Virginia Wine Board
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Annual Report - July 2016

Evaluation of Powdery Mildew Quinoxyfen Resistance and Assessment of Variability of Grape Downy Mildew Sensitivity to Fungicides

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Objectives

1. Determine the frequency and geographic extent of quinoxyfen (Quintec) resistance (QR) of grape powdery mildew
2. Characterize QR isolates with respect to survival and competitiveness
3. Continue to collect grape downy mildew isolates from vineyards with histories of heavy phosphite fungicide use, and immediately assay their sensitivity to phosphite fungicide.
4. If resistance or reduced sensitivity is found, determine its stability by periodically assaying and comparing isolates maintained on treated as well as untreated plants.
5. Maintain the capability to conduct analyses of potential cases of resistance to at-risk fungicides, such as mandipropamid (Revus), fluopicolide (Presidio), and mefenoxam (Ridomil) for downy mildew, and boscalid (Endura, Pristine) for powdery mildew.

Activities and Results

Powdery Mildew – Quinoxyfen (objectives 1 and 2)

Two field tests were conducted in the summer of 2015 at a commercial vineyard in western Virginia, where quinoxyfen-resistant isolates had been discovered in 2013 and 2014. The objective was to determine to what extent quinoxyfen can still contribute to the control of powdery mildew, in light of a statement on the FRAC website that in Europe in the presence of adapted isolates "Field performance is not affected when the products have been used according to label recommendations" (FRAC AZN Working Group 2011 Minutes). One trial was set up in two rows of Chambourcin; the other trial was located in a row of Pinot noir. The trial consisted of five treatments, which included treatments with/without quinoxyfen, or contained quinoxyfen only as part of the control scheme. Each treatment replicated four times. For control of downy mildew and black rot, spray program supplemented with 0.4% Prophyt +1 lb/A mancozeb (early sprays) or 0.4% Prophyt+10.4

oz/A Abound (late sprays, powdery and downy mildew at this location were QoI resistant).

Powdery mildew development in the Chambourcin plots was not sufficient to acquire valid disease severity rating on July 28 (14 days after the previous application) and Aug 12 (15 days after the last application). A foliar rating at September 5 (53 days after last spray) is summarized in Table 1. None of the differences were statistically significant.

Table 1. Foliar powdery mildew infection, Chambourcin, September 5, 2015, 53 days after the last anti-powdery mildew spray.

Treatment and per acre rate	Leaf infection %
1 Control	0.31
2 Vivando, 10.3 fl oz	0.38
3 Rally, 3 oz rotated with Endura 4.5 oz + Sulfur 1 lb	0.12
4 Quintec, 4 fl oz	0.22
5 Quintec, 4 fl oz + Rally, 3 oz rotated w Endura 4.5 oz + Sulfur 1 lb	0.13

None of the differences were statistically significant (Tukey's HSD)

In Pinot noir plots (Table 2), a cluster rating was conducted on July 14 (after three treatment applications), with the result showing that all treatments still provided good control. However, a foliar rating on Aug 12 (15 days after the last application), showed significantly more powdery mildew in the Quintec plots than in the other fungicide treatments.

Four hundred and two (402) powdery mildew isolates were sampled and bioassayed to determine the sensitivity to Quintec in 2015. Of these, 253 were resistant. The mean resistance frequency in non-Quintec vines was 49%, while the resistance frequency in Quintec treated vines was 81%, indicating that a regular Quintec application clearly increased the frequency of the Quintec resistance, as would be expected. For comparison, the mean resistance frequency was 63% in 2014. The resistance frequency was maintained at a fairly stable level for the whole 2015 season.

Table 2. Powdery mildew infection of clusters and leaves, Pinot noir 2015.

	Cluster infection %, 7/14	Foliar colonies per 4-min search, 8/12	Leaf infection %, 8/23
1 Control	10.8 A	127.8 A	5.3 A
2 Vivando	0.1 B	0.1 C	0.0 C
3 Rally/Endura+Sulfur	1.1 B	1.3 C	0.1 C
4 Quintec	1.7 B	35.3 B	2.9 B
5 Quintec+Rally/Endura+Sulfur	0.5 B	1.1 C	0.1 C

Data not followed by the same letter are significantly different (Tukey's HSD).

7/14 cluster infection: 30 clusters per plot evaluated separately by two evaluators

8/12: foliar colonies were counted in a 2-minute search by two evaluators, one on each side of the row

8/23: leaf infection as percent of berry cluster surface, two evaluators, one checking 50 leaves per plot, the other 15 leaves per plot.

In the 2016 season, a new field trial has been set up in the same vineyard in western Virginia. The purpose is to confirm to what extent quinoxyfen still controls powdery mildew in a situation where half of the powdery mildew population consists of resistant isolates. The trial was set up in two rows of Pinot noir vines. The trial consists of ten treatments, comparing different quinoxyfen application times, different numbers of applications and in combination with different other fungicides (Table 3). Early-season powdery mildew development has been very light at this location. We also included several anti-downy mildew treatments in this trial, as described below

In 2015, powdery mildew isolates were collected at two vineyards close to the field trial site. One vineyard was about 5 miles to the west, and the other one was about 10 miles to the northeast of the QR vineyard. These isolates were acquired on "sentinel" Chardonnay vines stationed at each of these locations. Among four "sentinel plants", two were sprayed with 10 ppm quinoxyfen on a regular basis and the remaining two were non-treated controls. These plants were visited at a 2-week interval and checked for powdery mildew. Among 19 isolates tested, 13 were able to grow on Quintec-treated leaves; 1 of these QR isolates was collected from a non-treated plant, while 12 resistant isolates were collected from treated plants.

Powdery mildew isolates collected as part of this research have been grown and increased in isolation cultures, to be used for genomic DNA sequencing in a search for markers of fungicide resistance, as described in the report for Project #15-1662-01

Downy Mildew – Phosphite (objectives 4 and 5)

In the above-mentioned powdery mildew trial in 2015, we used Prophyt, a phosphite fungicide for downy mildew control. It was used at 0.4% in early applications, and increased to 0.5% (highest label rate) in late July when downy mildew was discovered not well controlled. Despite the consistent application, the trial rows experienced a severe downy mildew outbreak after four applications. Isolates collected from these vines were able to grow on leaf tissue treated with higher rates than our "standard" isolates, but

results are still incomplete on how much higher. These less sensitive isolates are being maintained on 0.2% Prophyt-treated potted grape plants for future research. In order to determine the downy mildew control efficacy of Prophyt in comparison with other "standard" treatments, we have included several Prophyt treatments in the 2016 field trial mentioned above (Table 3).

Table 3. Treatments in 2016 field trial, each replicated four times

Treatment	Description	
	Powdery mildew control	Downy mildew control
T1	PM control	Prophyt/Revus
T2	4 Quintec early	Mancozeb/Captan/Revus
T3	2 Quintec early	3 Prophyt early
T4	2 Quintec middle	3 prophyt late
T5	4 Quintec early	6 Prophyt
T6	2 Quintec late	3 Prophyt early
T7	Vivando	DM control
T8	Aprovia	Mancozeb/Captan/Revus
T9	4 Quintec early	3 Prophyt early
T10	2 Quintec middle	3 Prophyt early

Downy mildew isolates have also been grown in leaf cultures to build up sufficient DNA for genomic DNA sequencing in a search for markers of fungicide resistance, as described in the report for Project #15-1662-01

Publications

Colcol, J.F. and Baudoin, A. B. 2016. Sensitivity of *Erysiphe necator* and *Plasmopara viticola* in Virginia and nearby states to QoI fungicides, boscalid, quinoxyfen, thiophanate methyl, and mefenoxam. Plant Disease 100: 337-344

Feng, X. and Baudoin, A.B. 2016. Quinoxyfen resistance frequency and effect on powdery mildew control in a resistance-affected vineyard. 2016 Potomac Division Meeting Phytopathology 106: S3.2 (Abstr.)