United States Department Of Agriculture
Agricultural Research Service

AFRS Fruit Update

Recent research at the
Appalachian Fruit Research Station
Kearneysville, WV

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Genetic Control of Resistance to Plum Pox Virus in Stone Fruits

Plum pox (Sharka) is a viral disease, classified as an invasive species that affects stone fruits from the genus *Prunus*, which includes peaches, apricots, nectarines, plums, almonds and cherries. The virus is transmitted from a tree to a tree by aphids and spread geographically by planting of infected nursery stock. The virus poses no danger to consumers but it ruins the eating quality and appearance of the fruit, decreases tree productivity and makes it more susceptible to other viruses. There is no cure for the disease; control measures include monitoring, use of certified nursery materials, aphid management and destruction of infected trees.

The virus has been known in Eastern Europe since 1915, and recently has also been found in the U.S. (Pennsylvania, Michigan and New York) Canada and Chile but not yet in California. Eradication efforts in Pennsylvania alone cost $40 million and 1600 acres of stone fruit was destroyed, mostly peaches, nectarines and plums. The need for a solution to plum pox virus grows more pressing by the day. The U.S. is third in world plum production with California responsible for 95% of the nation's plum output and 70% of the world's dried plums.

A group of researchers including Dr. Ralph Scorza and Dr. Ann Callahan at the USDA's Appalachian Fruit Research Station (Kearneysville, WV), Cornell University and INRA France have created a European (or prune) plum variety 'HoneySweet' (trial name C-5) that is resistant to the plum pox virus (PPV). Resistance was achieved by taking the gene from the virus that is normally responsible for the production of virus' coat protein and inserting several copies of it into plum cells. Instead of producing the virus' coat protein, however, the special orientation of these copies in the plum cells triggers a natural plant defense mechanism that targets the virus for destruction. This process, known as 'gene silencing', is particularly attractive from the standpoint of alleviating concerns surrounding the acceptability of transgenic plants. This is because the transgene (virus coat protein gene) inserted into 'HoneySweet', does not produce any virus coat protein in plant tissues, but triggers the powerful natural plant defense mechanism.

'HoneySweet' fruit quality is excellent and productivity is very good. Ten years of field-testing in Europe have shown that 'HoneySweet' maintained resistance after repeated challenges. The PPV resistance can be readily transferred to other plums of the same type (European plums) through traditional breeding. This could enable traditional breeding programs to incorporate the resistance to PPV in new plum varieties. Work on incorporating this gene into peaches is ongoing.

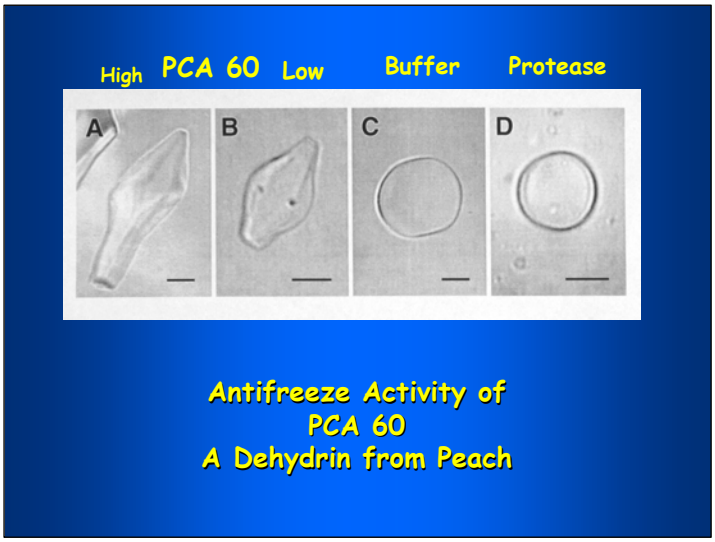
The 'HoneySweet' plum is currently undergoing a review by the USDA-Animal and Plant Health Inspection Service (APHIS) and Federal Drug Administration (FDA). An additional review will soon also be conducted by the U.S. Environmental Protection Agency (EPA). It is anticipated that PPV will be eradicated from the U.S. but if not, and PPV continues its advance, 'HoneySweet' and its progeny will be ready for the plum industry to use to protect the production of this important crop. Dr. Scorza can be reached at (304) 725-3451 x 322 Ralph.Scorza@ars.usda.gov

Natural Chemicals Protecting Plants- Dehydrins.

Plants have had to adapt to a wide range of water availability throughout the year because in the growing season, rainfall may be inadequate or in excess and in winter water is unavailable to plants because it is often present as ice. These conditions may all result in plant drying (dehydration). Plants have structural features that help them limit water loss – for example the presence of wax on leafy surfaces and bark on a tree's branches and trunk as well as small openings in leaves called stomata, which have the ability to close or open depending upon how well the plant is supplied with water. There are also special plant-produced natural chemical compounds (proteins) that enable the plant to deal with water shortages (stress) including a class of functional proteins called dehydrins. Originally coined from "dehydration induced" protein, dehydrins are found in every plant examined to date, and in most tissues, including seeds. Dehydrin production is stimulated by environmentally unfavorable conditions that results in cellular dehydration such as salinity, drought, freezing, etc.

Drs. Michael Wisniewski, Carole Bassett, and Tim Artlip are studying the presence of dehydrins in peach and apple trees and their role in making tress more resistant to a variety of unfavorable environmental conditions, especially freezes, frosts and water deficit. They identified several specific dehydrins in apple and peach trees and found that their natural content fluctuate with the seasons, reaching a maximum accumulation in winter through early spring. This higher level of dehydrin is coincidental with an improved plant hardiness during this time. Their study also showed that the plant hormone abscisic acid (ABA) has the ability to stimulate dehydrin production in plants. Ongoing genetic research is expected to further characterize how dehydrin genes respond to a variety

of environmental conditions. Such knowledge will provide growers with potentially new tools to manipulate dehydrin content in plants and help them better cope with unfavorable environmental conditions such as freezing temperatures and drought. Additionally, AFRS scientists are over expressing dehydrin genes specifically in apple flowers in order to improve their hardiness to late spring frosts. For further information contact Dr. Wisniewski or Dr. Bassett at 304-725-3451or by email at Michael.Wisniewski@ars.usda.gov or Carole.Bassett@ars.usda.gov.



The above figure illustrates how dehydrin protein isolated from peach bark tissues affects the shape of growing ice crystals. By binding to growing ice crystals, the peach dehydrin causes the formation of small needle-like crystals (A and B) which are less disruptive to plant tissues than the large, amorphous ice crystals (C and D) that normally form and tear tissue apart (scale bar 10 microns).

Particle Film Technology & Plant Protection

SURROUND® is a clay based product that when applied to the surfaces of leaves and fruits has a number of beneficial effects. This product was co-developed by Dr. Mike Glenn, Dr. Gary Puterka and also Englehard Corp in 1996 (presently BASF, Research Triangle Park, NC). The product is made from kaolin clay, which is heated & mixed with adhesion and spreading compounds. It is mixed with water and applied using traditional sprayers. Upon drying, it leaves a fine white film. It acts as a porous barrier that protects against insect and solar damage. The film can be washed off before consumption of produce. The film is non toxic, can be used on crops, and is considered 'organic'. It must be applied before pests or high temperature are present and must be reapplied every two weeks to protect new growth or after a heavy rain.

Protection against insect damage: SURROUND® protects plants in a number of ways. Apple maggot fly uses apples for mating and egg laying. The application to red apples reduces the visual cues that the insect uses to find the apple. If the insect lands on the fruit, the film reduces the amount of time in contact with the fruits, indicating there is some objectionable quality of the film to the insect. Contact with the film also causes mortality in the fly. Ninety nine percent control of apple maggot fly is achieved with SURROUND®. SURROUND® has shown successes in pest

reduction with pear psylla, rust mite, codling moth, leafhopper, plum curculio, Japanese beetles and others. The mechanisms of action are to confuse, irritate and repel insects. SURROUND® does not affect earthworms or honeybees.

Reducing heat stress, enhance fruit color & finish,
The particle film reflects infrared and ultraviolet light but transmits photosynthetically light needed for photosynthesis. The white particle film reflects heat and keeping plant parts cooler can increase photosynthesis, yield and improve fruit quality. There is a 3 to 6°F temperature difference in coated versus uncoated apple fruit. On average, there is a 50% sunburn reduction on apples when SURROUND® is applied. SURROUND® can improve red color development in the unexposed surfaces of apples.

SURROUND® had a limited commercial launch in 1999 to apple and pear growers. It is now used on grapes, walnuts, tomatoes, & citrus on over 200,000 acres in the US and internationally as well. SURROUND® is used on 75% of the northern Washington state pear crop and 35% across the state. Improvements in the adhesion and mixing qualities will result in new formulations of SURROUND®.

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Increasing Strawberry Production- Double Cropping

Consumers demand strawberries year round, but domestic acreage planted is on the decline. Imports can fill gaps in the crop, but there exists a strong niche for late season and early spring production.

Dr. Fumiomi Takeda has been exploring the 'double cropping' of strawberries. This involves harvesting spring flowering (cv. Carmine -short day) runner tips in early July or August and rooting them in containers. These transplants are then established in the field in early September. Of the plants started in July, 80 to 100 percent had fruit in November. Among August started plants, however, flower buds had emerged in only a third of plants. Under protection (unheated hoop houses), July planted transplants produced fruit into late December and averaged about 12 ounces per plant in costal Maryland. Hoop houses can provide up to a 15 degree Fahrenheit level of protection, depending on the climate and daily conditions. Fruit production ranged from 20 to 24 ounces /plant during a 4-week harvest in the spring of the following year. Plants plugged in July produced 26% more fruit than those plugged in August. Fruit quality is higher in the fall but the time to maturity is longer (from ~28 to ~45 days). Growers interested in fall production of strawberries can purchase virus free plug plants from nurseries in Virginia and North Carolina (Aaron Creek Nursery, Buffalo Junction, VA and Norton Creek Farms, Cashiers, NC).

Strawberries can also be produced in a soil-less medium as an annual crop. This approach requires irrigation but avoids many of the traditional soil borne pathogens and eliminates the need for fumigating the soil. Long grow bags (36" length) containing perlite & peat are planted with strawberry stock in late August in the field. A fall crop can be produced (under protection) and then an earlier larger crop can be produced in spring. The plants and media can be discarded and

the process repeated. With short day cv. Carmine, crop yields are equivalent to or greater than in-ground plantings. Compared to the soil-produced strawberries, harvesting is more efficient, the need for pesticides is reduced and fruit is cleaner and larger. Fruit delivered during non-peak production times can also command higher prices in the market.

Dr Takeda is also investigating the mechanism of flowering in short day strawberries in collaboration with Dr. Kevin Folta of the University of Florida. This research aims at identifying genes responsible for earlier flowering. Double cropping is possible in some cultivars and planting a mix of varieties would ensure steady production over time. More research is needed to discover and optimize the factors that make strawberries amenable to double cropping. Dr. Takeda can be reached at (304) 725-3451 x 212 or at Fumi.Takeda@ars.usda.gov

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