Powdery Mildew and Other Disease Control on Almond

Project No.: **09-PATH7-Holtz**

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Interpretive Summary:

Two species of powdery mildew have been reported on almond, the apple powdery mildew fungus *Podosphaera leucotricha* and the peach powdery mildew fungus *Sphaerotheca pannosa*. We believe the apple powdery mildew fungus is responsible for symptoms on almond similar to symptoms associated with Peach Rusty Spot, but both organisms may be present. Severe powdery mildew like symptoms has been observed in the south east portion of Madera County in almond orchards near locations where Granny Smith Apples were once grown. Almond growers in these locations believe that yields have been reduced by as much as 30% due to the occurrence of these symptoms. A higher percentage of nut kernels appear aborted due to powdery mildew like symptoms on the hull. Because the powdery mildew fungi are obligate parasites they cannot be isolated or grown in culture like other fungi. We conducted fungicide trials from 2005-2009 to see if observed symptoms could be correlated to fungicide applications. Fungicides applications from petal fall to 60 days after have significantly reduced disease symptoms (**Table 1**) and further supported our hypothesis that this malady is caused by a powdery mildew species.

Objectives:

1) We would like to determine what registered fungicides provide the best control for Powdery Mildew on Almond and also the best application timing for disease control. Consideration should be given to develop a disease management program that avoids developing fungicide resistance not only with this species of powdery mildew but the other fungal diseases typically sprayed during the same timing period such as Anthracnose, Alternaria, and Scab.
2) We would also like to evaluate both conventional, organic, and developmental unregistered fungicides for their efficacy to control brown rot, shot hole, anthracnose, and scab bloom time diseases of almond.

Materials and Methods:

Replicated and randomized block experiments were placed in grower cooperator orchards in order to evaluate the efficacy of the fungicides tested. Single tree replications are usually used. Different almond varieties are chosen for specific studies because some varieties are more resistant to certain diseases than others. Fungicide trials are rated for disease a few weeks after bloom when symptoms are visible. Jim Adaskaveg is trying to molecularly identify the powdery infecting almond.

A Carmel variety orchard on a 22 x 22 spacing was divided into 5 replications of 30 treatments in a RCBD. Treatments were applied with hand gun applicators delivering 150 gallons of spray solution per acre at 200 psi. Application dates are indicated at the end of the report. The orchard was periodically checked for the various target diseases. Powdery mildew developed and was evaluated on July 13 2009. Percent incidence and severity were rated. Data was arcsin transformed for mean separation and back transformed for reporting purposes.

Results and Discussion:

Percent incidence: the least incidence of powdery mildew was exhibited by the following: Scala 12.8 fl oz at timing 1 followed by USF2016A 4 fl oz at timing 2&4 rotated with Rovral at 1 pt mixed with R11 at timing 3; Adament at 4 oz; YT669 at 8 and 15 fl oz mixed with Syl-Tac; LEM17 at 19.2 oz mixed with YT669 at 7.7 fl oz and Syl-Tac; Lime sulfur at 4 gallons or Vangard 75 oz mixed with Syl-Tac at timing 1 followed by Laredo 12.8 fl oz mixed with Induce. These treatments were not significantly different from the following: USF2016A 4 fl oz; TopsinM76 DF 1 lb mixed with Ziram 6 lb and Dyne-Amic at timing 1 & 2, followed by Penncozeb 8 lb mixed with Dyne-Amic; Topsin 1 lb mixed with Ziram 4 lb and Dyne-Amic at timing 1 followed by Tebuzol 8 oz mixed with Dyne-Amic at timing 2 followed by Ziram 8 lb mixed with Dyne-Amic; Quash 5 fl oz mixed with Induce at timing 1,3,4 rotated with Abound 12.8 fl oz mixed with Dyne-Amic; A15909 14 fl oz mixed with Dyne-Amic; Indar 6 fl oz mixed with Kinetic at timing 1& 2, followed by Dithane75DF mixed with Kinetic at timing 3&4, followed by Quintec 7 fl oz mixed with Kinetic or Vangard 7.5 oz at timing 1 followed by Pristine 14.5 oz at timing 2 & 4 rotated with Laredo 12.8 fl oz mixed with Induce. All treatments provided significantly less incidence of powdery mildew on the nuts than the UTC which exhibited 48 to 55 percent incidence.

Percent Severity: Scala 12.8 fl oz at timing 1 followed by USF2016A 4 fl oz at timing 2&4 rotated with Rovral at 1 pt mixed with R11 at timing 3; Adament at 4 oz; YT669 at 8 and 15 fl oz mixed with Syl-Tac; LEM17 at 19.2 oz mixed with YT669 at 7.7 fl oz and Syl-Tac; Lime sulfur at 4 gallons or Vangard 75 oz mixed with Syl-Tac at timing 1 followed by Laredo 12.8 fl oz mixed with Induce. These treatments were not significantly different from the following: TopsinM76 DF 1 lb mixed with Ziram 6 lb and Dyne-Amic at timing 1 & 2, followed by Penncozeb 8 lb mixed with Dyne-Amic; Topsin 1 lb mixed with Ziram 4 lb and Dyne-Amic at timing 1 followed by Tebuzol 8 oz mixed with Dyne-Amic at timing 2 followed by Ziram 8 lb mixed with Dyne-Amic; Quash 5 fl oz mixed with

Induce at timing 1,3,4 rotated with Abound 12.8 fl oz mixed with Dyne-Amic; A15909 14 fl oz mixed with Dyne-Amic; Indar 6 fl oz mixed with Kinetic at timing 1& 2, followed by Dithane75DF mixed with Kinetic at timing 3&4, followed by Quintec 7 fl oz mixed with Kinetic or Vangard 7.5 oz at timing 1 followed by Pristine 14.5 oz at timing 2 & 4 rotated with Laredo 12.8 fl oz mixed with Induce. All treatments exhibited significantly less severity of powdery mildew than the UTC except Indar 6 fl oz at timing 1 only which exhibited 29% severity and Vangard 7.5 oz mixed with SylTac at timing 1 followed by one application of Laredo 12.8 fl oz mixed with Induce which was actually significantly higher for powdery mildew than the UTC. It appears that powdery mildew treatments at full bloom or petal fall are not effective treatments, however, applications after petal fall at 2, 5, at 7 weeks after petal fall, provide excellent control of powdery mildew in almonds. Research will continue to determine the best timing of application and the best rotation of materials for effective, economical powdery mildew control in almond.

Recent Publications:

Fungicides are grouped into their respective chemical classes and rated against each other for their efficacy to control certain diseases at a particular stage in bloom development. Information from fungicide trials are incorporated into the UC IPM publication “Efficacy and timing of fungicides, bactericides, and biologicals for deciduous tree fruit, nut, strawberry, and vine crops” http://www.ipm.ucdavis.edu that is published every year.

Adaskaveg, J., Gubler, D., Michailides, T., Holtz, B. 2009. Efficacy and timing of fungicides, bactericides, and biologicals for deciduous tree fruit, nut, strawberry, and vine crops. UC IPM publication, http://www.ipm.ucdavis.edu

Holtz, B. A. and T.M. Martin-Duvall. 2007. Evaluation of fungicides for control of brown rot on almond, 2006. Plant Disease Management Reports 1:STF005, APSnet, St. Paul, MN, http://www.plantmanagementnetwork.org/.

Holtz, B. A. and T.M. Martin-Duvall. 2007. Evaluation of fungicides for control of shot hole on almond, 2006. Plant Disease Management Reports 1:STF006, APSnet, St. Paul, MN, http://www.plantmanagementnetwork.org/.

Holtz, B. A. and T.M. Martin-Duvall. 2007. Evaluation of fungicides for control of powdery mildew on almond, 2006. Plant Disease Management Reports 1:STF009, APSnet, St. Paul, MN, http://www.plantmanagementnetwork.org/.

Table 1. Fungicide applications from petal fall to 7 weeks after petal fall vs. powdery mildew-like symptoms.

Treatments, products per acre, treatment timings a, b, c, d, or e	% Incidence	% Severity
Vangard 75WG 7.5 oz + SylTac 6.4 fl oz (a); Laredo EW 12.8 fl oz + Induce 24 fl oz (b,c)	0.0 h	0.0 k
Lime Sulfur 4 gal (a,b,c,d)	0.0 h	0.0 k
DPXLEM17 19.2 fl oz + DPXYT669 7.7 fl oz +Syl-Tac 6.4 fl oz (a,b,c,d)	0.0 h	0.0 k
DPXYT669 2.08SC 15.4 fl oz + Syl-Tac 6.4 fl oz (a,b,c,d)	0.0 h	0.0 k
DPXYT669 2.08SC 8 fl oz + Syl-Tac 6.4 fl oz (a,b,c,d)	0.0 h	0.0 k
Adament 50WG 4 oz (a,b,c,d)	0.0 h	0.0 k
Scala SC 12.8 fl oz (a);USF 2016A 4 fl oz (b,d); Rovral 4F 1 pt + R11 48 fl oz (c)	0.0 h	0.0 k
Vangard 75WD 7.5 oz +Syl-Tac 6.4 fl oz (a); Pristine 38WDG 14.5 oz (b,d); Laredo EW 12.8 fl oz + Induce 24 fl oz (c,e)	0.2 gh	0.2 jk
Indar 2F 6 fl oz + Kinetic 9.6 fl oz (a,b); Dithane 75DF 6 lb + Kinetic 9.6 fl oz (c,d); Quintec 2.08SC + Kinetic 9.6 fl oz (e)	0.2 gh	0.2 jk
A15909 14 fl oz + Dyne-Amic (a,b,c,d)	0.2 gh	0.2 jk
Quash 2WDG 5 fl oz + Induce 4 fl oz (a,c,d); Abound 2.08SC 12.8 fl oz + Dyne-Amic 4 fl oz (b)	0.2 gh	0.2 jk
TopsinM 70WDG 1 lb + Ziram 76DF 6 lb + Dyne-Amic 4 fl oz (a); Tebuzol 8 oz + Dyne-Amic 4 fl oz (b); Ziram 76DF 8 lb + Dyne-Amic 4 fl oz (c,d)	0.2 gh	0.2 jk
TopsinM 70WDG 1 lb + Penncozeb 75DF 6 lb + Dyne-Amic 4 fl oz (a,b); Penncozeb 75DF 8 lb + Dyne-Amic 4 fl oz (c,d)	0.2 gh	0.2 jk
USF 2016A 4 fl oz (a,b,c,d)	0.41 fgh	3.22 i
Indar 2F 6 fl oz + Kinetic 9.6 fl oz (a); Indar 2F + Dithane F45 4 lb + Kinetic 9.6 fl oz (b); Dithane F45 6 lb + Quintec 2.08SC + Kinetic 9.6 fl oz (c,d) 7 fl oz; Quintec 2.08SC 7 fl oz + Kinetic 9.6 fl oz (e)	1.55 efg	7.84 gh
Microthiol Disperss 80WDP 15 lb (a,b,c,d)	1.82 efg	7.89 gh
Pristine 38WDG 14.5 oz (a,b,c,d)	1.82 efg	4.98 hi
Inspire Super 14 fl oz + Dyne-Amic 4 fl oz (a,b,c,d)	2.37 def	16.05 ef
Microthiol Disperss 80WDP 10 lb (a,b,c,d)	2.37 def	8.27 gh
Vangard 75WD 7.5 oz +Syl-Tac 6.4 fl oz (a); Laredo EW 12.8 fl oz + Induce 24 fl oz (b)	4.73 cde	45.86 a
TopsinM 70WDG 1 lb + 415 Oil 1.5 gal (a); Tebuzol 8 oz + Dyne-Amic 4 fl oz (b); Ziram 76DF 8 lb + Dyne-Amic 4 fl oz (c,d)	5.87 cd	17.86 de
TopsinM 70WDG 1 lb + Ziram 76DF 6 lb + Dyne-Amic 4 fl oz (a,b); Ziram 76DF 6 lb + Dyne-Amic 4 fl oz (c,d)	5.87 cd	10.26 g
DPXLEM17 14 fl oz (a,b); DPXLEM17 14 fl oz + Manzate Pro-Stick 5.3 lb (c,d)	5.87 cd	23.57 cd
Quash 50WG 2.5 oz + Induce 4 fl oz (a,c,d); Abound 2.08SC 12.8 fl oz +Dyne-Amic 4 fl oz(b)	6.08 cd	10.32 g
DPXLEM17 14 fl oz (a,b,c,d)	7.81 c	11.12 fg
Vangard 75WD 7.5 oz +Syl-Tac 6.4 fl oz (a); Laredo EW 12.8 fl oz + Induce 24 fl oz (b,c,d)	8.65 bc	6.98 gh
DPXLEM17 20 fl oz (a,b,c,d)	14.72 b	16.48 e
Indar 2F 6 fl oz (a)	14.86 b	29.64 bc
UTC 1 (Water Control)	48.00 a	35.67 b
UTC 2 (Water Control)	55.00 a	36.61 b

a = full bloom timing, February 27, 2009, target pest brown rot
b = petal fall timing, March 18, 2009, shot hole and brown rot
c = 2 weeks past petal fall, April 13, 2009, scab and powdery mildew
d = 5 weeks past petal fall, April 30, 2009, scab and powdery mildew
e = 7 weeks past petal fall, May 20, 2009, powdery mildew