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The Pomology Post

Madera County

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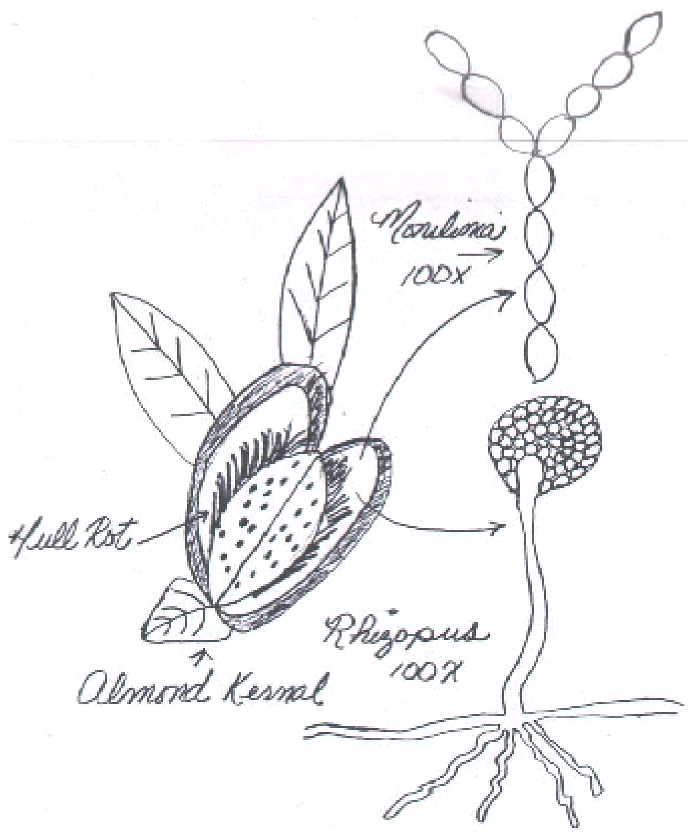
Hull Rot on Almonds in Madera County

by Brent A. Holtz, Ph.D., UCCE Madera



Many growers noticed this spring that their Nonpareil and Sonora almond varieties lacked bloom in the lower half of their trees while other varieties, like Carmel, displayed normal bloom. Most of the orchards I observed with these symptoms I attributed to hull rot infections which took place the previous growing season after hull split. Many growers confuse hull rot with shading out since both can produce dead wood in the lower canopy. I believe that hull rot actually enhances shading out as the tree abandons infected wood in the lower canopy for healthy wood receiving sunlight at the top of the canopy. Irrigation management is the only control for Hull Rot and if you have hull rot I suggest you come to our Almond Field Day on May 7, 2001, at the Sherman Thomas Ranch in Madera, as we discuss proper irrigation management in order to prevent this serious yield reducing disease.

As almond trees approach harvest, at about mid hull split, clusters of dry leaves begin to appear scattered through the tree canopy. Individual spurs, small shoots or entire small branches may collapse. The loss of fruiting wood, especially in the lower parts of the tree, can negatively affect yield for years to come. Nonpareil is usually the most severely affected cultivar though Sonora and Kapareil can also sustain extensive damage.

Hull rot is caused by either of two fungi, *Monilinia fructicola* or *Rhizopus stolonifer*. *Monilinia fructicola* is best known as one of the brown rot fungi and *R. stolonifer* often is called the bread mold fungus. These two organisms are very different but cause similar disease symptoms on almonds. As the name implies, a lesion or dryish rotted area develops on the hull, and dense masses of *Rhizopus* spores produce a powdery dark gray to black growth between the hull and the shell. *Monilinia* spores are buff-colored and can be seen on inner and outer hull surfaces. The nutmeat is not damaged, but a toxin produced in the infected hull moves from the hull into the neighboring leaves and shoots causing death of these tissues.

Neither *Monilinia* or *Rhizopus* are able to invade the healthy outer hull surface. Only after hull split begins can spores gain access to the inside of the hull and initiate infections. Once hull split starts, trees are at risk of becoming infected. One or both pathogens may be present in an orchard, but *Monilinia* hull rot is less common in southern San Joaquin Valley orchards than in other almond growing regions of the state. Leaves may become infected near infected nuts and sometime the hole spur or shoot can die as well. Clusters of dead leaves can become visible in the summer scattered among healthy green foliage. Spur and leaf die-back are attributed to fumaric acid which is produced by the pathogens and transported to the leaves and shoots. The black vascular tissues in the dead spurs and wood can be traced back to a pedicel or infected fruit. The nut kernal is not harmed but the death of the fruiting wood reduces bloom and yield in subsequent years. Sometimes infected fruit does not fall during mechanical harvest and must be removed by hand poling and can also provide overwintering sites for navel orangeworm (NOW).

Cultural practices play a crucial role in determining the severity of hull rot in an orchard. Vigorous, heavily-cropped, well-watered and fertilized orchards suffer the most damage. I have often referred to hull rot as the "good growers disease" since the disease is often worse in well maintained orchards. The reasons for this are not clear. The association with heavy crops might be simply a matter of numbers: more infected fruit means more toxin produced which results in more leaf and shoot death.

Research by Drs. Beth Teviotdale , David Goldhammer and Mario Viveros have shown that hull rot can be reduced by inflicting mild water stress on trees during early hull split. In experiments in Kern County, hull rot incidence was lessened by half or more when half the normal amount of water was delivered to trees for two weeks during early hull split. Eliminating irrigation during the two weeks preceding harvest reduced hull rot by 400-500%, but completely denying trees water for two weeks may be dangerous and less drastic irrigation reductions may also reduce disease and stress trees less. In their research they irrigated almond trees at 70, 85, and 100% of potential evapotranspiration (Etc). There were two types of deficit irrigation: sustained and regulated. The sustained irrigation was just reduced irrigation the whole season while the regulated started the year at normal irrigation but then drastically reduced irrigations (50% Etc) during the period preceeding and during hull split. For Kern county those dates included 50% Etc from 1-15 July (85% season Etc reduction) or 1 June- 31 July (70% season Etc reduction). The regulated deficit irrigations were much more effective at reducing hull rot than the sustained deficit irrigations.

Soils can vary greatly throughout the state, and irrigation management may be difficult in some orchards. The University of California is currently testing several approaches to reduce water use under different irrigation strategies and soil types. Experiments in Stanislaus County demonstrated that hull rot severity increases with increasing amounts of nitrogen. Nitrogen should not be applied in excess of that needed for tree health and productivity. The nitrogen content of the irrigation water should be included in calculations of required added fertilizer. In another UC trial we are experimenting with midday stem water potential readings to monitor deficit irrigations in almonds to reduce hull rot without severely stressing our trees. We will demonstrate this technique at our field meeting on May 7. See you there!!!!

Hull Rot Trial/Madera County--the following irrigation schedule resulted in a 50% reduction in Hull Rot in a Madera County Trial in 1997.

Dates	Deficit Irrigation (Cut-Off)	Normal Irrigation	% Hull Split
June 9-12	100% (24 hr)	100%	
June 16-19	50% (12 hr)	100%	1%-June20/21
June 23-26	50%	100%	
June 30-July 3	0 (no irrigation)	100%	5-40%
July 7-10	50%	100%	>40%
July 21-24	0 (dry down)	0	
July 28-31	Harvest		
Post Harvest	100%	100%	

Diagnosing Nutritional Problems Using Leaf Analysis

by Brent A. Holtz, Ph.D., UCCE Madera

Leaf analysis of tree fruits can be used to identify nutritional problems, to detect low levels of nutrients before harmful deficiencies occur, and to measure tree responses to applied fertilizers. Such analyses are extremely helpful in identifying multiple deficiencies and excess levels. Tissue analyses are not a substitute for careful observation of non-nutritional factors such as diseases, pests, soil depth and moisture, crop control, and generally good horticultural practices.

Leaf analysis is more useful than soil analysis in diagnosing mineral deficiencies and toxicities. The tissue generally sampled and chemically analyzed is the leaf. The mineral composition of a leaf is determined by many factors, such as its stage of development, climatic conditions, availability of mineral elements in the soil, root distribution and activity, crop load, and irrigation. The tree integrates all these factors and the composition of the leaf reflects this integration. Desirable concentrations of elements, critical levels below which deficiencies occur, and the levels above which toxicities can develop have been established for most elements. Analytical results of a sample in question can be compared with those values to determine a deficiency, adequacy, or toxicity, and help one decide if measures should be taken to correct a situation.

Seasonal use and level of mineral elements.

In interpreting leaf analysis, a knowledge of the seasonal-use pattern of mineral nutrients is helpful. At bud break in the spring, when root activity is still minimal, many elements stored in stem and root tissues become available to the rapidly developing buds. Much of the nitrogen (N), phosphorus (P), zinc (Zn), and perhaps potassium (K) initially required come from stored supply and are redistributed to the growing points. Most of the P and Zn in the leaves have accumulated there by the time leaves reach full size. On the other hand, calcium (Ca), which is essential in cell wall formation, is not redistributed but comes directly form the soil by root absorption. Thus, Ca accumulates in the leaves as the season progresses and reaches its highest level at summer's end, about a month before leaf fall. The levels of magnesium (Mg), manganese (Mn), boron (B), copper (Cu), chloride (Cl), and sodium (Na) tend to remain constant or only increase slightly. However, if B, Cl, and Na are present in toxic amounts in the soil, they will increase greatly during the season and reach their highest levels in the leaves at the end of the summer.

The concentration of mineral nutrients in leaves will change as the leaves emerge, grow to full size, and then senesce in autumn. For many elements, the least change in concentration occurs from late June through July. Leaf samples should be taken during that period because the critical levels established through experimentation and observations are based on samples taken at this time (table 1). However, if one wants to compare a good tree with a poor one, leaf sampling can be done any time leaves are present, provided one is aware of concentration patterns (fig. 1).

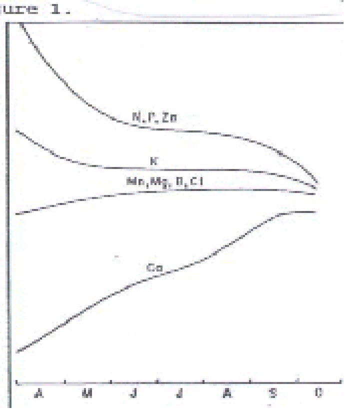
Table 1.

Critical Nutrient Levels (Dry Weight Basis) for Fruit and Nut Trees Sampled in July.

	Almonds	Apples	Pistachios	Peaches/Nect	Prunes
Nitrogen (N) %					
deficient below	2.0	1.9	2.3	2.3	2.2
adequate	2.1 to 2.6	2.2-2.4	2.5-2.9	2.4-3.3	2.3-2.8
Potassium (K) %					
deficient below	1.0	1.0	1.0	1.0	1.0
adequate over	1.4	1.2	1.6-2.0	1.2	1.3
Calcium (Ca) %					
adequate over	2.0	1.0	1.3	1.0	1.0
Magnesium (Mg) %					
adequate over	0.25	0.25	1.2	0.25	0.25
Sodium (Na) %					
excess over	0.25	--	?	0.2	0.2
Chloride (Cl) %					
excess over	0.3	0.3	0.1-0.3	0.3	0.3
Boron (B) ppm†					
deficient below	25	20	90	18	25
adequate	30-65	25-70	120-150	20-80	30-80
excess over	85	100	--	100	100
Zinc (Zn) ppm					
adequate over	18	18	10-15	20	18
Copper (Cu) ppm					
adequate over	4	4	6-10	4	4
Manganese (Mn) ppm					
adequate over	20	20	30-80	20	20
Phosphorus (P) %					
adequate between	0.1-0.3	0.1-0.3	0.1-0.3	0.1-0.3	0.1-0.3

†Boron sample hulls at harvest (30-80 ppm in hulls is deficient; 80-200 ppm is sufficient; >200 ppm is excessive)

Figure 1.



Sampling procedure.

Critical nutrient standards for tree fruits are based on spur leaves rather than on shoot leaves, so the usual leaf sampling method is to sample spur leaves. Leaves are taken from spurs reachable from the ground and picked at random around the tree at different heights. Leaves higher up in trees may be more likely to be deficient in some nutrients. One to two leaves can be taken from each of about 50 spurs for a total of about 75 leaves. Normally, leaves are collected in paper bags and stored in portable ice chests. Plastic bags are often used, especially for samples that must be kept fresh for several days until taken to a laboratory for analysis. Leaves in plastic bags must be kept cool and protected from direct sunlight.

Ideally, every 10 acres of an orchard, every soil type, and every variety should be sampled separately. Growers, however, prefer to sample problem blocks and take a few samples per year from good blocks. Answers to problem areas are often found by comparing samples from the problem areas with samples from good areas in the same orchard. The sampling unit should represent trees of the same age, variety, and rootstock, growing on similar soils of the same fertility level. Each sample should be collected so that leaves come from representative trees over the entire sample area. Where samples taken annually are to be compared, the pattern of sampling should be the same; better yet, samples should be taken from the same marked trees. All off-type trees, odd varieties, replants, and atypical trees should be avoided.

Spray residues of micronutrients cannot be washed off leaves satisfactorily, so it is worthless to analyze micro nutrient-sprayed leaves. Where N and K sprays are used, the amount of macro element spray residue is small compared to total content of N and K in the leaf, and therefore analyses can be safely made a week after application. If you want to spray micronutrients and also have leaf analysis done, you can bag some branches while spraying, then remove the bags and flag those branches, and then sample from these same branches in July.

Almond Field Day

Monday, May 7, 2001
8:30-11:00 AM
Location: Sherman Thomas Ranch, 25810 Avenue 11, Madera CA 93637

8:30 AM **Introduction**: *Brent A. Holtz*, UCCE Madera County

Ant Control

8:35 AM **Ant identification in the Field and Control Measures**
Walter Odus Bentley, IPM Advisor-Kearney Ag Center

9:10 AM **Ant Trials in Fresno County**
Mark Freeman, Pomology Farm Advisor

Hull Rot Control

9:30 AM **Effects of Deficit Irrigation on Hull Rot**
Dr. Beth Teviotdale, Extension Plant Pathologist, UC Davis/KAC

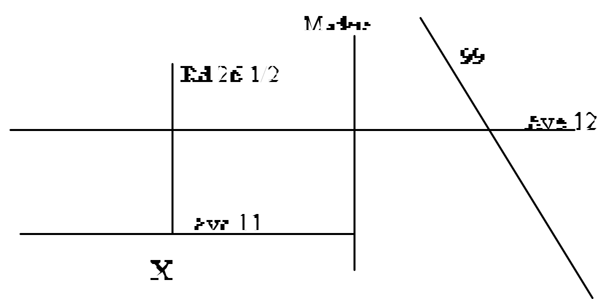
10:00 AM **Using a Pressure Bomb to Monitor Irrigations**
Dr. Bruce Lampinen, Almond and Walnut Pomology Extension Specialist, UCD

10:30 AM **Grower Perspective-Using the Bomb**
Mike Braga, Sherman Thomas Ranch

10:40 AM **Hull Rot Pruning Trial**
Dr. Brent Holtz, UCCE Farm Advisor

11:00 AM Adjourn

2.5 hours of PCA credit applied for



UPCOMING EVENTS

May 10-11, 2001	**Assessment of Agricultural Soils and Land Capabilities: The Basics**.
May 14-15, 2001	**Assessment of Agricultural Soils II: Soils of Trees, Vines and other Perennials**
	Location: Cabernet Room, Silo Union, Hutchison Drive, UCDavis.
	Fee $385. Register by phone toll free -800-752-0881 or online at www.universityextension.ucdavis.edu.

Sincerely,

Brent A. Holtz, Ph.D.
Pomology Farm Advisor