PROJECT NO.: ARS 531 Terminating Report

Comment:
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TITLE: Brownheart Disorder in 'Braeburn'

YEAR INITIATED: 1994-1995 **CURRENT YEAR:** 1999-2000
TERMINATING YEAR: 1999-2000

PERSONNEL: Dr. Eric A. Curry, Plant Physiologist
USDA, ARS, TFRL, Wenatchee, WA

COOPERATOR: Gene Kupferman, Postharvest Extension Specialist
WSU, TFREC, Wenatchee, WA

JUSTIFICATION:

'Braeburn' is still the leading apple cultivar in New Zealand. It is a late season apple harvested after 'Delicious' which uniquely has both high soluble solids and high acidity. In addition, the flesh is unusually dense resulting in a very firm fruit. The 'Braeburn' industry in the northwest is still rather young, however, more and more plantings are being established and are beginning to bear fruit. Brownheart (BBD) is a disorder particular to this cultivar in that it may be visible in the flesh as early as August. It appears to develop somewhat sporadically on the tree, and generally cannot be detected at harvest until the fruit is cut. It appears as a dense, brown volume, which may be small and localized or may fill the entire fruit. After storage, however, the internal browning may fill the cortex and may become visible to a sorter or consumer. The success of this cultivar rests with the elimination of affected fruit from the market. This is the sole project on Brownheart in the Pacific Northwest.

OBJECTIVE:

The objective of the project was to determine causal factors and responsible for, and relationships associated with the development of Brownheart disorder in 'Braeburn' apples. Fruit maturity, ambient temperature, cropping, storage conditions and fruit treatments were being investigated.

PROGRESS:

Several trials were established and one continuing trial was concluded. The large maturity study comprising 8 orchards and 4 years was completed along with storage exams and BBD assessment. Data suggest that the most consistent relationship over the 2-month harvest period is the starch rating followed by ground color. The relationship between these two indices is not always constant. In 1994, 1995, and 1996 when the coefficient for starch rating increased, so did those for ground color. In 1997, however, there was a high value for the starch rating coefficient and a lower than expected value for the ground color correlation coefficient. Importantly, there is no relationship between harvest date and ethylene concentration. Even if only the last 3 harvest dates are selected, the correlation coefficient is close to zero. In 93% of our samples, ethylene remained less than 1 ppm; 97% were less than 2 ppm. Orchard averages rarely exceeded 0.5 ppm. The point of this is that for some cultivars such as 'Delicious' the internal ethylene is an important index with which to assess maturity. In 'Braeburn' it is not. In half of the orchards, ground color showed a higher correlation than did starch rating. Nevertheless, what must be kept in mind is that ground color in itself is not a consistent physiological marker of fruit maturity. Although it may indicate when the fruit appears most marketable, dependence on ground color as a maturity index could result in a rather short marketing period. Lastly, with regards to maturity, the best correlation is for ground color and starch rating which is only 0.49, or, in other words, these two indices correlate only half the time. The bottom line of these maturity data is that the best information regarding the physiological state of the fruit for harvest is derived from the starch test. Data from all other indices should be secondary to the starch rating. In another preliminary trial DPA and squalene were evaluated for ability to reduce both scald and internal browning. Generally, DPA at 1350 ppm reduced the incidence of BBD that occurred during the first month after harvest. Although browning can be seen in fruit on the tree, the most common occurrence is that which appears the first 3-4 weeks after harvest. Of the 2 harvest dates, DPA eliminated about 60% of the disorder on fruit picked on the earlier date, i.e. Oct 21. That fruit picked on Nov 4 was not affected. Increasing the rate to 2700 ppm had no effect. DPA only reduced the internal browning seen during the first month. Squalene, which inhibits scald, induced a 3-fold increase in BBD when examined 1 month after treatment. The third manifestation of browning appears after about 4 months storage in CA most often. None of the treatments had any affect on this.

PROGRESS (Current Year):

1. 1998 was a very low BBD year. The experiments we established showed little if any BBD. Therefore, we conducted two trials to attempt to induce BBD. In the first experiment, we treated fruit at harvest (10/19/98 from an orchard with a previous history of severe BBD) with AVG (400 ppm), Nutrisave (2%), or Wax (full strength) and stored the fruit for 1, 4 or 6

months. Because both Nutrisave and Wax inhibit gas transfer, we expected to see BBD develop. Fruit treated with 400 ppm AVG would have had low respiration and ethylene evolution, and therefore, theoretically, low BBD. After 6 months regular storage, the average internal ethylene was about 5 ppm in AVG treated fruit and 300+ for all other treatments, yet there was no difference in scald, BBD, or cavitation. The other experiment designed to induce BBD was established by treating fruit with either 0, 500, 1000, or 1500 DPA and placing each treatment into regular storage, low CO2 (2.5% O_2, 0.5% CO_2), or high CO_2 (2.5% O_2, 2.5% CO_2), for 1, 3, or 6 months. BBD in this trial for any of the treatments never exceeded 6% except in one case where watercore was present and the BBD value after 6 months storage was 10%. Generally, core blush was lowest with low CO_2 + DPA. Internal breakdown was also lowest in regular or low CO_2, plus DPA.

2. Because 1998 was a very low BBD year according to fruit we evaluated, I decided to compare temperatures this year with those from 1995 in which BBD was severe. Recall, first, this cultivar originated in Nelson, NZ where weather is milder than that of northcentral Washington. Compare temperatures from Hawke's Bay, New Zealand where much of the 'Braeburn' is grown, with that of Royal City from 1992-1995. Table 1 shows that average daily maximum in the spring (March for Washington, September for New Zealand) is 60.1F in Hawke's Bay and 53.4F in Royal City. Similarly, the average minimum is 39.7F in Hawke's Bay and 33.8F in Royal City. Contrast this with average maximum and minimum values for both areas and we find that the Royal City area has significantly lower spring temperatures and higher temperatures in the summer. This is further verified by examining the absolute maximum and minimum temperatures over this 4-year period. The Royal City area may experience both colder spring temperatures and hotter summer temperatures by more than 10F.

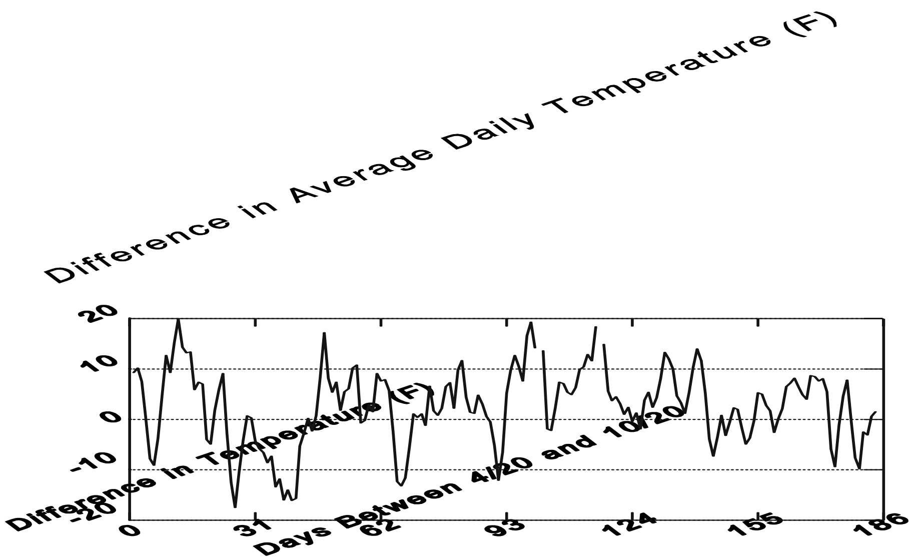
Table 1. Average minimum and maximum, and absolute maximum and minimum temperatures* for spring (March for Royal City, September for Hawke's Bay), and summer (July for Royal City, January for Hawke's Bay) from 1993-1996.

	Spring(March)		Summer(July)	
	Avg. Max (F)	Avg. Min (F)	Avg. Max (F)	Avg. Min (F)
Hawke's Bay	60.1 F	39.7 F	76.5 F	53.9 F
Royal City	53.4 F	33.8 F	84.4 F	57.5 F
	Max. (F)	Min. (F)	Max. (F)	Min. (F)
Hawke's Bay	72.1 F	27.1 F	91.4 F	37.0 F
Royal City	75.2 F	11.8 F	102.2 F	46.4 F

*Data obtained by Dr. E. Kupferman from HortResearch, New Zealand.

Although this spread of temperatures may seem slight, they are at the stress inducing thresholds, and therefore become significant. Clearly, the 'Braeburn' growing region of Hawke's Bay is less severe than many of those in Washington. Other data relating temperature to disorders in 'Braeburn', (BBD) comes from Washington State. Fruit from the 1995 growing season showed significantly more BBD than that from the 1998 growing season. The relationship in temperature between these two years is shown in Figure 1. A brief explanation follows. The line on the graph represents the different in temperature from 1995 to 1998 (i.e. $Temp_{1995} - Temp_{1998}$) for the 6-month growing season of April 20 through October 20. The major tic marks on the horizontal axis each represent about a month. The vertical axis represents the difference in temperature. When the line is greater than zero, 1998 was warmer on that particular day by the amount indicated. Conversely, when the line on the graph is negative, the temperature in 1998 was colder than that on the same day in 1995 by the indicated amount.

Figure 1. Difference in average daily temperature (F) between 1998 and 1995 for Royal City between April 20 and October 20.



From these data (obtained from PAWS) it is clear that for the most part, 1998 was warmer than 1995. The first critical period would be approximately during the first 20 days. These days averaged about 10 degrees warmer in 1998 than in 1995. Indeed, on some days the difference was almost 20 degrees warmer in 1998. Springtime temperatures could have a significant impact on fruit quality. For example, if uptake of calcium (and/or other elements) is related to warm weather during the cell division stage of fruit growth, these two years could show remarkably different fruit quality attributes — which was the case. Also, temperatures during the summer of 1998, after approximately day 50, remained higher for the next three months. Whether the first 30 days of growth is more important than the rest of the summer is not clear. More research must be done to determine when the effects of temperature have the greatest impact on the quality of fruit after harvest.