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Disease evaluation of selected cold climate wine grape cultivars in Vermont, USA

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Abstract: Cold climate wine grape production is a "new" crop in the diversification of agriculture in Vermont and other northern states. In the past, commercial wine grape production was not recommended in the colder regions of the USA because of problems with winter survival of the vines. However, cold climate wine grape cultivars are now available which survive -34 °C to -37 °C winter temperatures. In addition to cold hardiness, these interspecific hybrids were bred for disease resistance and potentially may require less overall fungicide use to produce high quality fruit. Few research studies have been conducted to determine their relative disease susceptibility and fungicide requirements. The purpose of this study was to compare disease incidence and severity during the 2010-2012 growing seasons among a selection of wine grape cultivars planted at the University of Vermont vineyard which included: Frontenac, La Crescent, St. Croix, Marquette, Prairie Star, Corot Noir, Vignoles, and Traminette. During each growing season, all cultivars received the same fungicide treatments totaling four to five applications each year. The following fungicides were applied either alone or in combination: mancozeb, mycobutanil, kresoxim-methyl, and captan. At the end of each growing season, disease incidence and severity were determined by examining 20 randomly selected leaves per plot and by visually assessing ten randomly selected fruit clusters per plot. Diseases that were assessed included: powdery mildew (*Erysiphe necator*); downy mildew (*Plasmopara viticola*); black rot (*Guignardia bidwellii*); *Phomopsis* leaf spot and fruit rot (*Phomopsis viticola*); angular leaf scorch (*Pseudopezicula tetraspora*); and anthracnose (*Elsinoe ampelina*). Powdery mildew was the most prevalent disease and was observed on the foliage of all cultivars in each year. Frontenac or Prairie Star ranked the highest numerically in percent leaves infected but were not significantly different from some of the other cultivars. No powdery mildew was observed on any fruit in any year. Downy mildew was also observed only on foliage and not on any fruit over the three years of the study. In 2010 and 2011, the highest foliar incidence was observed on Vignoles; in 2012, the highest foliar incidence was observed on La Crescent vines although Vignoles vines (and Traminette vines) were removed from the study at the beginning of the 2012 growing season and were no longer part of the study. *Phomopsis* foliar symptoms were not observed in any year but fruit rot symptoms were observed in 2010 and 2012. In 2012, Frontenac had the highest incidence and severity, followed by Marquette. Black rot, angular leaf scorch and anthracnose were either not observed or at very low incidence during the three growing seasons. In summary, differences in disease incidence and severity among the cultivars were observed for some diseases. Future research which allows for comparison of multiple fungicide programs during a growing season is needed to determine the innate disease resistance/susceptibility of these cultivars and how best to incorporate this knowledge into effective disease management programs that address economic, health, and environmental concerns.

Key words: grape diseases, cold climate wine grape cultivars

Introduction

Cold climate wine grape production is a rapidly emerging "new" crop in the diversification of agriculture in Vermont and other northern states offering significant value-added and agri-tourism economic opportunities. In the past, commercial wine grape production was not recommended in the colder regions of the USA because of problems with winter survival of

the vines. However, cold climate wine grape cultivars such as those developed by the University of Minnesota breeding program (University of Minnesota, 2012) and a private breeder from Wisconsin (Smith, 2006) are now available commercially. These wine grape cultivars survive -34 °C to -37 °C winter temperatures (Smiley *et al*., 2008) and are being planted in Vermont on newly created farms or as an alternative crop on existing farms. In addition to cold hardiness, these interspecific hybrids were bred for disease resistance and potentially may require less overall fungicide use to produce high quality fruit. However, little research has been conducted to determine their relative disease susceptibility and fungicide requirements.

The purpose of this research was to compare disease incidence and severity during the 2010-2012 growing seasons among a selection of cold climate wine grape cultivars planted in the University of Vermont vineyard and managed using an integrated pest management approach (Berkett, 2009).

Material and methods

The vineyard at the University of Vermont Horticulture Research Center, South Burlington, Vermont, USA (44° 28'N 73° 12'W; Elev. 71 meters) was planted in 2007 using a randomized complete block experimental design of six blocks with four-vine plots of each of the following cultivars per block: Frontenac, La Crescent, St. Croix, Marquette, Prairie Star, Corot Noir, Vignoles, and Traminette. The first five cultivars are considered cold climate cultivars, whereas Corot Noir, Vignoles, and Traminette are considered "cool" climate cultivars which were included for comparison. The vineyard is part of multi-state USDA research projects (NE-1020 and NIFA-SCRI Northern Grapes Project) to evaluate wine grape cultivars (Burr, 2004; Martinson, 2011). The vineyard site represents the coldest winter and coolest growing season conditions of any of the NE-1020 sites in the eastern USA. The vines are trained to a high-wire cordon system. Just before the 2012 growing season, Vignoles and Traminette vines were removed because of poor viticultural performance.

During each growing season (2010-2012), environmental conditions were monitored with an on-site Davis Vantage Pro Wireless Weather Station (Davis Instruments Corp., Hayward, CA). Environmental conditions and information on the critical periods to manage grape diseases were integrated to determine the need to apply fungicides during each growing season. Selection of specific fungicides was based on efficacy, spectrum of activity, and resistance management considerations. All cultivars received the same fungicide treatments totaling four applications in 2010 and five applications in both 2011 and 2012. The following fungicides were applied either alone or in combination at standard label rates: mancozeb (Manzate 75 DF, Griffin LLC, Valdosta, GA), mycobutanil (Rally, Dow AgroSciences LLC, Indianapolis, IN), kresoxim-methyl (Sovran, BASF Corp, Research Triangle, NC), and captan (Captan 80 WDG, Drexel Chemical Co., Memphis, TN). All applications were applied with a Rears Pul-Blast 300 Airblast Sprayer (Rears Manufacturing, Inc., Eugene, OR) calibrated to deliver 935 liters per hectare at 1.035 MPa pressure. Standard insecticide and nutritional sprays were uniformly applied to all cultivars during each growing season.

Disease incidence and severity on fruit clusters were determined by visually assessing ten randomly selected clusters per four vine plot at the time each cultivar was harvested. Foliage disease incidence and severity were determined by examining 20 randomly selected leaves per plot collected between 11-14 Sept each year. The Horsfall-Barrett scale was used to rate disease severity (area infected) on clusters and foliage. Diseases that were assessed included: powdery mildew (*Erysiphe necator*); downy mildew (*Plasmopara viticola*); black rot

(*Guignardia bidwellii*); *Phomopsis* leaf spot and fruit rot (*Phomopsis viticola*); angular leaf scorch (*Pseudopezicula tetraspora*); and anthracnose (*Elsinoe ampelina*). Cultivar data were compared using an analysis of variance (PROC GLM) with significance level of 0.05 (SAS Version 9.2; SAS Institute, Cary, NC). If the overall F-test was significant, pairwise comparisons were performed using Tukey's HSD test. Data in the form of proportions were transformed using the arcsine square root transformation and analyses were performed on the transformed data.

Results and discussion

Powdery mildew was the most prevalent disease and was observed on the foliage of all cultivars in each year (Table 1). Frontenac or Prairie Star ranked the highest numerically in percent leaves infected but were not significantly different from some of the other cultivars. In general, powdery mildew severity appeared higher in 2012 which was probably related to favorable weather conditions in that season. No powdery mildew was observed on any fruit in any year.

Downy mildew was also observed only on foliage and not on any fruit over the three years of the study (Table 1). In 2010 and 2011, the highest foliar incidence was observed on Vignoles; in 2012, the highest foliar incidence was observed on La Crescent vines. No downy mildew symptoms were observed on Frontenac during the study.

Phomopsis foliar symptoms were not observed in any year but fruit rot symptoms were seen in 2010 and 2012 (Table 1). In 2012, Frontenac had the highest incidence and severity, followed by Marquette.

Black rot, angular leaf scorch and anthracnose were either not observed or at very low incidence during the three growing seasons.

In summary, although all vines were treated the same, there were differences in foliar incidence and severity among cultivars for powdery mildew and downy mildew, and for *Phomopsis* fruit rot which may reflect the cultivars' relative susceptibility to these diseases. It is important to note that no powdery or downy mildew was observed on any fruit although foliar incidence was high on some cultivars. On average, eight fungicide applications annually are typical for *Vinifera* and French hybrid grapes in the region (Weigle *et al*., 2003). In this study, only four or five fungicide sprays were applied. Because of vineyard restrictions, there were no non-sprayed plots to determine natural levels of disease and therefore, it cannot be determined with certainty whether the fungicide program was effective against black rot, angular leaf scorch or anthracnose or whether disease did not develop because inoculum was not present and/or conditions were not favorable for infection. These diseases have been observed in vineyards in Vermont, with Frontenac, La Crescent, Marquette, and St. Croix considered to be highly susceptible to black rot and La Crescent, Marquette, and Vignoles rated as highly susceptible to anthracnose (Berkett, 2011). *Phomopsis* leaf spot symptoms have also been observed in Vermont vineyards (Berkett, non-published) although the cultivars grown in the state generally are not considered highly susceptible to the disease (Berkett, 2011). Future research that incorporates non-sprayed plots and allows for comparison of multiple fungicide programs during a growing season is needed to determine the innate disease resistance/susceptibility of these cultivars and how best to incorporate this knowledge into effective disease management programs that address economic, health, and environmental concerns.

Table 1. Comparison of incidence and severity of powdery mildew, downy mildew, and *Phomopsis* symptoms, 2010-2012.

Powdery Mildew*												
	2010				2011				2012			
	Foliage		Cluster		Foliage		Cluster		Foliage		Cluster	
Cultivar	% Inc.**	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.
Corot Noir	55.83 ab	2.05 bcd	0.00	0.00	46.67 ab	2.52 ab	0.00	0.00	54.17 c	8.97 b	0.00	0.00
Frontenac	85.00 a	14.70 a	0.00	0.00	77.50 a	7.52 a	0.00	0.00	81.67 ab	13.09 ab	0.00	0.00
LaCrescent	47.50 b	4.33 bc	0.00	0.00	52.50 ab	3.40 ab	0.00	0.00	59.17 bc	13.53 ab	0.00	0.00
Marquette	56.67 ab	3.40 bc	0.00	0.00	42.50 bc	1.85 b	0.00	0.00	67.50 bc	7.80 b	0.00	0.00
Prairie Star	57.50 ab	3.80 bc	0.00	0.00	53.33 ab	2.87 ab	0.00	0.00	94.17 a	28.47 a	0.00	0.00
St. Croix	58.33 ab	6.63 b	0.00	0.00	36.67 bc	1.33 b	0.00	0.00	53.33 c	4.75 b	0.00	0.00
Traminette	5.83 c	0.14 d	0.00	0.00	10.83 c	0.79 b	0.00	0.00	.	.	.	.
Vignoles	12.50 c	0.66 cd	0.00	0.00	45.83 ab	2.32 b	.	.	.	.	.	.
Downy Mildew*												
	2010				2011				2012			
	Foliage		Cluster		Foliage		Cluster		Foliage		Cluster	
Cultivar	% Inc.**	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.
Corot Noir	34.17 b	5.75 b	0.00	0.00	75.00 b	13.33 b	0.00	0.00	47.50 b	6.78 ab	0.00	0.00
Frontenac	0.00 c	0.00 c	0.00	0.00	0.00 c	0.00 c	0.00	0.00	0.00 c	0.00 c	0.00	0.00
LaCrescent	0.00 c	0.00 c	0.00	0.00	0.83 c	0.02 c	0.00	0.00	79.17 a	9.14 a	0.00	0.00
Marquette	0.00 c	0.00 c	0.00	0.00	0.83 c	0.02 c	0.00	0.00	0.00 c	0.00 c	0.00	0.00
Prairie Star	0.00 c	0.00 c	0.00	0.00	1.67 c	0.10 c	0.00	0.00	0.00 c	0.00 c	0.00	0.00
St. Croix	0.00 c	0.00 c	0.00	0.00	3.33 c	0.10 c	0.00	0.00	40.00 b	3.92 b	0.00	0.00
Traminette	1.67 c	0.06 c	0.00	0.00	0.00 c	0.00 c	0.00	0.00	.	.	.	.
Vignoles	92.50 a	12.70 a	0.00	0.00	95.00 a	21.22 a	.	.	.	.	.	.
Phomopsis*												
	2010				2011				2012			
	Foliage		Cluster		Foliage		Cluster		Foliage		Cluster	
Cultivar	% Inc.**	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.	% Inc.	% Area Inf.
Corot Noir	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 c	0.00 b
Frontenac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.67 a	5.88 a
LaCrescent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67 c	0.08 b
Marquette	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.33 b	0.82 b
Prairie Star	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00 c	0.12 b
St. Croix	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67 c	0.04 b
Traminette	0.00	0.00	2.00	0.05	0.00	0.00	0.00	0.00	.	.	.	.
Vignoles	0.00	0.00	8.33	0.23	0.00	0.00	.	.	.	.	.	.

*Values represent the mean from 6 replicate four-vine plots per cultivar of 20 leaves or 10 clusters per plot. Disease severity (area infected) was rated using the Horsfall-Barratt scale and converted to percentages using the Elanco conversion tables. Means followed by the same letters within columns are not significantly different according to Tukey's Studentized Range (HSD) Test ($p \leq 0.05$).

**Inc.= Incidence; Inf.= Infected

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