Final Project Report

Vineyard Cover Crop Management in the North Willamette Valley: I. Effects of Cover Crop Management on Vine Vigor and Fruit Quality of Pinot Noir

Patricia A. Skinkis, Ph.D.

Summary

High vegetative vine growth (vigor) is common in the cool-climate viticulture region of the Willamette Valley of Oregon due to high spring soil moisture, high water-holding capacity of soils, and cool spring and summer growing conditions. Because irrigation cannot be used to manage vine growth and vigor, permanent grass grown between vine rows serve as one of very few tools to reduce vine vegetative growth. Perennial grass cover management was successfully used to reduce vine vegetative vigor and increase fruit quality of Pinot noir from 2007-2009. Three alley management regimes, including clean cultivated (C), alternate alley tillage (A), and solid cover (S) of an established perennial grass cover, were evaluated in two commercial Pinot noir vineyard sites in the Willamette Valley. Late-season irrigation was also evaluated within the treatments for one vineyard site. Vine growth parameters and soil moisture were monitored throughout the season. Vines had reduced canopy growth with S compared with C and A due to 22% lower total leaf area per vine, smaller leaves and greater sunlight infiltration. Pruning weights and cane weights were between 18-42% lower with solid grass cover than the clean cultivated treatments over the course of the study, indicating vine size decline. Competition of the grass cover for soil moisture is not likely to be the contributing factor to vine size decrease in this study. In-row soil moisture and vine stem water potential did not differ with treatments for 2007-2009. Nitrogen (N) competition was observed with treatments as bloom petiole N differed by treatment in 2009 with C vines having the highest N content (1.07%) compared to solid cover (0.66%) and with differences at véraison. Leaf chlorophyll concentrations were 14-25% lower in S than in C and A vines throughout the growing season. Yeast available nitrogen concentration of must was lower in S compared to A and C over the course of the study. Berry anthocyanins and total phenolics were found highest in the S treatment. Irrigation used within this study had limited impact on vine size or fruit quality parameters measured. This study suggests that differences in vine size, anthocyanin and phenolic concentration may be linked to reduced N.

I. Project Title: Vineyard Cover Crop Management in the North Willamette Valley: I. Effects of Cover Crop Management on Vine Vigor and Fruit Quality of Pinot Noir

II. Principal Investigator

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Part II of this project was conducted by Michael Qian, PhD, Oregon State University, Department of Food Science and Technology with separate funding from OWB. A separate final report is being filed by Dr. Qian.

Cooperators

Allen Holstein and Jaime Cantu, Stoller Vineyards, PO Box 280, Dundee, OR 97115. ph: 503-209-2245, email: Holstein@arglyewinery.com. Role: Mr. Holstein and Mr. Cantu have provided experimental plots and maintained these plots for the study.

Leigh Bartholomew, Archery Summit Vineyards, PO Box 85, Dundee, OR 97115; ph: 541-864-4954, e-mail: leighb@archerysummit.com. Role: Ms. Bartholomew has provided and maintained an experimental plot for years 2007 and 2008.

III. Summary

Perennial grass cover crop management can be successfully used as a management tool in cool climate vineyards. This trial resulted in differences in vine size and fruit composition over the three using three permanent grass cover crop in comparison to alternate tilled and clean cultivated treatments. A permanent grass cover effectively reduced pruning weights and vine size, increased canopy sunlight infiltration and resulted in increased fruit anthocyanins and phenolics; however, a decrease in must nitrogen was observed, but experimental wines did not have issues with slow or stuck fermentations. Nitrogen in tissue tests also indicate that levels may become restrictive to vine growth in the future; however, at this point the N status has not limited yield or berry ripening. The late season irrigation for maintenance of ET in this cool climate has not proven to cause differences in vine size and has had only limited effect on fruit quality within alleyway management treatments. Further research into this study will be conducted to understand physiological mechanisms for the observed vine vigor changes and fruit composition. This study has helped determine best management practices for established vineyard management in the Willamette Valley of Oregon and other cool climate regions by helping define the use of a practical tool in cover management to manage vine size, reduce tillage, and reduce fertilizer and irrigation inputs in the vineyard.

IV. Objectives and Experiments Conducted to Meet Objectives

A three-year was carried out in the North Willamette Valley Dundee Hills during the 2007-2009 growing season. The main trial vineyard contained Pinot Noir clone 115 grafted to 101-14 rootstock planted in 1998 to spacing of 1.5 m x 2.13 m (vine x row). The permanent grass consisted of reemerging red fescue and was established in the alleyways of the vineyard three years prior to the study implementation. The vine row (width of 45 cm) was kept free of weeds throughout the season using an in-row cultivator. Three alleyway management treatments were compared for the competitive effect on grapevines: spring tillage of alternate alleyways (A) or tillage of every alleyway (C – clean cultivated) and permanent grass, no tilling (S). In the S and A, the permanent grass was mowed until the grass went quiescent in mid-late summer. Tillage of the cover occurred shortly after bud break. Tilled areas were roto-tilled in spring and summer to keep weed vegetation from establishing. The vineyard was managed per regular maintenance (fungicide applications, mowing, in-row cultivation for weed control, hedging and leaf pulling, and crop thinning). The vineyard block was set up as a completely randomized design with each of the three treatments replicated five times with 16 vines per replicate. Late season irrigation was tested within each plot where 8 vines (in a separate row) were irrigated and the other half was not irrigated. Irrigation began on the commercial site by the discretion of the site manager, based on summer evapotranspiration rates. Irrigation generally began in mid-July and continued through early September. A second research vineyard site was used in the study form 2007-2008. However, this second site was removed from the study due to a lack of cover crop density in years 1 and 2 and the treatments were lost due to inadvertent tillage in the treatment block during 2009. Data shown in this report reflect results obtained on the main site previously described.

Objective 1. Evaluate vine vegetative vigor in treatments with different alleyway management.

The influences of cover crop management on vine vigor were evaluated by measuring several growth parameters: pruning weight, cane weight, shoot number, shoot length, leaf area and canopy density. Shoot lengths were taken pre-bloom and post-fruit set (prior to hedging). Once the canopy was fully developed, leaf area was measured. Canopy density was quantified using point quadrat analysis (Smart and Robinson 1991, Meyers and Vandenheuvel 2008) and the sunfleck method (Smart and Robinson 1991). Shoot number per vine and cluster per shoot were recorded during the growing season. Shoot number was used with pruning weights to determine cane weight, an estimation of vine vigor. Vine yield weight at harvest was measured per vine to determine crop load (yield/pruning weight). Pruning weights were measured during the dormant period following the growing season to determine vine size and vegetative growth in response to treatments.

To understand the treatment impact on vine-grass nitrogen competition, N concentration of tissues was determined at bloom (petioles) and véraison (leaf blade) during 2008 and 2009 by collecting appropriate leaf samples and submitting them to the Oregon State University Central Analytical Lab. Leaf chlorophyll was measured using a chlorophyll meter (Minolta SPAD 502, Konica Minolta, USA) in 2009 after a difference in canopy color was observed between cover treatments.

Objective 2. Evaluate the effect of alleyway management on vine water stress and soil moisture.

To determine the impacts of soil moisture competition from the presence or absence of alleyway cover, vines and soil were monitored for water status. Vines were monitored for water potential, starting before bloom in June up to ripening in September. Xylem water potential (Ψ_s) was measured using a pressure chamber (PMS Instruments, Albany, OR). Soil moisture was monitored in the vine row using capacitance probes (AquaPro Sensors, Ducor, CA) concurrently with the xylem water potential measurements.

Objective 3. Determine grape composition as effected by alleyway vegetation management.

Basic grape maturity parameters were monitored during ripening to ensure proper grape development and identify differences that may occur during this ripening phase. Soluble solids, pH and titratable acidity of grape samples were measured weekly, beginning after véraison. Weekly samples consisted of seven clusters per treatment replicate. Soluble solids (°Brix) of juice samples will be measured using a hand held refractometer, and juice pH will be determined using a Scholar 425 pH meter and Sentix 62 electrode. Titratable acidity will be analyzed with the titrametric procedure using NaOH as described by Zoecklein et al.1999.

Must analysis was conducted on fruit collected from each treatment. Treatment replicates were harvested separately and consisted of a 20 cluster sample collected on the last sampling date (commercial harvest). Samples were processed to must according to industry standard practices and analyzed for soluble solids (°Brix), pH and titratable acidity. Yeast available nitrogen concentrations (YAN) of fruit were determined with an enzymatic assay for ammonia from r-biopharm, and the NOPA assay for primary amines (Dukes and Butzke 1998). Fruit was analyzed for berry skin polyphenol and anthocyanin concentration using the Folin-Ciocalteau (Singleton and Rossi 1965) and pH-differential (Giusti and Wrolstad 1996) methods, respectively.

A minimum of 12 kg of fruit was harvested per treatment for wine production. Wine components analysis was conducted by Dr. Michael Qian who is funded through a separate grant from OWB from 2007-2009. Results of grape compositional analysis will be used to relate vine water potential, canopy density and ripening dynamics to grape and wine quality.

Statistical Analysis

Statistical analysis was conducted using the general linear models analysis of variance for parametric data and Kruskal-Wallis for non-parametric data as appropriate. Parameters measured across the three years were analyzed with Repeated Measures approaches. All statistical analysis was conducted with SAS 9.2 statistical software.

V. Summary of Major Research Accomplishments and Results

For brevity of this report, not all data is shown, but major findings reported herein.

Objective 1. Evaluate vine vegetative vigor in treatments with different alleyway management.

Vine growth and development measurements taken throughout the growing seasons of this three year study indicate that solid grass cover reduced total vine size from high to moderate vigor. Pruning weights and individual cane weights measured during the dormant season following each experimental year show a significant treatment effect (Table 1) with solid cover treatments having pruning weights ranging 18, 28 and 42% lower than weights of clean cultivated treatments, respectively for 2007, 2008 and 2009. Alternate tilled treatments fall within the middle range between solid grass cover and no cover (clean cultivated). The pruning weights per vine and cane weights of clean cultivated indicate a very high vigor status of the vines (60-80 g/cane) while the solid grass cover treatments are more towards the moderate vigor range.

While pruning weights indicated a total vine size decline with solid grass cover, leaf area measurements during the growing season were not found to differ for total leaf area per vine.

However, there were differences in total leaf area per shoot and sunlight infiltration through the canopy with treatment (Table 2). Solid grass cover treatments had 15-24% less leaf area per shoot amongst canopies with same shoot density and length. However, shoot lengths prior to fruit set were found to be 12% shorter in solid grass treatments than the other two treatments (*P<0.0001*). By mid-season, shoot lengths were similar across treatments as shoots reached the top trellis wire and all treatments were subjected to hedging. A lack of difference may be due to the canopy manipulation practices associated with VSP-trained canopies, such as hedging and leaf removal that occurred in the vineyard per standard management protocols. Results of sunfleck analysis conducted near véraison show the solid cover treatment with higher canopy sunlight infiltration than the clean cultivated treatment (Table 2). Vine leaf area was reduced in 2009 at a greater level than observed in the other two treatments from 2008 to 2009, and likely altered the vine leaf area exposure and cluster zone exposure.

Table 1. Dormant pruning weights and vine shoot measurements

	Treatment	**2007**	**2008**	**2009**	**All Years**
Shoots/vine	Solid cover	19	20	23	21
	Alternate till	19	20	24	21
	Clean cultivated	19	20	23	21
		n.s.	n.s.	n.s.	n.s
Pruning wt (kg/vine)	Solid cover	1.54	1.06	1.14	1.20
	Alternate till	1.76	1.29	1.71	1.53
	Clean cultivated	1.86	1.46	1.96	1.71
		**	***	***	***
Cane wt (g/shoot)	Solid cover	72.6	49.7	49.3	55.3
	Alternate till	84.6	57.6	71.6	68.6
	Clean cultivated	91.2	65.0	86.2	78.1
		**	***	***	***

Means presented with significance **P<0.001 and ***P<0.0001, n.s.- not significant. No difference with irrigation was found. Repeated measures ANCOVA indicate a significant treatment, year and treatment x year effect. There was no significant irrigation effect (between or within subjects).

Table 2. Canopy Density and Leaf Area 2008-2009

Year	**Treatment**	**shoots/vine**	**leaves/shoot**	**leaf area/shoot (cm^2)**	**leaf area/vine (m^2)**	**% Sunflecks**
2008	Solid cover	21	30 [1]	1894 b[1]	4.04	16.8 a[1]
	Alternate till	22	32	2176 a	4.82	16.7 a
	Clean cultivate	21	33	2230 a	4.68	5.1 b
	P	n.s.	n.s.	*	n.s.	*
2009	Solid cover	23	36	1530	3.54	18.1 a[1]
	Alternate till	24	36	1951	4.69	9.2 b
	Clean cultivate	23	38	2010	4.52	6.4 b
	P	n.s.	n.s.	**	n.s.	***

Means presented. [1] GLM ANOVA, all others Kruskal-Wallis (α=0.05). *P<0.05,

**P<0.001, ***P<0.0001. No irrigation effect found, P>0.05.

Results of tissue nutrient tests indicate that vineyard floor management impacted nitrogen levels at both bloom and véraison sampling in 2009 (Table 3). There was no difference between treatments in petiole nitrogen in 2008, but sub-plots that were irrigated the previous season had higher bloom petiole nitrogen than non-irrigated treatments. However, this trend was not observed in 2009. Véraison sampling of tissues was included in 2009 to try to understand the treatment-effect on nitrogen status after observing lower leaf chlorophyll in the solid cover treatments during spring 2009. Both leaf chlorophyll (Figure 1) and nitrogen concentrations were found to be significantly lower in the solid cover treatment in comparison to the alternate and complete tilled treatments. In 2009, all three treatments segregated statistically with a trend of lower nitrogen and chlorophyll with increasing grass cover. There was no effect of irrigation on chlorophyll or nitrogen concentrations in 2009.

Table 3. Vine tissue nitrogen concentrations with alleyway grass management

		Bloom*			**Véraison****		
Year	Treatment	**%N**	**%C**	**C:N**	**%N**	**%C**	**C:N**
2008	Solid Cover	0.98	39.3	40.2			
	Alternate	0.96	39.2	42.1			
	Clean Cultivated	0.97	39.2	41.7			
	P	*0.6828*[b]	*0.9156*[b]	*0.5417*[b]			
	Irrigated	1.04 a	39.1	37.9 b			
	Dry	0.90 b	39.4	44.8 a			
	P	*<0.0001*[b]	*0.0528*[b]	*<0.0001*[b]			
2009	Solid Cover	0.66	38.6	58.8	1.69 c	43.5 a	25.8 a
	Alternate	0.93	37.2	39.9	1.90 b	42.3 b	22.4 b
	Clean Cultivated	1.07	36.9	34.6	2.00 a	42.2 b	21.1 c
	P	*<0.0001*[a]	*<0.0001*[a]	*<0.0001*[a]	*<0.0001*[b]	*<0.0001*[b]	*<0.0001*[b]

Means presented. Statistical analysis [a] Kruskal-Wallis or [b] ANOVA, α=0.05, means separation of normal data with REGWQ. Tissue used includes * petiole or ** leaf blade. No irrigation effect for 2009 samples. Treatment x irrigation effect for 2008 samples (P<0.001).

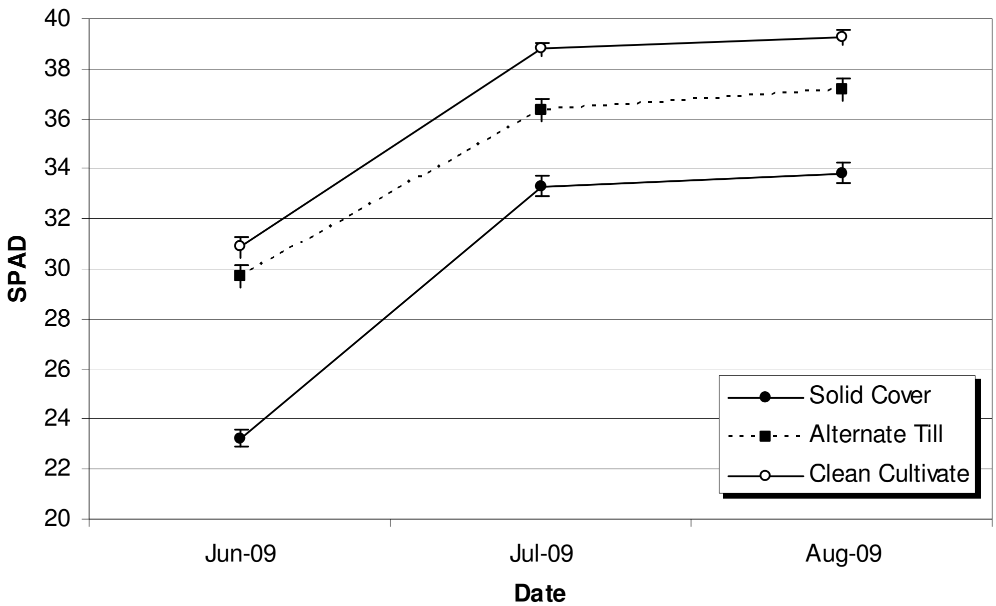

Figure 1. Mean (+ SEM) chlorophyll content (SPAD units) measured across the season in 2009. Repeated measures ANOVA indicate significance by treatment over the course of the study *P<0.00001*. Irrigation-effect was only significant on 8/1/2009 (*P=0.00005*) with irrigated vines within treatments having higher readings that non-irrigated vines. There was no treatment x irrigation effect found.

<u>Objective 2.</u> Evaluate the effect of alleyway management on vine water stress and soil moisture.

Soil moisture measurements taken during the growing seasons of 2007-2009 indicate no effect of alleyway treatment or irrigation on in-row soil moisture during the three years of the study. The one exception was in 2009 when later season soil moisture was found to be lower in the cultivated treatments of alternate till and clean cultivated (Figure 2). During this later part of the season each year, irrigation was applied as the vineyard manager and winemaker wanted to support berry development in stage II and III of berry ripening. The amount of water applied was relatively low, less than 2-4 gallons per week from mid-July to early-September, and had no effect on weekly soil moisture readings in 2007 or 2008. There was no effect of the management treatments or irrigation on stem water potential when monitored across all three years. Vines never reached stem water potential measures below -1.0 MPa. Also, because there was no difference in stem water potential observed across treatments, the differences in pruning and cane weights are not likely to be explained by water stress. Additionally, lack of water stress would explain why a greater disparity of leaf area was not observed between treatments. However, the reduction in total vine pruning weights and lower leaf area per shoot may be linked to grass-vine nutrient competition (N) limiting growth other than through leaf expansion limitation often observed with decreasing water potential.

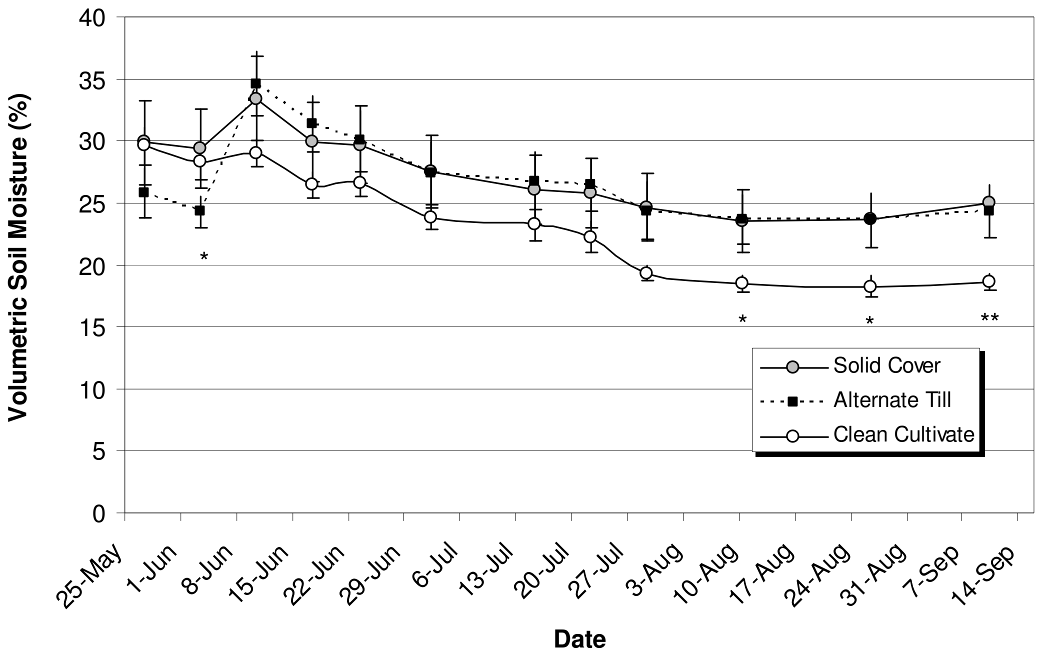

Figure 2. Mean (+SEM) volumetric soil moisture to 76 cm depth in the vine row during 2009. Statistical significance indicated *P<0.05, **P<0.01 between alleyway treatments. There was no difference with irrigation.

<u>Objective 3</u>. Determine grape composition as effected by alleyway vegetation management

Vine yield, cluster weight and berry weights were not found to differ by alleyway management or irrigation. Berry soluble solids at harvest also were not found to differ by treatments during the study. Alleyway treatments influenced pH and titratable acidity only in 2009 with a slightly lower TA (8.8 g/L (S) compared to 9.1(A) and 9.7 g/L (C), $p<0.05$) and pH (pH=3.20 (S) and pH=3.25 (C and A), $P<0.05$) observed with solid grass cover. Repeated measures of these data did not show treatment effects across years for cluster weight, berry weight, berries/cluster, SS, pH, nor TA. Although vine size was decreased and nitrogen content lower with solid cover, there is no evidence that yield or basic maturity was impacted at this point.

Most notable differences in fruit quality were observed in yeast assimilable nitrogen (YAN). Yeast assimilable nitrogen concentration of must was found the lowest in the solid cover treatment in all three years of the study (Figure 3). By years two and three, the solid cover treatment must had concentrations lower than is generally considered optimum for yeast fermentation in wines at ~140 mg/L (Butzke 1998). Must nitrogen concentration coupled with the decreasing vine tissue nitrogen and observed decrease in chlorophyll is to be expected with a grass alleyaway, particularly if additional nitrogen fertilizers are not added in the vineyard. Although YAN concentrations are rather low in 2009, there were no problems with sluggish or stuck fermentations in trial wines.

Berry total anthocyanins and phenolics were found to differ with alleyway management treatment. Solid grass cover had consistently higher anthocyanins (Figure 4) and phenolics (Table 4) while clean cultivated treatments had the lowest when compared across seasons.

Irrigation had no impact on the anthocyanin concentration in berries across the seasons. However, there was an observed irrigation effect in 2009 for total phenolics, and a significant treatment and irrigation effect across all years when compared through repeated measures (Table 4).

Other literature suggests that anthocyanins and phenolics increase in vines under water stress or in combination with increased cluster sunlight exposure. However, results of this study indicate that the vines were not under conditions considered to be stress (-1.2 MPa) and did not differ in stem water potential across treatments. The difference in phenolics and anthocyanins observed in 2008 and 2009 could be related to differences in canopy sunlight infiltration and potential impacts on microclimate of the cluster zone. Canopy density as measured by point quadrat analysis and sunfleck was highest in the clean cultivated treatment vines, and is verified by higher leaf area/shoot. Microclimatic differences within the cluster zone of the three treatments should be minimal as vines were leaf pulled in the cluster zone, thereby manipulating the immediate cluster microclimate without variability across treatments. These data suggest that nitrogen limitation may be playing a critical physiological role in altering fruit anthocyanin and phenolic composition while decreasing fruit YAN and vine biomass gain. Manipulating vine N status may be a more viable option for vine vigor control in the cool climate than is management of water potential.

Fruit and wine flavor composition has been studied in 2007-2009. Research results from the 2007 and 2008 fruit and wine do not indicate qualitative or quantitative differences in volatile aroma compounds with alleyway management treatments or irrigation. Based on vine growth and fruit analysis data from the 2009 season, we expect to see differences in aroma compounds influenced by treatment for 2009; however, samples are not yet analyzed by the Qian lab. Preliminary sensory data gathered from 2008 vintage tastings, indicate no aroma differences with alleyway management treatments or irrigation; however wine color was found higher in solid cover treatment wines.

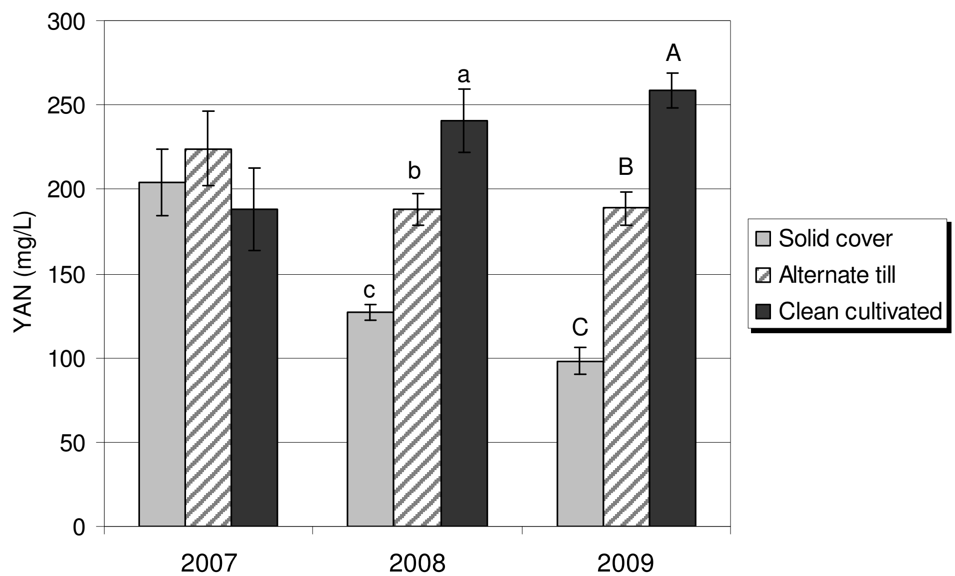

Figure 3. Yeast Assimilable Nitrogen (YAN) concentration (means $\pm$ SEM). Letters indicate differences in treatment means, P<0.0001, REGWQ. No difference was found with irrigation.

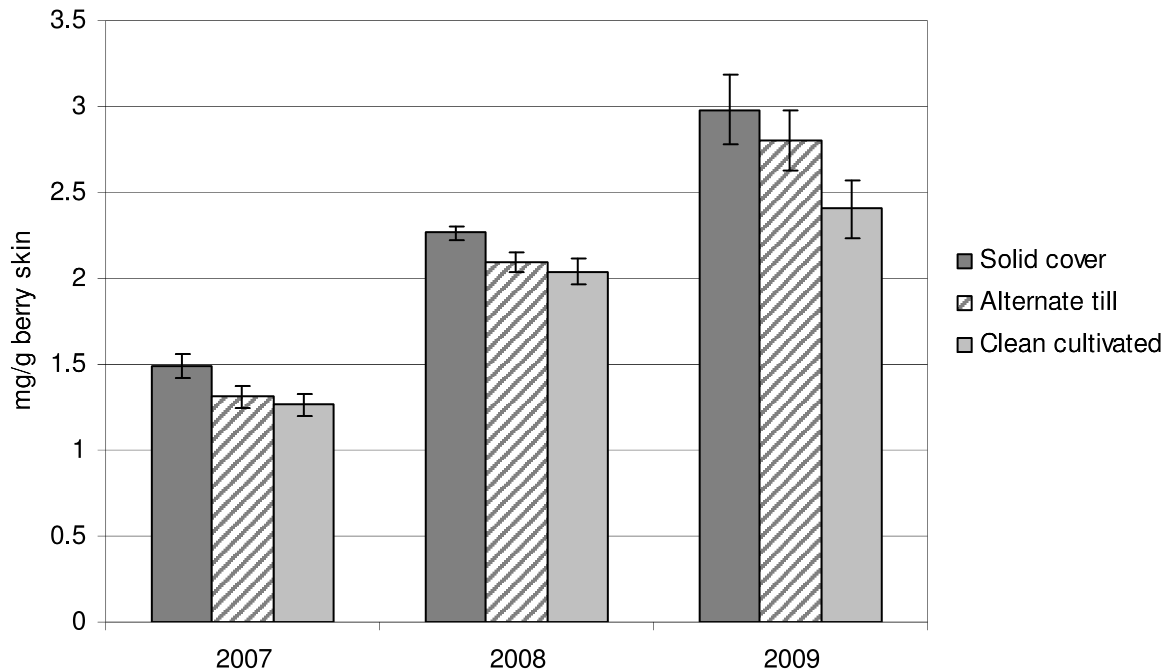

Figure 4. Mean (+SEM) total berry skin anthocyanin content (mg/g). Repeated measures ANOVA - multivariate test conducted across years indicate significant treatment (*P<0.0001*).

Table 4. Total Skin Phenolics (mg/g berry skin)

Vineyard Floor Management	Ripening Phase Irrigation	2007	2008	2009	All Years
Solid cover	Irrigated	5.78	21.01	11.55	12.78
	Non-irrigated	6.11	21.14	11.62	12.96
Alternate tilled	Irrigated	5.98	17.95	9.22	11.05
	Non-irrigated	6.30	19.48	11.86	12.55
Clean cultivated	Irrigated	5.81	18.45	9.64	11.30
	Non-irrigated	5.82	20.19	11.12	12.38
Between-subject effects	Treatment	0.6767	0.0213	0.0716	0.0099
	Irrigation	0.4664	0.0997	0.0040	0.0047
	Treatment x Irrigation	0.8868	0.5676	0.0772	0.1967
Within-subject effects	Year				<0.0001
	Year x Treatment				0.1161
	Year x Irrigation				0.1266
	Year x Treatment x Irrigation				0.4094

Means presented in mg/g berry skin. General linear models ANOVA results for each year are presented as between-subject effects with within-subject effects of repeated measures ANCOVA - multivariate test conducted across years.

VI. Outside Presentations of Research:

Because of the PI's role in extension, a number of presentations have been made regarding this project to the Oregon winegrape industry. A total of 12 presentations have been made to various grower groups. The results of this work were presented during the Oregon Wine Industry Symposium in Eugene, OR in February 2008 and 2009. The preliminary research results were presented in workshops across the state of Oregon (southern Oregon and Willamette Valley at various workshops, field days and seminar events. During the growing seasons of 2007-2009, Dr. Skinkis met with a group of Willamette Valley growers and winemakers for field meetings that showcased this project on-site to discuss observations made in the study. The results of this work have also been presented to academic groups through the American Society for Enology and Viticulture Annual Conference (2009), Intervitis/Interfructa Conference in Stuttgart, Germany (2010) and at the OSU Viticulture & Enology Research Colloquium (2010).

Currently, data and results are being compiled for submission in a peer-reviewed journal such as *HortScience, AJEV* or other relevant journal. Beyond academic publications, Dr. Skinkis extends research findings directly to industry members and other researchers through published newsletters and reports online at http://wine.oregonstate.edu.

VII. Research Success Statements:

This study will provide growers with information on best management practices for vineyard floor management, particularly for permanent grass cover crop management by providing them with a tool to control vine vigor in the cool climate Willamette Valley of Oregon. Based on an industry survey conducted by OSU Viticulture, fifty-one percent of the industry currently uses permanent grass cover crop management. This research can help them better understand how soil tillage methods may be utilized to moderate vine vigor, nitrogen status and fruit quality in their vineyard. It is apparent that tillage of the grassed alleyways is not necessary in high vigor vineyards with significant spring soil moisture. By maintaining permanent grass cover rather than tilling or removing cover crop, there is a potential savings of $142/acre in tractor fuel and herbicide costs if they do not till every alleyway or alternate alleyways. This research indicates that the grassed alleyways did not significantly reduce soil moisture in-row nor increase vine water stress in Jory soils, and late season irrigation had limited impacts on vine growth or fruit quality. This suggests that permanent grassed cover can be used as a tool to reduce vine vigor in dry-farmed vineyards of the Willamette Valley without a need for water inputs, depending on the soil depth, water holding capacity and growing conditions during the summer. Finally, results of this first stage of the study show increased fruit anthocyanins and phenolics which is desirable for Pinot noir wine production and may increase grower potential for higher fruit prices or use of fruit in higher quality wines, particularly if vine vigor is reduced and concomitantly, vine balance is adjusted.

While permanent grass covers are more costly to establish up-front than planting inexpensive small grains for winter soil erosion control, the grower could establish a permanent grass cover and maintain it for a longer duration of time if reductions in vine vigor are not limiting production nor quality, particularly yeast assimilable nitrogen. Additional years of the research will indicate how many years will be possible for maintenance of a permanent sod stand before renovation (tillage and replanting to some other cover crop) is required.

VIII. Fund Status

This study was funded by the Oregon Wine Board during from August 2007-August 2010. The PI and co-PIs of parts I and II of this study have discussed a continuation of this trial for another three-year period based on interest expressed by the Oregon winegrape industry. A grant proposal has been submitted in January 2010 for further consideration and funding. This next step is to carry out additional experiments on this trial site to quantify compounding impacts of grass management on vine vigor, understand hormone physiology and berry quality parameters and the potential role of nitrogen limitation. Research plans are currently being prepared for continuing in the 2010 growing season and viticulture measurements will commence in May 2010 for the second phase of this study, pending award.

I would like to express my gratitude to the Oregon Wine Board for funding this project and to the industry members who have worked within this project to identify needs, implement the project and share the outcomes within the industry.

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