



Second generation almonds are susceptible to almond replant disease

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

Many of the first almond orchards planted in Madera County are being pushed out and replanted again, usually to almonds. And many vineyards have also been pushed out and are being planted to almonds. Often growers call me out to examine their second generation almond orchards with the common complaint that they just aren't growing like their first generation trees grew. Most of these growers did have their soils tested for nematodes, and in many cases the nematode numbers came back so low that they decided not to fumigate. "Why bother with the extra expense if you don't need it?" was their most common reply.

Well, nematodes are only half the story in certain soils, and most growers that planted their second generation trees without fumigating wish that they had fumigated before replanting. The other half of the story is termed "Replant Disease" by Dr. Greg Browne, a USDA plant pathologist at UC Davis. Replant Disease is a replant problem found usually when second generation almonds are planted in the same soil after the first generation is removed. Replant Disease is usually more apparent in orchards in the first, second, or third years after replanting but symptoms of

reduced tree growth and ultimately yield may be impacted for the entire orchard's life. Replant disease can occur in the absence of typical replant problems commonly caused by either plant parasitic nematodes, nutrient deficiencies or toxicities, improper soil pH, limiting soil physical conditions such as hard pan or a clay layer, poor plant-soil water relations, or known plant pathogenic fungi like *Phytophthora*.

Replant Disease has been severe in several almond plantings in Butte County where Dr. Browne and Joe Connell, the Butte County farm advisor, have studied this problem. In many of the soils found in Butte County and the Sacramento Valley, plant parasitic nematodes are usually absent and are not involved in the replant disease observed. But severe replant disease does exist there in the absence of nematodes. Joe Connell has observed as much as fifty to ninety percent tree loss in some replant sites due to replant disease. More commonly in replant sites the trees are not killed out right but may suffer from reduced tree vigor the entire orchard's life. Dr. Browne and Joe Connell began testing a number of fumigates in order to examine if they would show efficacy against almond

replant disease while also looking for alternative fumigants for methyl bromide, which will soon be phased out.

In these orchard experiments, tree site and broadcast fumigation with methyl bromide, chloropicrin, Telone II, Telone C35 (Tellone II plus chloropicrin), and iodomethane in various combinations prevented replant disease in the absence of nematodes. Interestingly, even low rates of chloropicrin were as effective as high rates of methyl bromide and more effective than equivalent low rates of methyl bromide. Data obtained from these experiments showed that chloropicrin could be a very successful replacement for methyl bromide at least when it comes to replant situations in the Sacramento Valley. Root stock growth and survival data indicated that although all the almond rootstocks are subject to replant disease, Mariana 2624 was the most susceptible. Interestingly, Maraiiana 2624 is one of the rootstocks most resistant to *Phytophthora*, hinting that *Phytophthora* may not be a major fungus involved in replant disease.

Dr. Browne has also examined the effect of replant disease on almonds after grape since a lot of

vineyards have been pulled out and planted to almonds. Results have indicated that there is a high degree of specificity between peach and grape replant disease. In soils from a peach orchard, almond rootstocks (peach) were severely stunted unless pre-plant fumigation was performed. And in such orchards fumigation improved shoot growth from 56-136%. In contrast, almond rootstocks grew well in grape soils regardless of fumigation treatment, and fumigation treatments only improved shoot growth by twelve to thirteen percent. In two orchard fumigation trials that Dr. Browne is currently conducting in Madera County with me and Agri-Land Farming, we have one trial in an orchard where almonds were planted after almonds in soils that did not have nematodes. And in the second orchard trial we have almonds following grape in soils that did have high populations of plant parasitic nematodes. In the almond after almond site most of the broadcast and row strip treatments of Telone II (1,3-D), Telone C35 (1,3-D plus chloropicrin), Midas (iodomethane), and Midas plus chloropicrin, and chloropicrin by itself marginally increased trunk diameters compared to non-fumigated controls in the absence of nematodes. Interestingly, in the almond after grape orchard the same treatments did not marginally improve plant growth compared to the controls during the first season. But the trees all had tremendous growth even though a treatment effect was not apparent after the first year. We speculate that as the nematode populations again build up we may see an effect of the fumigation in the second and third years of the trial.

It is likely that there are a number of fungi and perhaps bacteria, other than the typical plant pathogens such as *Phytophthora* and crown gall, that had high populations living on the roots of the previous generation of trees. These fungi and bacteria could still be present decomposing old roots in the new orchard and are most likely the cause of replant disease. This is still speculation, but Dr. Browne's research has found a number of fungi and bacteria associated with replant disease, and given the fact that fumigation with materials known to kill soilborne fungi and bacteria has shown efficacy against replant disease, provides evidence that replant disease is related to organisms present in replant soils. Dr. Browne's laboratory is currently isolating hundreds of organisms from replant sites that they hope to correlate with replant disease in the future.

Another replant problem is typically found on the coarse textured soils of the upper San Joaquin Valley where ring nematode populations can reach high levels and contribute to poor tree vigor and the development of bacterial canker. In such soils, Roger Duncan, the Stanislaus County Farm Advisor, working with Dr. Mike McKenry, a UC Riverside nematologist, have found that pre-plant fumigation treatments can drastically improve tree growth and crop yields in such soils. Metam sodium (Vapam or Sectagon) can be used successfully and cheaply in sandy soils that can infiltrate 6-8 inches of water in 12 hours or less. Telone II has performed well in sandy soils and applying Telone II to greater depths may negate the requirement for

moisture at the field surface. Chloropicrin has performed well in replant disease sites and has been found to stimulate tree growth. Chloropicrin's performance is enhanced by dry soil conditions, but care must be taken to avoid off gassing for odors can be phytotoxic to leaves of nearby trees and severely irritate people. Iodomethane is currently not registered but in preliminary tests its performance may exceed methyl bromides, however phytotoxicity has been seen in some crops after treatments including trees on Nemaguard rootstock.

Dr. McKenry has found that Roundup can help reduce nematodes. That is when it is applied to recently cut down tree trunks it can kill the entire root system in less than 60 days. This is important since roots and nematodes living on them can stay alive for years after a tree is pushed out or falls over. Thus, by actually killing the root system of the first generation almond you can kill many of the nematodes that would have stayed alive on the old roots, just waiting to jump root to root onto the second generation trees.

When you have high populations of nematodes the decision to fumigate is a "no brainer," it is when you do not have nematodes that the decision becomes more critical. After looking at many replant situations with and without nematodes, I recommend pre-plant fumigation in replant situations even without nematodes. Better safe than sorry is my reply when the bottom line on a twenty year plus investment is based on that orchard's future yields.

FOLIAR SPRAYS CAN REDUCE PERENNIAL PHYTOPHTHORA CANKER

by Brent Holtz, Ph.D.

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Perennial Phytophthora Canker has killed many almond trees in the San Joaquin Valley. Two plant pathogenic fungi, *Phytophthora cactorum* and *Phytophthora citricola* are primarily responsible. Phytophthora means “plant destroyer” and in the case of this disease on almond the two fungi were aptly named. The same Dr. Browne mentioned above for his nice work studying replant disease has also done some very good work studying Perennial Phytophthora Canker; this despite his absent minded professor type personality that often leaves him a bit dazed and confused while driving around Madera County looking for his test plots. But with Dr. Browne’s accomplishments we respectfully overlook his absent mindedness and realize he is preoccupied with “higher” thoughts.

Dr. Browne has termed this disease “Perennial Phytophthora Canker” because it is lethal, perennial, and is not associated with pruning wounds in order to differentiate it from “Pruning Wound Canker” which is another disease caused by, *Phytophthora syringae*, a similar fungus that is typically annual, non-lethal, and associated with pruning wounds. Perennial Phytophthora Canker kills almond trees by girdling the scion and is usually initiated in a conducive environment either below the soil surface or on the tree trunk where the trunk and branches join. *Phytophthora cactorum* is usually associated with infections initiated near the soil surface, while

Phytophthora citricola typically causes aboveground infections initiated near tree branch crotch pockets.

Effective management for soilborne infections include establishing the graft union above the soil surface at planting time (almond scion tissue is more susceptible than peach rootstock to *Phytophthora* spp.), avoiding *Phytophthora*-susceptible rootstocks such as Hansen 536 (peach x almond hybrid), and using proper soil water management (not over irrigating).

A typical source of inoculum for above ground infections is likely debris from the orchard floor containing fungal spores that are blown onto trees during harvest. This debris and spores are most likely washed off the tree during rains, with some accumulating in main-branch crotch pockets or depressions where main branch scaffolds join the tree trunk. These scaffold pockets containing soil, water, and fungal spores most likely offer a conducive environment for *Phytophthora* infections to take place. Effective control measures are lacking for above ground Perennial Phytophthora infections. Fortunately, Dr. Browne’s research has provided almond growers with some control measures that can be taken to prevent Perennial Phytophthora Canker.

Dr. Browne along with other researchers have shown that phosphonates (e.g. inorganic and organic salts of phosphonic acid)

have provided systemic activity against a number of diseases caused by many of the *Phytophthora* species of plant parasitic fungi. The phosphonic acid derived from phosphonates probably disrupts *Phytophthora* growth and appears to intensify almond tree defenses against infection. Fortunately, the phosphonate can be translocated both upwards and downwards in the tree due to its mobility in both xylem (water going up) and phloem (sugars going down) tissues.

In trials performed by Dr. Browne, a preventative foliar spray with phosphonate in the fall or spring of roughly 2 pounds per acre active ingredient (2.2 kg ai/ha) suppressed the development of Phytophthora cankers after wound inoculations of the fungus were made 15 days to 5 months after spraying. The Phytophthora cankers on trees sprayed with phosphonate before inoculation were 22 to 98 % smaller than those on trees that received no phosphonate. Dormant foliar applications of phosphonate were ineffective, probably because the dormant trees lacked the expanded leaves necessary to absorb phosphonate.

Dr. Browne also found that preventative chemigation of phosphonate into irrigation water in the spring or summer also inhibited Phytophthora canker expansion. Chemigation was only effective during periods of high crop evapotranspiration and not during periods of low water use. The sources of phosphonate used in Dr.

Browne's experiments included Phostrol (Nufarm Americas, Inc.) at 0.41 gallons/acre (3.8 liters/ha) and NutriPhite P foliar (4-30-8) applied at 0.46 gallons/acre (4.3 liters/ha). NutriPhite P Soil (0-60-0) was

applied via chemigation at 0.46 gallons/acre (3.9 pounds phosphonic acid/acre). Finally, thanks to the absent minded Dr. Browne, there is something that growers can do as a preventative

measure to reduce *Phytophthora* infections. In orchards where *Phytophthora* has been a perennial problem, I strongly suggest that you apply preventative phosphonate sprays in either the fall or spring.

COMING EVENTS:

32st Almond Industry Conference, December 1-2, 2004 at the Modesto Centre Plaza. Contact the Almond Board of California, Modesto, 209-549-8262. www.AlmondBoard.com

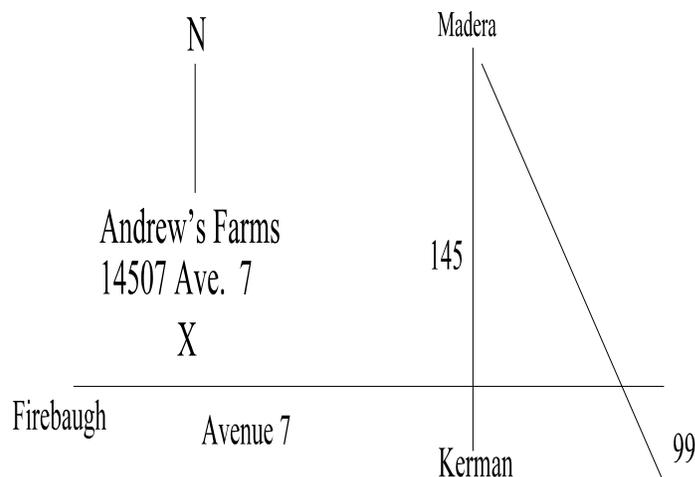
University of California Almond Brush Shredding Demonstration

November 10, 2004

9:00 AM - 12 Noon

Location: George Andrew's Ranch, 14507 Avenue 7, Madera CA

- 09:00 AM Wood chipping almond brush in the San Joaquin Valley
Brent Holtz, PhD, UC Pomology Farm Advisor Madera County
- 09:20 AM Brush burning regulation SB 705 (Florez)
Wayne Clarke, San Joaquin Air Pollution Control District
- 09:40 AM The consequence of chipping or shredding: the Huller's Perspective
Darren Linqvist, Central California Almond Growers Association
- 10:00 AM Shredding almond prunings—a grower's perspective
Larry Lowder and Chester Andrews, Andrew's Farms
- 10:15 AM DiAnna Custom Shredder
Joe DiAnna, custom brush shredding and harvesting
- 10:30 AM Rears Self Powered Pull Shredder
Keith Bursey Shredding
- 10:45 AM Jack Rabbit Wood Chipper
Cory Edwards and Frank Roque, Western Ag Chipping
- 11:00 AM Flory Industries Pow'r Trak Shredder
Bert Walters and Sons Custom Brush Shredding





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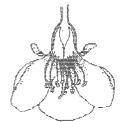
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Sincerely,

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The Pomology Post



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