame Seedless' grapes. Respiration and ethylene production rates of 'O'Henry' peaches were not affected by previous exposure to 0.3 ppm ozone. In every test, no phytotoxic injuries of fruit tissues were observed in ozonated or ambient atmosphere treatments.

EFFECT OF GASEOUS OZONE EXPOSURE ON THE DEVELOPMENT OF GREEN AND BLUE MOLDS ON COLD STORED CITRUS FRUIT

Lluís Palou, Dept. of Pomology, University of California, Davis, Kearney Agricultural Center, Parlier, CA; **Joseph L. Smilanick**, Horticultural Crops Research Lab, USDA-ARS, Fresno, CA; **Carlos H. Crisosto**, Dept. of Pomology, University of California, Davis, Kearney Agricultural Center, Parlier, CA; and **Monir Mansour**, College of Agriculture, Menofiya University, Shebin El-Kom, Egypt

The effects of gaseous ozone exposure on in vitro growth of *Penicillium digitatum* and *Penicillium italicum* and development of postharvest green and blue molds on artificially inoculated citrus fruit were evaluated. Valencia oranges were continuously exposed to 0.3 ± 0.05 ppm (vol/vol) ozone at 5ºC for 4 weeks. Eureka lemons were exposed to an intermittent day-night ozone cycle (0.3 ± 0.01 ppm ozone only at night) in a commercial cold storage room at 4.5ºC for 9 weeks. Both oranges and lemons were continuously exposed to 1.0 ± 0.05 ppm ozone at 10ºC in an export container for 2 weeks. Exposure to ozone did not reduce final incidence of green or blue mold, although incidence of both diseases was delayed about 1 week and infections developed more slowly under ozone. Sporulation was prevented or reduced by gaseous ozone without noticeable ozone phytotoxicity to the fruit. A synergistic effect between ozone exposure and low temperature was observed for prevention of

sporulation. The proliferation of spores of fungicide-resistant strains of these pathogens, which often develop during storage, may be delayed, presumably prolonging the useful life of postharvest fungicides. In vitro radial growth of *P. italicum*, but not of *P. digitatum*, during a 5-day incubation period at 20ºC was significantly reduced by a previous 0.3 ± 0.05 ppm ozone exposure at 5ºC for 4 days. Inoculum density did not influence the effect of gaseous ozone on decay incidence or severity on oranges exposed to 0.3 ± 0.05 ppm ozone at 20ºC for 1 week. Susceptibility of oranges to decay was not affected by a previous continuous exposure to 0.3 ± 0.05 ppm ozone at 20ºC for 1 week. A corona discharge ozone generator was effective in abating ethylene in an empty export container.

MINIMUM CONSTANT SULFUR DIOXIDE EMISSION RATES TO CONTROL GRAY MOLD OF COLD-STORED TABLE GRAPES

Lluís Palou, **Carlos H. Crisosto**, **David Garner**, **Lisa M. Basinal**, Dept. of Pomology, University of California, Davis, Kearney Agricultural Center, Parlier, CA; **Joseph L. Smilanick**, Horticultural Crops Research Laboratory, USDA-ARS, Fresno, CA; and **Juan P. Zoffoli**, Dept. de Fruticultura, Pontificia Universidad Católica, Santiago, Chile

Sulfur dioxide generating pads are used worldwide for the control of gray mold, caused by *Botrytis cinerea*, during long-term cold storage and/or export shipment of table grapes. We established the minimum effective sulfur dioxide emission rates to control the decay of berries and aerial mycelial growth of the fungus among berries (nesting). For the evaluation of gray mold incidence, surface-sterilized individual 'Redglobe' berries were placed on plastic grids and sprayed with a spore suspension of *B. cinerea*. For the evaluation of gray mold nesting, a central syringe-inoculated berry surrounded by six healthy berries were placed in open Petri dishes. The grapes were placed inside gas-tight containers attached to a flow-through fumigation system and continuously exposed to sulfur dioxide at 0ºC and 95-98% RH for 6 weeks. The amounts of sulfur dioxide applied by weight of the grapes were 0.00, 0.55, 1.09, 2.19, 4.37, and 6.56 $\mu mol\ kg^{-1}\ h^{-1}$ in the containers with sprayed-inoculated berries and 0.00, 0.45, 0.91, 1.82, 3.64, and 5.47 $\mu mol\ kg^{-1}\ h^{-1}$ in the containers with berries in Petri dishes (inlet concentrations of 0.00, 0.25, 0.50, 1.00, 2.00, or 3.00 $\mu L\ L^{-1}$ in both cases). None of these sulfur dioxide emission rates completely controlled berry decay, while nesting was effectively prevented by sulfur dioxide emission rates of 3.64 and 5.47 $\mu mol\ kg^{-1}\ h^{-1}$ (inlet concentrations of 2.00 and 3.00 ppm). Both gray mold incidence and nesting were higher among control fruit at high relative humidity (95-98% RH) than at low relative humidity (65-75% RH), but no significant differences were observed when an inlet sulfur dioxide concentration of 3.00 ppm was applied. Sulfur dioxide was continuously sorbed by the grapes during exposure, and the concentration of sulfur dioxide in the air discharged from the fumigation chambers was lower than that applied. Sulfur dioxide did not visibly injure any fruit in these tests.

HIGH CO_2 DURING COLD STORAGE LIMITS BOTRYTIS LOSSES BUT ACCELERATES RACHIS AND BERRY BROWNING OF 'THOMPSON SEEDLESS' TABLE GRAPES

Carlos H. Crisosto, David Garner, and Gayle Crisosto, Department of Pomology, University of California at Davis, Kearney Agricultural Center, Parlier, CA

Controlled atmosphere conditions for control of storage decays of 'Thompson Seedless' table grapes was evaluated during 1998-2000. During the first season, early (16.5% SSC) and late harvested (19% SSC) grapes were exposed

to 5, 10, 15, 20 and 25% CO2 combined with 3, 6 and 12% O2. During the second and last seasons, 10 and 15% CO2 combined with 3, 6 and 12% O2 were used. In all trials, all fruit were initially SO2 fumigated and air stored grapes were used as controls. Storage atmospheres did not affect SSC, TA, SSC:TA, or berry shatter. The main storage limitations for early harvested 'Thompson Seedless' table grapes were "off flavor," and rachis and berry browning development. Rachis and berry browning, and "off flavors" resulted when early harvested 'Thompson Seedless' grapes were stored in CO2 concentrations >10%. However, CO2 $\geq$15% was needed to control total decay and nesting development independent of O2 concentrations. CA was more effective when late harvested grapes were used. For this work early harvested grapes were defined as near 16% SSC and late harvested grapes as near 20% SSC. Based on our work, we do not suggest the use of CA storage/shipment for early harvested 'Thompson Seedless' table grapes. The combination of 15% CO2 with 3, 6 or 12% O2 is suggested for up to 12 weeks storage only for late harvested 'Thompson Seedless' table grapes.

HIGH CO_2 DURING COLD STORAGE LIMITS BOTRYTIS LOSSES BUT ACCELERATES RACHIS BROWNING OF 'REDGLOBE' TABLE GRAPES

Carlos H. Crisosto, David Garner, and Gayle Crisosto, Department of Pomology, University of California at Davis, Kearney Agricultural Center, Parlier, CA

In order to determine optimum CO2 and O2 concentrations for 'Redglobe' table grape storage as a potential substitute to SO2 for controlling botrytis decay development without affecting grape quality, research was carried out during the 1998-2000 seasons. During the first season, early (14% SSC) and late harvested (17% SSC) 'Redglobe' grapes were exposed to sixteen atmosphere gas combinations, which consisted of CO2 at 5, 10, 15, 20, and 25%; combined with O2 at 3, 6, and 12%. During the second season, 10% CO2 + 3% O2, 10% CO2 + 6% O2, 10% CO2 + 12% O2, 15% CO2 + 3% O2, 15% CO2 + 6% O2, or 15% CO2 + 12% O2 treatments were used. In both seasons, air stored grapes were used as a control. In the last season, late harvested 'Redglobe' grapes were subjected to 12% CO2 +6% O2 and standard commercial storage practices. Exposure of 'Redglobe' grapes to CO2 and O2 combinations up to 12 weeks did not affect SSC, TA, SSC:TA, or berry shatter and browning. Rachis browning was accelerated and trained judges perceived "off flavor" in grapes exposed to CO2 levels >10% and >15% for early and late harvested 'Redglobe' grapes, respectively. Thus, early harvested grapes were more sensitive to high CO2 levels than late harvested grapes. CO2 >10% controlled total decay and nesting independent of O2 concentrations measured at arrival and after three days at 20ºC, simulating a retail display period. The use of CA was maximized when more mature grapes were used. The main negative results of storage were stem browning and "off flavor" development. Based on these data, 10% CO2 combined with 3, 6 or 12% O2 is suggested for up to 12 weeks storage for late harvested 'Redglobe' grapes. Ten percent CO2+ 6%O2 is suggested only up to 4 weeks for early harvested 'Redglobe' grapes.

POMEGRANATE POSTHARVEST FUNGICIDE UPDATE

Submitted by **Jim Adaskaveg,** Dept. of Plant Pathology, UC Riverside

August 14, 2001 **No.** 01-19

CALIFORNIA AUTHORIZATION FOR PESTICIDE USE UNDER U.S. EPA SECTION 18 SPECIFIC EXEMPTION FOR DISTRIBUTION AND USE ONLY WITHIN CALIFORNIA

Pursuant to authority granted under Section 18 of the Federal Insecticide, Fungicide and Rodenticide Act and 40 CFR, Part 166,

approval is granted to use the pesticide shown below to control specified emergency.

Product: Scholar Fungicide
EPA Reg. No. 100-98060-EE
Firm Name: Syngenta
Location: Fresno, Kern, and Tulare Counties
Crop/Site/Commodity: Pomegranates
Target Pest/ Problem: Gray Mold (*Botrytis cinerea*)
Method of Application: Dip Treatment (Post-harvest)
Dosage: Use 1 lb of product (0.5 lb a.i.) per 100 gal of water or a wax/oil emulsion per 200,000 lb of fruit.
Dilution Rate: See "Dosage" above.
Frequency/Timing of Application: Treat fruit only once. Dip solution shall be replaced with fresh dip solution after 200,000 lb of fruit has been treated.
Restricted Entry Interval (REI): N/A
Preharvest Interval (PHI): N/A
Effective Date: August 14, 2001
Expiration Date: November 15, 2001
Other Requirements:

1. Only 30,000,000 lb of fruit may be treated.
2. U.S. EPA has determined that there is low potential for environmental exposure, the risk of ecological effects from this post-harvest application is negligible.
3. The U.S. EPA has established a time-limited tolerance for residues of fludioxonil (4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1H-pyrrole-3-carbonitrile) in or on pomegranates at **5.0 ppm**.

All applicable directions, restrictions, and precautions on the U.S. EPA registered label and this label must be followed.

This labeling must be in the possession of the user at the time of pesticide application.

Tank mixing with other compatible pesticides, spray adjuvants and fertilizers is allowed as long as all labeling and regulatory requirements are met and tank mixing is not otherwise prohibited.

The Department shall be immediately informed of any adverse effects resulting from the use of this exemption.

Please note: The U.S. EPA expects concerned growers or grower groups to work towards the registration of use patterns that may be needed on a continuing basis. It will, therefore, be necessary to require applicants wishing to renew emergency exemptions to provide a progress report on residue tolerance and registration along with request for reissuance of an emergency exemption.

Without substantial progress in pursuing a tolerance and registration for the use in question, it will be difficult to obtain an emergency exemption for another season. The pesticide manufacturer or Western Region IR-4 may be contacted regarding the initiation of a pesticide petition for residue tolerance.

A final report must be submitted by the county agricultural commissioner or Pesticide Registration, Department of Pesticide Regulation within 45 days of the expiration date of this exemption. This report must include the following information:

a. Amount of product used.
b. Units (i.e., acres, tree, cattle) treated.
c. Number of applications.
d. Estimate of effectiveness.
e. Any adverse effects noted.

Prior to use under this exemption, a permit must be obtained from the county agricultural commissioner. The permit shall state the maximum number of acres to be treated, maximum amount of product that may be applied, and dealer from which the product may be purchased. The purchaser (permittee) or purchaser's (permittee's) agent must provide the seller, or person delivering the restricted material, a copy of the permit on the date the restricted material is delivered. The dealer shall maintain a record of each sale which shall be made available to representatives of the

Department of Pesticide Regulation or county agricultural commissioner upon request. Such records shall include the date of sale or delivery, permit number, identity and amount of product purchased, and the name of the purchaser.

All applications of this material shall be made by or under the supervision of a certified applicator certified for this category of pest control.

Agricultural pest control businesses shall submit a pesticide use report to the county agricultural commissioner within seven days of each treatment. Growers who apply this material shall submit a pesticide use report to the county agricultural commissioner by the 10th day of the month following the month in which the applications are made. The county agricultural commissioner, in cooperation with the Department of Pesticide Regulation, will monitor the use of the product under this exemption and will prepare a written report describing any unusual or adverse effects attributable to this use.

This exemption does not constitute a recommendation of the Department of Pesticide Regulation and will not prevent quarantine action if illegal residues are found in or on any crop. Neither the Department nor the county agricultural commissioner, manufacturer or the formulator makes any warranty of merchantability, fitness of purpose, or otherwise, expressed or implied, concerning the use of a pesticide in accordance with these provisions. The user and/or grower acknowledges the preceding disclaimer and accepts liability for any possible damage or nonperformance resulting from this use.

This is Not an Authorized Label

Ralph E. Shields
Supervisor of Registration
Pesticide Registration Branch
(916) 324-3519
E-mail: rshields@cdpr.ca.gov

California Environmental Protection Agency

POSTHARVEST ABSTRACTS – FROM 5TH INTERNATIONAL PEACH SYMPOSIUM

HOW DO WE INCREASE PEACH CONSUMPTION?

Carlos H. Crisosto, Department of Pomology, University of California, Davis, CA

Source: Oral Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

In the last decade, total production of new yellow and white flesh peach cultivars with different titratable acidities and flavors has increased rapidly. However, USA peach consumption has remained steady at approximately 2.0-kilos/per capita/per year in the last 20 years. Consumer surveys have associated low peach consumption mainly with the presence of flesh browning, and flesh mealiness (chilling injury or internal breakdown), and the lack of consumer understanding between mature and ripe peaches. In both cases, consumers do not perceive potential peach flavor. In peaches, chilling injury symptoms develop faster at temperatures between 2.2 and 8.8°C than at 0°C, which are typical during transit, warehouse and retail store handling operations.

Short and long term approaches to increase peach consumption are being tested. In the short-term: proper temperature management for packers, shippers, transportation, buyers and receivers, and preconditioning/preripening treatments at the shipping point are commercially used with success in California; and educational promotional programs on peach handling/ripening for peach buyers, retailers and consumers have been established. In addition, sensory evaluation research

programs to define peach quality attributes and understand consumer preferences including the potential role of ethnic factors are being developed. As a long-term solution, programs to understand the genetic and biochemical basis of flavor, antioxidant attribute pathways, and chilling injury genetic control by using available molecular genetics technologies are developing. The use of this new information and techniques for breeding programs will allow the development of peach cultivars with new flavor and improved antioxidant attributes and freedom from chilling injury susceptibility.

ETHYLENE PERCEPTION IN PEACH: EXPRESSION OF TWO GENES ENCODING ETHYLENE RECEPTOR DURING FRUIT RIPENING AND IN FRUITS TREATED WITH 1-METHYLCYCLOPROPENE

C. Bonghi, **A. Rasori**, **F. Ziliotto**, **A. Ramina** and **P. Tonutti**, Department of Environmental Agronomy and Crop Science, Agripolis-Legnaro (Padova), Italy

Source: Oral Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

We have isolated two peach (*Prunus persica*) genes, *Pp-ETR1* and *Pp-ERS1*, homologous to the Arabidopsis ethylene receptor genes ETR1 and ERS1. Expression analysis, carried out by RT-PCR, was performed during fruit ripening (cv Maria Marta) and after treatment with 1-methylcyclopropene (1-MCP), an inhibitor of ethylene action. The level of *Pp-ETR1* transcripts remained unchanged throughout ripening, whereas *Pp-ERS1* mRNA increased in parallel with the ethylene climacteric. Fruits harvested at the preclimacteric stage (firmness value of about 70-80N), were treated with 1-MCP (1µl l^{-1}) for 12h at 20°C and then transferred to air. Ethylene evolution and mRNA accumulation of *Pp-ETR1* and *Pp-ERS1* were markedly reduced at the end of the treatment, but a rise of both parameters was observed after 24 and 72h in air during the post-treatment phase. These data suggest that, under our experimental condition, ethylene receptors are regenerated within a short time. 1-MCP caused a slight delay in flesh firmness decline at the end of the treatment. This was due to a reduction of both endo-polygalacturonase (PG) mRNA and activity. The effect disappeared after 72h, when ethylene biosynthesis and perception returned to the control level.

ETHYLENE RESPONSIVE GENES ARE DIFFERENTIALLY REGULATED DURING ORGAN ABSCISSION, SENESCENCE AND WOUNDING IN PEACH (*PRUNUS PERSICA*)

Benedetto Ruperti, **Silvana Pagni**, **Angelo Ramina**, Department of Environmental Agronomy and Crop Science, University of Padova, Legnaro, (Padova), Italy; and **Luigi Cattivelli**, Istituto Sperimentale per la Cerealicoltura, Fiorenzuola d'Arda, Italy

Source: Oral Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Ethylene responsive genes from Peach (*Prunus persica*, L. Batsch) were isolated by differential screening of a cDNA library constructed from abscission zones in which cell separation had been evoked by treatment with the ethylene analogue propylene. DNA and deduced protein sequences of four selected clones, termed PpAz, revealed homology to thaumatin-like proteins (*PpAz8* and *PpAz44*), to proteins belonging to the PR4 class of pathogenesis related (PR) proteins (*PpAz89*), and to fungal and plant beta-D-xylosidases (*PpAz152*). The transcripts belonging to the three PR-like genes PpAz8, PpAz44 and PpAz89, were shown to accumulate preferentially and preventively in the fruit and leaf abscission zones through an ethylene dependent pathway. PpAz152 transcript showed a remarkably different accumulation pattern being consistently induced through an early pathway and only slightly stimulated by propylene. On the

contrary, a complex pattern of transcript accumulation was found for the four genes in response to wounding of leaves and during organ development and senescence. Based on this evidence, the existence of multiple regulatory pathways underlying the differential expression of the four PpAz genes in the different tissues and physiological processes is hypothesized.

THE EFFECTS OF CHILLING TEMPERATURE ON JUICINESS AND ETHYLENE EVOLUTION IN PEACH FRUIT

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Source: Oral Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

During the past three years we conducted a series of studies on peach storageability. Longitudinal studies using incubators set at 0, 2.5, 5, 7.5 and 10°C showed that less juice was extractable by centrifugation after storage at temperatures below 7.5°C. Fruits held at 7.5°C or greater were capable of fully softening in storage while fruit held at 5°C softened less. Studies demonstrated that storage at 2.5°C or less suppressed ethylene production dramatically. Shipping-mature 'Redhaven' were successfully held for up to six weeks in storage at 0°C. After holding for seven days at room temperature, fruit still softened and became juicy. Ethylene evolution also increased dramatically at room temperature. Six weeks of storage at 0°C did not appear to damage the fruit's ability to evolve ethylene.

Short-term studies of the effect of temperature on ethylene were conducted at temperatures from 0°C to 20°C. After equilibration, ethylene evolution was measured. Arrhenius plots of ethylene production were linear and did not show an inflection point at chilling temperatures. An unusually high Q_{10} was measured for ethylene production in peach and nectarine. This may contribute to the development of postharvest disorders.

Our working hypothesis was that flesh mealiness resulted from 'chilling injury.' While it was an attractive hypothesis, it was difficult to prove. Commercial observations of mealiness in late-harvested fruit would also argue against chilling injury. In hindsight, storage recommendations of 0°C rather than 5°C also seem illogical if mealiness is a symptom of chilling injury. We postulate that peach and nectarine disorders that occur in storage at 5°C are caused by the production of low levels of ethylene that induce some ripening-related genes. Mealiness and the lack of juice may then occur during senescent breakdown, not chilling injury.

IMMUNOLOGICAL DETECTION OF RIPENING-RELATED PROTEINS IN STONEFRUIT

Barry McGlasson and **Paul Holford**, Centre for Horticulture and Plant Sciences, University of Western Sydney, Hawkesbury Campus, Richmond, NSW, Australia

Source: Oral Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

The objective of this research was to identify ripening-related proteins in stone fruit that can be used as an index of ripening and whose expression is not affected by growing conditions. The initial research was conducted with Japanese-type plums. Fruit were harvested at several stages during development, including optimum commercial harvest maturity, as determined by changes in skin colour, firmness, titratable acidity, soluble solids concentrations and storage life at 0°C. Total proteins were extracted from the fruit and separated by 2-D polyacrylamide gel electrophoresis. Four proteins were detected

that are synthesised a few days before ideal commercial maturity. Closely related proteins were also found in extracts of maturing peaches and nectarines. Monoclonal antibodies (mAbs) were raised against conjugated oligopeptides designed from amino acid sequence data from two of the proteins. However, the mAbs could not reliably detect the proteins either in protein extracts or juice samples from fresh fruit. Research is continuing on the properties of the ripening-related proteins that should enable the development of a highly sensitive immunological field test of maturity.

INCREASING FRUIT QUALITY IN PEACH AND NECTARINES: THE MAIN GOALS OF ISF-FO (ITALY)

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Sezione di Forlì, Forlì, Italy

Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

In the mid 1980s, the Forlì branch of the Istituto Sperimentale per la Frutticoltura started a breeding program with the precise aim of improving fruit quality in peach. The main objectives pursued and the results obtained were:

1. Join the excellent flavour of the traditional white-fleshed Italian varieties with the good commercial characteristics of cultivars from USA. Alba, Bea, Neve and Crizia, have already been released and several promising selections are under advanced evaluation. Although of high quality standard, the material selected does not match high flesh consistency with the very good flavour of the old Italian varieties, presumably because flesh hardiness plays a role in determining the fruit flavour.
2. Introduce the "stony hard" character in genotypes with high agronomical standard but melting flesh. The selection IFF 331, together with the "stony hard" character has very good fruit colour and size.
3. Increase Vitamin C content, which is generally poor in peach fruit. We have a few sources of high ascorbic acid content also characterised by the good flavour. In the progeny deriving from the first crosses, a wide range of variability was found for colour, fruit size and Vitamin C content.
4. Obtain early ripening peach and nectarine cultivars with a small and split-pit resistant stone. Few of the seedlings obtained satisfy the desired characteristics. Moreover, all the nectarines in F2 were sensitive to skin cracking and surface speckling.

ANTHOCYANIN AND PHENOLIC CONTENT IN RED FLESHED PEACHES AND PLUMS AND THE RELATIONSHIP TO ANTIOXIDANT ACTIVITY

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Department of Horticultural Sciences,
Texas A&M University, College Station, TX;
and **W. R. Okie**, USDA-ARS,
S.E. Fruit & Nut Research Lab, Byron, GA

Source: Oral Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Fruit samples were collected from 8 red-flesh peaches and 13 red-fleshed plums from plots at the USDA-ARS Prunus collection at Byron, GA in August and frozen at -20°C. These were assayed for total phenolics and anthocyanin content as well as antioxidant activity. The anthocyanin content of the peaches ranged from 3.4 to 22.0 mg/100g tissue and that of the plums ranged from 19.4 to 101.7 mg/100g tissue. The total phenolics content for peaches ranged from 99 to 261 mg chlorogenic acid/ 100 g tissue and the phenolic content of plums ranged from 158 to 245 mg chlorogenic acid/ 100 g tissue. The anti-oxidant activity ranged from 440 to 1780 ug equivalent Trolox/ g tissue for peaches and from 1250 to 3240 ug equivalent Trolox/ g tissue for the plums. Correlation analysis indicated that the anthocyanin content but not the phenolic

content was well correlated with the anti-oxidant activity. Additional amounts of extracts are being prepared for the assays for anti-microbial and anti-cancer activity.

NIRS EVALUATION OF PEACH AND NECTARINE FRUIT QUALITY IN PRE- AND POST-HARVEST CONDITIONS

G. Costa, **M. Noferini**, **G. Fiori**, **O. Miserocchi** and **A.M. Bregoli**, Department of Arboriculture, University of Bologna, Bologna, Italy

Source: Oral Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Fruit quality at harvest is usually determined by the external appearance (skin color, fruit shape, absence of defects and bruises, commercial size, etc.) while internal fruit characteristics, which may better meet consumer expectations, are traditionally determined in a destructive manner on a given number of fruits. In recent years, non-destructive methods using near-infrared spectroscopy (NIRS) to evaluate parameters for estimating maturity have been applied to different fruit species. The advantage of this technique is the possibility of checking the maturity stage directly on the tree or to grade a large number of fruits in packing houses. The present study reports the results recorded with two NIRS instruments, one portable and one stationary, used to estimate soluble solids content (SSC), flesh firmness (FF), dry matter content, and total titratable acidity in peach and nectarine fruits. The predicted quality parameters (SSC, FF, dry matter, and acidity) were similar to the respective data collected destructively, which were recorded as reference measures in both field and packing house conditions. The best results were with soluble solids prediction, where SEP values ranged ± 0.61.

EVALUATION OF WHITE FLESHED PEACH AND NECTARINE VARIETIES IN NEW JERSEY

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Forty-six white-fleshed peach and nectarine varieties were planted and evaluated for tree and fruit characteristics in New Jersey from 1985 through 2000. In the planting, standard varieties like Raritan Rose, White, Rose, Redrose, and Summer Pearl developed at the New Jersey Agricultural Experiment Station were compared to varieties from public and private breeding programs and growers. Many varieties had better fruit firmness, more red skin color and better undercolor, and lower pubescence than the standard varieties. White Lady was the best. Arctic Jay nectarine was one of the most promising but had only been evaluated four years. Carolina Belle, Klondike, Blushing Star, Sugar Giant, Lady Nancy, Snow King and Snow Giant all possessed superior characteristics to standards and showed promise for planting.

QUALITY OF PEACH AND NECTARINE FRUIT COMMERCIALISED IN ROMAGNA (ITALY): A TWO-YEARS' SURVEY

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Fruit quality of Integrated Peach Production in Romagna (Po Valley, Italy) was investigated in 1999 and 2000 on 54 peach and nectarine

cultivars. Each year, more than 3,000 commercially mature peach and nectarine 15-30 fruit samples, handled by two important firms, were analysed by Pimprenelle automated laboratory (SETOP, France). The characteristics assessed for each fruit (more than 100,000 in the two years) were: weight, soluble sugar content, titratable acidity and flesh firmness. Compared to peaches, nectarines generally showed greater flesh firmness, higher soluble sugar and titratable acidity percentage, and lower fruit weight. Late harvest increased soluble sugar content and fruit size. Although more than 90% of the fruit scored satisfactory for size (>C, that is 56 mm in diameter) and soluble sugar content (>7 °Brix measured by Pimprenelle), over 50% were too high in flesh firmness (>5 kg/cm^2).

This study showed that the Romagna area has the potential to produce high quality fruit both from the sanitary and organoleptic point of view; a further rationalisation of harvest criteria is needed to improve the percentage of production satisfying high quality requisites.

There were very few differences between the data registered in the two years.

EFFECTS OF HARVEST DATE AND FRUIT POSITION ALONG THE TREE CANOPY ON PEACH FRUIT QUALITY

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

The evolution of physico-chemical fruit characteristics were studied during peach fruit ripening. The aim of this study was to simultaneously analyze the pattern of different qualitative characteristics of individual fruits in different areas of the peach canopy. This study was carried out on a white fleshed peach cultivar (*Prunus persica* L. Batsch cv. 'Alba') and a yellow fleshed peach cultivar (*Prunus persica* L. Batsch cv. 'Fire Prince'). Tree canopies were divided into three horizontal layers (lower, mid, upper layer) and all the fruits from each layer were harvested separately. Three harvests were performed at 7-day intervals. Fruit diameter, fruit fresh weight, percentage of red surface color, firmness and soluble solid content were determined. To distinguish among fruits of the different harvest dates and fruit canopy positions, a discriminant analysis procedure was applied to experimental data. The discriminant analysis procedure extracted five discriminant functions for each cultivar. In the present study, the fruit qualitative differences between the three canopy layers changed throughout the on-tree-ripening process; fruit canopy position was indicated as a major factor affecting fruit quality. Fruit ripening gradients among canopy layers were less evident on second and third harvest date for Fire Prince and Alba peach cultivars, respectively. Fruit discriminant scores summarized fruit quality characteristics well, but their use as a fruit quality index and/or as a harvest index needs to be tested further. In addition, our results suggest that the lower canopy layer can play an important role in the production of high quality fruits like the other two canopy layers.

PEACH FRUIT RIPENING AFFECTED BY AVG

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

A close link exists between the reaching of "on-tree physiological maturity" and key traits responsible for peach fruit quality. Quality is defined by several chemical, physical and

sensory parameters, and their evolution is controlled by ethylene. As a rule, progression of ripening may be related to adequate amounts of ethylene, while the onset of the process may be due to enhanced hormone sensitivity. An approach to manipulate ripening could be achieved by applying substances which inhibit ethylene production such as aminoethoxyvinylglycine (AVG). Redhaven peach was treated with AVG at concentrations ranging from 60 to 250 ppm at 10 days before harvest, during the last phases of fruit growth. The following data were collected: fruit growth, ethylene emission, drop and main fruit quality parameters. Fruit soluble solids content and flesh softening were also monitored during post-harvest period.

In all the tested experimental situations AVG reduced and delayed the onset of fruit ethylene emission as compared to control, impaired fruit drop and affected fruit quality. Particularly fruit flesh softening was delayed in all the varieties taken into consideration, while soluble solids content showed a slight increase.

ASSESSMENT OF PRODUCTION AND RETAIL HANDLING PRACTICES OF PEACHES, PLUMS AND NECTARINES ON MICROBIAL FOOD SAFETY RISK REDUCTION

Rodrigo A. Cifuentes, Department of Pomology; **Linda J. Harris**, Department of Food Science; **Ana M. Hernandez** and **Trevor V. Suslow**, Department of Vegetable Crops; University of California, Davis, CA

Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

The effect of different pre- and postharvest factors on the survival of the avirulent indicator *Salmonella* Typhimurium LT2^{rif} on peaches, nectarines and plums was assessed following simulated contamination. The survival of the indicator strain inoculated on wounded and non-wounded skin of yellow- and white-fleshed peaches (9 var.), nectarines (3 var.), and plums (3 var.) was studied. Additionally, interactions with maturity at harvest, storage conditions (time, temperature and relative humidity), inoculum drying time (2 hr) versus immediate storage, brushing/defuzzing, and use of commercial wax formulations were also evaluated. No major differences in survival of indicator strain on non-wounded or wounded peach skin were observed between CA Well Mature and CA Tree Ripe maturity stages, as well as between varieties under the different storage conditions. On non-wounded fruit, the population levels of *Salmonella* Typhimurium LT2^{rif} decrease almost to the limit of detection (1.77 $\log_{10}$ CFU/cm^2) after 24 hr of storage under all temperatures (0°, 10° and 20°C) and RH (low and high) when the inoculum was allowed to dry at 22°C/60%RH for 2 hr before storage. However, when immediately stored, considerable higher populations can be recovered under the different storage conditions for up to 21 days. On wounded tissue, population levels increase over time when stored at 20°C (high and low RH), or maintain or slightly decrease when stored at 0°C and 10°C. Simulated commercial brushing/ defuzzing and use of wax formulations enhance bacterial survival as compared to non-waxed, non-brushed fruit surfaces.

COLOR VARIABILITY CORRELATED WITH FRUIT QUALITY AT DIFFERENT PEACH GENOTYPES

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Color of peach skin is an important visual indicator of fruit maturity. Many peach cultivars are harvested according to color, and consumers prefer peaches of a particular color

with yellow or white flesh. To characterize color variability of different peach genotypes a rapid and accurate method of estimating color of new cultivars is required. This method has to reflect physics - chemical changes occurring in fruit and accurately mirror changes perceived by the human eye. The aim was to estimate color of fresh fruit using the tristimulus color system which measures color objective, quickly and indestructibly expressing color as CIELAB color variables. Eight yellow flesh peaches and three white flesh peaches were analyzed by spectral measurement in reflexion. For fruit quality, measurements of soluble solid content and total titratable acidity were made. With reference to color differences ?ECMC, the new hybrids studied have small value compared to their standards which are in the acceptable limit. The ratio soluble solid/titratable acidity shows values among 14-23 which indicates a balanced taste, which corresponds to an optimal maturity.

EFFECTIVENESS OF 1-MCP ON POSTHARVEST DETERIORATION OF NECTARINES AND PEACHES STORED AT DIFFERENT TEMPERATURES

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Flesh browning, mealiness and softening are the main causes of postharvest deterioration of peaches and nectarines. The gas application of three concentrations of 1- Methylcyclopropene (1-MCP) (0.5; 1.0; 1.5 g/m3) was evaluated on one peach (September Sun), and two nectarine (Arctic Snow and Flamekist) cultivars stored for 17, 23 and 34 days at 0, 5 and 10°C. The gas was applied at 20 °C for a period of 48 hours and the different concentrations were compared with a delayed cooling process done at the same conditions and with control fruit where the fruit was cooled rapidly. High incidence of flesh browning and mealiness was obtained with all the cultivars after 23 days of storage at 0 and 5°C, otherwise total reduction was attained at 10°C but with a high rate of fruit softening. 1-MCP did not reduce the softening at this temperature. Delayed cooling reduced the incidence of mealiness in all the cultivars after 17 days of storage at all the temperatures evaluated, but a high rate of softening was obtained. Although 1-MCP reduced the rate of softening, the mealiness was reduced only on Arctic Snow and September Sun cultivars. The best results of delayed cooling and 1-MCP treatments were obtained with Arctic Snow cultivar.

MEALINESS AND EXPANSIN EXPRESSION IN PEACHES

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Storage at cold temperatures often results in the development of a mealy flesh texture in peaches. It is believed that alterations in the activities of enzymes involved in pectin breakdown are a primary cause of this disorder. Expansin, a ripening-related protein, is thought to alter the interaction of pectolytic enzymes with their substrates and may play a role in the development of mealiness. Peach cultivars 'O'Henry' and 'Summer Lady' were placed in cold storage at 5° C and the development of mealiness during storage quantified by measuring free water in the tissue. Mealiness was visually apparent in the tissue when free water percentages reached 38% for 'O'Henry' and 46% for 'Summer Lady'. Tissue samples

with a range of free water percentages were collected and quantified for expansin by Western blotting and probing with LeExp1 expansin antibodies. Expansin was abundant in juicy tissues but declined greatly in amount as free water levels decreased. The decline preceded the onset of visual symptoms of mealiness. Differences in expansin amount were also similarly apparent between juicy and mealy regions within individual fruit with mealy regions containing substantially less expansin than juicy regions of the same fruit.

INFLUENCE OF CANOPY FRUIT POSITION ON MATURITY AND QUALITY OF 'ANGELUS' PEACHES

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

The influence of canopy fruit position on the quality and maturity parameters was studied on peach fruit [*Prunus persica* (L.) Batsch.] cv. 'Angelus', during the 1998-99 Chilean season.

Within the tree, after fruit set, fruit were marked at three positions: (a) the top, between 2.5-5.0m above ground level, with fruit completely exposed to the sunlight; (b) the middle, between 1.0-2.5m above ground level, with fruit illuminated but not completely exposed to the sunlight; and (c) the bottom, at 1.0m above ground level, with fruit inside the lower part of the canopy, not exposed to the sunlight.

Before, during and after harvest, radiation levels were measured from the top, middle and bottom canopy. In addition, a leaf analysis was made in the positions mentioned above. Six harvests were done and 20 fruit per harvest were collected. After the fruit reached a pulp temperature of 20ºC, non-destructive analyses were done (L*, C* and H_{ab} ground and over color, rate of ethylene production, respiratory rate, fresh weight and diameter) on labeled fruit. Additionally, destructive analyses were done to 15 fruit (flesh color, firmness, soluble solids, titratable acidity, SS/TA ratio and pH). The other 5 fruit were stored at 20ºC as a ripening period, and were later measured by the same parameters mentioned above.

Fruit ground and flesh color, percentage of over color, rate of ethylene production, soluble solids, and pH were greater at the top than in the lower positions of the canopy. The fruit size and fresh weight were reduced under shade conditions.

Moderate and strong correlations existed between the log of ethylene production with fruit firmness, and they also showed the highest values of correlation coefficient (R) with the a* and H_{ab} parameters of the ground and flesh color. This association was related to the fruit position within the tree.

COMBINED HEAT SHOCK AND CONTROLLED ATMOSPHERE REDUCED INTERNAL BREAKDOWN OF 'FLAVORCREST' PEACH

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Chilling injury is a limiting factor for commercial life of peaches (*Prunus persica* (L.) Batsch). High CO_2 controlled atmosphere (CA) is a proven technology to overcome the disorder, while heat shock (HS) treatments appear to be an emerging alternative, although showing some undesirable side effects. The objective of this experiment was to combine both, CA and HS, to improve control of chilling injury. 'Flavorcrest' peaches were heat

treated for 24 h at 39 ± 1°C (HS39) and 0 ± 1°C (HS0) followed by cold storage with three levels of CA: 5% O_2 + 15% CO_2 (MI); 5% O_2 + 20% CO_2 (MA); and air (AIR). Firmness, juice content and flesh color were evaluated at harvest and after 3 and 4 weeks of storage. Control fruits (AIR + HS0) showed "leatheriness" after 3 weeks; by this time HS39, MI and MA, alone or combined were enough to overcome the problem; by 4 weeks only fruits receiving MI or MA softened adequately. Combined treatments were useful to improve juiciness, and were the only alternative reaching 4 weeks with commercial quality; although fruits that received HS39 had generally redder flesh than others, this side effect was improved by CA.

EFFECT OF MODIFIED ATMOSPHERE PACKAGING AND MATURITY ON SUSCEPTIBILITY TO MEALINESS AND FLESH BROWNING OF PEACH CULTIVARS

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

The susceptibility of mealiness and flesh browning physiological disorders was evaluated after 3, 5 and 6 weeks on ripe Sweet September, September Sun, Ryan Sun and Rosario Red peach cultivars harvested at three times and stored under modified atmosphere packaging (experimental bag P_2UC 965 (Chile). High incidence (>40%) of mealiness and flesh browning was detected in all the varieties even at 3 weeks of storage. Sweet September, Ryan Sun and Rosario Red were most susceptible to mealiness in more mature fruit. MAP reduced incidence of mealiness after 3 months storage at acceptable commercial level (<20%) only in Sweet September cultivar. Total control of flesh browning was obtained with MAP in all the cultivars and maturity levels evaluated. High concentration of carbon dioxide was attained with MAP. This information suggests that MAP gives only partial control to physiological disorder symptoms. Mealiness symptoms were difficult to control by using MAP.

CHARACTERIZATION OF cDNAs ENCODING EXPANSINS (CELL WALL-LOOSENING PROTEINS) EXPRESSED IN RIPE PEACH FRUIT

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Expansins are plant cell wall proteins that have the capacity to induce extension in isolated cell walls and are thought to mediate pH-dependent cell expansion. Recently, an expansin gene (*LeExp1*) that is specifically expressed in ripening fruit has been identified in tomato, and expansins were proposed to contribute to cell wall disassembly in ripening fruit. In this study, three unique cDNA clones putatively encoding expansins (*PpExp1*, *PpExp2* and *PpExp3*), which are expressed in ripe fruit of peach (*Prunus persica* (L.) Batsch cv Akatsuki), were isolated and their mRNA accumulation patterns were characterized. The predicted amino acid sequences of *PpExp1*, *PpExp2* and *PpExp3* share from 68 to 80% identities. A phylogenetic tree of deduced amino acid sequences of expansins showed that *PpExp1*, *PpExp2* and *PpExp3* fell into three different phylogenetic subgroups. RNA gel blot analysis showed that each of these expansin cDNAs was detected in fruit-specific and showed a different and characteristic pattern of mRNA accumulation, suggesting that these peach expansins were individually regulated and have a divergent role in fruit tissue. We also investigated the mRNA

accumulations in unripe fruit with ethylene (10μl/L) treatment, and possible functions of peach expansin genes in fruit ripening were discussed.

CORRELATION BETWEEN THINNING AMOUNT AND FRUIT QUALITY IN PEACH AND NECTARINE

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Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

Peach and nectarine usually set more fruit than needed for a quality crop, and thinning is an important means to improve size, quality, and to stimulate floral initiation for next year's crop. Thinning done at the wrong time or a weak thinning can cause an extreme variability in size and quality.

To optimize the period and the amount of thinning, a two years' trial was carried on peach 'Elegant Lady' and nectarine 'Venus' evaluating the influence of low, medium, and high manual thinning in terms of size, weight, and organoleptic traits of fruits.

June drop in non-thinned trees determined an irregular distribution of the remaining fruits on the trees causing an excessive yield of small, poor quality fruits. The intense thinning heavily reduced the yield but the fruits were "extra size" not suitable for marketing and a high percentage of them were deformed. The best results in terms of quality and size were obtained with medium thinning; this was probably due to a good accumulation of total soluble solids content and titratable acidity during the growth season.

A COMMUNICATIONS MODEL (NY PEACH NEWS): A COLLABORATIVE EFFORT TO EVALUATE PEACH/NECTARINE CULTIVARS FOR SUITABILITY TO NEW YORK CLIMATES AND MARKETS

Robert L. Andersen, **Stephen A. Hoying**, **Terence L. Robinson**, and **Steven A. McKay**,
Cornell University, Geneva and Ithaca, NY

Source: Poster Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

New York peach production might be considered inconsequential to many, but to New York farm-stands and NY's agritourism along Lake Ontario and in the Hudson River Valley's many historic community farmers-markets it is important to have this crop succeed with ripe, locally grown peaches that drip with ripeness and flavor. Wholesale production and marketing of NY-grown peaches is increasingly perceived as likely to succeed with high-end consumers who seek better quality fruit. Regionally specific markets for processed fruit products containing regionally grown processing-style peaches as a primary component are proving to be successful in eastern Canada, New York, and New England. New York's weather is adverse for peaches. Hence, variety testing for adaptation to New York's climate and market uses is essential to keep peach orchards prosperous. The Great Lakes Fruit Extension Workers have developed a professional, in-service, training network that shares applied research planning for the region and meets annually to report results. Results of peach variety testing from Ontario, Michigan and New York are formulated into newsletter format and regional Peach Extension Workshops with published syllabi are effectively modernizing the array of varieties and kinds of peaches being successfully grown and marketed.

THE ROLE OF ETHYLENE IN PEACH AND NECTARINE RIPENING FOLLOWING STORAGE

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Source: Oral Presentation, 5th International Peach Symposium, Davis, CA, July 8-11, 2001.

After prolonged storage, peaches and nectarines do not ripen and become soft and juicy, but instead develop a dry woolly texture. These fruit produce less ethylene than normally ripening fruit. Woolly fruit have higher levels of 1-aminocyclopropane-1-carboxylic acid and less 1-aminocyclopropane-1-carboxylic acid oxidase activity than healthy fruit. The disorder can be alleviated by storing the fruits in the presence of exogenous ethylene, and can be exacerbated by treatment with the ethylene action inhibitor 1-methylcyclopropene. Storage manipulations such as delayed storage and intermittent warming allow the fruit to continue to produce ethylene following storage, and therefore act to prevent woolliness development. After storage transcription of polygalacturonase is positively regulated by ethylene, while pectin esterase and 1,4-ß-endoglucanase are negatively regulated. The loss of ability to produce ethylene in stored peaches and nectarines causes changes in the activities of these cell wall hydrolytic enzymes which are partially regulated by ethylene, and this leads to the development of woolliness.

FUTURE EVENTS

Tree Fruit Winter Meeting – December 5, 2001, Dinuba, CA. Contact Scott Johnson (559) 646-6547, or Kevin Day (559) 685-3309 ext. 211.

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