



# The Pomology Post

Madera County

Volume 44, February 2004

## Spring Control of Almond Diseases

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



Almond trees are susceptible to bloom and foliar diseases when it rains at bloom, and the decision of when to spray and what fungicides to use can be quite difficult. In the San Joaquin Valley we are usually in a low precipitation region and we cannot predict when and how much it is going to rain. We often receive rain during bloom which can result in favorable conditions for several plant pathogenic fungi to cause spring time diseases of almonds. The main diseases in almonds are Brown Rot Blossom Blight, Green Fruit Rot or Jacket Rot, and Shothole. Other less familiar diseases include Scab, Rust, Leaf Blight and Anthracnose. The fungi that cause these diseases are usually always present in almond orchards, sometimes in higher or

lower amounts depending on the previous years disease levels and current environmental conditions.

### Fungicide Control Programs

Generally, a good disease control program is based upon a wise choice of fungicides and good timing and coverage. Growers should assess the diseases present in their orchards and select materials carefully. Not all fungicides are equally effective on all diseases (fig. 1). It is a good idea to use more than one kind of fungicide for a broader spectrum of activity.

Usually two sprays are made for brown rot control. The first is usually done at 5-20 % bloom using a systemic fungicide such. Some of these fungicides may require a contact fungicide to reduce resistance. Resistance to these fungicides can develop over time and repeated use, thus try to rotate the fungicides you use. The second spray should be done at about 80% to full bloom or two weeks after the first spray. This is the most effective brown rot spray (fig. 2). Depending on the weather, a third

spray may be necessary if rains persist and two weeks of protection have gone by. Since we cannot

predict the weather at bloom time, we must at least take some initial action to protect our crop. Application techniques are also important. Usually ground application is better than air; but care must be taken that both are applied correctly. In general, use properly calibrated and directed nozzles and maintain a slow speed.

### Brown Rot and Shot Hole

Most orchards are treated at least once during bloom for brown rot. The brown rot fungus (*Monilinia laxa*) attacks the tree by invading the anthers and pistils of the flower when it is open. From there the fungus can move into and kill the spur or shoot. Young fruit are also susceptible in early spring and infection of fruit may extend to and kill spurs and shoots. Although all cultivars of almond are susceptible to brown rot, they vary in their degree of susceptibility; Butte is the most susceptible variety followed by Carmel. Ne Plus Ultra and Mission are only moderately susceptible, while Nonpareil and Peerless are the least susceptible to brown rot. Varieties that are susceptible to Green Rot or Jacket Rot (caused by *Monilina laxa*, *Botrytis cinerea*, *Sclerotinia sclerotiorum*) are Butte, Ne Plus

Ultra, Merced, Carmel, Price or any variety with tight clusters. Nonpareil can be affected by this disease if the right environmental conditions occur. The time of infection for Green Fruit Rot or Jacket Rot is from flower opening to petal fall. Brown Rot Blossom blight is usually controlled pink bud and full bloom treatments with the full bloom treatment the most important in my opinion. A third petal fall spray may be necessary in years favorable to disease (rain). If bloom is strung out and the weather is wet and rainy, no more than ten days should elapse between treatments.

### **Shot Hole**

The Shot Hole fungus (*Wilsonomyces carpophilus*) is notoriously more prevalent in wet years. This fungus requires water for all its activities, so periods of extended rainfall create a situation that favors Shot Hole disease epidemics. The fungus can cause lesions on leaves and fruit, but most of the time it infects the leaves as they emerge from the leaf bud. Leaf infections lead to defoliation, which usually occurs in early spring. Shot hole infection of young fruit, shortly after they emerge from the jacket, can cause the fruit to drop. As fruits enlarge, shot hole infection results in a lesion but the fruit no longer fall. About the first of May, when the embryo of the nut begins to grow, the hull becomes resistant to infection and no further lesions develop. Shot Hole is usually controlled by fungicide applications after bloom.

### **Scab**

Until recently, scab (*Cladosporium carpophilum*) was considered more of a curiosity rather than a crop threatening disease. This has

changed! In the last several years more and more orchards have developed scab problems and the disease is often serious. The fungus causes greasy black spots on fruit, leaves, and green shoots. The shoot lesions are the overwintering sites for the fungus and the source of new spores in the spring. No apparent damage is done to the fruit, but the leaves fall. Scab can completely defoliate a tree in a short time. Severe defoliation in early summer was even observed in several orchards in Madera County last year. All cultivars appear susceptible, but Carmel seems especially vulnerable. Scab is controlled by fungicide applications from 2 to 5 weeks after bloom. Earlier treatments are not effective alone, but increase the protection provided by the later treatment. Applications later than 5 weeks after bloom are less effective, especially in the southern part of the San Joaquin Valley. Not all fungicides are effective against scab, thus it is important to include scab-active materials in an overall treatment program.

### **Rust**

Rust (*Tranzschelia discolor f. sp. dulcis*) can also cause defoliation. Both rust and scab are favored by high humidity and usually are worse in years when late spring rains occur. Orchard culture that produces humid conditions for long periods is ideal for both diseases. Like scab, rust usually appears in late spring or early summer. The fungus attacks leaves but not fruit. On leaves, it produces small, bright yellow dots on the upper leaf surface, and reddish orange pustules on the lower leaf surface. The only material registered that has

any efficacy is sulfur. One or two applications of sulfur in late spring can usually control rust.

### **Leaf Spot**

Still another defoliating disease, Alternaria leaf spot, is also new to the San Joaquin Valley. Nothing is known about the disease except that it appears in early summer, causes large lesions on leaves, and can cause defoliation. Carmel, Nonpareil, Butte, Price, Sonora, Mission, and Peerless are affected. Sonora is somewhat more susceptible than the others. Leaf Spot has been around for several years, and only at a few locations has it caused enough damage to be of concern. But be on the alert! Rovral applied at 5 weeks after petal fall has some efficacy against Alternaria leaf spot, but does not prevent serious defoliation. The limitation of treatment no later than five weeks after petal fall may be partly responsible for the poor control.

### **Leaf Blight**

The leaf blight fungus attacks the base of the leaf petiole and the bud that sits between the leaf and shoot. The leaf dies, turns a light tan color, and remains stuck to the tree. Later these leaves are then covered with the black growth of secondary fungi decomposing the infected leaves. Leaf death is of less importance, however, than the bud death that accompanies it. Leaf blight is more common in Northern California and fortunately we see it seldom here in Madera County. Generally, scab and shot hole programs control leaf blight.

## **Anthracnose**

An extremely damaging fungal disease, Anthracnose (*Colletotrichum gloeosporioides*) was severe in some orchards in Northern California last year. Anthracnose has been in California for many years, but has become more severe recently, attacking leaves and fruit. Leaf lesions have a bleached appearance and can cause the leaves to drop, though defoliation is not usually very pronounced. On fruit, Anthracnose causes deep crater-like lesions; the affected area turns a rusty reddish brown, and older fruit often gum profusely. Inside, the nut meat is destroyed. The fungus is reported to invade the wood, and the branches upon which infected fruit reside weaken and die. Thus, in addition to destroying the crop, long term damage and weakening of the tree may occur. Varietal differences in susceptibility are not clear. It appears that good scab control programs appear to provide some control against this disease. Orchards which have a history of anthracnose should be treated during bloom, preferably

at pink bud, to help reduce inoculum build-up as much as to protect blossoms. Trees should be protected before every rain, thus repeated applications may be necessary through spring.

## **Fungicide Control Programs**

Generally, a good disease control program is based upon a wise choice of fungicides and good timing and coverage. Growers should assess the diseases present in their orchards and select materials carefully. Not all fungicides are equally effective on all diseases (fig. 1). It is a good idea to use more than one kind of fungicide for a broader spectrum of activity and to prevent pathogen populations from becoming resistant. This will be especially important with using Strobilurin fungicides (Abound, Cabrio, Flint, Sovran, and Pristine). Pristine is a Strobilurin fungicide that is combined with Carboxyanilide to slow resistance development.

Usually two sprays are made for brown rot control. The first is usually done at 5-20 % bloom using a

systemic fungicide such. Some of these fungicides may require a contact fungicide to reduce resistance. Resistance to these fungicides can develop over time and repeated use, thus try to rotate the fungicides you use. The second spray should be done at about 80% to full bloom or two weeks after the first spray. This is the most effective brown rot spray. Depending on the weather, a third spray may be necessary if rains persist and two weeks of protection have gone by. Since we cannot predict the weather at bloom time, we must at least take some initial action to protect our crop. Application techniques are also important. Usually ground application is better than air; but care must be taken that both are applied correctly. In general, use properly calibrated and directed nozzles and maintain a slow speed. The fungicide efficacy and timing for deciduous tree fruit and nut crops and grapevines 2004 can be found at [www.uckac.edu/plantpath](http://www.uckac.edu/plantpath). Good Luck!!!

## **UPCOMING EVENTS:**

**San Joaquin Valley Dried Plum Day**, Tuesday, March 2, 2004, 8 AM -12 Noon, University of California Cooperative Extension Tulare County, 4437 S. Laspina St. B, Tulare, CA. Topics: toping dried plum trees, irrigation management in dried plum, economic analysis of reduced risk practices, new dried plum varieties, integrated prune farming practices (IPFP), and managing nitrogen in prunes. 2 hours of PCA/PCO/CCA credits applied for.

**INTERNET SUBSCRIPTION: The Pomology Post is available on the Internet at <http://cemadera.ucdavis.edu>. Go to PUBLICATIONS, NEWSLETTERS, THE POMOLOGY POST. All issues of the Pomology Post are posted. If you subscribe, the newsletter will be emailed to you as soon as it is posted. CHECK IT OUT!**

The University of California, in accordance with applicable Federal and State law and University policy, does not discriminate on the basis of race, color, national origin, religion, sex, disability, age, medical condition (cancer-related), ancestry, marital status, citizenship, sexual orientation, or status as a Vietnam-era veteran or special disabled veteran.

Inquiries regarding the University's nondiscrimination policies may be directed to the Affirmative Action Director, University of California, Division of Agriculture & Natural Resources, 1111 Franklin Street, 6<sup>th</sup> Floor, Oakland, CA 94607-5200 (telephone: 510-987-0096).

### ALMOND—FUNGICIDE EFFICACY

Fungicide	Resistance risk	Brown rot	Jacket rot	Leaf blight	Shot hole	Scab	Rust <sup>1</sup>	Anthracnose	Alternaria	Silver leaf
Benlate <sup>2</sup>	high	++++	++++	++++ <sup>7</sup>	----	+++	+	----	----	----
Pristine <sup>1</sup>	medium	++++	+++	?	++++	++++	ND	+++	+++	----
Rovral + oil <sup>3</sup>	low	++++	++++	?	+++	+/-	++	----	+++ <sup>9</sup>	----
Topsin M <sup>2</sup>	high	++++	++++	+++ <sup>7</sup>	----	+++	+	----	----	----
Vanguard	high	++++	++++	?	++	----	?	?	+ <sup>9</sup>	----
Abound	high	+++	----	+++	+++	++++	+++	++++	+++	----
Elevate	high	+++	++++	?	+	?	?	----	?	----
Flint	high	+++	----	+++	+++	++++	+++	++++	+++	----
Laredo	high	+++	----	+++	++	----	+	++	----	----
Rovral	low	+++	+++	?	+++	----	----	----	+++ <sup>10</sup>	----
Bravo/Echo <sup>4</sup>	low	++	NR	NR	+++	?	NR	+++	NR	----
Captan <sup>5</sup>	low	++	++	+++	+++	+++	----	+++	----	----
Maneb	low	++	+	++	++	+++	+++	++	----	----
Rally <sup>5</sup>	high	++	----	+++	+/-	----	+	++	----	----
Ziram	low	++	+	++	+++	+++	----	+++	+	----
Copper	low	+/-	+/-	----	+ <sup>8</sup>	----	----	----	?	?
Sulfur	low	+/-	+/-	----	----	+++	++	----	----	----
PlantShield (NR)	low	----	----	----	----	----	----	----	----	+++

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective, and ? = unknown. NR = not registered, ND = no data

1. Of the materials listed, only sulfur, Abound, and Flint are registered for use in late spring and early summer when treatment is recommended. Applications of Pristine only at 5 weeks after petal fall will not adequately control late-season diseases.
2. Benlate label withdrawn. Strains of the brown rot fungi *Monilinia laxa* and *M. fructicola* resistant to Benlate and Topsin have been found in some California almond orchards. Resistant strains of the jacket rot fungus, *Botrytis cinerea*, have been reported in California on crops other than almond and stone fruits. Resistant strains of the scab fungus, *Cladosporium carpophilum*, have been reported on other crops but not in California.
3. Oil is a "light" summer oil, 1 to 2% volume/volume.
4. Echo, Bravo Ultrex, and Bravo Weather Stik are currently registered.
5. Do not use in combination with or shortly before or after oil treatment.
6. Efficacy is better in concentrate (80-100 gal/acre) than in dilute sprays.
7. Excellent control obtained with combination of Benlate and Captan; activity of Topsin should be similar to that of Benlate.
8. The low rates necessary to avoid phytotoxicity in spring reduce the efficacy of copper.
9. Not registered for use later than 5 weeks after petal fall; three spring applications improve the effectiveness of Abound summer treatments.
10. Efficacy reduced at high temperatures and relative humidity; experimental for Alternaria.

fig 1.

## ALMOND—TREATMENT TIMING

**Note: not all indicated timings may be necessary for disease control.**

Disease	Dormant	Bloom			Spring <sup>a</sup>		Summer	
		Pink bud	Full bloom	Petal fall	2W	5W	May	June
Alternaria	----	----	----	----	----	+++	+++	+++
Anthracnose <sup>b</sup>	----	+++	+++	+++	+++	+++	+++	+++
Brown rot	----	++	+++	+	----	----	----	----
Green fruit rot	----	----	+++	----	----	----	----	----
Leaf blight	----	----	+++	++	+	----	----	----
Scab <sup>c</sup>	+	+	+	+	+++	+++	++	+
Shot hole <sup>d</sup>	+ <sup>e</sup>	+	++	+++	+++	++	----	----
Rust	----	----	----	----	----	+++	+++	+ <sup>f</sup>

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

1. Two (2W) and five (5W) weeks after petal fall are general timings to represent early post bloom and the latest time that most fungicides can be applied. The exact timing is not critical but depends more on the occurrence of rainfall.
2. If anthracnose was damaging in previous years and temperatures are moderate (63F or higher) during bloom, make the first application at pink bud. Otherwise treatment can begin at or shortly after petal fall. In all cases, application should be repeated at 7- to 10-day intervals when rains occurs during periods of moderate temperatures. Treatment should, if possible, precede any late spring and early summer rains. Rotate fungicides, using different fungicide classes, as a resistance management strategy.
3. Early treatments (during bloom) have minimal effect on scab; the 5W treatment usually is most effective. Treatments after 5W are useful in northern areas where late spring and early summer rains occur. Dormant treatment with liquid lime sulfur improves efficacy of spring control programs.
4. If pathogen spores were found during fall leaf monitoring, apply a shot hole fungicide during bloom, preferably at petal fall or when young leaves first appear. Re-apply when spores are found on new leaves or if heavy persistent spring rains occur. If pathogen spores were not present the previous fall, shot hole control may be delayed until spores are seen on new leaves in spring.
5. Dormant copper treatment seldom reduces shot hole infection, but may be useful in severely affected orchards and must be followed by a good spring program.
6. Treatment in June is important only if late spring and early summer rains occur.

## **Almond Frost Protection**

Joseph H. Connell, UCCE  
Farm Advisor, Butte County

Whenever we discuss frost protection we're usually talking about mild, radiation frosts that occur on still, clear nights, often with the development of a strong inversion. Under these conditions we can often provide adequate protection by running water, or, with helicopters or wind machines in narrow valleys.

More damage is likely when advection frosts move cold air into orchards from accumulation areas outside the orchard. Cold air can drain out of canyons and will fill in low spots where air drainage is blocked. The cold air mass may overwhelm the upwind edge of the orchard for 10 to 15 rows even with solid-set sprinklers running. Advection frosts occur with wind present but if water is adequate and the wind is not too strong the majority of the orchard may still be protected. Radiation and Advection frosts on the same night. Note the temperature response to the wind speed and direction that shows the effect of mixing vs. cold air drainage.

### **Soil and Groundcover Condition**

Groundcover condition can affect orchard minimums with taller groundcover being a generally colder condition. Soil heat storage is reduced because sunlight is reflected and water is evaporated. Our work confirmed that the taller the cover, the colder the orchard floor, but, once the cover was 4 inches or more in height there was little difference in

temperature. We also found that bare, moist soil is the warmest, but this is true only when the surface is moist. If pre-frost conditions are dry and windy and a dry crust forms on the surface, then, bare soil can be colder than a surface with a short (less than 2 inch) groundcover that tends to keep the surface moist with dew from the grasses and weeds.

The ground surface must be moist for bare ground to be warmest. Bare, firm, dry surfaces are likely to be colder. Follow dry windy conditions with a light irrigation to moisten the soil before a frost to obtain the greatest heat storage. Overall, bare ground is best if you can keep the soil surface moist. Be sure to keep groundcovers cut short to 2 inches or less during frost season. Dry soil has many air spaces, lower heat storage capacity, and low heat conductivity resulting in colder minimums. Moist soil has more heat storage in its water, has higher conductivity, and it will have higher minimum temperatures. Irrigation should ideally wet the top foot over the entire orchard surface, soil moisture should be near field capacity, and these conditions should be achieved in advance to gain the most advantage.

### **Sprinklers and Micro-sprinklers**

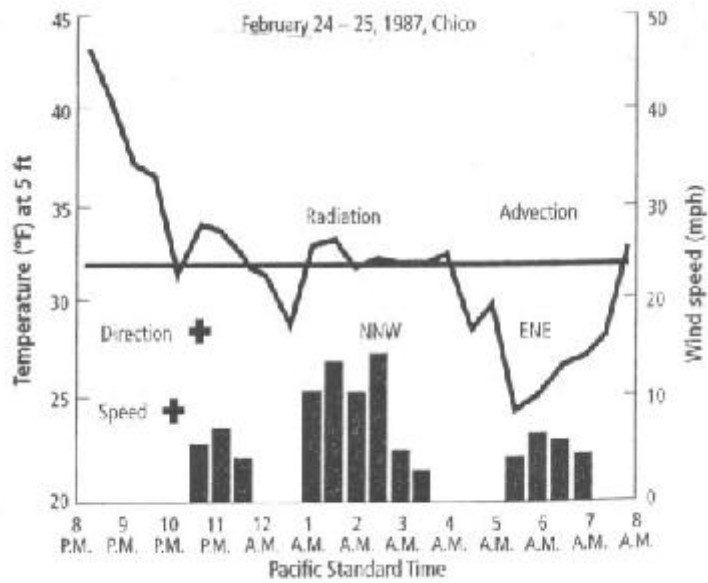
Under tree sprinklers work to provide protection because the heat contained in the water is added to the orchard system. As water cools, and then freezes, it releases a great deal of latent heat. This sensible heat is radiated or convected into the trees, thus providing protection. Sprinklers can be safely turned off when the wet bulb temperature

upwind of the protected orchard is above the critical crop damage temperature or when all the ice melts.

In some orchards, frost protection is limited by the amount of water or pipe available. For those using movable aluminum pipe, we compared protection with sprinkler lines in every middle, every other middle or every fourth middle. Air temperature in all sprinkler areas was 1 to 2°F warmer than the unsprinkled control and there were no differences between these spacings. Soil surface temperatures were colder the further from the sprinklers with the dry centers between the lines in every fourth middle as cold as the unsprinkled control. Line spacing directly affects soil surface temperature but air movement evens out the benefits. Without air movement, protection may fail between the widely spaced lines. If these limitations apply in your orchard, concentrate your available resources (pipes and water) adjacent to the most frost susceptible variety rows.

We have also studied frost protection with micro-sprinklers applying 15, 25, and 40 gallons per minute per acre. The low application rate gave less protection than the higher rate. There was little difference in observed air temperatures in our experiments. However, the exposed temperatures were 1 to 2°F warmer at the higher water rates. Exposed temperature is what the buds themselves experience. The fact that our low water application gave a lower exposed temperature indicates that protection with under tree micro-sprinklers is coming mostly from radiation rather than convection.

We found a greater separation in exposed temperatures between the low and medium/high rates on the colder nights. Thus, micro-sprinkler application rate had little effect on air temperature but did affect temperature of exposed buds and flowers. Higher soil surface temperatures from higher application rates led to more radiation heating. This may be even more important if there is wind since convection is less effective then, but radiation would be unaffected under windy conditions.



For special assistance regarding our programs, please contact us.

~ Reprint freely with credit to: Brent A. Holtz, Ph.D., Pomology Farm Advisor, University of California Cooperative Extension, Madera, CA.

Sincerely,

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