1993-1994 FINAL PROGRESS REPORT

Project: 198

Title: The Prediction and Control of Superficial Scald of New Apple Cultivars

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Accomplishments:

1) A model to assist in the prediction of scald in 'Delicious' apples is in the last stages of development with the help of researchers around the world.

2) Scald development in 'Fuji' and 'Braeburn' apples was assessed for 2 years during which it was determined that the use of DPA, although controlling scald in one year, worsened it the preceding year. Scald on 'Fuji' apples may pose a serious problem.

3) Storage of 'Fuji' and 'Braeburn' in ultra-low oxygen controlled scald without any deleterious effects.

4) Ultra-low oxygen storage followed by periodic increases resulted in retention of firmness of 'Granny Smith', 'Fuji' and 'Braeburn' but not of 'Delicious'.

5) Hot water dips alone are insufficient to control scald in any of the apple cultivars examined but might be used effectively in conjunction with reduced rates of DPA.

6) A number of alternative antioxidants have been evaluated over the past 3 years and several show considerable promise for controlling scald.

Results:

Based on a preliminary model constructed from data collected by the Apple Maturity Program it appeared a scald model could be developed for 'Delicious' apples in Washington. A five-year study was initiated in 1988 on mature 'Oregon Spur'/Seedling trees in 3 orchards. Temperature data and fruit samples were collected weekly beginning August 1 of each year. A fruit sample was assessed at harvest and another placed in regular storage for 6 months for scald evaluation. Two models were generated. The first was a scald prediction model generated using maturity parameters (including ethylene evolution at harvest) and accumulated temperature. The model

The model was able to correctly predict scald 85% of the time. The most influential temperatures were those less than 35F and greater than 85F. Ethylene, or, in other words, the stage of ripening also had a significant impact on the correctness of the prediction. Data were also sent to Dr. Bill Bramlage at the University of Massachusetts to validate a global model he and his team are developing. Preliminary indications are the model can predict scald correctly about 70% of the time.

Late season cultivars were evaluated for scald development and scald control using DPA. The first year fruit was dipped for 1 minute in 0, 500, 1000, or 2000 ppm DPA, allowed to air dry and placed in regular storage. After 6 months storage, scald on 'Granny Smith' was reduced to about 20% with either 500 or 1000 ppm and to 5% with 2000 ppm. On both 'Fuji' and 'Braeburn' 500 ppm DPA reduced scald minimally, however, both 1000 ppm and 2000 ppm increased scald. In a related study, Both 'Fuji' and 'Granny Smith' were dipped in water for 1 minute held at temperatures ranging from 20C (68F) to 60C (140F) to determine at what temperature heat might inhibit scald development and at what temperature tissue breakdown would occur. Treatments included hot water dips at temperatures of 20C, 30C, 40C, 50C, and 60C. In 'Granny Smith', temperatures above 50C resulted in slight to moderate tissue damage. Scald, on the other hand, wasn't reduced until temperature of the dip reached 60. Results of these studies indicate 1) Dipping fruit in water at elevated temperature is not an option for controlling scald in 'Braeburn', 'Fuji', or 'Granny Smith' cultivars. Perhaps when used in conjunction with DPA, elevated water temperatures might act in concert as shown for 'Delicious'. This was investigated in 1992 with 'Granny Smith' using the rates of 0, 500, 1000, and 2000 ppm together with temperatures of 20C, 30C, 40C and 50C and dipped for either 15 or 30 seconds. In these studies, it was found that heat reduces the amount of DPA necessary to reduce the development of scald in storage. A 15 second dip of 50C water containing 500 ppm DPA was almost as effective as 20C water containing 2000 ppm however, protection against scald development was not as long lived as with the higher rates.

'Braeburn' maturity, storability, and scald susceptibility were examined a second year using a 7-year-old block in Milton-Freewater. This cultivar showed a steady reduction in scald as harvest date was delayed. Fruit harvested by the middle of October and stored for 6 months in regular storage had a scald rating of three compared with 38 for the first harvest. Firmness after 10 days ripening was 14 lb. compared with 20 lb.. at harvest. After 10 months, firmness for the latest harvested fruit in regular storage was 12.9 lb., whereas firmness for fruit in CA (1%O_2, 1% CO_2) was 15.0 lb. Acidity for fruit in CA was 0.37, almost double that of fruit in regular storage. Soluble solids for fruit in CA was 10.3, which was comparable to that of fruit in regular storage.

Ultra-low oxygen shock trials were evaluated again on 'Braeburn', 'Delicious', 'Fuji', and 'Granny Smith' apples. Fruit was held in 1% CO_2. The ultra-low oxygen treatments were: 1) 0.5% (4 weeks), 1.0% (8 weeks), 1.5% (6 weeks), 2% (6 weeks); 2) 0.5% (6 weeks), 1.0% (6 weeks), 1.5% (6 weeks), 2% (6 weeks); 3) 0.5% (8 weeks), 1.0% (4 weeks), 1.5% (6 weeks), 2% (6 weeks); 4) 0.5% (10 weeks), 1.0% (2 weeks), 1.5% (6 weeks), 2% (6 weeks); and 5) 0.5% (12 weeks),

1.0% (0 weeks), 1.5% (6 weeks), and 2% (6 weeks). These fruit were compared with fruit in regular storage for 24 weeks. Generally, all of the treatments reduced scald to a rating less than 5% except for 'Fuji', which had about 10%. All treatments improved firmness except in 'Delicious'. All treatments maintained higher acid levels than the RA treatment.

Lastly, a number of compounds were assayed for either scald induction or inhibition on 'Granny Smith' and 'Delicious' apples. Of the 13 compounds tested the first year, 2 of the more lipid soluble compounds (applied as a fruit surface wipe) showed almost complete inhibition of scald. These compounds were wheat germ oil (extremely high in vitamin E) and farnesene. The results with farnesene were unexpected because the presence of this compound in the fruit skin has been reported to be directly associated with the development of the disorder. Farnesene from several different sources was obtained because the technical material was determined to be of variable composition. Farnesene, farnesene acetone, farnesyl acetate, and squalene (a farnesene dimer) were also added to the treatment list along with emulsions of farnesene and wheat germ oil generated with a high pressure homogenizer at the WSU Food Sciences pilot plant in Pullman. These emulsions were stable for several months. At the end of the 1992 storage season it was evident that all farnesene formulations were not the same. Some of the treatments caused damage whereas others did not. Wheat germ oil emulsions showed some measure of success. It was also decided that farnesene was too pungent to serve as an antioxidant, however, farnesyl acetone and squalene applied as fruit wipes were odorless and showed considerable promise as scald control agents. In 1993, 2 other natural compounds were evaluated for control of scald. Results will be available in March 1994.

Publications:

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Curry, E.A. Predicting scald of 'Delicious' apples by temperature at harvest. Acta Hort. 276:71-78 1990. (Proceedings)

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Curry, E.A. Scald: Prediction and Control. Proc. Wash. State Hort. Assn. 86:208-209. 1991. (Proceedings)

Curry, E.A. 1993. An Integrated Approach to Scald Control. Proc. Int. Scald Symposium (Accepted for Publication 3/93).

Curry, E.A. 1993. Scald Reduction in 'Granny Smith' Apples With Hot Water. Proc. Int. Scald Symposium (Accepted for Publication 3/93).