MANAGEMENT OF ALTERNARIA AND BOTRYOSPHAERIA BLIGHTS

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A. Alternaria Late Blight.

Alternaria late blight caused by *Alternaria alternata*, *A. tenuissima*, and *A. arborescens*, continues to be a major disease in California pistachio orchards that have prolonged periods of dew and high relative humidity. The widespread development of strobilurin-resistant isolates of these fungi has resulted in the greatly reduced effectiveness of several fungicides in this class. Several disease forecasting models have been developed for Alternaria diseases in other crops. The objectives of the 2006 study were: 1) test new fungicide treatments for control of Alternaria late blight; 2) to monitor resistance development in *Alternaria* isolates under varying fungicide applications, and 3) to evaluate the potential of the DSV and Alter-Rater models to predict late blight development and assist in timing fungicide sprays to control this disease.

The efficacy trial showed that the most effective treatment was three sprays of Pristine®. Other effective treatments, listed in order of effectiveness, were three sprays of Endura®, Vanguard® at the 10 oz/acre rate, CGA169374, Scala™, Gem™ alternated with Scala™), four sprays with different combinations of Topsin®, Pristine®, Echo®, and Cuprofix®. LEM17 shows some promise in controlling this disease. As was the case last year, disease control with Endura™ (boscalid) was nearly the same as that of Pristine® (pyraclostrobin and boscalid). This fact, along with the poor efficacy of sprays consisting of strobilurins alone (Abound® (Trt 12) and Gem™ (Trt 14), is further evidence of the decline of Alternaria late blight control with strobilurin fungicides.

The DSV model showed more promise in predicting Alternaria late blight than did the Alter-Rater model. There was a positive relationship between disease incidence on shoots with fruit and cumulative DSV values. We observed that cumulative DSV values were in the range of 75 to 150 when disease incidence was moderate to severe while cumulative DSV values were near zero when disease incidence was very light. On the other hand, we observed a negative relationship between cumulative Alter-Rater scores and disease incidence. We observed daily increases in the Alter-Rater points of about 2.7-3.2 for the three orchards with moderate to severe late blight symptoms, and observed rates of 1.9 and 2.6 for the two orchards with light symptoms. The DSV model, which only considers leaf wetness and temperature, appears to predict the development of Alternaria late blight symptoms on pistachio better than the Alter-Rater model, which also considers rain fall events. The pattern of accumulation of DSV values was fairly similar to that observed 2005. However, the date when late blight symptoms developed on the leaves was quite different in 2005 and 2006. In general, disease symptoms developed on average about 23 days later in 2006. This was approximately the difference between bloom date and harvest date for these two seasons. Thus it appears that disease development is strongly influenced by the age of the leaves, and that this factor must somehow be incorporated into the development of the DSV model. The Florida model-based sprays at either 100 (three sprays) or 150 point intervals (two sprays) and the DSV-based sprays relying on 10 unit increase in the 7-day DSV (three sprays) resulted in the best control. The DSV-based spray relying on the 14 unit increase in the 7-day DSV (one spray) was not significantly different from the unsprayed control. At this point, we cannot tell if the increased efficacy is due to strategically timed sprays or simply the number of sprays that the model thresholds called for.

Conclusions and Practical Applications

- ✓ Pristine®, Endura™, Vangard®, CGA169374, and Scala™ performed well in the 2006 efficacy trial. LEM17 (representing a different class of fungicides), which was evaluated separately, shows some promise.
- ✓ The Disease Severity Value (DSV) model seemed to predict Alternaria late blight better than the Alter-Rater model. It was observed that symptoms of Alternaria late blight developed about three weeks (23 days) later in 2006 than in 2005, which approximated the delay in bloom in 2006 compared to 2005. Sprays using the various thresholds of these models showed that those based on the Alter-Rater's 100 or 150 scores and on the DSV's 10 unit increase in the 7-day DSV performed the best.
- ✓ In general, symptoms of Alternaria late blight appeared earlier and higher incidence of disease developed on leaves of shoots with fruit than in shoots without fruit.
- ✓ *Alternaria alternata* isolates highly resistant to Pristine® have been detected. The same isolates were cross resistant to pyraclostrobin and boscalid, the two component of Pristine®. The fact that no cross-resistance relationship exists between the two active ingredients in Pristine® among the majority of the *Alternaria* isolates lead us to conclude that resistance to Pristine® in *A. alternata* occurs via a case of multiple resistance.
- ✓ Despite the development of resistance to pyraclostrobin, Pristine® still remains effective against Alternaria late blight disease in most cases since the majority of *Alternaria* isolates in the orchards are still sensitive to boscalid, the second fungicide component of the Pristine® mixture.
- ✓ However, a risk of resistance development among *Alternaria* populations to boscalid fungicide exists, particularly in orchard sprayed frequently with Pristine®, leading to the selection of boscalid/pyraclostrobin resistant subpopulations.
- ✓ Frequent treatments could result in an increase of the isolates that display this double phenotype and may eventually result in failure of disease control.
- ✓ Thus, incorporation of anti-resistance strategies to avoid the selection and the development of these resistant isolates should be considered. These strategies include avoiding the use of strobilurins where resistance has been detected and, in order to prolong the useful life of boscalid fungicide in the mixture Pristine®, the use of this fungicide must be combined and alternated with fungicides having different mode of action.

B. Botryosphaeria and Botrytis Blights.

The best performing fungicides for controlling panicle and shoot blight were all strobilurins or treatments either including strobilurins in the spray schedule or formulations of fungicides containing strobilurins along with a second active ingredient in a different fungicide class. The most consistently effective treatment, when assessing cluster blight on the tree or blighted fruit after harvest, was three sprays of Pristine® (pyraclostrobin and boscalid). USF 2010 (trifloxystrobin and tebuconazole), was essentially as effective. Other effective fungicides included three sprays of a tank mix of Gem™+Scala™, three sprays of Gem™, three sprays of Rovral®, and three sprays of Abound®. Treatments which consisted of four sprays of Topsin® or Topsin® and Echo® 720 at bloom, followed by Pristine®, the Echo® 720+Cuprofix® 40, and Pristine®, were also quite effective. Of a total of 60 *B. dothidea* isolates collected from treatments that included strobilurins in our Glenn County efficacy trial, 10% had a loss of sensitivity to Abound®. For instance, more than 50% of the conidia of these isolates germinated in media amended with 10 ppm azoxystrobin, but none of the germinated spores were able to produce a viable colony when transferred on media lacking the chemical. From a total of 100 *B. dothidea* isolates collected from commercial orchards, 21% of isolates had this loss of sensitivity to azoxystrobin (Abound®). This loss of sensitivity in the 2006 isolates of *B. dothidea* is similar to that determined in a previous study in 2004. No resistance to Pristine® was detected in any of these isolates collected in 2006.

Bud break of pistachios was late by about two weeks in 2006. Thus, the few rain events after bud break meant that there were few infection events by *Botryosphaeria* in 2006. So disease incidence was low in our experiment evaluating early season rain event sprays and temperature threshold based sprays. When the disease incidence on the trees was recorded, all spray treatments proved more effective than the unsprayed control ($P < 0.05$); but when the fruit samples collected at harvest were recorded for disease incidence, these results showed that the grower’s spray and the 20-hour above 90°C threshold sprays provided more consistent control, while the “rain event” spray and the 40- or 60-hour above 90°C threshold were somewhat less effective. Most likely, the greater effectiveness of the 20-hour temperature threshold (five sprays) and the grower’s spray schedule (four sprays) is explained by the fact that each of these treatments included one spray just prior to the May 19 and 21 rains, in addition to three or four other sprays. The single early rain event spray was applied just after this rain event.

A tank mix of Topsin® and Echo® 720 was most effective at controlling symptoms of Botrytis blight on the female flower clusters. Next in effectiveness was USF 2010. Slightly less effective were Pristine® and V-10116 with or without V-10135. We observed a decrease in efficacy with Topsin® when sprayed with a 50:50 mixture of sensitive and resistant isolates compared with sensitive isolates alone. Topsin® did not significantly prevent infection of clusters in this test when 50% of the *Botrytis* isolates were resistant to this fungicide. Of the 164 *Botrytis cinerea* isolates isolated from pistachio buds in 14 orchards in 2006, 64% were resistant to Topsin®. However, there were no reports that Topsin® did not work well in controlling the disease in growers’ fields.

Conclusions and Practical Applications

- ✓ The two most effective fungicide treatments were the premixes Pristine® and USF2010.

- ✓ The growers spray schedule (four sprays) and the 20-, 40-, and 60-hour temperature threshold sprays (five sprays, 3 sprays, and 2 sprays, respectively) were equally effective and very comparable to the one spray based on the rain event.

- ✓ Botrytis blossom and shoot blight was most effectively controlled by the tank mix of Topsin® and Echo® 720, and by the premixes USF2010 or Pristine®.

- ✓ We determined that 64% of *Botrytis cinerea* isolates were resistant to thiophanate-methyl (Topsin®) and there was a high degree of cross resistance to benomyl and thiophanate-methyl. We observed a decrease in efficacy with this fungicide when sprayed on clusters inoculated with a mixture (50%:50%) of sensitive and resistant isolates of *Botrytis cinerea*, but no failure of the fungicide was reported in growers fields in 2006.

- ✓ A low percentage of *B. dothidea* population showed a loss in sensitivity to azoxystrobin (Abound®), similar to that observed in 2004. No truly resistant isolates could be detected though, since the germinated spores in the presence of Abound® failed to develop viable colonies. No resistant isolates of *B. dothidea* to Pristine® were detected either.