Research Note

Performance of Zinfandel and Primitivo Grapevine Selections in the Central San Joaquin Valley, California

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Abstract: Zinfandel and Primitivo grapevines selections (*Vitis vinifera*) from Foundation Plant Services at UC Davis were evaluated near Fresno, California. Zinfandel selections FPS 1A, 2, and 3 and Primitivo selections FPS 3, 5, and 6 were planted in April 1997 as own-rooted cuttings, and fruit yield and quality were assessed annually from 2000 to 2003. There were few differences among the Zinfandel selections. Primitivo selections were generally superior to those of Zinfandel, having earlier fruit maturity, similar or higher yield, and similar or lower bunch rot susceptibility. Selections Primitivo 3 and 6 were particularly desirable, having the highest yield and lowest sour rot susceptibility, respectively.

Key words: clones, germplasm, clonal evaluation

Zinfandel and Primitivo are considered to be selections of the same grapevine (*Vitis vinifera* L.) cultivar (Bowers 1998), recently identified as Crljenak kastelanski (Maletic et al. 2004). This cultivar was once grown in the eastern United States as a table grape called Black St. Peter's, but by the mid-1800s it was highly regarded in California as a red winegrape known as Zinfandel (Sullivan 1982, Wolpert 1996). Zinfandel is now the second most widely grown black-fruited winegrape cultivar in California, behind Cabernet Sauvignon. In 2003 there were more than 20,300 ha of Zinfandel vines statewide, with about 26% of those in the central and southern San Joaquin Valley (CDFA 2003a).

Although the central and southern valley is an important Zinfandel growing region, fruits from there tend not to develop the strong varietal flavor characteristics desired for premium red wines and are thus most suitable for White Zinfandel or lower priced wines. As a result, Zinfandel grapes from the central and southern San Joaquin Valley sold for about $250 per ton in 2003, whereas the average California-wide price was $428 per ton (CDFA 2003b). Therefore, the goal of many grapegrowers from the region is to optimize yield of acceptable-quality fruit.

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Planting superior germplasm is a fundamental viticultural practice to enhance yield and quality. For example, a major impediment to producing Zinfadel fruit of acceptable quality in the central San Joaquin Valley is the cultivar's high susceptibility to sour rot (Smith 2003). No chemical treatments are known to prevent sour rot, a disease complex involving several types of microorganisms including bacteria and fungi (Marois et al. 1992), but Zinfandel selections may vary in their susceptibility to it (Verdegaal and Rous 1995).

Foundation Plant Services (FPS) at the University of California, Davis, offers more than 14 selections of Zinfandel and Primitivo, but the relative merits of these selections, when grown in the southcentral San Joaquin Valley, are unknown. The fruit of Primitivo selections are thought to be earlier ripening and less susceptible to sour rot than those of Zinfandel (Smith 2003), but Primitivo 3 is the only selection that has been evaluated in California (Verdegaal and Rous 1995, Wolpert 1996). The objective of this research was to assess the performance of three selections each of Zinfandel and Primitivo in Fresno County, California, a warm-climate region.

Materials and Methods

Own-rooted grapevine cuttings of Zinfandel 1A, 2, and 3 and Primitivo 3, 5, and 6 were obtained from FPS (Table 1) and planted in April 1997 to a vineyard at the Kearney Agricultural Center, Parlier, California. In Fresno County, most commercial winegrape vineyards (~85%) are on their own roots (P. Christensen, personal observation, 2005). The selections were planted in a randomized, complete block design replicated 10 times. Each treatment replicate consisted of a single vine. Vines were spaced about 2.3 m within rows and 3.0 m between rows. Within-row spacing was wider than average to facilitate harvest of the single-vine plots. The vineyard soil was classified as a Hanford fine sandy loam with a rooting depth of about 1.5 m (USDA 1971). Vines were irrigated by furrow between May and September of each year for 24 hr every 3 weeks.

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. Such a trellis is the most common, if not the standard, system in the San Joaquin Valley, where the climate is too warm and the vines too vigorous for a vertical shoot-positioned trellis. 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 two-node spurs per vine: about 8 to 9 spurs per m cordon. Flower clusters were counted after shoot thinning, to about 32 shoots per vine, in spring 2001, and every year thereafter until 2003, the last season data were collected.

All vines, regardless of selection, were harvested on the same day, although harvest dates differed each year: 5 Sept 2000; 28 August 2001; 5 Sept 2002; 29 August 2003. At each harvest, 100 berries per vine were collected, weighed, and macerated in a blender. Soluble solids from their filtered juice was 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 was determined by titration with 0.133 *N* NaOH to an 8.20 end point using an automatic titrator (900A, Orion Research). The clusters on each vine were then harvested and weighed. The incidence of cluster rots was recorded (from 2001 to 2003), the clusters were weighed, and the number of berries per cluster were calculated. Sour rot incidence was evaluated based on the proportion of clusters having four or more adjoining berries with decay.

All data were subjected to analysis of variance using the GLM procedure of SAS software (SAS Institute, Cary, NC). Block, year, block by year interaction, 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

Though each variable measured differed between years, selection effects were consistent and independent of year (Tables 2 and 3). Vines of Primitivo 3 produced about 15% higher yields than any other selection. Zinfandel 3 had better yields than 1A, but similar yields to the other selections (Table 2). Average cluster weight was between 0.30 and 0.35 kg, with between 104 and 126 berries per cluster, regardless of the selection (Table 2). Thus, the superior yield of Primitivo 3 vines was mostly due to the higher number of clusters they formed compared to the other selections (Table 2).

These data are in contrast with those collected in the northern San Joaquin Valley, where Zinfandel selections 1A, 2, and 3 produced similar yields that were generally greater than those of Primitivo 3, the only Primitivo selection previously evaluated (Verdegaal and Rous 1995,

Table 1 Foundation Plant Services (FPS) selection numbers and sources for Zinfandel and Primitivo grapevine selections.

FPS No.	Source
Zinfandel 1A	Lodi, Calif., Handel vineyard 1V4
Zinfandel 2	Lodi, Calif., Handel vineyard 1V6
Zinfandel 3	Livermore, Calif., Ruetz vineyard #1
Primitivo 3	Bari, Italy PI 325796A
Primitivo 5	Calo, Italy from selection 1
Primitivo 6	Calo, Italy from selection 2

Table 2 Yield and yield components of Zinfandel (Z) and Primitivo (P) grapevine selections, Parlier, CA, 2000–2003.

	Yield/vine (kg)	Cluster wt (kg)	Berries/cluster (no)	Clusters/vine (no)	Berry wt (g)
Year					
2000	24.3 a[a]	-[b]	-[b]	-[b]	2.44 c
2001	23.8 a	0.27 b	103 b	77 b	2.61 b
2002	22.4 a	0.21 c	74 c	106 a	2.88 a
2003	20.0 b	0.46 a	162 a	53 c	2.89 a
Selection					
Z 1A	20.4 c	0.30	104	73 b	2.77 a
Z 2	21.3 bc	0.31	107	75 b	2.75 a
Z 3	23.4 b	0.35	126	75 b	2.76 a
P 3	26.0 a	0.32	116	91 a	2.64 b
P 5	22.2 bc	0.30	117	79 b	2.57 b
P 6	22.1 bc	0.31	110	80 b	2.78 a
Significance					
Year (Y)	<0.001	<0.001	<0.001	<0.001	<0.001
Selection (S)	<0.001	0.11	0.10	<0.001	<0.001
Y • S	0.57	0.96	0.92	0.13	0.19

[a]Means, within year, selection, and columns, followed by a different letter are significantly different according to Duncan's new multiple range test, $p < 0.05$.
[b]Data not reported.

Table 3 Sour rot incidence of grape clusters, and soluble solids, titratable acidity (TA), and pH of grape juice from Zinfandel (Z) and Primitivo (P) grapevine selections, Parlier, CA, 2000–2003.

	Sour rot incidence (%)	Soluble solids (Brix)	TA (g/100 mL)	pH
Year				
2000	-[a]	18.53 d	0.61 b	3.38 d
2001	29 c[b]	22.66 a	0.50 d	3.57 a
2002	63 a	20.67 b	0.58 c	3.44 c
2003	46 b	20.20 c	0.73 a	3.48 b
Selection				
Z 1A	50 ab	20.05 c	0.60	3.47 b
Z 2	55 a	20.16 c	0.60	3.45 b
Z 3	52 ab	19.56 d	0.59	3.45 b
P 3	40 cd	21.10 b	0.61	3.46 b
P 5	44 bc	20.82 b	0.62	3.48 b
P 6	34 d	22.00 a	0.60	3.52 a
Significance				
Year (Y)	<0.001	<0.001	<0.001	<0.001
Selection (S)	<0.001	<0.001	0.10	0.009
Y • S	0.06	0.18	0.95	0.07

[a]Data not reported.
[b]Means, within year, selection, and columns, followed by a different letter are significantly different according to Duncan's new multiple range test, $p < 0.05$.

Wolpert 1996). Further, the Zinfandel selections in those studies had fewer and larger clusters than Primitivo 3. Differences between these studies suggest an interaction between the selections and their rootstocks (Wolpert [1996] grafted the selections to Harmony), the value of regional data for making recommendations on planting material, or both.

All of the selections suffered from sour rot, but fewer clusters of Primitivo 6 were affected by rot compared to any selection other than Primitivo 3 (Table 3). Verdegaal and Rous (1995) observed less sour rot in Primitivo 3 than in some Zinfandel selections, but sour rot in general is much less of a problem in the northern San Joaquin Valley than it is further south. Primitivo 3 and 5 had smaller berries than the other selections (Table 2), but each selection had large berries for winegrapes (Table 2). Such large berries are typical of Zinfandel and probably account for its high susceptibility to sour rot (Marois et al. 1992) and its early acceptance as a table grape (Smith 2003, Sullivan 1982, Wolpert 1996).

Each of the Primitivo selections had higher soluble solids at harvest than any of the Zinfandel selections (Table 3), as observed by others (Verdegaal and Rous 1995, Wolpert 1996). That is perhaps not surprising since the Italians named the cultivar Primitivo for its precocious fruit maturation (Russo et al. 2003). Even so, Primitivo 3 is notable in that it had high yields of fruit with high soluble solids. The titratable acidity of the fruit's juice did not differ between selections (Table 3); only minor differences in titratable acidity between selections were noted by others (Verdegaal and Rous 1995, Wolpert 1996). The fruit of Primitivo 6 had a higher juice pH than the others (Table 3), reflecting the earlier maturity of that selection's fruit. The earlier maturity of Primitivo 6, as compared to Primitivo 3, could be due to its lower yield.

Conclusion

There were few differences between the Zinfandel selections tested. The Primitivo selections performed the best, having earlier fruit maturity, similar or higher yield, and similar or lower bunch rot susceptibility than the Zinfandel selections. Selections Primitivo 3 and 6 were particularly desirable, having the highest yield and lowest bunch rot susceptibility, respectively.

Literature Cited

Bowers, J.E. 1998. The use of simple sequence repeat (SSR) and amplification fragment length polymorphism (AFLP) markers for analysis of interrelationships and origins of winegrape cultivars. Ph.D. thesis, University of California, Davis.

CDFA. 2003a. Grape Acreage Report. California Department of Food and Agriculture, Sacramento, CA.

CDFA. 2003b. Grape Crush Report, 2003 Crop. California Department of Food and Agriculture, Sacramento, CA.

Maletic, E., I. Pejic, J. Karoglan Kontic, J. Piljac, G.S. Dangl, A. Vokurka, T. Lacombe, N. Mirosevic, and C.P. Meredith. 2004. Zinfandel, Dobricic, and Plavac mali: The genetic relationship among three cultivars of the Dalmation coast of Croatia. Am. J. Enol. Vitic. 55:174-180.

Marois, J.J., A.M. Bledsoe, and L.J. Bettiga. 1992. Miscellaneous secondary invaders and sour rot. *In* Grape Pest Management, 2d ed. D.L. Flaherty et al. (Eds.), p. 69. University of California Division of Agricultural and Natural Resources, Oakland.

Russo, G., V. Liuzzi, L. D'Andrea, and G. Alviti. 2003. Comparison among five clones of "Primitivo" vine in Southern Italy. *In* VIII International Congress on Grape. E. Hajdu and É. Borbás (Eds.). Acta Hort. (ISHS) 603:779-786.

Smith, R.J. 2003. Zinfandel. *In* Wine Grape Varieties in California. L.P. Christensen et al. (Eds.), pp. 163-166. University of California Division of Agricultural and Natural Resources, Oakland.

Sullivan, C.L. 1982. Zinfandel: A true *vinifera*. Vinifera Wine Growers J. 9:71-86.

USDA. 1971. Soil Survey, Eastern Fresno Area, California. USDA Soil Conservation Service, Washington, DC.

Verdegaal, P.S., and C. Rous. 1995. Evaluation of five Zinfandel clones and one Primitivo clone for red wine in the Lodi appellation of California. *In* Proceedings of the International Symposium on Clonal Selection. J.M. Rantz (Ed.), pp. 153-156. American Society for Enology and Viticulture, Davis, CA.

Wolpert, J.A. 1996. Performance of Zinfandel and Primitivo clones in a warm climate. Am. J. Enol. Vitic. 47:124-126.