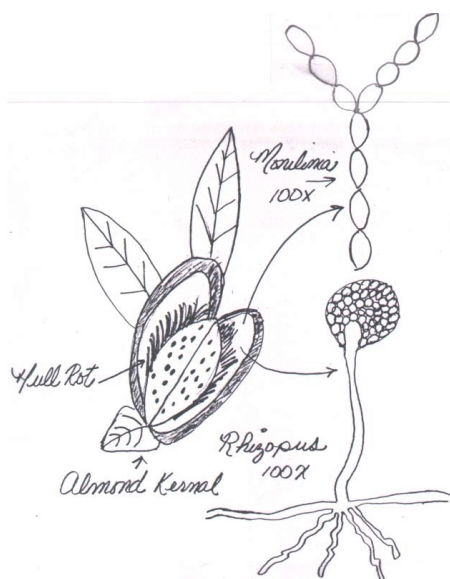




## Hull Rot Management on Almonds

by Brent Holtz, Ph.D., University of California Pomology Advisor



Many growers noticed this spring that their Nonpareil, Sonora, Butte, or Monterey almond varieties lacked bloom in the lower half of their trees along with a lot of dead fruiting spurs while other varieties like Carmel displayed normal bloom and growth in the lower tree canopy. Most of the orchards I observed with these symptoms I attribute to hull rot infections that 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. I also believe that hull rot is the single greatest yield reducer of vigorous young almond orchards in the central San Joaquin Valley that are entering their prime production years!!! Irrigation management is the only practical control for Hull Rot and the following article addresses hull rot management.

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 due to hull rot infections. 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* is often called the bread mold fungus, and will turn bread left out black and moldy. In the southern San Joaquin Valley I believe that *Rhizopus* is the primary pathogen responsible for hull rot while *Monilinia* may be more

important in the Sacramento Valley. These two organisms are very different but can cause similar disease symptoms on almond. 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 nut meat 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* nor *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 kernel 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. Beth Teviotdale calls hull rot the “gout of almond diseases—too much food and drink is bad for almonds just like it is bad for us.” 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

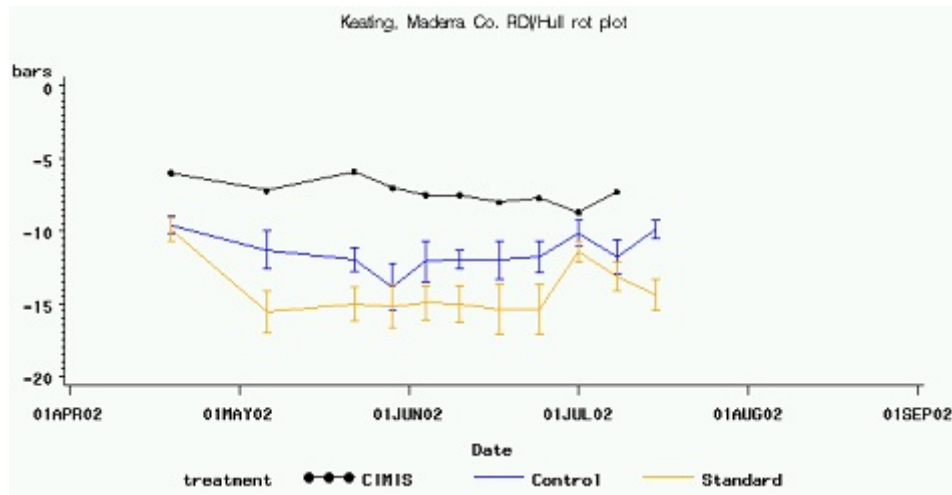
two weeks may be dangerous and less drastic irrigation reductions may also reduce disease and stress trees less. In their research they irrigated almond trees at 70, 85, and 100% of potential evapotranspiration (Etc). There were two types of deficit irrigation: sustained and regulated. The sustained 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 preceding 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.

The University of California tested several approaches to reduce water use under different irrigation strategies and soil types. In a large cooperative trial lead by Dr. Ken Shackel in Pomology at UC Davis and farm advisors, we used midday stem water potentials to monitor deficit irrigation in almond in order to reduce hull rot without severely stressing trees. We use a pressure bomb to monitor midday stem water potentials (SWP) through the season in order to keep fully irrigated trees between stem water potentials of -7 to -9 bars. Then during hull split we tried to irrigate less in order to achieve stem water potentials between -14 to -18 bars. The higher the negative number, the more water stress. Figure 1 shows a graph of our 2002 data where the grower standard is our RDI reduced deficient irrigation

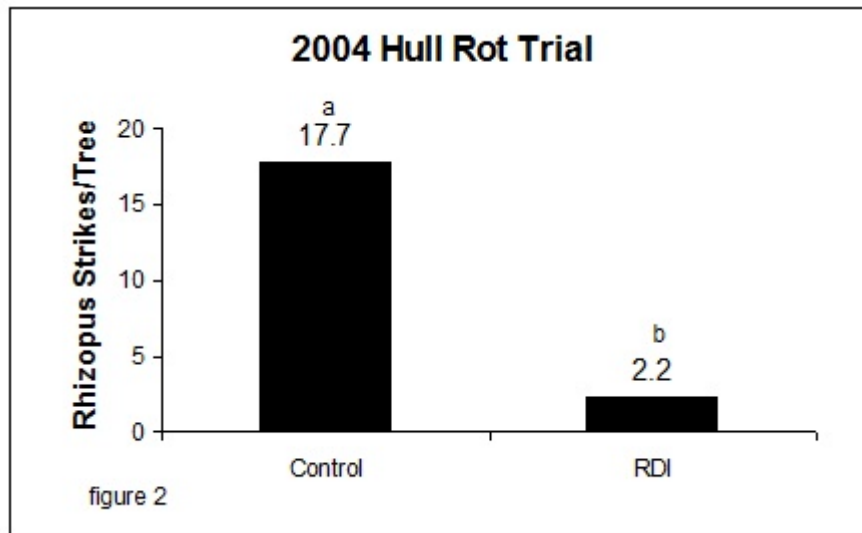
treatment (-14 to -18 bars) while the control consists of fully irrigated trees (-7 to -9 bars). Hull rot in the fully irrigated treatment averaged 44.4 strikes per trees while the RDI treatment averaged only 17.7 in 2002. In 2003 hull rot in the fully irrigated treatment averaged 17.7 strikes per trees while the RDI treatment averaged only 2.0 (figure 2). In both years the differences were significant.

By using the pressure bomb to monitor tree stem water potentials we are imposing enough stress to reduce hull rot and not over stress the trees so that they are susceptible to mite damage or defoliation. Soils can vary greatly throughout the state and irrigation management can be very difficult. For instance, in some orchard experiments we could withhold water and reach -14 bars in just a few days while in other orchards with deep, well-drained soils it might take as long as 20-30 days to achieve -14 bars in stress. This is why irrigation management using mid day stem water potentials and a pressure bomb is in my belief the only real management strategy for hull rot control. Other benefits of hull split stress are more uniform nut maturity and earlier harvest which will have a significant impact on Navel Orange Worm (NOW) control and damage. 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.

**Figure 1**



**Figure 2**



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Sincerely,

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