Annual report to Virginia Wine Board
August 2008

Title: Optimized grape potential through root system and soil moisture manipulations

Principal Investigator: Tony K. Wolf

Award amount: $20,679

Objectives:

1) Evaluate the impact of complete ground cover vs. under-trellis weed control, three rootstocks, and three root manipulation techniques as means of regulating the vegetative/reproductive balance of Cabernet Sauvignon clone #337 (VA site)
2) Evaluate cover crop species and root pruning to impose water stress on Cabernet Sauvignon vines (NC site)

Progress:

Vine on left was planted in a root-restriction bag to constrict vegetative vine development. Vines are in second season in the vineyard.

Objective #1: Cabernet Sauvignon, clone #337 was planted and trellis constructed as described in FY 2007 first quarter report (30 September 2006). Progress since then includes routine vineyard management (pruning, early season vine training, pest management, etc.). Vines have made excellent growth and trellis construction was completed spring 2007. Soil moisture probe access tubes (12) were installed in June 2007. Border vines (Petit Manseng) were planted in guard rows and buffer plots in May 2007. The growth suppression afforded by root-restriction bags was evident by mid-summer of 2007 (Photo to left). Irrigation components were purchased and main line was installed in September 2007. The individual dripper lines were installed in the spring of 2008. Under-trellis cover crops, where appropriate for treatment are established.

Graduate student Tremain Hatch commenced data collection on a portion of this project during the 2008 growing season. Extensive data were collected on vine shoot growth rate, canopy development, vine water status and photosynthetic performance, and data are currently being collected on fruit composition in advance of harvest.

Figure 2. Cabernet Sauvignon at Winchester, November 2007.

The Winchester Cabernet Sauvignon project has, within the first year of data collection, shown a very positive effect of (1) rootstock, (2) ground cover, and (3) root restriction on reducing superfluous leaf development in what is normally an over vigorous variety. We have achieved savings in terms of labor involved in shoot hedging, and labor involved in terms of breaking out lateral shoots from canopy fruit zones. A more detailed report in December 2008 will illustrate the effects on canopy architecture. We are currently in the process of evaluating the treatment effects on primary fruit chemistry (sugar, pH, TA and color density). Another graduate student is being brought into the project, in collaboration with Dr. Bruce Zoecklein, to conduct wine-making and to extend our evaluation of treatment effects on secondary fruit composition.

In sum, this project is on track with projected milestones.

Objective #2: The work of graduate student Gill Giese at Shelton Vineyards in Dobson, NC is proceeding as proposed. This project asks two very basic questions:

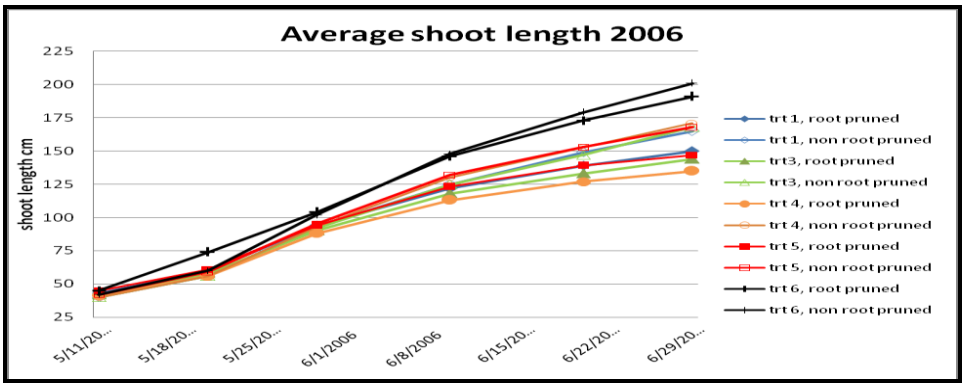
- Can the vegetative growth period and berry size of mature Cabernet Sauvignon grapevines be regulated with permanent, under-trellis cover crops or root-pruning?
- If so, do those responses translate to improved grape and wine potential quality?

This project is similar to that in Objective number 1 in that we're trying to alter the balance of vegetative growth and fruit. Ideally, we'd like vegetative growth of grapevines, particularly shoot extension, to cease at about the time of veraison. The continued vegetative growth of vines in the final ripening of the crop is often associated with "vegetal" character in wines from methoxypyrazines and other compounds that can be formed in young leaves. The continued vegetative development of vines also contributes to fruit rot problems and increased labor for trimming. We'd also like to produce grapes that have relatively small berries. Small berries have a greater surface-to-volume ratio than do large berries; small berries thus have greater concentrations of flavor and aroma compounds. Achieving smaller berries and restricted vegetative development might be possible by regulating the water available to vines by competition (under-trellis grass) or by root system restriction (root bags, root-pruning, or "size-restricting" rootstocks).

Multiple shoot growth measures among treatments in 2006 and 2007 revealed a reduction in the extent of shoot growth achieved by root pruning, as well as a reduction in shoot length/growth rate with several of the ground covers (Figure 1). The effects of root pruning and cover crops on restricting vegetative growth of these vines was pronounced in the early part of the season; however, the vines still required shoot hedging by mid-July in order to keep shoot tops from elongating to the point of shading the fruit zone of canopies.

Dormant season pruning weights were collected each winter and also showed that both root-pruning and cover crops were effective in reducing vine size. Vine pruning weights have been reduced by all ground covers over the three years that pruning weights have been measured (Figure 2); however, even the pruning weights of the herbicide control have decreased, particularly following the 2007 season. The reductions from 2006 to 2007 were likely due in part to the very dry conditions of 2007 at this site.

Berry weights and primary fruit chemistry were generally unaffected by treatments in either 2006 or 2007, although a slight reduction in berry weight (desirable) was observed with the root pruning treatments during 2007 (data not shown).



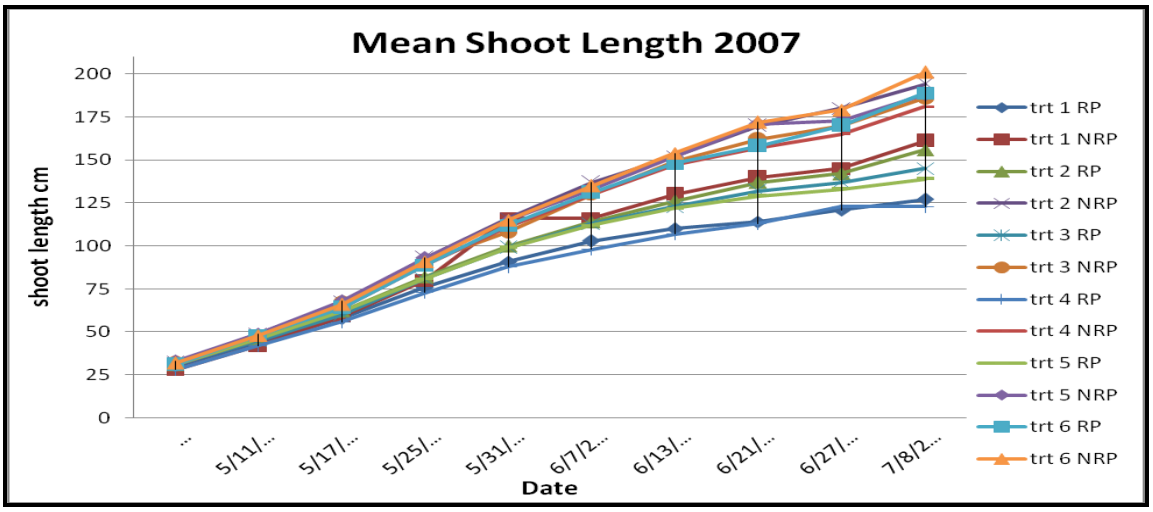


Figure 1. Shoot length as affected by cover crops (or no cover crops) under trellis and root-pruning (or no root pruning) at various times during the 2006 (upper) and 2007 (lower) growing seasons.

Legend for shoot growth figures:

Treatment #1: 'K-31' Fescue
Treatment #2: 'Aurora Gold' Fescue
Treatment #3: Perennial ryegrass
Treatment #4: Orchardgrass
Treatment #5: 'Elite-II' Fescue
Treatment #6: Herbicide strip (control)

"Bucket lysimeters" are used to quantify the loss of water due to evapotranspiration of the cover crop, relative to a bare soil (herbicide "control"). The buckets (5 gallon pails) are filled with vineyard soil and either planted to cover crop or not. They are embedded in the vineyard, flush with the soil surface and their weight is then monitored every few days to record water loss as a function of the cover crop. This system allows us to estimate how much soil moisture the cover crops are using from the soil profile. Data from the 2006 season are depicted in Figure 3. Note that, over time, the buckets planted to a cover crop (K-31 fescue) used more moisture (became lighter) than the non-planted buckets. This result is totally expected, but the data gives us the ability to actually calculate soil moisture use (in inches of moisture per acre), which is an important measure of evapotranspiration used in irrigation scheduling (Table 1)..

For example, in Table 2, we can see that in the period from 30 June to 5 July the buckets that were planted to K-31 fescue used an equivalent of 0.25 acre-inches of soil moisture, compared to only 0.08 acre inches for buckets without cover crop. Remember, we're trying to use soil moisture with the cover crops to reduce vegetative vigor of these vines.

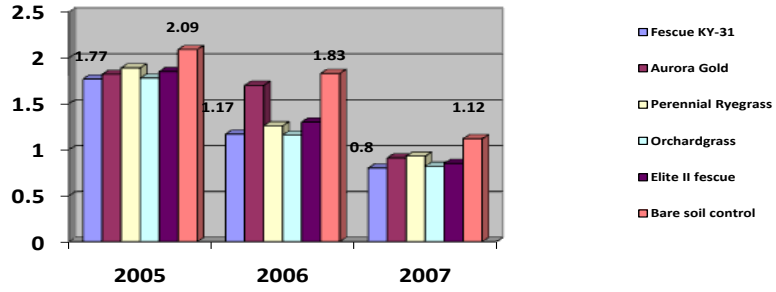


Figure 2. Effect of ground covers on mean pruning weights (root pruned or not) over the 3 year test period from 2005-2007.

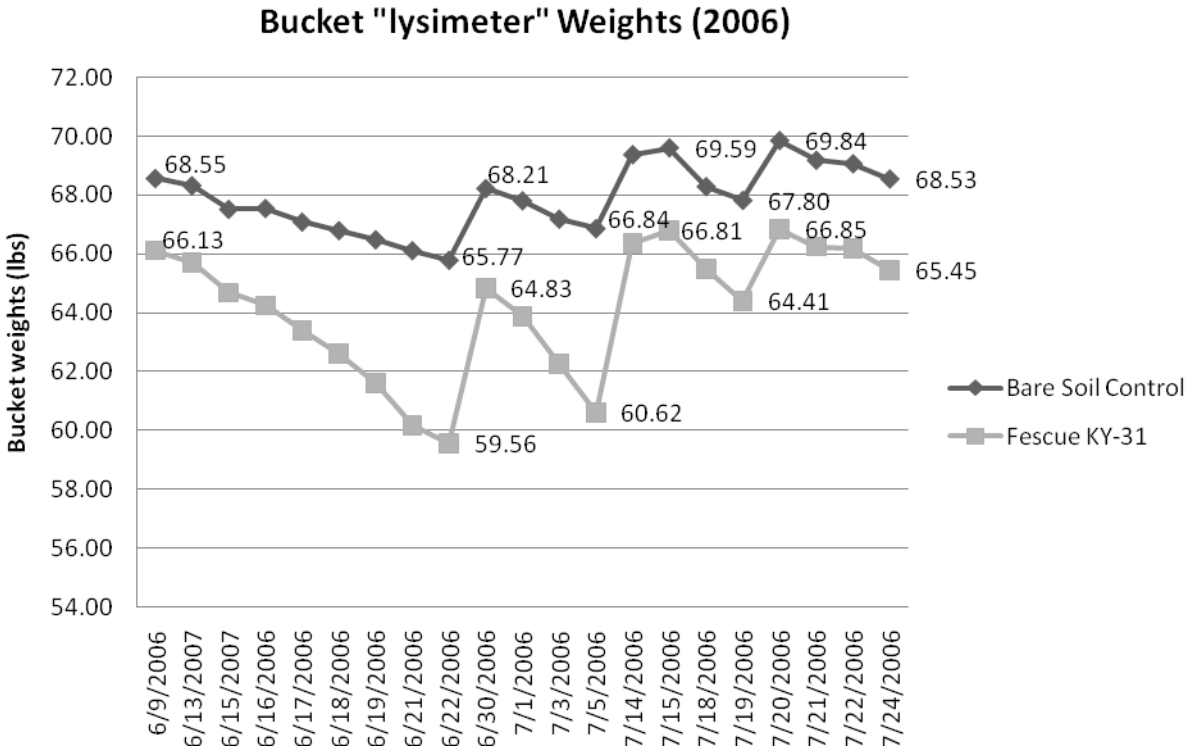


Figure 3. Depiction of the loss of water or reduction in weight of pails of soil either planted to a cover crop (Fescue, K-31) or not planted to cover crop (bare soil) and installed in the vineyard.

Table 1. Daily and periodic water weight loss (lbs) in Fescue KY-31 ground cover and herbicide strip control in inches per acre or mm of water loss per hectare, 2006.

Dry Down Period (days) Treatment	**Total * loss (lbs)**	**Daily ** Loss (lbs)**	**Total * Loss (mm)**	**Daily** Loss (mm)**	**Total loss (in)**	**Daily loss (in)**
6/9 to 6/22						
herbicide strip	2.78	.21	19.90	1.53	.78	.06
Fescue KY-31	6.57	.51	47.04	3.62	1.85	.14
6/30 to 7/5						
herbicide strip	1.37	.27	9.80	1.96	.39	.08
Fescue KY-31	4.21	.84	30.14	6.03	1.24	.25
7/15 to 7/19						
herbicide strip	1.79	.45	12.82	3.21	.50	.13
Fescue KY-31	2.40	.60	17.18	4.30	.68	.17
7/20 to 7/24						
herbicide strip	1.31	.33	9.38	2.36	.37	.09
Fescue KY-31	1.40	.35	10.02	2.51	.39	.09
Combined periods 6/9 to 7/24 (45 days)						
herbicide strip	7.25	.16	51.91	1.15	2.04	.05
Fescue KY-31	14.18	.32	101.53	2.26	4.00	.09

* total water loss collected as lbs is converted to total loss in mm using the conversion factor of approximately 7.16 mm equal to 1 lb of water loss

**daily water loss in lbs is converted to daily loss in mm using the conversion factor of 7.16mm per lb of water

Table 2 includes a rating of “stand density” or general performance of the cover crops during the 2007 and 2008 (early) seasons. The lower the stand density number, the better the competitive nature of the cover crop. All cover crops performed reasonably well with the possible exception of Aurora Gold fescue, with a stand density of 3.55 in 2008.

Table 2 Stand density rating* and biomass (dry weight) of ground cover treatments.

	2007		2008		
	Stand Density		Stand Density		
TREATMENT	Row Middle	Under Trellis	Row Middle	Under Trellis	Biomass weight (g)
Fescue KY-31	2.57b		2.48 bc	2.70 ab	12.16 a
Aurora GOLD	NA		4.59 a	3.55 a	7.62 ab
Perennial Ryegrass	3.55a		3.08 bc	2.86 ab	3.06 b
Orchardgrass	3.44a		3.33 b	3.30 ab	4.93 b
Elite II Fescue	2.88ab		2.67 bc	2.15 b	5.92 b
Herbicide strip control	NA		2.29 c	NA	NA

* numerical ranking ranging from 1 to 6, 1 = "perfect stand" with no plants present except the treatment cover crop and 6= >75 percent of area inspected occupied by non sown ground cover treatment species

[a b] Means in a column followed by the same letter are not different at $p < 0.05$.

NA= not available

Research papers were presented on this research at two meetings in July 2007:
- American Society for Enology and Viticulture/Eastern Section, 16-17 July, Fogelsville, PA
- Viticulture Research Forum, University of California, Davis, 17-19 July, Davis, CA

Mr. Giese will also present an update on this work at the VA Vineyards Association's annual technical conference in February 2008.

Summary: Project is on track. Growth suppression has been possible with cover crops or root-pruning. Effects on fruit chemistry and potential wine quality are still uncertain; however Mr. Giese's current research focus is addressing this question. A more detailed summary report will be provided in December 2008 for this ongoing project.