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Yield, Quality Attributes, and Degree Day Requirements of Various Wine Grapes under Climatic Conditions of Intermountain West Region

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Abstract

Adaptability, yield, quality attributes, and growing degree day (GDD) requirements of 15 wine grape cultivar clones planted in 1997 under climatic conditions of southwest Idaho (Intermountain West Region) were evaluated during 1999-2001. 'Viognier 01' was an excellent white wine grape and 'Valdepenase 03' an outstanding red wine grape. Wines of 'Carignane 06', 'Grenache 03', and 'Meunier 01' were not satisfactory. Relatively low wine quality of 'Carignane 06' and 'Grenache 03' grapes could in part be related to their high yield. Wine of 'Petite Verdot 01' was excellent; however, its very low yields do not economically justify growing this grape under southwest Idaho conditions. Cumulative growing degree days were sufficient to mature all wine grapes tested in this study.

Introduction

Vine adaptability and fruit quality attributes of wine grape cultivars to a geographical region need to be evaluated before they are widely planted on a commercial scale. Interest in production of wine grapes has increased throughout the world, and this interest is partially due to the medical reports implying certain health benefits associated with wine consumption. California is the major producer of wine grapes in the U.S., and thus, numerous research projects are conducted on various viticultural aspects of wine grapes, including breeding and cultivar evaluations in that state. Adaptability and quality of wine grapes in different regions of the United States have been reported (1, 2, 3, 5, 8, 10).

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Kaps and Odneal (5) reported performance of 27 wine grape cultivars in the Missouri Ozark region. Based on that study, 'Catawba', 'Cayuga White', 'Chambourcin', 'Norton', 'Seyval blanc', 'Vidal blanc', and 'Vignoles' were found to be best suited for the region. In an evaluation of 13 cultivars, Wolf and Miller (10) reported that 'Fer', 'Mourvedre', 'Petite Verdot', and 'Tannat' were acceptable for commercial production in northern Virginia.

Hamman (3) reported GDD for 17 years and grape fruit quality over 5 years for western Colorado region. He reported that the average GDD (50 °F or 10 °C base) in that region was 3284 with 163 frost free days. In that report, 'White Reiesling', 'Chardonnay', 'Muscat Blanc', 'Limberger', 'Cabernet Sauvignon', 'Merlot' and 'Cabernet Franc' showed low incidences of winter injury and had very acceptable ecological characteristics (3).

Wine grapes have been grown in southwest Idaho since the early 1960's. In 1999, there were 266 ha of wine grapes in southwest Idaho (4), which has increased to approximately 363 ha in 2003 (personal knowledge). Long and warm days during spring and summer and cool nights in September and October, combined with well-drained sandy-loam soil provide excellent conditions for production of high quality wine grapes in southwest Idaho. In spite of these favorable conditions, wine grapes in the region are subjected to the risk of severe winter injury in some years. However, since phylloxera (*Phylloxera daktulospharia* vitifolia) does not exist in Idaho, most wine grape vines were established on their own roots. Thus, when severe winter injury damages the upper portions of the vines, they may re-grow and a new canopy can be established.

In spite of considerable commercial production and potential for expansion in the region, information on the adaptability of wine grapes in the Intermountain Western region of the USA is limited (3, 6, 7), and no information is available for the wine grape cultivar adaptability and fruit quality in Idaho. The objective of this project was to study the adaptability, yield, fruit quality, maturity, GDD requirements, and preliminary wine quality of 15 wine grapes cultivar clones grown under climatic conditions of southwest Idaho.

Materials and Methods

The experiment was arranged as a randomized complete block design with four replications (blocks) of eight vines per block. The experimental vineyard, consisting of 15 cultivar clones of wine grapes was established at the University of Idaho Parma Research and Extension Center in southwestern Idaho in the spring of 1997. The cultivar clones were as follows: 'Cabernet Franc 01', 'Cabernet Sauvignon 11', 'Carignane 06', 'Dolcetto 01', 'Grenache 03', 'Limberger 02', 'Malbec 06', 'Merlot 08', 'Meunier 01', 'Nebbiolo 01', 'Petite Verdot 01', 'Petite Sirah 03', 'Pinot Noir 18', 'Valdepenase 03', and 'Viognier 01'.

All plant materials were obtained as No. 1 dormant cuttings of 0.63 to 1.9 cm diameter and 35.5 cm length from Foundation Plant Materials Services (FPMS) at the University of California-Davis. To induce roots on the cuttings, they were dipped in IBA (Rootone). A 60-cm deep hole was dug on the ground, and about 34 cm of cuttings were buried in a damp soil with the basal ends upward. Then the rooting ends of cuttings were covered with about 4 cm of fine sand and covered with a black plastic, and sand was kept damp for about 6 weeks (March 5 to April 18). With this technique, the rooting end of each cutting was kept warm and moist, while the rest of the cutting was kept cooler. After 6 weeks, roots or callus were formed only on the rooting area, while the rest of cutting was not as advanced.

The vines were planted at 2.13 m x 2.43 m spacing. The vineyard soil was sandy loam with a pH of about 7.5. Pressure-treated wooden posts with 2.43 m length were installed at 4.87 m spacing, with 1.82 m above the ground. One 2.28-m galvanized metal post (U shape) was pounded next to each vine with 46 cm in the ground. Twelve-gauge galvanized wires were installed at 41 cm, 107 cm, and 127 cm from the ground as drip irrigation line wire, cordon wire, and catch wire, respectively. A 15-cm cross-arm was installed horizontally on each metal post at

168 cm from the ground. Two parallel wires were installed, one on each side of the cross-arm, to keep the shoots in an upright position.

The vines remained uncut and grew as bush during the first growing season. During the following dormant season (early March), two trunks per vine were selected and trained as a cordon system, and the rest were removed. Other than these two trunks, any new growth below the cordon arms was removed during the subsequent growing or dormant seasons every year. Each cordon arm was spur-pruned to leave 6 to 8 spurs of 2 buds (for red wine grapes) and 3 buds (for the white wine grapes), not counting the basal buds, during the dormant season (early March) of every year. During May of every year, new shoots were thinned out to leave an approximately 8-10 cm space between shoots of each arm for better light penetration and air movement, and all downward growing shoots were also removed. Some of the shoots were positioned upward between the two wires on the cross-arms during each growing season.

A drip line was installed on the lowest wire with two 3.78-L/hr emitters per vine to deliver total of 7.56 L/hr water per vine. Each emitter was placed 17.8 cm away from the vine trunk. Soil moisture was monitored by WaterMark Sensors and/or a neutron probes and vines were irrigated twice a week. During summer months, each vine received approximately 30 to 45 L/week in 1997 and 1998, 60 L/week in 1999, and 76 L/week in 2000 and 106 L/week in 2001. Each vine received actual N at rates of 0.6 g, 2.6 g, 6.7 g, 11.6 g, 28.0 g in 1997, 1998, 1999, 2000, and 2001, respectively. Each vine received actual amounts of 9.7 g P in 2000, 23.4 g P in 2001 and 11.7 g of K in 2000 and 28.0 g of K in 2001.

Weeds were controlled mechanically by hand during the first two years of planting, and after that they were controlled by application of glyphosate (Roundup) twice a year. The vineyard floor was disked three times a year and kept clean. No pesticide was applied to this vineyard during the period of experiment as no insect damage was observed. Vines were sprayed with sulfur once or twice a year to control powdery mildew.

Twenty berries were randomly picked from each of the central 6 vines in each block (120 berries from each block) once or twice a week, and the soluble solids concentration (SSC) of the composite juice sample was measured for each of the four blocks by placing three to four drops of juice on a handheld, temperature-compensated refractometer (Atago N1, Tokyo, Japan).

In 1999, harvest time for each cultivar clone was determined based on color and taste of berries. In 2000 and 2001, however, a cultivar clone was harvested when most of the berries had a SSC of 22 to 25° Brix (target SSC for harvest).

Cumulative growing degree days (GDD) were calculated from March 1st through harvest date for each cultivar clone, using the formula developed in California (9) as follows: GDD = [(daily maximum temperature + daily minimum temperature/2) - 50 F]. None of the grapes had any visible bud growth prior to March 1st. Therefore, this date was chosen as the first date for the cumulative GDD calculation. Cumulative GDD aids in determination of cultivar adaptability for a given location.

Grapes from all four blocks for each cultivar clone were combined and wines were made at Parma Ridge and Ste Chapelle wineries in southwestern Idaho in 1999, 2000, and 2001. Several wine tasting surveys were conducted by 20-40 people. Wine tasters were members of Idaho and Washington wine growers associations. In these surveys, tasters provided a subjective description and preference for the wines made from of these grapes and ranked the wines from 1 (strongly disliked) progressively to 10 (excellent).

Data were analyzed using analysis of variance procedures. Fisher's protected LSD ($p \leq 0.05$) was used to separate treatment means. Statistical analyses were carried out using SAS (SAS Institute Inc., Cary, N.C.).

Results and Discussion

Yield per vine and per hectare is reported in Table 1. Although vines were less mature in 1999 and did not have full production, all red wine grape cultivar clones, except 'Petite Verdot 01' and 'Meunier 01', averaged greater than 7.5 MT/ha per year (4.44 kg/vine per year) and 'Viognier 01' (the only white wine

Table 1. Yield of 15 wine grape cultivar clones growing under conditions of the Intermountain West Region, in southwest Idaho, USA during 1999-2001[z].

Cultivar clone	Yield per vine (kg)					Yield ($MT.ha^{-1}$)				
	1999	2000	2001	3-year total	3-year average	1999	2000	2001	3-year total	3-year average
Cabernet Franc 01	1.90 cd	7.55 cde	10.40 a	19.86 cde	6.62 cde	3.32 cd	12.89 cde	17.77 a	33.92 cde	11.31 cde
Cabernet Sauvignon 11	1.98 cd	5.38 e	8.72 ab	16.09 def	5.36 def	3.39 cd	9.19 e	14.88 ab	27.47 def	9.16 def
Carignane 06	2.88 bc	13.81 a	9.72 ab	26.42 a	8.80 a	4.92 bc	23.58 a	16.60 ab	45.11 a	15.04 a
Dolcetto 01	4.67 a	11.20 b	10.65 a	26.53 a	8.84 a	7.97 a	19.13 b	18.18 a	45.29 a	15.10 a
Grenache 03	2.63 bcd	11.53 ab	11.14 a	25.31 ab	8.44 ab	4.50 bcd	19.70 ab	19.02 a	43.22 ab	14.41 ab
Limberger 02	3.53 ab	8.24 cd	9.24 ab	21.02 bcd	7.00 bcd	6.04 ab	14.07 cd	15.78 ab	35.89 bcd	11.96 bcd
Malbec 06	2.53 bcd	6.14 de	8.90 ab	17.59 cdef	5.86 cdef	4.32 bcd	10.49 de	15.21 ab	30.03 cdef	10.01 cdef
Merlot 08	2.07 bcd	6.52 de	5.41 c	14.01 f	4.67 f	3.54 bcd	11.13 de	9.25 c	23.93 f	7.98 f
Meunier 01	1.71 cd	6.83 de	4.28 c	12.83 f	4.28 f	2.92 cd	11.67 de	7.31 c	21.90 f	7.30 f
Nebbiolo 01	2.42 bcd	7.31 cde	6.79 bc	16.53 def	5.51 def	4.14 bcd	12.48 cde	11.60 bc	28.23 def	9.41 def
Petite Sirah 03	2.25 bcd	9.44 bc	10.79 a	22.50 abc	7.50 abc	3.8 bcd	16.12 bc	18.43 a	38.42 abc	12.81 abc
Petite Verdot 01	1.25 d	1.31 f	0.87 d	3.43 g	1.14 g	2.15 d	2.23 f	1.48 d	5.87 g	1.96 g
Pinot Noir 18	1.86 cd	8.47 cd	4.87 c	15.21 ef	5.07 ef	3.18 cd	14.47 cd	8.31 c	25.97 ef	8.66 ef
Valdepenase 03	2.83 bc	6.88 de	11.38 a	21.09 bcd	7.03 bcd	4.83 bc	11.75 de	19.43 a	36.02 bcd	12.00 bcd
Viognier 01	3.08 bc	6.92 de	10.70 a	20.70 bcd	6.90 bcd	5.26 bc	11.82 de	18.27 a	35.36 bcd	11.79 bcd

[z]Mean separation within columns using Fisher's LSD, $p \leq 0.05$. Each value is the average of four blocks, each with 6 vines.

Table 2. Cluster and berry weights and soluble solids concentration of 15 wine grape cultivar clones growing under the environmental conditions of the Intermountain West Region in southwest Idaho, USA during 1999-2001.

	Cluster weight (g)				Berry weight(g)				Soluble solids concentration (°Brix)			
Cultivar clone	1999	2000	2001	3 year avg.	1999	2000	2001	3-year avg.	1999	2000	2001	3-year avg.
Cabernet Franc 01	126 cde	238 bcde	192 de	185 def	0.86 fgh	1.28 de	1.55 cde	1.24 ef	18.5 c	25.1 ab	24.6 b	22.8 abc
Cabernet Sauvignon 11	89 ef	186 cdefg	177 e	152 fg	0.87 efgh	1.17 ef	1.34 efg	1.14 fg	18.2 cd	24.1 abcd	24.7 b	22.3 bcde
Carignane 06	191 b	344 a	278 b	271 ab	1.08 cde	1.84 a	1.77 b	1.65 a	15.1 e	21.4 e	23.4 bcde	20.2 f
Dolcetto 01	187 b	248 bcd	284 b	240 bc	1.33 a	1.63 bc	1.43 def	1.47 bc	15.3 e	23.6 abcde	22.3 efg	20.4 f
Grenache 03	253 a	291 ab	334 a	293 a	1.24 abc	1.72 ab	2.03 a	1.65 a	18.5 c	22.5 de	24.4 bc	21.6 de
Limberger 02	167 bcd	214 cdefg	225 cd	202 cde	1.07 cdef	1.36 d	1.55 cde	1.33 cde	18.3 c	22.8 bcde	23.0 defg	21.4 ef
Malbec 06	105 ef	170 efg	115 f	130 g	1.09 bcd	1.62 bc	1.50 cde	1.40 cd	20.7 ab	24.9 abc	22.2 efg	22.6 abcd
Merlot 08	99 ef	183 defg	151 ef	144 fg	1.02 cdefg	1.29 de	1.43 def	1.25 ef	21.9 a	24.9 abc	23.7 bcd	23.5 a
Meunier 01	106 ef	145 g	128 f	127 g	1.01 defg	1.13 ef	1.12 ghi	1.10 g	19.9 bc	23.4 abcde	21.9 g	22.1 bcde
Nebbiolo 01	166 bcd	246 bcd	287 b	233 bc	1.04 cdefg	1.35 d	1.58 bcd	1.34 cde	16.4 de	25.2 a	24.5 bc	22.1 bcde
Petite Sirah 03	173 bc	257 bc	248 bc	226 cd	1.14 abcd	1.53 c	1.23 fgh	1.30 de	18.2 cd	21.9 de	24.0 bcd	21.4 ef
Petite Verdot 01	57 f	56 h	44 g	53 h	0.72 h	0.85 g	0.95 i	0.86 h	18.1 cd	24.1 abcd	26.2 a	23.0 ab
Pinot Noir 18	116 de	152 fg	119 f	129 g	0.98 defg	1.22 de	1.08 ih	1.09 g	19.6 bc	22.6 de	23.2 cdef	21.8 cde
Valdepenase 03	199 ab	219 bcdef	248 bc	222 cd	1.31 ab	1.75 ab	1.70 bc	1.59 ab	20.7 ab	22.0 de	22.2 efg	21.6 de
Viognier 01	99.5 ef	211 cdefg	177 e	163 efg	0.83 gh	1.04 f	1.13 ghi	1.00 gh	15.9 e	22.7 cde	22.1 fg	20.2 f

[z] Mean separation within columns using Fisher's LSD, $p \leq 0.05$. Each value is the average of four blocks, each with 6 vines.

Table 3. Date of harvest (maturity) and cumulative degree-days to maturity for different wine grapes growing under the environmental conditions of Intermountain West Region in southwest Idaho during 1999-2001.

	Harvest date				Cumulative growing degree- day (March 1st to harvest)[z]			
Cultivar clone	1999	2000	2001	3-year average	1999	2000	2001	2000&2001 average
Cabernet Franc 01	24 Sept	4 Oct	28 Sept	29 Sept	2982	3304	3214	3259
Cabernet Sauvignon 11	24 Sept	27 Sept	5 Oct	29 Sept	2982	3200	3300	3250
Carignane 06	8 Oct	17 Oct	12 Oct	12 Oct	3125	3462	3362	3412
Dolcetto 01	15 Oct	17 Oct	12 Oct	15 Oct	3176	3462	3362	3412
Grenache 03	24 Sept	27 Sept	5 Oct	29 Sept	2982	3200	3300	3250
Limberger 02	24 Sept	14 Sept	17 Sept	18 Sept	2982	2991	3033	3012
Malbec 06	24 Sept	21 Sept	17 Sept	21 Sept	2982	3129	3033	3081
Merlot 08	24 Sept	21 Sept	7 Sept	17 Sept	2982	3129	2845	2987
Meunier 01	24 Sept	14 Sept	17 Sept	18 Sept	2982	2991	3033	3012
Nebbiolo 01	8 Oct	17 Oct	28 Sept	7 Oct	3125	3462	3214	3338
Petite Sirah 03	1 Oct	4 Oct	12 Oct	6 Oct	3064	3304	3362	3333
Petite Verdot 01	1 Oct	17 Oct	12 Oct	10 Oct	3064	3462	3362	3412
Pinot Noir 18	24 Sept	14 Sept	17 Sept	18 Sept	2982	2991	3033	3012
Valdepenase 03	24 Sept	31 Aug	17 Sept	14 Sept	2982	2797	3033	2925
Viognier 01	8 Oct	21 Sept	17 Sept	26 Sept	3125	3129	3033	3081

[z]GDD= [(daily maximum temperature + daily minimum temperature/2)-50°F].

grape in this experiment) averaged 11.79 kg/ha per year (6.90 kg/vine per year) over the three growing seasons of 1999, 2000, and 2001 (Table 1). Historically, red wine grapes are believed to produce about 7.5 MT/ha per year and white grape wines about 9.7 MT/ha per year in Idaho (personal communication with Idaho wine grape growers). So, production for most of these cultivar clones was greater than the historical average for Idaho. 'Carignane 06', 'Dolcetto 01', and 'Grenache 03' had relatively higher yields while 'Petite Verdot 01', 'Meunier 01', 'Merlot 08', and 'Pinot Noir 18' had lower cumulative yield over the three-year study than most other grapes (Table 1). 'Grenache 03' often had significantly larger clusters and berries than other grapes (Table 2), which in part could have led to higher yield in this cultivar (Table 1). On the other hand, 'Petite Verdot 01' had often significantly smaller clusters and berries than other grapes during all three seasons (Table 2), resulting in lower yields in this cultivar (Table 1).

Among the 15 cultivar clones tested in this experiment, the first harvested grape in 2000 was 'Valdapenase 03' (August 31st) and in 2001 was 'Merlot 08' (September 7th) (Table 3). In 2001, 'Valdepenase 03' was harvested on September 17. Averaging over three years, 'Valdapenase 03' and 'Merlot 08' had earlier harvest dates while 'Carignane 06', 'Dolcetto 01', and 'Petite Verdot 01' were harvested later than other grapes (Table 3).

In 1999, when grapes were harvested based only on berry color and taste, SSC for different cultivar clones ranged from 15.1 to 20.7 °Brix (Table 2), resulting in a lower GDD accumulation when compared to 2000 and 2001 (Table 3). In 2000 and 2001, SSC ranged from 21.4 to 26.2° Brix, which were closer to the anticipated or target SSC of 22 to 25° Brix. Thus, a more accurate cumulative GDD mean for each cultivar clone is based on the 2000 and 2001 seasons (Table 3).

Since the first frost in southwest Idaho often occurs after October 30, most of the tested grapes can be grown in this area. However, one must consider that in years with low GDD accumulation, 'Carignane 06', 'Dolcetto 01', and 'Petite Verdot 01' may not mature sufficiently. It is particularly important to avoid planting these cultivar clones in areas that have lower GDD accumulation than southwestern Idaho. Other grapes tested in this experiment had sufficient cumulative GDD to mature during all years of this study (Table 3).

In all three years, 'Viognier 01', 'Valdepenase 03', and 'Petite Verdot 01' received high preference rankings by the wine tasters (data not shown). According to these rankings, it seems that 'Viognier 01' is an excellent white wine grape and 'Valdepenase 03' is an excellent red wine grape for southwestern Idaho. There are sufficient cumulative GDD in the region to mature the fruits of these cultivar clones. Each of these cultivar clones had cumulative yields of greater than 20 kg per vine (greater than 35 $MT.ha^{-1}$) over the 1999 to 2001 period (Table 1). In 2001, we had to cluster thin the 'Viognier 01' crop about two to three weeks before harvest to increase the SSC to acceptable levels.

'Petite Verdot 01' wine was described as great "color, soft tannins, and smooth" by wine tasters and received a preference ranking of 7 to 8 (out of 10, data not shown). 'Viognier 01' and 'Valdepenase 03' received favorable rankings ranging from 7 to 9 by tasters (data not shown). 'Viognier 01' wine was described as "nice, peachy, citrus, and crispy" by most evaluators. Wines of 'Carignane 06', 'Grenache 03', and 'Meunier 01' did not receive high rankings (less than 5 out of 10). The relatively low preference for 'Carignane 06' and 'Grenache 03' wines could in part be related to their high yields (Table 1), although SSC values in these cultivar clones in 2000 and 2001 were between 21.4 to 24.4° Brix (Table 2), which were close to the 22 to 25° target SSC. Performance of these cultivars with cluster thinning deserves further study. 'Meunier 01' had relatively low wine performance ranking in spite of its low production (Table 1), and thus is not recommended for planting in southwestern Idaho.

Over-all, 'Viognier 01' was an excellent white wine grape and 'Valdepenase 03' an outstanding red wine grape for southwest Idaho. We do not recommend growing 'Petite Verdot 01' under southwest Idaho's climatic conditions in spite of its excellent wine quality. Low yield of this grape does not economically justify its commercial production.

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