Canopy Management Practices to Improve Light Interception and Quality of ‘Frontenac’, ‘La Crescent’ and ‘Marquette’ Grapes

Penoach Vineyard & Winery, Adel, IA
Snus Hill Winery, Madrid, IA

Dylan Rolfes, Gail Nonnecke and Paul Domoto
Dept. of Horticulture, Iowa State University

Background and Rationale: Cold-hardy *Vitis riparia* hybrids have allowed the recent expansion of the wine industry into the upper Midwest, impacting the economy and culture of the region. While these hybrids have created new opportunities, they also present several challenges; they are cold-hardy, but often more vigorous than the traditional *V. vinifera* hybrid grapes and tend to produce fruit with quality characteristics that challenge winemaking. During maturation, the grapes tend to retain high levels of acids, exhibit a rapid rise in pH, possess a different profile of malic to tartaric acid than other hybrids, and wines from these grapes often have an “herbaceous” character. These characteristics also have been associated with grapes grown in overly shaded canopies. This study was undertaken to determine if canopy management practices that modify light environment through the canopy would improve fruit characteristics of ‘Frontenac’, ‘La Crescent’ and ‘Marquette’ grapes, and assess the potential cost-effectiveness for conducting the practices by measuring labor time.

Treatments: Treatments were applied to vines trained to a single curtain bilateral cordon system and included all combinations of:

- Control treatment with no canopy management practices applied **(C)**
- Post-bloom shoot positioning **(SP)**
- Pre-bloom shoot thinning (removal of adventitious basal shoots and double shoots per node) **(ST)**
- Post bloom removal of axillary (lateral) shoots in the fruiting zone **(LT)**

Methods: For ‘Frontenac’ and ‘La Crescent’ in 2012 and ‘Frontenac’, ‘La Crescent’, and ‘Marquette’ in 2013, treatments were applied to 3-vine panels and replicated 4 times in a randomized complete block design. Time to perform each practice per vine was recorded. Prior to harvest, the photosynthetically active radiation (PAR) was measured with *LICOR* LI-191 line quantum sensor placed parallel to the cordon and under the clusters. Fruit were harvested, weighed and a 300-berry sub-sample was collected to analyze fruit quality characteristics (Brix, pH, and TA). Data were analyzed using Tukey’s adjustment for multiple comparisons. Analysis of malic and tartaric acid levels is currently being conducted.

Results: Across all three cultivars of grapes in 2013 (Tables 1-3), LT, and any treatment including LT, required the highest amount of labor. These treatments also provided the highest amount of sunlight penetration to the fruiting zone. Yield and individual berry weight showed only minor variation between treatments among all cultivars. LT seemed to have the most effect on lowering total soluble solids, but these results became less consistent when LT was only a portion of the treatment. SP showed a minor effect on lowering total soluble solids, and ST showed even less of an effect. There was no clear pattern to how the treatments affected pH. LT showed the greatest effect on lowering total acidity, but also was inconsistent when LT was only a portion of the treatment.

Table 1. Labor requirements (per vine across the season), light penetration, yield, berry weight, and fruit quality indices in 'Frontenac' canopy management trial, Adel, IA, 2013.

Treatment	Total labor (min.)	Sunlight exposure (% of full sun)	Yield (kg/m)	Berry weight (g/ berry)	Average soluble solids	Average pH	Average total acidity
C	6.4 c	15 de	2.9 a	0.89 b	25.06 abc	3.47 d	10.59 a
SP	8.6 cb	21 cd	2.7 a	0.93 a	24.60 c	3.58 ab	10.54 ab
ST	7.7 c	13 e	1.9 b	0.86 c	25.75 a	3.57 abc	10.37 abc
LT	15.1 a	21 cd	3.0 a	0.90 ab	25.54 c	3.56 abc	10.56 a
SP+ST	10.5 b	22 cd	2.1 b	0.84 c	25.41 ab	3.57 abc	10.52 ab
SP+LT	15.2 a	31 ab	2.7 a	0.85 c	24.90 bc	3.55 bc	10.43 abc
ST+LT	14.7 a	24 bc	1.9 b	0.84 c	25.44 ab	3.61 a	10.16 c
SP+ST+LT	16.7 a	36 a	1.9 b	0.85 c	24.98 bc	3.51 cd	10.24 bc
LSD	*2.4*	*7*	*0.7*	*0.03*	*0.77*	*0.06*	*0.31*

Treatment means followed by the same letter within a column are not significantly different at the α=0.05 level.

Table 2. Labor requirements (per vine across the season), light penetration, yield, berry weight, and fruit quality indices in 'La Crescent' canopy management trial, Madrid, IA, 2013.

Treatment	Total labor (min.)	Sunlight exposure (% of full sun)	Yield (kg/m)	Berry weight (g/berry)	Average soluble solids	Average pH	Average total acidity
C	8.4 ef	6 d	3.2 a	1.20 bc	24.15 a	3.28 e	11.60 a
SP	12.5 cd	15 c	3.0 a	1.24 a	22.30 d	3.36 d	11.08 bc
ST	6.4 f	19 c	1.8 b	1.19 bc	23.27 bc	3.36 cd	10.53 d
LT	10.2 bc	15 c	2.0 b	1.24 ab	24.75 c	3.40 ab	11.08 bc
SP+ST	12.1 de	20 bc	1.8 b	1.19 c	23.82 abc	3.37 bcd	7.41 d
SP+LT	17.3 a	28 a	2.5 ab	1.22 abc	23.85 ab	3.36 d	11.23 abc
ST+LT	13.1 c	20 bc	1.5 b	1.21 abc	23.08 c	3.39 abc	10.98 bcd
SP+ST+LT	16.6 ab	27 ab	1.6 b	1.19 c	23.93 ab	3.42 a	10.75 cd
LSD	*2.7*	*8*	*1.0*	*0.05*	*0.76*	*0.03*	*0.50*

Treatment means followed by the same letter within a column are not significantly different at the α=0.05 level.

Table 3. Labor requirements (per vine across the season), light penetration, yield, berry weight, and fruit quality indices in 'Marquette' canopy management trial, Adel, IA, 2013.

Treatment	Total labor (sec.)	Sunlight exposure (% of full sun)	Yield (kg/m)	Berry weight (g/berry)	Average soluble solids	Average pH	Average total acidity
C	7.0 d	10 c	1.1	0.96 abcd	27.39 a	3.82 bc	8.49 bc
SP	8.6 d	27 b	1.0	0.98 ab	26.55 ab	3.71 de	9.28 ab
ST	7.4 d	12 c	0.9	0.93 cd	26.86 ab	3.64 e	9.54 a
LT	16.7 ab	28 b	1.1	0.98 a	24.75 c	3.87 ab	7.24 d
SP+ST	12.1 c	18 c	1.1	0.92 d	25.63 bc	3.91 a	7.41 d
SP+LT	16.9 ab	32 b	0.8	0.94 bcd	25.94 bc	3.77 cd	8.93 ab
ST+LT	14.2 bc	47 a	0.9	0.92 d	24.79 c	3.94 a	7.84 cd
SP+ST+LT	19.0 a	29 b	0.9	0.97 abc	26.88 ab	3.72 d	9.56 a
LSD	*2.8*	*9*	*0.4*	*0.04*	*1.41*	*0.08*	*0.95*

Treatment means followed by the same letter within a column are not significantly different at the α=0.05 level. Columns where no letters are present indicate a lack of significant differences among all treatments.

What the results mean:

- The practice of post-bloom removal of axillary (lateral) shoots (LT) had the most effect on improving fruit quality.
- LT opened the canopy to a higher degree of light penetration than did any of the other treatments, and had the greatest effect on lowering both total soluble solids and total acidity, but required the highest labor.
- LT is an effective method of canopy management for improving sunlight penetration, and an improved sunlight penetration was associated with better fruit quality indices.
- The utilization of LT as a portion of a canopy management plan, which involved additional treatments (SP or ST), showed inconsistent results in the influence on fruit quality indices, but still retained its ability to effectively open the canopy and increase sunlight penetration. Overall, the optimal ranges for fruit quality indices of wine grapes for generic wines (Table 4) were best approached by treatments including LT.
- The cost effectiveness of the different treatments will depend on the relative price points at which the grower is able to sell grapes with higher quality indices that require higher labor amounts.

Table 4. Recommended ranges of soluble solids concentrations, total acidity and pH in wine grapes at harvest for generic wine types that may be compared to treatment results.

Type of Wine	Soluble solids concentration (%)	Total acidity (g tartaric acid/L)	pH
Sparkling	17.0 – 20.0	7.0 – 9.0	2.8 – 3.2
White Table	19.0 – 23.0	7.0 – 8.0	3.0 – 3..3
Red Table	20.0 – 24.0	6.0 – 7.5	3.2 – 3.4
Sweet Table	22.0 – 25.0	6.5 – 8.0	3.2 – 3.4
Desert	23.0 – 26.0	5.0 – 7.5	3.3 – 3.7

Above table adapted from Wolfe, T.K. 2008. Wine grape production guide for eastern North America. Natural Resource, Agriculture, and Engineering Service (NRAES) Cooperative Extension. NRAES-145. Ithaca, NY.