Research Note

Yield Components and Fruit Composition of Six Chardonnay Grapevine Clones in the Central San Joaquin Valley, California

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Abstract: Chardonnay grapevine (*Vitis vinifera*) clones from Foundation Plant Services (FPS), University of California, Davis, were evaluated near Fresno, California. Chardonnay selections FPS 4, 6, 15, 18, 20, and 37 were planted in April 1997 as own-rooted cuttings, and fruit yield and quality were assessed annually between 2000 and 2003. Yield differences among clones were inconsistent, but vines of clone 4 generally had fewer and heavier clusters than vines of other clones, whereas vines of clones 6 and 15 generally had more and lighter clusters. Differences in cluster weight were mainly due to the number of berries per cluster. The fruits of clone 4 had higher soluble solids, lower pH, and similar or higher titratable acidity than the fruits of other clones. However, clone 4 had similar or worse sour rot incidence than the other clones, in contrast with clone 15, which usually had much less sour rot than the others. Results suggest that growers in the San Joaquin Valley, or in other warm-climate areas, might consider planting clone 15 instead of clone 4.

Key words: clonal selection, germplasm, sour rot

Chardonnay is the most widely cultivated winegrape (*Vitis vinifera* L.) in California, with more than 37,810 ha statewide in 2004 (CDFA 2005). Because of its popularity, the Foundation Plant Services (FPS) at the University of California, Davis, has developed and maintained an active program to expand their offerings of registered Chardonnay clones. More than 70 registered Chardonnay clones and subclones from California, Italy, and, especially, France are now available to California growers. However, growers may find it difficult to make an informed decision on what to plant because the relative merits of most of these selections are unknown.

Research in Australia (Cirami 1993, Oag 1991) and in the Salinas (Bettiga 2003) and Napa (Wolpert et al. 1994) Valleys of California has shown that Chardonnay clones may differ with respect to yield and to fruit composition. In both California trials, selection 4, which is currently the California industry's standard clone, was the highest yielding (Bettiga 2003, Wolpert 1994). Its high yields were mainly due to its exceptionally heavy clusters compared with the other selections.

Clones bearing large or heavy clusters may be acceptable in cool climates, but in the warm climate of the San Joaquin Valley, where ~7% of California's Chardonnay is grown (CASS 2005), particularly heavy clusters may be more susceptible to sour rot than smaller, or lighter, clusters (Vail et al. 1998). If so, another clone may be superior to clone 4 in the San Joaquin Valley, but the performance of Chardonnay clones in the Valley has not been assessed. Therefore, the objective of this research was to evaluate the performance of six selections of Chardonnay in Fresno County, California, a warm-climate region.

Materials and Methods

Own-rooted grapevine cuttings of registered Chardonnay clones FPS 4, 6, 15, 18, 20, and 37, were obtained from FPS (Table 1) and planted in April 1997 in a vineyard at Kearney Agricultural Center, Parlier. Clones were planted in a randomized, complete block design with 10 single-vine replicates. Vines were spaced about 2.3 m within rows, and 3 m between rows. Within-row spacing was wider than

Table 1 Foundation Plant Services (FPS) selection numbers and sources for Chardonnay grapevine clones.

FPS clone	Source
4	Martini 5V21, Olmo #66
6	Martini 3V4, Olmo #68
15	Prosser, WA, LR2V6
18	Rauscedo 8, Italy
20	Cornegliano 7, Italy
37	France, 95

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normal to allow a 0.3-m gap between the ends of the cordons to facilitate harvest of the single-vine plots. Vineyard soil was classified as Hanford fine sandy loam with a rooting depth of about 1.5 m (USDA 1971). Vines were subjected to standard cultural practices each year.

The second winter after planting, each grapevine was pruned to two canes that were retained as permanent bilateral cordons. Cordons were supported by a single wire mounted on a trellis at 1.35 m above the vineyard floor. The trellises also had one foliar catch wire about 0.3 m above the cordon wire. Shoot thinning was performed the following spring, leaving 8 to 9 shoots per cordon for permanent spur positions. Each subsequent winter, vines were pruned to 16 to 18 two-node spurs per vine. Flower clusters were counted after shoot thinning, in spring 2000, and every year thereafter until 2003, the last season data were collected.

All vines, regardless of selection, were harvested on the same day, but harvest dates differed each year: 25 Aug 2000, 15 Aug 2001, 27 Aug 2002, and 19 Sept 2003. Fruits of different clones were harvested on the same date so that any differences in the maturation rate among clones could be detected. At each harvest, 100 berries per vine were collected, weighed, and macerated in a blender. Soluble solids from their filtered juice were measured with a temperature-compensating digital refractometer (Palette 101, Atago, Farmingdale, NY). Juice pH was measured with a meter (SA720, Orion Research, Boston, MA) and titratable acidity (TA) was determined by titration with 0.133 *N* NaOH to an 8.20 end point using an automatic titrator (900A, Orion Research). Then, the clusters on each vine were harvested and weighed. Incidence of sour rot was recorded and the number of berries per cluster was calculated. Sour rot incidence was evaluated based on the proportion of clusters having four or more adjoining berries with decay (Fidelibus et al. 2005).

Yield, yield components, and fruit composition data were subjected to analysis of variance using the GLM procedure of SAS software (SAS Institute, Inc., Cary, NC). Block, year, and block by year and block by treatment interaction were considered random effects. When treatment effects were significant ($p \leq 0.05$), treatment means were separated by Duncan's new multiple range test.

Results and Discussion

Differences among clones with respect to yield and to yield components (clusters per vine, cluster weight, berries per cluster, and berry weight) depended on the year as indicated by the highly significant year by clone interaction effects for those variables (Tables 2 and 3). In 2000, vines of clone 4 were among the lowest yielding, but in 2001, vines of that clone were among the highest yielding of the clones tested (Table 2). In contrast, vines of clone 15 had among the highest yields in 2000 but were among the poorest yielding in 2001. Vines of other clones had more consistent yields, and all vines, regardless of clone, had similar yields in 2002 and 2003. Other studies also reported that differences among clones, with respect to yield, varied according to year (Bettiga 2003, Wolpert 1994), but annual differences in those studies were less striking than differences shown here.

Table 2 Yield of Chardonnay clones, 2000 to 2003.

	Total yield/vine (kg)				
Clone	**2000**	**2001**	**2002**	**2003**	**4-yr avg**
4	16.2 c[a]	26.2 a	21.7	23.8	21.9 a
6	17.1 bc	21.3 b	24.2	25.4	22.0 a
15	19.6 ab	15.2 c	21.7	23.0	19.9 b
18	20.8 a	23.1 ab	22.2	24.2	22.6 a
20	21.6 a	20.6 b	22.6	23.7	22.1 a
37	19.9 ab	24.7 ab	22.9	25.5	23.2 a
Significance					
Year (Y)					<0.001
Treatment (T)	0.008	<0.001	0.335	0.300	0.002
Y • T					<0.001

[a]Means followed by a different letter are significantly different, within columns, according to Duncan's new MRT, $p \leq 0.05$.

Table 3 Clusters per vine and cluster weight of Chardonnay clones, 2000 to 2003.

	Clusters per vine (no.)					Cluster wt (kg)				
Clone	**2000**	**2001**	**2002**	**2003**	**4-yr avg**	**2000**	**2001**	**2002**	**2003**	**4-yr avg**
4	73 c[a]	92 c	92 d	56 d	78 d	0.23 a	0.29 a	0.24 a	0.44 a	0.29 a
6	93 ab	116 ab	148 a	72 ab	107 a	0.18 b	0.18 b	0.17 c	0.36 c	0.22 c
15	90 ab	121 ab	138 ab	77 a	107 a	0.22 ab	0.13 c	0.16 c	0.30 d	0.20 d
18	81 bc	110 ab	118 c	65 bc	93 c	0.26 a	0.21 b	0.19 c	0.38 bc	0.26 b
20	96 a	107 b	129 bc	59 cd	98 bc	0.23 a	0.19 b	0.18 bc	0.41 ab	0.25 b
37	85 abc	124 a	140 ab	70 ab	105 ab	0.24 a	0.20 b	0.16 c	0.37 bc	0.24 bc
Significance										
Year (Y)					<0.001					<0.001
Treatment (T)	0.0061	<0.001	<0.001	<0.001	<0.001	0.014	<0.001	<0.001	<0.001	<0.001
Y • T					0.002					<0.001

[a]Means followed by a different letter are significantly different, within columns, according to Duncan's new MRT, $p \leq 0.05$.

Table 4 Berries per cluster and berry weight of Chardonnay clones, 2000 to 2003.

	Berries/cluster (no.)					Berry wt (g)				
Clone	**2000**	**2001**	**2002**	**2003**	**4-yr avg**	**2000**	**2001**	**2002**	**2003**	**4-yr avg**
4	158 bc[a]	195 a	154 a	279 a	192 a	1.4 b	1.5 ab	1.5 a	1.6 b	1.5 b
6	130 c	125 b	107 c	225 b	147 cd	1.4 bc	1.5 b	1.5 a	1.6 b	1.5 b
15	167 ab	84 c	110 c	190 c	138 d	1.3 e	1.5 ab	1.4 b	1.6 b	1.5 c
18	192 a	143 b	120 b	233 b	172 b	1.4 de	1.5 ab	1.6 a	1.6 b	1.5 b
20	151 bc	123 b	107 c	231 b	153 c	1.5 a	1.5 ab	1.6 a	1.8 a	1.6 a
37	174 ab	133 b	104 c	227 b	158 c	1.4 cd	1.5 ab	1.6 a	1.6 b	1.5 b
Significance										
Year (Y)						<0.001				<0.001
Treatment (T)	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	0.182	<0.001	<0.001	<0.001
Y • T						<0.001				<0.001

[a]Means followed by a different letter are significantly different, within columns, according to Duncan's new MRT, $p \leq 0.05$.

Table 5 Sour rot incidence of grape clusters of Chardonnay clones, 2000 to 2003.

	Sour rot incidence (%)				
Clone	**2000**	**2001**	**2002**	**2003**	**4-yr avg**
4	7	18 a[a]	9 a	35 a	16 a
6	6	12 a	5 bc	17 b	10 b
15	6	2 b	2 c	4 c	4 c
18	12	14 a	4 bc	26 ab	14 ab
20	9	13 a	7 ab	23 ab	13 ab
37	13	19 a	9 a	22 ab	15 a
Significance					
Year (Y)					<0.001
Treatment (T)	0.195	<0.001	0.001	<0.001	<0.001
Y • T					0.003

[a]Means followed by a different letter are significantly different, within columns, according to Duncan's new MRT, $p \leq 0.05$.

Table 6 Soluble solids, pH, and titratable acidity (TA) of Chardonnay clones, 2000 to 2003.

	Soluble solids (Brix)	**pH**	**TA (g/100 mL)**
Year			
2000	23.1 b[a]	3.52 c	0.559 b
2001	21.8 c	3.46 d	0.630 a
2002	23.8 a	3.69 b	0.553 b
2003	22.9 b	4.03 a	0.483 c
Clone			
4	23.7 a	3.60 c	0.584 a
6	22.9 b	3.70 a	0.555 b
15	22.8 b	3.70 ab	0.581 a
18	22.7 bc	3.67 b	0.534 c
20	22.4 c	3.68 ab	0.555 b
37	23 b	3.68 ab	0.534 c
Significance			
Year (Y)	<0.001	<0.001	<0.001
Treatment (T)	<0.001	<0.001	<0.001
Y • T	0.285	0.866	0.800

[a]Means followed by a different letter are significantly different, within year, clone, and columns, according to Duncan's new MRT, $p \leq 0.05$.

Although vines of clone 4 had relatively variable yields, their yield components differed from the other clones in a rather consistent manner (Table 3). For example, vines of clone 4 had the fewest clusters each year of the clones tested and the heaviest clusters in three out of four years. Vines of clones 6 and 15 also consistently differed from vines of other clones by having more and lighter clusters. These findings are similar to other studies (Bettiga 2003, Wolpert 1994).

The clusters of clone 4 were generally heavier than clusters of other clones because they usually had the most berries per cluster (Table 4), as reported elsewhere (Bettiga 2003, Wolpert 1994). Differences among other clones with respect to the number of berries per cluster or to berry weight were less consistent, though vines of clone 15 had the fewest berries per cluster in two of four years, and vines of clone 20 had the heaviest berries of the clones tested in two of four years.

Fruits of each clone were susceptible to sour rot, but in 2001 and 2003 vines of clone 15 had 80 to 90% fewer clusters with rot than the vines of other clones, and in 2002 they had at least 70% fewer clusters with rot than the vines of clones 4, 20, or 37 (Table 5). Clones 4, 20, and 37 often had similarly high incidence of sour rot. These findings are in agreement with a study that found Chardonnay clone 15 had the least compact clusters, and the lowest sour rot incidence, of several clones tested (Vail et al. 1998). The relatively good sour rot resistance of clone 15 could enhance its yield, relative to the other clones, by reducing the amount of fruit needing to be culled.

Differences among clones with regard to fruit composition were independent of year (Table 6), despite annual yield variations. Vines of clone 4 had fruits with some of the most desirable characteristics of the clones tested: higher soluble solids, lower pH, and high titratable acidities (Table 6). The fruits of clone 15 had fewer soluble solids, and a higher pH than the fruits of clone 4, but a similarly high titratable acidity. Wolpert et al. (1994) reported that clone 4 was late-maturating, perhaps because of its relatively high yields in that trial.

Conclusions

Results indicate that growers in the central San Joaquin Valley may wish to consider planting Chardonnay clone 15 instead of clone 4. Clone 4 generally had good yield and good fruit composition but, among the clones tested, it was one of the most susceptible to sour rot. Clone 15 had lower yields, but was much less susceptible to sour rot, and it had good fruit composition.

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