

Report for 2007 research  
**Improving Wine Grape Production in Acid Soils with Rootstocks and Soil Management**

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**Objectives**

1. Viticulture: Evaluate the interaction of rootstock and soil pH on the vegetative and reproductive growth and juice quality of two *V. vinifera* and two hybrid scion varieties.
2. Mineral Nutrition: Measure the vine tissue nutrient concentrations at bloom and veraison on the different scion, rootstock, and soil pH treatment combinations and develop tissue sampling protocols and management guidelines for the mineral nutrition of highly weathered, acidic soil, cool climate vineyards.
3. Education: Develop and deliver educational information on best management viticulture practices for wine grape production in the Lake Erie Grape Belt and similar production areas. Introduce Lake Erie growers to the materials, methods, and science of wine grape and wine production.

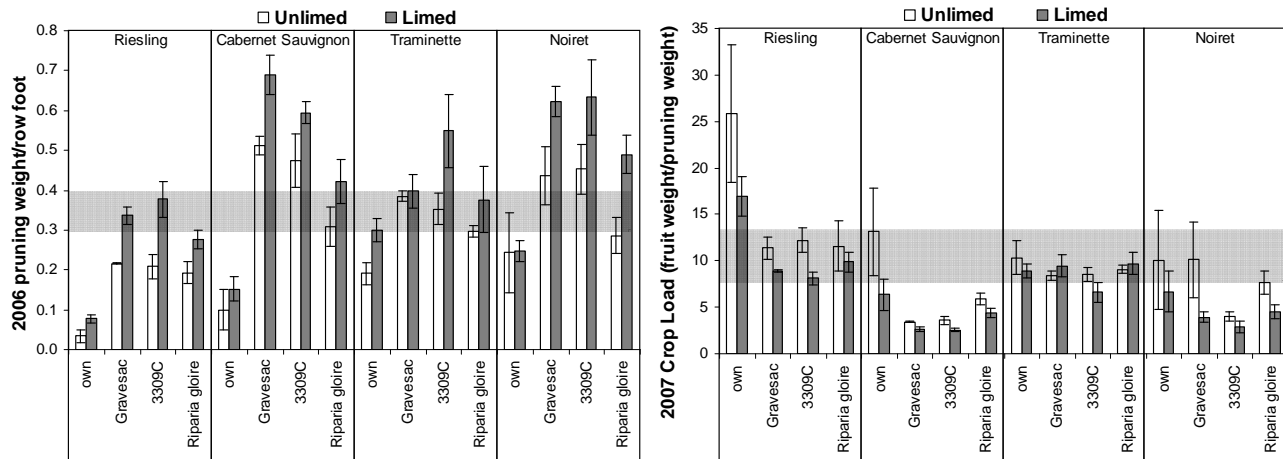
**Experimental treatment factors**

The experiment is a 4 x 4 x 2 factorial with four randomized replicate blocks and either six (hybrids) or eight (*V. vinifera*) vines per block. This factorial was planted in 2003 at the Fredonia Vineyard Lab.

4 Scion varieties:	white vinifera red vinifera white hybrid red hybrid	'White Riesling' clone 239 'Cabernet Sauvignon' clone 8 'Traminette' 'Noiret'
4 Rootstocks/systems	ownrooted deep rooting acid tolerant shallow rooting	'C3309' 'Gravesac' 'Riparia Gloire'
2 Soil conditions	untreated limestone	soil pH 5.0-5.5 soil pH 6.0-6.5

**Results**

Soils in the Lake Erie grape region are generally strongly acidic which can lead to vine mineral nutrient imbalance, poor root growth, and inadequate vine size. The primary purpose of this experiment is to measure the effect of soil pH and rootstock selection on vine growth and nutrient health. The premise being that a healthy and appropriate sized canopy for the spacing/training system is the first half of crop load (leaf area : fruit weight) and a pre-requisite for quality fruit production. Crop size or the variation of crop size with pruning or crop thinning is the second half of crop load and will also influence fruit quality. However, crop size was conservatively maintained with respect to variety so that the influence of treatments on canopy growth and health as well as subsequent juice quality could be measured.



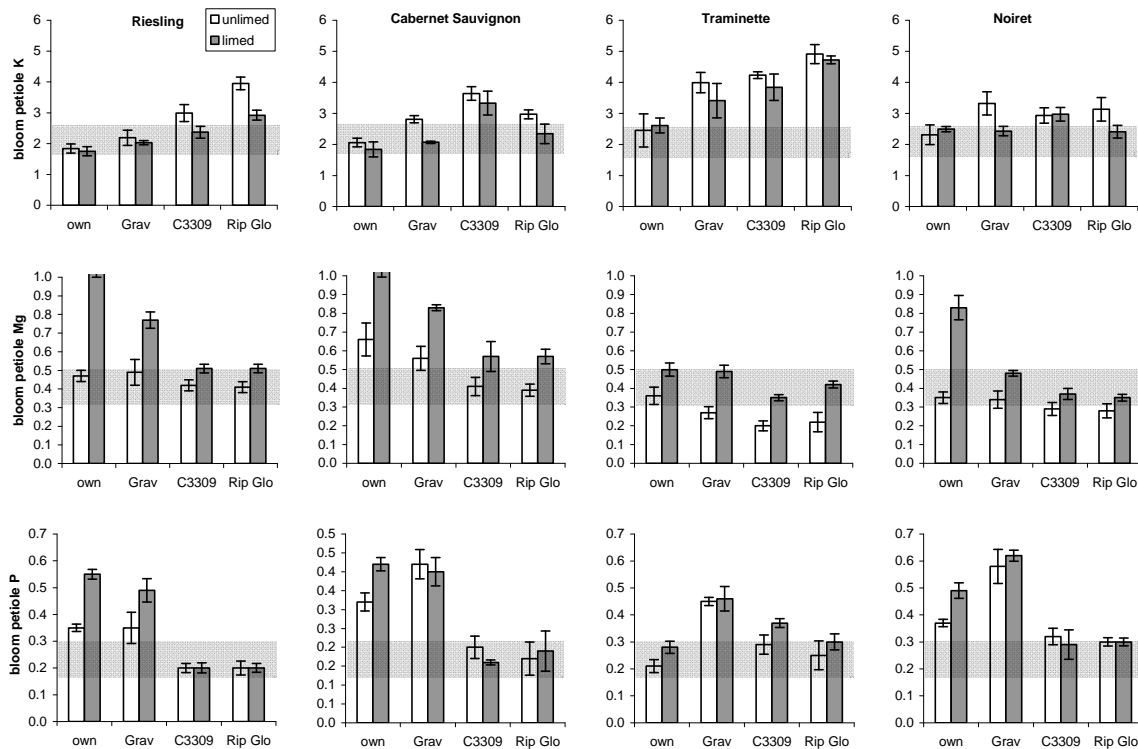
**Figure 1: The effect of variety, rootstock, and soil pH on vine size (left) and crop load (right) in 2007** (each bar is the mean of four block  $\pm$  st. error). All vines were trained to low wire cordon with vertical shoot positioning and pruned to 4 shoots/row foot. The *V. vinifera* were 9 foot row by 6 foot vine spacing and the hybrids were 9 foot row and 8 foot vine spacing; therefore, the vine size data is expressed as pruning weight per row foot. Optimum vine size for this system should be approximately 0.35 pounds/row foot (indicated by shaded box). For crop control, Riesling was thinned to 2 clusters/shoot, Cabernet was thinned to 1 cluster/shoot, and the hybrids were not thinned. Optimum crop load varies with variety and growing region; however, general crop load values around 10 should be appropriate for the Lake Erie region. Lower values indicate under-cropping and larger values indicate over-cropping.

**Riesling:** Riesling tended to have the lowest vine size of the four varieties at comparable treatments. Rootstock and soil pH both had an effect on vine size. Limed-Gravesac and limed-3309C vines were in the target range for vine size. In addition, the 2 clusters/shoot crop level gave adequate crop load. Limed-Riparia vines were close to the target vine size but the devigorating effect of Riparia held back vegetative growth compared to Gravesac and 3309C. This was measured in all varieties. Unlimed vines had smaller vine size and own-rooted *V. vinifera* continued to perform poorly.

**Cabernet Sauvignon:** Treatment effects on Cabernet Sauvignon were similar to Riesling; however, the overall vine size for Cabernet was higher. Therefore, different treatments hit the target vine size. Limed-Gravesac and limed-3309C were too large for the single-wire VSP. Unlimed vines on Gravesac and 3309C had lower vine size but also had leaf nutrient deficiencies (3309C more severe than Gravesac). Limed-Riparia vines had healthy leaves and near optimum vine size. Cabernet Sauvignon vines were crop adjusted to 1 cluster/shoot which contributed to the low crop load values. Yield on Cabernet Sauvignon was approximately 4 tons/acre and because it is late ripening, the lower crop load was arguably appropriate.

**Traminette:** Traminette showed similar treatment patterns to the *V. vinifera* but with one exception. Own rooted Traminette had near optimum vine size especially under good nutrient management.

**Noiret:** Noiret had the largest vine size. Own rooted vines and vines grafted to Riparia came the closest to the target vine size. Noiret was also a low producer for the given vine size leading to low crop load values. In general, Noiret was too large on this site for single-wire VSP and would benefit from canopy division.

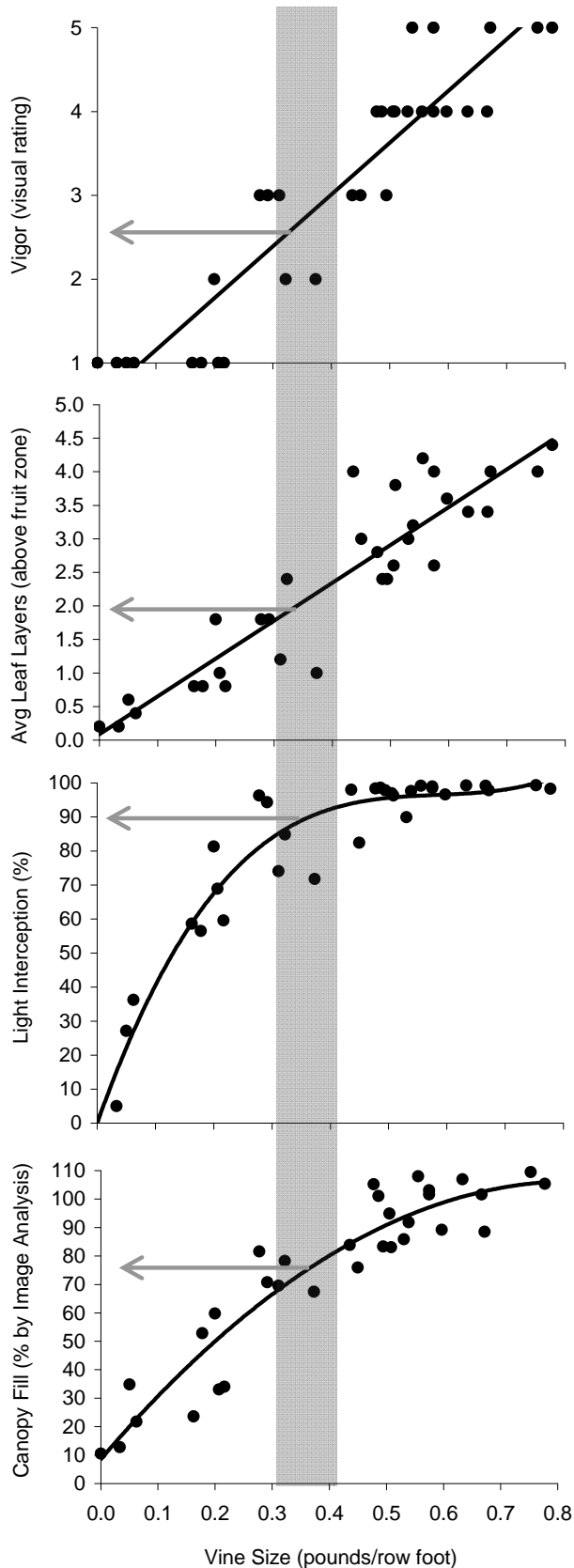


**Figure 2: The effect of variety, rootstock, and soil pH on bloom petiole K, Mg, and P.** (Each bar is the mean of 4 blocks  $\pm$  st. error, shaded box indicates target values). Bloom petioles and leaf blades as well as veraison petioles were collected from each variety, rootstock, and soil pH combination for mineral nutrient analysis. Bloom petioles appeared to be the best indicator of vine nutrient status and were used for this report. There were three major observations in 2007 which were also seen in 2006. (1) Increasing soil pH with limestone decreased petiole K and increased petiole Mg (typically leading to better nutrient balance). (2) Gravesac rootstock had higher P and Mg compared to 3309C and Riparia gloire (showing its usefulness in acid soils). (3) Traminette had higher K and lower Mg values than the other varieties (making it more susceptible to acid soil conditions).

### Canopy Assessment:



**Figure 3: Cabernet Sauvignon canopy series.** Treatments had an effect on vine size (fig 1) and subsequent canopy size. The images were all taken on the same day and show the range of canopy growth from inadequate (left) to over-vigorous (right). Five canopy measurements were taken and compared to add quantitative measurements to the visual observations in the field.



**Figure 4: The relationship between vine size and vigor, leaf layer, light interception, and canopy fill (from top to bottom) in Cabernet Sauvignon.** (Each point is the mean of six count vines). As expected, there was a positive relationship between vine size and all canopy measurements (see correlation table). Visual observations and point quadrat canopy analysis (leaf layers) were relatively easy, needed no specialized equipment, and had fairly linear relationships with vine size (see appendix for methods used). Light interception just above the fruit zone had a positive relationship with vine size until the vines became relatively large (0.5 pounds/row foot) or dense (3 leaf layers), at which point 100% of the photosynthetically active radiation (PAR) was being intercepted by the canopy (just above the fruit zone). Canopy fill by digital image analysis was relatively more labor intensive (more on the computer than in the field) but gave more information about a larger section of the canopy (4 foot wide x 4 foot tall). In general, a target vine size of 0.35 pounds/row foot corresponded to a 3 vigor rating, 2.0-2.5 leaf layers, 80-90% light interception, and 75-80% canopy fill. Figure 1 indicates which treatments hit the target.

**Correlation coefficients of the five canopy measurements taken in 2007.**

	Vigor	Leaf Layer	Light Inter	Vine Size	Image Analysis
Vigor	1.000	0.896	0.808	0.927	0.911
Leaf Layer		1.000	0.818	0.916	0.876
Light Inter			1.000	0.844	0.908
Vine Size				1.000	0.930
Image Analysis					1.000

**Wine:** With the persistence of treatment effects from the viticulture portion of this experiment, experimental wines are being produced from treatment sub-sets and evaluated to determine if soil pH or rootstocks have an effect on wine sensory attributes.

2006 Harvest: Wine was produced in Fredonia on all four varieties, two rootstocks (3309C and Riparia gloire) and two soil H (limed and unlimed). Fermentations were not replicated. Finished wine samples were sent to Dr. Andrew Reynolds at Brock University for sensory analysis.

2007 Harvest: As part of the NY Wine and Grape Foundation's Total Quality Focus program, wine was produced from Riesling and Traminette (at Geneva V&B Lab) and Cabernet Sauvignon (at Fredonia Lab) on two rootstocks (3309C and Riparia gloire) and two soil H (limed and unlimed). Fermentations were replicated (3X). Finished wines will be sent to Dr. Andrew Reynolds at Brock University for sensory analysis.

2008 Harvest: For the final year of the experiment, we will propose through the TQF program to produce wine from all treatment combinations for sensory analysis.

**Tasting notes from 2006 wine:** The following are informal and preliminary tasting notes from the 2006 vintage. The sensory differences were large enough to pursue further investigation. As indicated, 2007 wine was fermented in triplicate lots and will be subject to scientific sensory evaluation at Brock University.

3309C rootstock on high soil pH: In general, the vines were over-vigorous and the wines were the least characteristic and produced the least favorable wine in the group. For example, the Riesling was described as having good acidity but was dilute in aroma and flavor with a poor finish. There were similar descriptors for Cab and Noiret.

3309C rootstock on low soil pH: In general, these vines were less-vigorous and had leaf nutrient deficiencies but tended to have the overall best wine notes. The Riesling was described as having good aroma and best fruit complexity with flavors of peach and grapefruit and a slight mineral finish. The Cab had the best balance between fruit and tannin and the Noiret had a good balance between fruit and pepper with a hint of smoke.

Riparia rootstock both high and low soil pH: The riparia treatments tended to fall between the two 3309C treatments. The wine had good characteristics but was always missing something. For example, the Riesling on riparia-high soil pH had good pineapple aroma and a nutty taste but lacked complexity when compared to the others. The Riesling on riparia-low soil pH had the highest fruit character (grapefruit/lemon zest/peach) but had no mineral finish.

**Conclusion:** Understanding the interaction of wine grape variety with vineyard soil characteristics and rootstock selection will help vineyard managers control canopy quantity (vine size) and quality (leaf nutrient deficiencies) to improve vine health and juice quality. The interactions of variety, rootstock, and soil pH in this study have yielded dramatic differences in vine size and vine nutrient health. Preliminary wine notes also indicate noticeable sensory differences in the wine – despite conservative crop load management across varieties. 2008 will be the last year for this study and activities will focus on root excavations and wine evaluation in addition to the base viticulture project.

## Appendix

### Improving Wine Grape Production in Acid Soils with Rootstocks and Soil Management

Terence Bates

**Appendix Table 1:** 2007 Viticulture data from the variety, rootstock, soil pH factorial at the Cornell Vineyard Laboratory in Fredonia, NY. Values are the means of four blocks. \* and \*\* indicate significance at 0.01 and 0.001, respectively.

Variety	soil pH	rootstock	2006 Pruning		2007 yield (tons/acre)	crop load (crop wt/pr wt)	juice soluble solids (°Brix)	clusters (number/vine)	cluster weight		berry weight (g)
			Weight (pounds/row foot)						(g)	berries/cluster	
Riesling	Unlimed	own rooted	0.03		1.5	25.9	17.9	35.8	36.9	34.3	1.1
		Gravesac	0.22		4.4	11.4	18.8	50.9	97.5	67.7	1.4
		C3309	0.21		5.3	12.2	17.8	56.3	103.3	68.3	1.5
		Riparia Gloire	0.19		4.9	11.6	17.8	55.1	99.2	71.7	1.4
			0.08		3.0	16.9	15.8	49.8	64.9	58.7	1.1
	Limed	own rooted	0.34		6.5	8.9	17.4	60.8	119.7	79.0	1.5
		Gravesac	0.38		6.5	8.1	17.5	63.5	115.8	75.8	1.5
		C3309	0.28		6.0	9.9	16.3	57.5	118.0	79.6	1.5
		Riparia Gloire									
		rootstock		*	**	*	*	*	**	*	**
		soil pH		**	**	*	**	*	**	*	**
	rootstock x soil pH										
Cabernet Sauvignon	Unlimed	own rooted	0.10		0.9	13.1	23.1	14.6	64.2	61.0	1.0
		Gravesac	0.51		3.8	3.4	23.1	31.1	139.2	109.4	1.3
		C3309	0.48		3.7	3.6	22.4	30.0	139.6	104.1	1.3
		Riparia Gloire	0.31		3.9	5.9	23.0	31.0	143.2	107.2	1.3
			0.15		1.7	6.4	21.8	19.1	100.7	99.6	1.0
	Limed	own rooted	0.69		4.1	2.7	22.7	31.8	148.3	112.9	1.3
		Gravesac	0.59		3.3	2.5	22.1	29.2	128.5	93.6	1.4
		C3309	0.42		3.9	4.4	22.2	30.0	147.3	109.5	1.4
		Riparia Gloire									
		rootstock		*	**	*	*	**	**	*	**
		soil pH		*	**	*	**	*	**	*	**
	rootstock x soil pH										
Traminette	Unlimed	own rooted	0.19		4.2	10.3	21.9	52.3	115.6	76.6	1.5
		Gravesac	0.38		7.4	8.4	21.9	79.5	141.3	88.8	1.6
		C3309	0.35		6.2	8.6	22.3	77.9	119.1	75.8	1.6
		Riparia Gloire	0.30		6.0	9.1	22.9	70.3	126.9	81.6	1.6
			0.30		5.9	8.9	20.6	64.8	137.3	89.2	1.5
	Limed	own rooted	0.40		8.2	9.4	21.1	78.7	157.2	104.3	1.5
		Gravesac	0.55		7.9	6.6	21.2	80.3	148.8	90.6	1.6
		C3309	0.38		7.7	9.7	21.2	72.9	157.3	100.2	1.6
		Riparia Gloire									
		rootstock		*	**	*	*	**	**	*	**
		soil pH		*	**	*	*	**	**	*	**
	rootstock x soil pH										
Noiret	Unlimed	own rooted	0.24		2.1	10.1	20.7	33.3	82.7	51.5	1.6
		Gravesac	0.44		5.2	10.1	19.6	58.6	133.5	75.9	1.8
		C3309	0.45		3.7	4.0	20.3	50.4	111.7	64.8	1.7
		Riparia Gloire	0.29		4.7	7.7	20.5	55.2	129.4	74.9	1.7
			0.25		2.9	6.7	19.9	40.9	100.4	60.8	1.7
	Limed	own rooted	0.62		5.4	3.9	19.3	60.6	135.8	80.6	1.7
		Gravesac	0.63		3.7	2.9	19.8	48.6	114.3	67.0	1.7
		C3309	0.49		5.0	4.5	19.7	51.3	146.6	81.2	1.8
		Riparia Gloire									
		rootstock		*	**	*	*	**	**	*	**
		soil pH		*	**	*	*	**	**	*	**
	rootstock x soil pH										

**Appendix Table 2:** 2007 canopy measurements taken and compared on Riesling, Cabernet Sauvignon, Traminette, and Noiret grapevines at the Cornell Vineyard Lab in Fredonia, NY. Data for Cabernet Sauvignon are presented in Figure 4 of the main report.

Measurement	Method
Vigor	Visual observation of canopy size between veraison and harvest (9/17/2007). Canopies were rated on a 1-5 scale. <b>Pro:</b> fast and inexpensive. <b>Con:</b> Subjective and relies on the experience of the individual.
Leaf Layer	Average leaf layer derived from point quadrat analysis. PQA was done by inserting a thin metal rod perpendicular to the canopy just above the fruit zone (x) times along a (y) distance of row. <b>Pro:</b> fast and inexpensive. <b>Con:</b> only gives a measurement of canopy density above the fruit zone.
Light Interception	% light interception calculated from the comparison of ambient light from the row center with canopy light measured with an AccuPar light bar meter. The canopy measurement was taken by inserting the light bar into the canopy, parallel with the row, and just above the fruit zone. <b>Pro:</b> fast and easy.

	<b>Con:</b> requires special equipment and (like leaf layer) only gives a measurement in a portion of the canopy.
Vine Size	Pruning weight per row foot calculated from dormant cane pruning weight measurements from each count vine collected in the winter. <b>Pro:</b> old standard to address vine vegetative growth. <b>Con:</b> labor intensive in the winter
Image Analysis	Digital photos of canopy growth taken between veraison and harvest are analyzed with Photoshop software to determine canopy fill. <b>Pro:</b> gives quantitative information on a larger portion of the canopy and has a high potential for automation and GPS/GIS. <b>Con:</b> the method is still being developed and currently requires the user to have an interest and knowledge of computer image analysis.

**Appendix Figure 1:** 2006 and 2007 Berry curve (20 days after bloom to harvest), juice soluble solids, juice pH, and juice TA (veraison to harvest) of four varieties on limed soil and grafted to 3309C rootstock.

