

## **Final Report** Northwest Center for Small Fruits Research 2004-2005 funding

**Title:** Water and nutrient competition with cover crops in Willamette Valley vineyards.

### **Principle Investigators:**

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### **Objectives:**

I. To evaluate the effects of five cover crop mixes on grapevine: a) water stress b) nutrient status c) fruit production and quality d) shoot growth e) mycorrhizal colonization.  
II. To evaluate cover crop mixes for their: a) establishment rate b) biomass production c) nutrient content.

### **Experimental Procedures:**

Seven cover crop treatments were applied at two commercial vineyards in the northern Willamette Valley (AS and JH) in the fall of 2003 and monitored for establishment and impact on vines in 2004 and 2005. Pinot noir grapevines (Pommard clone on 3309 rootstock) were grown at both sites (AS planted in 1994, JH planted in 2001). AS was planted at a density of 5123 vines ha<sup>-1</sup>, and JH was planted at 2690 vines ha<sup>-1</sup>. Treatments applied were: winter annuals (**WA**, oats, rye and vetch), clover mix (**CM**, subclovers, clovers and medic), native grass mix (**NGM**, Willamette Valley upland prairie species), native meadow mix (**NMM**, forbs plus grasses), perennial grass and clover mix (**PGCM**, sheep fescue, dwarf perennial rye, hard fescue, subclovers, clovers and medic), resident vegetation (**RV**), and a clean-cultivated control (**CC**). Each treatment was replicated four times at each site in a randomized complete block design. Treatments were applied to four adjacent alleys effecting 8 or 10 vines in three vine rows with one clean-cultivated border row dividing blocks.

Cover crop establishment was measured by taking digital photographs and by destructive sampling of biomass above 10 cm (mowing height) each time the vineyard was mowed according to the growers' practices. Weeds were sorted from cover crops, and both residues were dried and weighed. Weeds and cover crops from each plot were recombined to determine the total N content. Over the course of the growing season, soil moisture content was measured in the vine row and alleys with time domain reflectometry, and midday vine leaf water potential was measured with a pressure bomb. Shoot lengths were measured twice during the spring and early summer of each year, but one site was hedged in 2005 prior to the second measurement. Leaves and petioles were collected at bloom and veraison for nutrient analysis (N, P, K, S, Ca, Mg, Mn, Cu, B, Zn and Fe). N was determined by combustion analysis in all samples, but other nutrients were analyzed by ICP-OES at one site in 2005 only. Root samples were taken at bloom and post harvest to a 45cm depth in the vine row and alley in three treatments (WA, PGCM and CC) and analyzed for fine root length and arbuscular mycorrhizal fungi (AMF) colonization. Fruit yield was assessed at harvest, and grape juice was analyzed for soluble solids, titratable acidity, pH and yeast assimilable nitrogen content (YANC). Shoot prunings were collected and measured in the winter during vine dormancy.

Data were analyzed by ANOVA and/or nonparametric tests, as appropriate. ANOVA was conducted using site, year (or sample date), and cover crop treatment as factors allowing for all interactions. Site was designated as a random factor to allow for the widest possible application of our results to Willamette Valley vineyards, and Tukey's post-hoc test was used to compare means. Variables that violated assumptions of variance were analyzed using the Kruskal-Wallis (K-W) nonparametric test. Effects of site, year (or sample date), and cover crop treatment were independently evaluated. Potential interactions between these factors were evaluated by including all possible treatment combinations in an analysis. The CC treatment was excluded

from the analysis of cover crop establishment (biomass, % weeds, N content). Since prune weight and juice YANC data were missing from one site in one year, these variables were analyzed using year and cover crop treatment as factors at one site (AS) and using only cover crop treatment at the other site (JH).

### **Results and Discussion:**

Vegetation biomass, % weeds, and N content of vegetation above 10 cm were significantly affected by cover crop treatment (Table 1). WA and CM treatments both produced significantly more biomass than the NGM, NMM, and RV treatments, with the PGCM being intermediate between these cover crop treatments. The WA, CM and PGCM treatments significantly suppressed weeds as compared to the RV treatment, while NGM and NMM did not. The quantity of N contributed to the plots was also highest in the WA, CM and PGCM treatments. NGM and NMM were again not different from the RV treatment for the N content of mowed residues. Site did not influence any of the cover crop establishment variables, but year affected the proportion of biomass as weeds. The quantity of weeds was lower in 2005 compared to 2004. Analysis of all possible combinations of factors (site, year, cover crop) were significant for each of the variables shown in Table 1, but in no case was any individual cover crop treatment significantly different between sites or years. Cover crop treatment was clearly the most important factor in dictating the amount of biomass produced and the total N contributed to plots, producing a wide range of biomass and N among the different cover crops.

Cover crop treatments, including the clean cultivated control, had little effect on soil water content, vine water status, or vine vegetative growth (Table 2). The average soil moisture over all sample dates in the vine row was not influenced by cover crops, although soil moisture in the alley was slightly higher in WA and CM treatments as compared to the PGCM treatment. The clean cultivated treatment was not different from any cover crop treatment at either location (vine row or alley). The largest driving force for soil moisture was sample date, with both sites declining over the season in both the vine row and alley (data not shown). Analysis of all possible combinations of factors were significant for soil moisture in both the vine row and alley, but differences between cover crop treatments on different dates at both sites were very small (~2%) and inconsistent. Sample date was also the most important factor affecting vine water status. Midday leaf water potential declined at both sites over the summer, although JH developed much greater water stress than AS in both years (data not shown). Vines at JH are much younger than vines at AS. Cover crop treatment had no effect on vine leaf water potential (Table 2). Leaf N concentration was affected by cover crop treatment at veraison, but not at bloom. At veraison, leaf N concentration was significantly higher in the CM treatment, as compared to the WA and NGM treatments. Other treatments, including CC, were not different from CM, WA and NGM. Early season shoot growth of vines and prune weights collected after each season were unaffected by cover crop treatments (Table 2).

Fine root length of vines and the extent of fine roots colonized by AMF were not different among the CC, WA, or PGCM treatments in either the vine row or alley (data not shown). Site had a major influence on roots and AMF in the vine row. Root length was significantly greater in the older vines at AS, while colonization by AMF (both total and active) was significantly greater in the younger vines at JH (data not shown). Fine roots and AMF colonization in the alley soil was primarily influenced by year and sample date, with higher values in 2005 and higher values after harvest compared to bloom.

Cover crop treatments had only a minor influence on fruit yield and quality of Pinot noir grapes (Table 3). Yield, cluster weights, sugars, pH, and acids were not influenced by cover crop treatments in both vineyards. However, YANC at AS was significantly affected by cover crop treatment and an interaction between cover crop treatment and year. The mean values for both years combined are shown in Table 3 for purposes of brevity. Accounting for the significant interaction between treatment and year, YANC was significantly higher in the CM treatment in

2005 than in the NMM treatment in 2005 and the PGCM treatment in 2004 with all other treatments in either year intermediate between these groups. The effect of the CM treatment was not supported by data from JH in 2005. Juice YANC was not affected by cover crop treatment at JH vineyard in 2005 (the only year we had data for that site).

The overall results from this two year study indicate no apparent advantage to cultivating between the vine rows of established vineyards. Indeed, while the different cover crop treatments sometimes had effects on the vineyard (soil moisture in the alley, leaf N at veraison, juice YANC), there was no case where any of the cover crop treatments were significantly different from the clean-cultivated control or resident vegetation treatments. Both cultivation and resident vegetation treatments can be thought of as typical alternatives to the use of cover crops.

### **Significance to Industry:**

Cover crops had little measurable influence on the growth and fruit quality of Pinot noir grapevines at two Willamette valley vineyards with different soils, different vine densities, and different aged vines. This two year study conducted under fairly normal rainfall and temperature patterns for the region, showed very little competition between cover crops and vines for water or nutrients. Since a clean-cultivated control was used in this study, it can be concluded that use of cover crops will not interfere with growth or nutrient and water uptake of established Pinot noir grapevines when cover crops are mowed in the spring and summer. Therefore, advantages of using cover crops (like protecting soil from erosion, adding organic matter to soil, providing plant diversity in the vineyard) may be more important considerations than the potential disadvantage of competition with vines when growers evaluate the use of cover crops in Oregon vineyards. The long term affect of certain cover crops, including the clover mix we used, could result in the supply of too much N to vines and this aspect should be further examined.

### **Funding Sources:**

NCSFR and CRIS base funds.

### **Research Impact:**

This study evaluated whether different cover crop mixtures grown in the alleyways between rows of grapevines in western Oregon and managed by spring and summer mowing would compete with vines for water or nutrients. Competition was assessed by monitoring soil moisture, vine water status, vine nutrient status, and fruit quality of vines in seven different treatments including a clean-cultivated control, which represented the least possible competitive situation. Results showed minor differences to occur among different cover cropped treatments, but no difference was found between any cropped treatments and the clean-cultivated control. Based on these findings, there is no advantage to cultivating alleyways in Willamette Valley vineyards and exposing hillside vineyards to increased risk of soil erosion.

### **Citations:**

Sweet, R.M. 2006. Water and Nutrient Effects of Cover Crops on Two Willamette Valley Vineyards. M.S. Thesis, Oregon State University.

Sweet, R.M. and Schreiner, R.P. 2007. Alleyway cover crops have little influence on Pinot noir grapevines in two Oregon vineyards. In preparation for Amer. J. Enol. & Vitic.

**Table 1.** Total alleyway biomass, proportion of biomass attributed to weeds, and total N content of six cover crop treatments above 10 cm at the first seasonal mowing date in two N. Willamette Valley vineyards over two years. Values represent means.

Treatment	Biomass (kg ha <sup>-1</sup> )	Percent biomass as weeds (%)	Total N content (kg ha <sup>-1</sup> )
WA	2444 a	6 d	37 ab
CM	2051 a	18 cd	66 a
NGM	737 b	69 ab	15 bc
NMM	498 b	58 abc	22 bc
PGCM	1272 ab	47 bc	40 ab
RV	566 b	100 a	5 c
significance level	<0.001	<0.001	<0.001

Means within a column followed by the same letter are not significantly different (Kruskal-Wallis @ 95% confidence).

**Table 2.** Effects of cover crop treatments on vine and soil parameters in two N. Willamette Valley vineyards over two years. Values represent means.

Treatment	Soil Moisture (% vol.)		Leaf water potential (MPa)	Leaf N (% dry mass)		Shoot Length (cm)	AS Only <sup>1</sup> Prune weights (g)
	Vine row	Alley		Bloom	Veraison		
CC	20.6	19.1 ab	-0.97	3.22	2.21 ab	97	913 a
WA	20.1	21.4 a	-1.03	3.09	2.06 b	87	770 a
CM	20.8	20.9 a	-1.04	3.31	2.26 a	90	961 a
NGM	21.1	20.4 ab	-0.96	3.14	2.07 b	96	752 a
NMM	20.7	20.2 ab	-1.03	3.20	2.12 ab	93	856 a
PGCM	19.4	18.7 b	-1.03	3.24	2.10 ab	89	750 a
RV	nd	nd	-1.03	3.21	2.12 ab	93	845 a
# sample dates	10	10	7	2	2	3	2
significance level	0.094	0.002	0.584	0.709	0.028	0.176	0.021
Test	K-W	K-W	K-W	ANOVA	ANOVA	ANOVA	ANOVA

<sup>1</sup> Prune weights were unavailable at JH in 2005.

Means within a column followed by the same letter are not significantly different (Kruskal-Wallis or Tukey's @ 95% confidence).

**Table 3.** Effects of cover crop treatments on yield and fruit quality of Pinot noir in two N. Willamette Valley vineyards over two years. Values represent means.

Treatment	Yield (kg)	Cluster mass (g)	Soluble solids (°brix)	pH	Titratable acidity (g L <sup>-1</sup> )	AS Only <sup>1</sup>
						YANC (mg L <sup>-1</sup> )
CC	1.05	61	24.4	3.29	6.88	209
WA	1.02	57	24.4	3.32	6.48	202
CM	0.92	55	24.0	3.34	6.36	244
NGM	1.06	58	24.7	3.29	6.50	207
NMM	1.06	58	24.1	3.28	6.64	184
PGCM	1.09	59	24.4	3.24	6.64	167
RV	1.04	58	24.2	3.30	6.35	205
# sample dates	2	2	2	2	2	2
significance level	0.265	0.807	0.746	0.859	0.620	0.017
Test	ANOVA	ANOVA	K-W	K-W	K-W	ANOVA

<sup>1</sup> YANC was unavailable at JH in 2004.