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Spring Control of Almond Diseases

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.

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 by a treatment at pink bud which is sufficient in most years, but a second application at full bloom or early petal fall 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. Ziram and Maneb show slight activity.

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.

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.

ALMOND—FUNGICIDE EFFICACY

Fungicide	Resistance risk	Brown rot	Jacket rot	Leaf blight	Shot hole	Scab	Rust[1]	Anthracnose	Alternaria
Benlate[2]	high	++++	++++	++++[6]	----	+++	+	----	----
Rovral + oil[3]	low	++++	++++	?	+++	+/-	++	----	+++[8]
Topsin M[2]	high	++++	++++	+++[6]	----	+++	+	----	----
Vangard	high	++++	++++	?	++	----	?	?	+++[9]
Abound	high	+++	-----	+++	+++	++++	+++	++++	+++
Elevate	high	+++	++++	?	+	?	?	----	?
Flint	high	+++	-----	+++	+++	++++	+++	++++	+++
Laredo	high	+++	----	+++	+	----	+	++	----
Rovral	low	+++	+++	?	+++	----	----	----	+++[8]
Captan[5]	low	++	++	+++	+++	+++	----	++	----
Maneb	low	++	+	++	++	+++	+++	++	----
Rally[4]	high	++	----	+++	+/-	----	+	++	----
Ziram	low	++	+	++	+++	+++	----	+++	+
Copper	low	+/-	+/-	----	+[7]	----	----	----	?
Sulfur	low	+/-	+/-	----	----	+++	++	----	----

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, ---- = ineffective, and ? = unknown.

1. Of the materials listed, only sulfur Abound and Flint are registered for use in late spring and early summer when treatment is recommended. Application only at 5 weeks after petal fall will not adequately control the disease.
2. Benlate label withdrawn. Strains of the brown rot fungi *Monilinia fructicola* 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. Efficacy is better in concentrate (30-100 gal/acre) than in dilute sprays.
5. Do not use in combination with or shortly before or after oil treatment.
6. Excellent control obtained with combination of Benlate and Captan; activity of Topsin should be similar to that of Benlate.
7. The low rates necessary to avoid phytotoxicity in spring reduce the efficacy of copper.
8. Not registered for use later than 5 weeks after petal fall; these spring applications improve the effectiveness of Abound summer treatments.
9. Experimental for Alternaria.

ALMOND—TREATMENT TIMING

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

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

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

a. 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.

b. 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. Alternate fungicides, using different fungicide classes, as a resistance management strategy.

c. 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.

d. 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.

e. 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.

f. Treatment in June is important only if late spring and early summer rains occur.

General Properties and Efficacy of Registered and Experimental Fungicides Used on Deciduous Tree Fruit and Nut Crops and Grapevines in California

PROPERTIES

Trade name	Fungicide	Class	Systemic action	Mode of action	Resistance potential
ML[a]	copper	Inorganic	No	Multi-site	Low
ML	sulfur	Inorganic	No	Multi-site	Low
Maneb	maneb	Carbamate (EBDC)[b]	No	Multi-site	Low
Thiram	thiram	Carbamate (DMDC)[c]	No	Multi-site	Low
Ziram	ziram	Carbamate (DMDC)[c]	No	Multi-site	Low
Rovral	iprodione	Dicarboximide	Yes	Multi-site	Low
Scala*	pyrimethanil	Anilinopyrimidine	No	Single-site	High
Vangard	cyprodinil	Anilinopyrimidine	Yes	Single-site	High
Botran	dichloran	Aromatic hydrocarbon	Slight	Single-site	High
Bravo	chlorothalonil	Aromatic nitrile	No	Multi-site	Low
Benlate**	benomyl	Benzimidazole	Yes	Single-site	Very high
Topsin-M	thioph.-methyl	Benzimidazole	Yes	Single-site	Very high
Syllit*	dodine	Guanidine	Yes	Few to multi-site	Medium
Elevate	fenhexamid	Hydroxyanilide	No	Single-site	High
Captan	captan	Phthalamide	No	Multi-site	Low
Quintec*	quinoxyfen	Quinoline	No	Single-site	Medium
Scholar[d]	fludioxonil	Phenylpyrrole	Contact	Few to multi	Low
Bayleton	triadimefon	DMI[e]-Triazole	Yes?	Single-site	High
Elite	tebuconazole	DMI-Triazole	Yes?	Single-site	High
Funginex**	triforine	DMI-Piperazine	Yes?	Single-site	High
Indar	fenbuconazole	DMI-Triazole	Yes?	Single-site	High
Orbit (Break)	propiconazole	DMI-Triazole	Yes?	Single-site	High
Procure	triflumizole	DMI-Imidazole	Yes?	Single-site	High
Rally/Laredo	myclobutanil	DMI-Triazole	Yes?	Single-site	High
Rubigan	fenarimol	DMI-Pyrimidine	Yes?	Single-site	High
Abound	azoxystrobin	Strobilurin	Yes?	Single-site	High
Cabrio	pyraclostrobin	Strobilurin	Yes?	Single-site	High
Flint	trifloxystrobin	Strobilurin	Yes?	Single-site	High
Sovran	kresoxymethyl	Strobilurin	Yes?	Single-site	High
AQ10	*Ampelomyces quisqualis*	Biological	No	Mycoparasite	Low
Serenade	*Bacillus subtilis*	Biological	No	Various	Low
JMS Stylet oil	low range oil	---	No	---	Low
Valero	cinnamic aldehyde	---	No	---	Low

* Experimental; registration pending
** Label withdrawn

a ML=many labels
b EBDC = ethylene bisdithiocarbamate
c DMDC = dimethyl dithiocarbamate
d Post harvest use only
e DMI, demethylation (sterol) inhibitor

? = not confirmed on stone fruit and nut crops using radioactive labeled compounds

NEW PUBLICATIONS

"Integrated Pest Management for Almonds" - Second Edition (3308) is available for $32.00. This edition of our best-selling guide for almonds is completely revised and expanded. Covers 120 different pest problems including diseases, insects and mites, nematodes, vertebrate pests, and weeds; including 10 new insect pests and diseases.

"California Master Gardener Handbook" (3382) is available for $30.00. This is the definitive guide to gardening in California! At over 700 pages, no other California gardening guide contains this depth of information.

UPCOMING EVENTS

San Joaquin Valley Dried Plum Day, Thursday, February 28, 2002. Registration 8:00 a.m. at the University of California Cooperative Extension-Tulare County, 4437 S. Laspina St. B, Tulare, CA. Contact Brent Holtz, 675-7879 Extension 209.

Sincerely,

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Pomology Farm Advisor