Peach and Nectarine Cork Spot: A Review of the 1998 Season

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Along with many other problems, fruit corking and spotting marred the 1998 season. The condition appears at or near harvest as dark sunken spots on the surface of the fruit. The fruit sides and blossom end are most greatly affected, symptoms are rarely observed on the shoulders. Internally, the flesh turns brown, dry, and corky, and sometimes the lesser-affected areas of the flesh take on a reddish-white coloration. Although it has been seen many times in the past - I first encountered the problem in 1985 - this year's problem was particularly severe with losses approaching 100% in some orchards. Mostly mid-season and some late-season varieties were affected. Both yellow and white-fleshed fruit were afflicted. Fruit from a range of soil types and tree ages were also harmed by this problem. Curiously, after causing severe damage, the problem lessened and virtually went away as the season progressed.

Early (c. 1930's) stone fruit reference materials cite a similar condition called "blossom-end breakdown" or "Sims Spot" after the variety of cling peach on which it was first discovered. This disorder is described as first developing as "small round light colored blister-like areas that always occur on the blossom end" and progressing to flesh symptoms similar to those described above. The biggest difference in symptomology between these references and what was observed in 1998 is that the recent problem was not limited exclusively to the blossom end of the fruit.

In the past when I have observed this problem it has almost always been on young (3^{rd} or 4^{th} leaf), vigorously growing, lightly cropped trees. Additionally, the problem was most severe when the season was cooler than normal. The problem was always restricted to mid-season or later varieties - I have never seen it occur on a variety ripening earlier than 'Elegant Lady'. I have seen the problem on a diverse enough range of varieties to be assured that no one particular nursery or plant breeder can be implicated in the problem.

The biggest question remains "What is the cause of the problem?" The safest answer is that we do not know. Many answers have been given, the most frequently cited being calcium deficiency. Based on what is known about calcium deficiency in apples (the problem is most severe in cool seasons, on lightly cropped vigorous trees), this appears to be sound. However, this does not explain why so many older, fully cropped orchards were afflicted in 1998. It also stands that if calcium were the sole cause of the problem, the condition would not have gone completely away as the season progressed.

The condition remains somewhat baffling and difficult to characterize. However, the following portion of this paper will attempt to discuss how several factors may influence fruit cork spot and flesh breakdown of stone fruits.

Nutrition

Calcium

Outside of experimental sand culture, there has never been a documented case of calcium deficiency on trees. By that I mean conditions where leaf deficiency symptoms occur and plant growth is affected. There are however, calcium related disorders that can occur despite plants having what appears to be sufficient concentrations of calcium in leaves and other plant tissues. The most common and well-known of these conditions includes bitter pit of apples.

There are two major calcium related disorders affecting apples, bitter pit and cork spot. The visual symptoms are similar. Dark spots on the fruit surface and dry corky breakdown of the flesh of the fruit. Bitter pit however, is a storage-related condition that only appears after fruit have been harvested and stored. Corking is a field-related problem affecting fruit on the tree. It is made worse under conditions of low calcium, but is not caused by low calcium. Corking is also variety sensitive and is worse under conditions of high vigor and moisture stress.

Calcium is one of the most widely studied elements in plant nutrition. Studies throughout the world have focused on the beneficial affect of calcium on fruit quality. In apple production it is common to include calcium with nearly every in-season spray application. Results of studies with stone fruit have been inconclusive. Most research performed with stone fruit indicates that it is exceedingly difficult to get calcium into the fruit. Several reasons may account for this including rates, timing, application method, and material formulation. Evidence exists that summer pruning may help improve calcium concentration in fruit since the removal of vigorous shoots reduces fruit competition for available calcium. While helpful as part of an overall program, summer pruning by itself is not adequate to control severe calcium related problems.

Boron

Boron deficiency is a potential problem in stone fruit production. We usually think of boron as affecting flowering and fruit set. However, the fruit symptoms of boron deficiency include internal and external corking accompanied by dry pithy lesions in the fruit. This description is very similar to what we experienced in 1998. In apples it is known that if boron deficiency does not become severe until late in the fruit developmental period, the main symptom may be internal cork formation. This condition is worsened under conditions of heat and/or water stress. (See below of a full discussion of this issue.) It is also known that boron deficiency in apple is often confused with cork spot (cork spot is calcium related). In peach, boron deficiency of this type causes fruit to develop brown, dry corky areas in the flesh. Additionally, boron is readily leached by heavy rain and deficiencies are common under conditions where there is poor root activity - wet cold springs for instance. Based on this information what we experienced in 1998 may have been boron related rather than calcium related.

Nutritional Balance

Both Ca and B deficiencies are made worse when trees are out of balance. This is usually interpreted to mean vigorously growing trees that have been pushed with excessive nitrogen. In

1998 it is well known that trees grew exceptionally well. Also, the spring rains and storms provided much free N.

Furthermore, boron is an element that is readily leached. The heavy winter and spring rains may have leached boron during the critical periods of fruit development as cited above. Additionally the cold wet soils early in the year did little to help root growth and this also likely impeded the uptake of both boron and calcium.

Plant Analysis

Plant analysis can be helpful for diagnosing either of these deficiencies. Boron deficiencies are easily detected by leaf analysis. In the case of calcium, leaf samples are unlikely to uncover deficiencies. Because of this, in apples - where calcium nutrition is so important - it is common to test fruit tissue calcium concentrations in both the flesh and peel. We do not know what critical levels may be for such tests of stone fruit. In the past we have analyzed peach and nectarine fruit affected with corking. Affected areas have sometimes been low in calcium, but these tissues are essentially diseased and so would naturally test low.

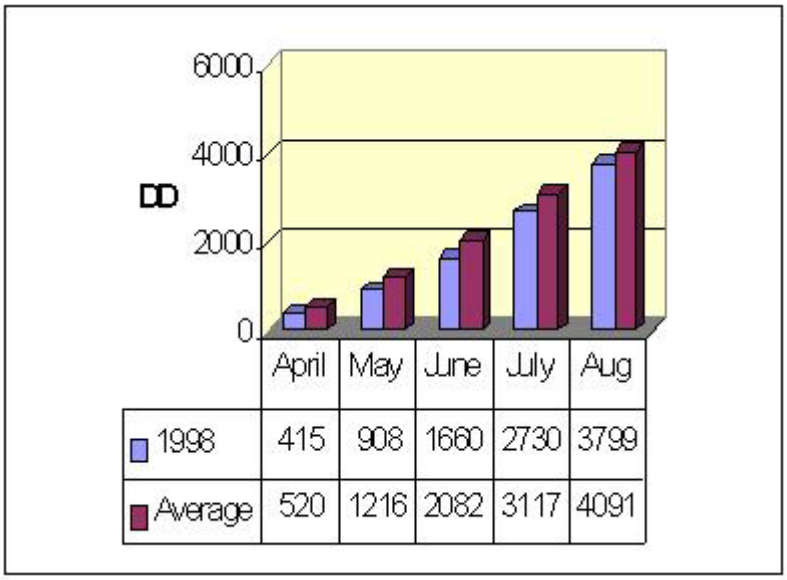
The best current recommendations can only be made to continue practicing good nutritional programs in all orchards. This includes adequate soil and tissue testing to maintain proper tree nutritional status. Excessive use of nitrogen especially should be avoided as it can cause both calcium and boron to be reduced in plant tissues.

Environmental Conditions

Seasonal Temperature Patterns

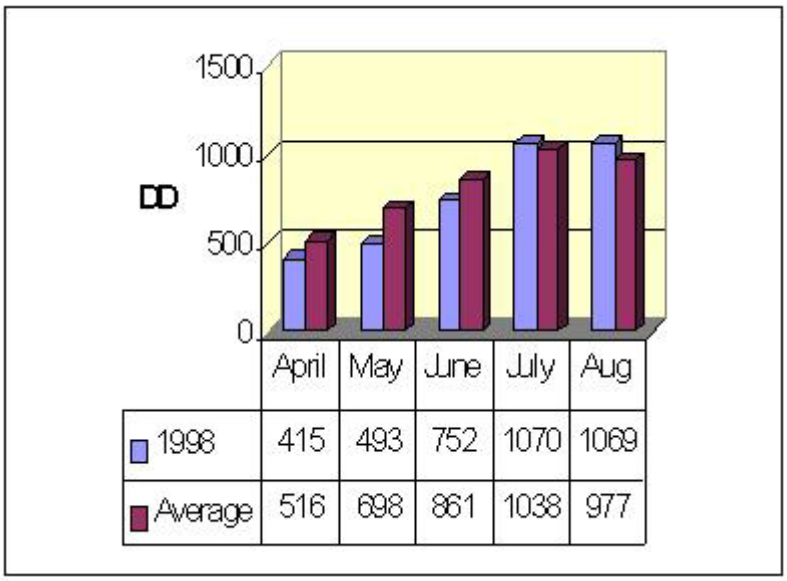
The 1998 season was considered to be a "cool" year, with fruit harvest running as much as several weeks later than "normal". The data shown below in figure 1 give a graphic representation of the heat unit accumulation that occurred during the season as compared to a 16-year average. Indeed, 1998 was the coldest season during the 16-year period available for analysis.

Figure 1. Seasonal total heat unit accumulation: 1998 vs. 16-year average.



A better understanding of the season can be gathered by looking below at figure 2. During the 16 year period studied, the coldest April, May, and June each occurred in 1998. August was hotter in 1998 than any of the other years. July 1998 was warmer than average, and it was the 5th hottest July of the 16-year period, with most of the heat accumulated after the middle of the month.

Figure 2. Monthly heat unit accumulation: 1998 vs. 16-year average.



From the temperature data presented, it is clear that 1998 was unique in several respects. The season was characterized as one of the coolest springs in history - this of course explains the lateness of the year. On the other hand, August was the warmest in recent history. The second half of July was abnormally warm was well. Fruits that ripened in late July and early August

were subjected to both an abnormally rapid warm up and great amounts of heat. These environmental conditions undoubtedly contributed to the problem of fruit corking. Fruit that entered the final ripening process after this abnormal warm-up seemed to develop and ripen properly without the corking problem being manifested.

Environmental Stress

Cool spring temperatures have been implicated in contributing to low calcium and boron concentrations in plants. Furthermore, boron accumulation is particularly sensitive to drought conditions. During periods of high water demand even well irrigated trees can undergo significant amounts of stress.

During July of 1998 it is likely that the high heat and water demand, after transitioning from an abnormally cool spring and early summer, may have caused some type of imbalance to occur in developing fruits. This stress might have affected both boron and calcium accumulation as well as many other physiological processes. Orchards that were stressed during this time may have been those that were most affected. This may help explain several of the discrepancies I noted this year such as adjacent or nearby blocks of the same varieties showing the problem in one location and not the other.

Conclusion

My personal opinion - deduced from observation rather than empirical controlled study data - is that the corking we observed in 1998 was as much caused by environmental stress as either boron or calcium deficiency. I believe that it is critical to remember that the problem occurred only after the severe warm up of mid-July and then affected varieties that ripened just after that. The problem then progressively lessened and eventually went away.

I do not think that calcium is as likely to be involved as boron. This is supported by evidence that orchards growing in high lime soils were just as likely to have the problem as those in growing in other soils. Boron may indeed be related to this problem because we know that it is readily leached during high rainfall years and that it is inherently low in many of our soils. Those with available records from 1998 should check to see that boron concentrations are in the proper range. If not, boron applications may be warranted.