

The Zinfandels of FPS

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THE STORY OF THE ZINFANDELS of Foundation Plant Services (FPS) is a complex one. Three distinct sources of clones may have developed separately in three countries for well over 100 years. The "Zinfandel" grape is grown across multiple climate regions, yielding many unique varietal wines. The grape's enigmatic path to California has never been completely resolved and possibly never will be. What is clear is that the grape known in the 19th century as "the Zinfandel" is the only important *V. vinifera* wine variety closely identified exclusively with California.

The best evidence suggests that Zinfandel came to California around 1850. Plant material was shared and exchanged freely up and down the state thereafter, especially during the wine boom of the late 19th century when many new varieties were imported from Europe and elsewhere. Along with the new varieties came grapevine virus diseases. Very little was known about the effect of plant viruses on grapevines until the 1940s. It wasn't until 1952 that the State of California formed an association to develop, maintain and distribute virus-free grape stock that was true to the variety name. (Alley and Golino 2000) The long history of propagation of the Zinfandel grape from non-certified field selections, and the uncertain origins of the grape have resulted in the existence of relatively few virus-tested clonal selections of certified origin in California. (Verdegaal and Rous 1995) In 1990, there were only five selections of Zinfandel registered in the Foundation Plant Services collection; today, forty-seven selections are 'in the pipeline' at various stages of virus testing, clean up, and inclusion in the Foundation vineyard.

Zinfandel is the fourth leading wine grape variety (behind Chardonnay, Cabernet Sauvignon, and Merlot) in total acreage in California. The California Department of Food and Agriculture reported in April 2007 that there were 52,361 acres of Zinfandel (including Primitivo) grapes planted in 2006. (California Agricultural Statistics Service 2007) Although Zinfandel has a presence in 44 counties, the areas with at least 1000 acres of Zinfandel/Primitivo standing are Amador, Fresno, Kern, Madera, Mendocino, Merced, Napa, Sacramento, San Joaquin, San Luis Obispo, Sonoma, and Tulare counties. These California counties lie in all five regions on the Winkler heat summation scale, from the coastal valley and hill areas (regions I-III)



Drs. Edi Maletić and Ivan Pejić examine a Plavac mali vine on the island of Solta off the Dalmation Coast. These researchers, from the University of Zagreb, collaborated with Dr. Carole Meredith to unravel the DNA mysteries of Zinfandel, and spoke at the UCD symposium 'Variety Focus: Zinfandel.' Photo courtesy of Ivan Pejić

to the Central Valley counties and portions of the Sierra foothills (regions IV-V).

Zinfandel wine takes many forms, in part due to the quality of grape, the vineyard management practices applied and the location of the vineyard within California's varied topography. Zinfandel grown for red wine production can be either tannin-rich (needing aging) or light and fruity with softer tannins. (Sullivan 2003) Zinfandel grapes grown in the hotter areas of the Central Valley (regions IV-V) are frequently made into white or pink Zinfandel, a popular wine with a higher sugar and lower alcohol content. Finally, late-harvested Zinfandel with its high alcohol content is appropriate for dessert wines in the style of port. The grape is complex and versatile.

The mystery of the origin and identity of California's Zinfandel variety has been reported thoroughly in many scientific journals, in historian Charles L. Sullivan's *Zinfandel: a History of a Grape and Its Wine* (2003) and Dr. Jasenka Piljac's *Zinfandel: A Croatian-American Wine Story*

(2004). Definitive genetic analysis in 2003 ultimately made a crucial link when it proved that California's Zinfandel, Italy's Primitivo and Croatia's Crljenak/Pribidrag all share the same DNA profile. (Maletić et al. 2003, 2004)

Although the path Zinfandel took to California is still not certain, the most plausible theory of the grape's journey to the United States starts with the Austrian Imperial Nursery collection in Vienna, from which an amateur horticulturist named George Gibbs brought the grape to Long Island, New York in the 1820s. At that time, the Austrian Empire included the kingdom of Hungary, of which the territory now known as Croatia was a part. The importance of this fact will later become apparent. In the early 1800s, Zinfandel (known then as Zinfindal, Zenfendel and Black St. Peters) was used as a table grape grown in hothouses on the East Coast. The origin of the name "Zinfandel" is similarly not clear. However, an 1830 text by William Robert Prince, *A Treatise on the Vine*, mentions a "Black Zinfandel of Hungary" in a list of foreign varieties of recent introduction to the United States. (Sullivan 2003)

Zinfandel's journey to California probably occurred around the time of the Gold Rush in the early 1850s. A search of public records by Sullivan revealed that many shipments of *V. vinifera* varieties, including Zinfandel, were made from the East Coast to the West Coast by men such as Frederick Macondray and Anthony P. Smith. *Vinifera* varieties were also imported from Europe around that time. Zinfandel began to be recognized as a wine in its own right in the 1860s and then emerged as an exceptional grape variety for wine making in northern California in the 1880s. Thereafter, the Zinfandel name would be closely identified with the State of California.

At the same time, a grape variety called Primitivo developed a reputation of its own in Italy. Primitivo is grown principally in Puglia (Apulia), a long fertile region along the Adriatic Coast in southeast Italy. Puglia, like California, experiences mild wet winters and hot summers with scarce rainfall. The name "Puglia" derives from the Roman *a-pluvia* or "lack of rain." (Robinson 2006) Because of the high alcohol and intense pigmentation of the wines made with Primitivo in the area, Primitivo wines are often used in Italy to fortify red wines made in cooler regions. (Golino, personal communication)

One theory posits that the Primitivo grape was taken across the Adriatic Sea from Croatia to Puglia in the 18th century. (Maletić et al. 2004; Robinson 2006) Dr. Giovanni Martelli of the Istituto di Patologia Vegetale in Bari, Italy, stated in an e-mail that the first recorded presence of the Primitivo grape in Italy was in Gioia del Colle, a small town of Puglia located in the hills of Murgia. Gioia is situ-

ated halfway between the Adriatic and Ionian Seas and halfway between Bari and Taranto. Mr. Francesco Filippo Indellicati, a local priest who was also a learned amateur botanist and agronomist, made a note of the Primitivo grape in Gioia town records in 1799. Today, over 70% of the vineyards in Puglia are in the plains with very high daytime temperatures. Primitivo is primarily cultivated on the western side of the flat Salento peninsula in Puglia near the city of Manduria, about 100 km southeast of Bari. Puglia and the Croatian region on the Dalmatian Coast have similar climatic conditions—marine influence, humidity, cool summer nights. The Salento peninsula (Puglia), central and southern Dalmatia, and certain warmer areas in the Central Valley of California are in Winkler climate zone IV. However, the growing season is drier in California than that of the central Dalmatian Coast. (Maletić et al. 2003)

In the late 1960s, USDA-ARS Plant Pathologist Dr. Austin Goheen discovered the Italian grape. He was dining one evening in Italy with Dr. Martelli when he tasted a wine he thought was a Zinfandel. The two men then went to a vineyard located between Bari and Gioia del Colle (40 km southeast of Bari), where Goheen collected the plant material which eventually became Primitivo FPS 03. He brought some plant material back to the USDA facility in Davis, California. Once Primitivo and Zinfandel were planted side-by-side, they appeared to be the same variety. (Maletić et al. 2003; Mirošević and Meredith 2000) Subsequent genetic comparison (isozyme patterns, restriction fragment length polymorphisms, microsatellite alleles) confirmed that the two grapes share the same genetic profile. (Bowers 1998; Maletić et al. 2003)

Although the DNA profiles for Zinfandel and Primitivo appear to be identical, some clonal divergence seems to have resulted over time, most likely attributable to the lengthy period of independent development of the two grapes in California and Italy, respectively. (DNA profiles are excellent for distinguishing between grapevine varieties but cannot be used to identify clones.) Dr. Andrew Walker states (personal communication) that it is difficult to visually distinguish California Zinfandel selections from the Primitivo selections now in the FPS collection when they are growing side-by-side in the field, but there are some subtle differences in appearance. Primitivo berries are slightly smaller than Zinfandel; the size discrepancy is noted if the two grapes are simultaneously viewed together or if one measures the berries. Both Primitivo and Zinfandel have tight clusters and thin skin, which favors bunch rot with this genotype. However, Primitivo has looser clusters than Zinfandel, and consequently less rot. In some environments, Dr. Walker has also seen a slight

difference with respect to hairiness on the leaves of the two groups of grapes. In California, Primitivo leaves can have felty, dense hair on the back of the leaves, while Zinfandel leaves have a cobwebby consistency. More observation across leaves of similar age and in similar climates and locations is needed to make a conclusive finding on differences between the leaves.

In a communication to the Alcohol and Tobacco Tax and Trade Bureau (TTB) of the U.S. Treasury Department on the issue of whether or not Zinfandel and Primitivo should be treated as synonyms for purposes of wine labeling, Dr. Carole Meredith of the University of California, Davis, whose lab was the first to make a genetic comparison of the two grapes, noted that the independent propagation of the two varieties has resulted in small differences, such as berry size or fruit composition, that she believed could be significant for wine-making. Although the European Union recognizes the name Zinfandel as a synonym for the Primitivo grape, TTB continues to maintain them as separate prime grape variety names used to designate American wines. Consequently, Zinfandel and Primitivo may not be used as synonyms on wine labels for wines made in the United States.

The search for the “true origin” of the Zinfandel grape took a new path in the 1990s. Many have speculated that Zinfandel may have its origin in Hungary or other areas of Eastern Europe, practically all of which was within the Austrian Empire at the time Zinfandel was brought to the United States.

Researchers from the Faculty of Agriculture, University of Zagreb (Drs. Edi Maletić and Ivan Pejić) and local experts in Dalmatia identified a Croatian grape called Plavac mali, an autochthonous Dalmatian cultivar that looked like Zinfandel. The Croatian scientists collaborated with Dr. Meredith to test the DNA profile of Plavac mali against Zinfandel and Primitivo. (Mirošević and Meredith 2000) The profiles did not match. The similarity of the two grapes was later explained by the discovery that Zinfandel is one of the parents of Plavac mali. (Maletić et al. 2004)

In 2001, the Croatian scientists found another local vine called Crljenak kaštelanski (“the red from the town of Kašteli”) in a coastal town called Kaštel Novi in central Dalmatia north of Split. The Kaštela region is an ancient wine-growing area in Eastern Europe, from the time before the Roman occupation. The climate is characterized by long and warm summers and mild winters, although the climate in Kaštela is wetter than California is during the growing season. (Maletić et al. 2004) In 2002, additional vines known locally as Pribidrag were found in the Dalmatian coastal town of Omiš.

Crljenak and Pribidrag looked morphologically identical to Zinfandel. Drs. Maletić and Pejić sent the vines to Dr. Meredith, who confirmed that the DNA profile of the two grapes was identical to Zinfandel. (Anonymous 2002) Records and herbarium specimens in Croatia indicate that this cultivar (known in Croatia by many synonyms) was once prominent in Dalmatia and either originated in Kaštela or had a lengthy association with that region. The scientists also concluded that their research results are con-



Crljenak kaštelanski vine in Croatia. The DNA profile for this Croatian variety has been shown to be identical to California Zinfandel, and vines have been brought to FPS for testing and evaluation. Croatian winemakers have also focused more attention on this variety, which previously had not been an important varietal in their winemaking industry.

Photo courtesy of Ivan Pejić

sistent with Zinfandel belonging to the broader Croatian gene pool in Dalmatia (as opposed to gene pools in Greece and Italy). The vines found to be identical to Zinfandel are rare in Croatia today. (Maletić et al. 2004) In fact, prior to its discovery in 2001, Crljenak had not been bottled as a varietal in its own right in Croatia. (M. Andrew Walker, personal communication)

One of the active parties in the effort to bring the Croatian grapevines to California is Ridge Vineyards, which imported Crljenak kaštelanski and Pribidrag plant material to the United States via FPS in 2002 and 2005, respectively. The source of the Crljenak vines was Kaštel Novi, Croatia, and the Pribidrag was from Svinisce and Marusici, Croatia. Ridge Vineyards and the Croatian scientists hope that testing under experimental conditions will show that the Croatian clone line possesses qualities that could enrich California Zinfandel wines. David Gates, Vice-President of Ridge Vineyards, stated, "The genetic variability in these selections from Croatia will hopefully add a bit more complexity and diversity to California Zinfandel. It will be fun to see in the coming years just how that genetic variability will express itself—viticulturally and in the wines made from these grapes." FPS selections of both Zinfandel and Primitivo were sent to Croatia as part of this international exchange, where they will be compared to indigenous clones for vineyard and winemaking performance.

The original Crljenak plant material suffered from virus and underwent shoot tissue culture propagation, the virus testing of which should be completed by 2008. The Pribidrag is a few years behind that. Once selections of each qualify for the California Grapevine Registration & Certification (R&C) Program, they will be released from federal quarantine, planted in the FPS Foundation vineyard, and distributed to Ridge Wines. Ridge Wines will retain an exclusive right to the plant material for two years, after which each selection will be available to the public.

Most of the Zinfandel plant material in California originated with the vines imported to the state in the mid-1800s. Trials are underway to explore the clonal diversity of 'Heritage' Zinfandel from around the state with the hope of finding superior material well adapted to our vineyard conditions. (See 'Public Heritage Zinfandel Clones') The discovery of the Croatian Zinfandel selections growing under the names Crljenak and Pribidrag could have a significant impact on the genetic diversity of the Zinfandel clonal material in California. Crljenak/Pribidrag was originally cultivated as a variety in central Europe, not in California or Italy. It would be reasonable to expect the greatest diversity of clonal variation would be in this region, perhaps with unique qualities that new clones of the grape from Croatia might offer to winemakers.

Primitivo offers another source of genetic diversity for California's Zinfandel since there may be important clonal variation in Italy. We do not know at this time whether the selections of Primitivo introduced by Dr. Goheen are typical of Italian clones.

It may be helpful to review some of the conventions at FPS for the identification of selections. Because it is difficult to tell clones apart objectively, and duplicate clones may come to the FPS collection from more than one source, each introduction receives a unique FPS selection number to preserve its identity. In addition, sub-clones that have been produced by heat treatment or tissue-culture virus-elimination therapy also receive unique numbers since their clonal performance may vary because of changes in vine health due to differing virus status or even the possibility of mutation during therapy.

REGISTERED FPS PUBLIC SELECTIONS

The registered and certified Zinfandel selections currently available to the public at FPS include Zinfandel FPS 01A, 02, 03 and 06. There are also a number of proprietary selections maintained at FPS for various owners.

Zinfandel FPS 01A and Zinfandel FPS 02 came to FPS in 1961 from a vineyard in Lodi owned by Leon Handel. The climate in the Lodi-Woodbridge area is amenable to growing good quality Zinfandel grapes due to the marine influences permeating the San Joaquin Delta region of the Central Valley. San Joaquin County has led the state in total Zinfandel acreage since the middle of the last century. (Sullivan 2003) Statistics reported by CDFA in the 2006 Grape Acreage report show that the San Joaquin Valley now has ~20,200 acres of Zinfandel (including Primitivo) of the ~50,000 acres of Zinfandel grapes planted in California.

The original plant material from Lodi tested negative for virus. Zinfandel FPS 1A and 02 were registered in the California Grapevine R&C Program in 1962 without any kind of virus elimination treatment. Both selections are still available from FPS as California Foundation stock.

Zinfandel FPS 06 was propagated from Zinfandel FPS 01A in 1966. The difference is that Zinfandel FPS 06 underwent heat treatment for 117 days. It first appeared on the registered selection list in 1967 and has consistently tested negative for all viruses.

Zinfandel FPS 03 came to FPS in 1964 from a vineyard (Reutz #1) near Livermore, California. Zinfandel has a long tradition in the Livermore Valley and was an important wine grape variety planted there as far back as 1885. (Sullivan 2003) According to Phil Wente of Wente Vineyards, the Reutz vineyard was a 40-acre farm owned

and farmed by Reinhardt Reutz on Vineyard Avenue just southeast of Pleasanton, California. The vineyard had been planted during Prohibition and, over the years, the grapes were sold to Ruby Hill Winery, Cresta Blanca Winery, Almaden, and Wente Bros. Winery. Mr. Wente explained, "When UC Davis began the process of collecting vines for the Foundation vineyard, my grandfather, Ernest Wente, told Harold Olmo that the best Zinfandel in the Livermore Valley was grown in the Reutz Vineyard. A number of other premier varieties were selected from the Livermore Valley as representative of their overall quality, and it was only natural that Zinfandel from this region would be considered as well, based on the quality wines produced over the years from the Reutz Vineyard." The Reutz vineyard was pulled out in the late 1970s when Mr. Reutz was unable to continue farming it.

Zinfandel FPS 03 did not receive heat treatment, and first appeared on the list of registered selections for public distribution in 1965. It is still available from FPS as California Foundation stock.

Primitivo FPS 03, 05 and 06 were imported from Italy. Primitivo FPS 03 was obtained in 1968 by Dr. Austin Goheen through the Istituto di Patologia Vegetale in Bari, Italy, the capital city of the Puglia region. The material that became Primitivo FPS 03 underwent heat treatment for 59 days before coming to the United States as USDA plant introduction (PI)325796-A-1. For a while, even after planting in the Foundation vineyard in 1971, the selection was known as Primitivo de Gioia, a synonym for Primitivo in the Vitis International Variety Catalogue. Some time prior to planting in the Brooks South vineyard in 1984, the name of this selection was changed to simply "Primitivo." Dr. Martelli explained that the name "Primitivo di Gioia" is the "older" denomination of the variety and now cannot be used any longer, even in Italy, because the European Union has determined that the names of grape cultivars grown in the EC cannot contain links to geographical locations. The TTB has imposed the same rule in the United States.

After arrival in Davis, the original mother plants of Primitivo FPS 03 tested negative for virus. Mother plants were established in the FPS Foundation block in 1971 but not professionally identified. Primitivo FPS 03 was first registered and distributed to the public in 1984 and it still available from FPS as California Foundation stock.

Primitivo FPS 05 and 06 are two of four selections that were sent from Italy to FPS in 1987 by Dr. Antonio Calò, of the Istituto Sperimentale Viticoltura in the Veneto region of northeast Italy. The Istituto is an experimental viticultural station established in 1923 in Conegliano and houses an ampelographic collection of more than 2000

grape varieties. (Robinson 2006) Selections 1 and 2 sent by Dr. Calò are now Primitivo FPS 05 and 06, respectively. These Primitivo selections were provided to FPS at the request of Dr. Goheen, who desired more Primitivo selections to compare to Zinfandel. Both selections tested negative for viruses and became registered in the R&C Program in September of 1994.

STUDIES ON PRIMITIVO AND ZINFANDEL

The publicly-available FPS Primitivo and Zinfandel selections underwent a series of comparisons by several research groups in California between 1990 and 2003.

The studies were conducted at three different sites, using varied experimental protocols for vine management. The results demonstrated that, although both varieties share the same DNA structure, there can be meaningful differences between the Primitivo and Zinfandel selections in terms of performance in the field and in the character of the wine produced.

The four publicly-available FPS Zinfandel selections (Zinfandel FPS 01A, 02, 03 and 06) and Primitivo FPS 03 were compared in a vineyard near Arbuckle, in the Sacramento Valley. The vines were planted in 1988, and data was taken for years 1990-1994. Harmony was used as rootstock, and the vines were trained to a T-trellis with a bilateral cordon formation on the lower wire. Vines were drip irrigated and spur pruned. (Wolpert 1996)

The researchers at Arbuckle found few differences in growth and yield parameters among Zinfandel clones. Zinfandel FPS 06 (the heat treated selection from Zinfandel FPS 01A) had been included in the trial to test whether heat treatment *per se* had any viticultural significance. Zinfandel FPS 06 did show some differences from Zinfandel FPS 01A in pruning (+ 0.2 kg) and berry (+ 0.15 g) weights. However, none of the Zinfandel selections demonstrated the looser clusters and smaller berries exhibited by Primitivo FPS 03.

Zinfandel selections FPS 01A, 02, 03, and 06 and Primitivo FPS 03 were included in another trial in the years 1991-1997 in the San Joaquin Valley near Lodi, California. The 1991-1993 vines were grown for White Zinfandel production and the remaining years for red Zinfandel. Vines were grown on Freedom rootstock, trained to a bilateral cordon and spur pruned. A low volume drip system provided irrigation. The production data was very similar over the years of the experiment in terms of trends and significant differences; the 1994 data was used to report the findings. (Verdegaal and Rous1995)

In the Lodi trial, there was little or no significant difference among the Zinfandel clones in terms of performance

in the field. The primary finding in this trial was a significant difference between Primitivo FPS 03 and the FPS Zinfandel clones. The Zinfandel group had higher yields and fewer clusters per vine, higher cluster and berry weights, and later maturity dates than Primitivo FPS 03. Using the 1994 data (for red wine production), they found that the Zinfandel group had lower soluble solids ($^{\circ}$ Brix) and later maturity dates than Primitivo FPS 03.

The most recent evaluation of the performance of FPS Zinfandel and Primitivo registered selections is an ongoing research study of grapevines planted in 1997 in a vineyard at the UC Kearney Agricultural Center in the southern San Joaquin Valley. The vines were grown on their own roots, common in Fresno County. They were trained in a bilateral cordon formation on a single wire mounted on a trellis. Vines were irrigated by furrow and spur pruned. Data reported in this study was taken in 2000, 2001, 2002 and 2003. (Fidelibus et al. 2005)

There were few differences observed between the Zinfandel selections tested in the Kearney trial. However, in the southern San Joaquin Valley (unlike in Arbuckle and Lodi), the Zinfandel selections yielded similar or lower weights (kg per vine) than the Primitivo selections. Zinfandel selections had fewer clusters per vine, a slightly higher berry weight overall, and lower soluble solids at harvest than Primitivo selections. It was posited that the differing yield findings of Primitivo and Zinfandel in Arbuckle/Lodi versus Kearney could be from a rootstock interaction and/or regional data for making recommendations on planting (e.g., rootstock vs. own roots).

Paul Verdegaal, farm advisor in San Joaquin County, stated in an e-mail: “My take on the feasibility of comparing Zinfandel clones across districts [appellations] is you will see differences (terroir) but in many cases they will be very subtle and affected by management, especially irrigation. The one “clone” that always seems to stand alone is Primitivo compared to any Zinfandel.”

Primitivo FPS 03 was the only registered FPS Primitivo selection included in all three clonal evaluations. In Arbuckle and Lodi, where the vines were grown on rootstock, Primitivo FPS 03 simultaneously produced more clusters per vine and a lower yield than the Zinfandels, explained by Primitivo 03 having had fewer and smaller berries. In Kearney, the vines were grown on their own roots. Primitivo FPS 03 had a 15% higher yield than the remaining

selections in the Kearney trial, despite the fact that (unlike Arbuckle and Lodi) average cluster weight and berries per cluster were similar for all selections. The higher yield for Primitivo 03 was attributed to a statistically significant higher number of clusters per vine for that selection versus all the others.

More importantly, the Primitivo selections in Kearney suffered substantially less sour rot than did the Zinfandel selections, evidencing a lower susceptibility to bunch rot. “One of the major impediments to producing Zinfandel fruit of acceptable quality in the central San Joaquin Valley is Zinfandel’s high susceptibility to sour rot.” (Fidelibus et al. 2005) Within the Primitivo selections themselves, Primitivo FPS 03 was second to Primitivo FPS 06 in the % clusters affected by rot (40%

versus 34%). The Lodi study also assessed the vines for bunch rot and, when rot was measurable during the trial, observed the least amount on Primitivo FPS 03. The Lodi researchers attributed that finding to Primitivo’s looser clusters, smaller berry size and earlier maturity date.

Soluble solids were measured in all three trials as $^{\circ}$ Brix. The Primitivo selection(s) had higher soluble solids at harvest than any of the Zinfandel selections in Kearney, Lodi, Arbuckle. That result is not surprising given the early fruit maturation of the Primitivo variety in general. For example, Primitivo FPS 03 ripened (on average) 7 to 10 days ahead of the Zinfandels in Lodi. However, Primitivo FPS 03 was singled out for special recognition by the Kearney researchers for its combined high yields of fruit (significantly higher than the other Primitivo and Zinfandel selections) plus high soluble solids. A significant addition to those positive findings is the relative low incidence of sour rot experienced by Primitivo FPS 03.

Primitivo FPS 05 and 06 were formally evaluated only at Kearney. The notable findings for those selections were: Primitivo FPS 05 (along with Primitivo FPS 03) had significantly smaller berries than the other selections; Primitivo FPS 06 had the lowest incidence (34%) of clusters affected by sour rot of all the selections; the fruit of Primitivo FPS 06 matured quite early and had a higher juice pH than the others; and Primitivo FPS 06 and Primitivo FPS 03 were characterized as the best performers in the trial in terms of fruit maturity, yield and bunch rot susceptibility.

The only reported wine tasting trials involving the FPS registered selections were done in conjunction with the

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— Paul Verdegaal, UC Cooperative Extension, San Joaquin County

trial in Lodi, California. The red wine tasting panels were done in 1994–1997, with wine lots made by Woodbridge Winery. In 1994, the wines were divided by the tasters into two groups. Zinfandel FPS 03, Primitivo FPS 03 and Zinfandel FPS 06 (in order of preference) were in the top group, with more dense color, better hue, and more black cherry and berry flavors. (Verdegaal and Rous 1995) It was considered surprising that two of the heavier yielding clones—Zinfandel FPS 03 and 06—were in the top group. In an e-mail from Paul Verdegaal, the farm advisor stated that in 1995 the same plots were not thinned enough but there were differences in the wines. The tasters preferred Zinfandel FPS 03, 06 and 02 to an overcropped Primitivo FPS 03 and Zinfandel FPS 01A. Verdegaal further stated that, in 1996, the plots were thinned and preferences split into three groups: (1) Primitivo FPS 03; (2) Zinfandel FPS 03, 06, and 02; and (3) Zinfandel FPS 01A.

The evidence from the three Central Valley trials showed that the Primitivo and Zinfandel “clones” performed in a substantially different fashion in Arbuckle, Lodi and Kearney. In all sites, the Primitivo fruit matured earlier than did the Zinfandel grapes. Not surprisingly, the name of the Primitivo variety comes from the Latin *primus*, which means ‘first.’ The Primitivo grape variety is “early at all stages of its physiologic development compared to other vine varieties.” (Calò et al. 2001) One significant finding differentiating the two sources of “clones” (Zinfandel and Primitivo) in all three locations is that Primitivo clusters continue to be structured differently (looser, less compact) than those of Zinfandel.

Finally, a study to compare 63 Zinfandel clones and field selections was initiated in 1995 on vines grown in the Zinfandel Heritage Vineyard located at the University of California's Oakville Experimental Vineyard in Napa



Zinfandel (left) and Primitivo in a comparative field trial in Lodi, California. Photos by Paul Verdegaal

County, California. Phase I of the study included Zinfandel selections FPS 01A, 02 and 03, as well as Primitivo FPS 03, 05, and 06. The remaining vines consisted of Zinfandel Heritage clones from various counties throughout California. Traditional management techniques were used in maintaining the vines, which were budded in 1995–96 (Phase I). St. George rootstock was used. The vines were head-trained (supported by split redwood stakes) and spur pruned. A subsurface drip irrigation system was employed. (Anderson et al. 1999) The project had not yet reached the replicated trial stage but certain preliminary observations were made from data collected at the 1998 harvest, including the facts that Primitivo matured ($^{\circ}$ Brix) sooner than Zinfandel and had lighter mean berry weights and cluster weights than Zinfandel. Primitivo clusters continue to be structured differently (looser, less compact) even when grown in the climate and topography of a county like Napa. The vines for the study were pulled out and the project was terminated in 2006.

FPS PROPRIETARY SELECTIONS

Zinfandel FPS 08 is a proprietary selection that was brought to FPS in 1996 by Bob Dempel of Dempel Farming Co. in Santa Rosa, California. The source of the plant material was 100-year-old Zinfandel vines planted on Bisordi Lane in Fulton, Sonoma County. Some of the original material submitted to FPS tested negative for virus and qualified to be planted into the Foundation block, where it was identified as Zinfandel FPS 08. This selection first appeared on the FPS Registered list in 1998. Zinfandel FPS 08 was removed from the Foundation block in 2006; however, mother vines in private increase blocks remain registered sources of California Certified Stock.

Dempel states that Zinfandel FPS 08 is known for its small clusters and berry size. Wine produced from Zinfandel FPS 08 berries by Paradise Ridge Winery (Santa Rosa) in 2003 exhibited deep color, a rich texture and brambly berry, spice and pepper flavors. (Vierra 2005) Mr. Dempel sells California certified Zinfandel FPS 08 vines propagated from his registered increase block at Dempel Ranch Vineyards in Hopland, California. Zinfandel FPS 08 is also available from Dempel's licensee, Sunridge Nurseries.

Zinfandel FPS 29 is a sub-clone of Zinfandel FPS 08, and was propagated by shoot tip tissue culture techniques from Zinfandel FPS 08. Zinfandel FPS 29 is a proprietary selection owned by Bob Dempel, who named it the Baldocchi Zinfandel clone in honor of his friend Dewey Baldocchi, a winemaker and pioneer in the Sonoma County grape industry. (Howie 1999) Zinfandel FPS 29 plant material has tested negative for virus and is expected to be added to the FPS Registered list within three years.

Zinfandel FPS 13 is a proprietary FPS selection owned by NovaVine Grapevine Nursery in Santa Rosa, California. The original plant material came to FPS in 1999 from an old vine Zinfandel vineyard owned by Milton and Ellen Heath. The vines of the NovaVine Zinfandel clone are grown in sandy loam soil on the Kelseyville benches (1300-2000 feet) at the base of Mount Konocti in Lake County. Jim Smith, manager of the source vineyard observed, "The vines [of this clone] yield a versatile grape that is very 'fruit forward' with a nose that 'jumps out of the glass.' Spiciness can be dictated by an open canopy (very fruity) or an extra-shaded canopy (heavy peppery characteristics)." Five wineries—Wild Hog, X Winery, DeLoach, Hall Crest, and Jelly Jar—have produced unique and very different wines composed almost solely of this clone's fruit.

All tests on Zinfandel FPS 13 at FPS were negative for viruses, and it was placed on the Registered selection list in 2006. Plant material for Zinfandel FPS 13 can be obtained through NovaVine Grapevine Nursery, Inc.

Zinfandel FPS 16 is an old-vine Zinfandel that is a proprietary selection owned by Kendall-Jackson for its Hartford Court label. The original plant material came to FPS in 1997 from a vineyard located on Wood Road in Forestville, Sonoma County, approximately 15 miles from the Pacific Coast. The vineyard was originally planted in the early 1900s, and the vines are head-trained on St. George rootstock. Don Hartford, owner of the Wood Road vineyard, noted: "This clone seems to do well in the cool Russian River Valley climate. It gets fully ripe while maintaining a great acid balance that promotes a bright fruit character as well as good weight and texture." Kendall-Jackson maintains another planting of this same Hartford clone on shallow gravelly (Huichica) clay loam soil atop a hill overlooking the Santa Rosa plain at Windsor, Sonoma County. Under cool, sometimes humid conditions, and shallow clay loam soil on a hillside, this Zinfandel clone is reported to ripen in a timely manner and produce concentrated flavors.

Zinfandel FPS 16 plant material was produced by shoot tip tissue culture propagation of the original Wood Lane plant material and became a Registered selection in 2006. Plant material may be obtained from Kendall-Jackson Nurseries, Santa Rosa, California.

PUBLIC HERITAGE ZINFANDEL CLONES

Several heritage ("old vine") clones may become publicly available through FPS in the future after more testing. Old-vine sources for Zinfandel plant material are sought after by wine makers. The theory is that grapes from very old vines maintained in the traditional head-trained style for vine balance produce more concentrated flavors.

(Sullivan 2003) The concentrated flavors are believed to be the result of lower crop yields under those parameters. In 2002, two groups of heritage Zinfandel grapevines were donated to FPS for the benefit of the public.

Gary Morisoli donated nine varieties from the Napa Morisoli Heritage Vineyard, which is thought to have been originally planted in the late 1800s. The vineyard was predominately Zinfandel but, as is common in older California vineyards, there were other varieties present, including both wine and table grapes. Morisoli's grandfather (born 1902) said that as a teenager, he began to replace some of the old vines in the vineyard as they died. Morisoli suspects that some of the original plantings remained in the vineyard. (Anonymous 2002) In 2001, ampelographer Jean-Michel Boursiquot, the soon-to-be Director of ENTAV in France, author Jim Wolpert, and FPS Director Deborah Golino visited the vineyard to examine the vines. About one-and-a-quarter acres of the vineyard remained. Boursiquot was able to identify nine varieties of interest to FPS and the public heritage clone program, and the vines were marked with the correct variety names. In December of that year, Dr. Golino collected dormant wood from those mature vines for testing and treatment at FPS.

The original plant material donated to FPS tested positive for several viruses and must undergo shoot tip tissue culture propagation prior to certification for the Foundation block. It is possible that plant material for this old Zinfandel selection will be available to the public by 2012.

A second source of old vine Zinfandel arrived at FPS at the same time as the Morisoli selection. The source of this second group was the Gate Vineyard (Niebaum-Coppola Estate) in Rutherford, California. That original plant material tested positive for virus and must undergo shoot tip tissue culture propagation. This source of heritage Zinfandel could be available to the public as early as 2012.

CALIFORNIA HERITAGE ZINFANDEL PROJECT

Another group of old-vine Zinfandel clones being collected and preserved for the benefit of the public are from the former Heritage Vineyard for California Zinfandel, created at the UC Oakville Experiment Station in 1995. This effort has been directed by Dr. James Wolpert of the University of California, Davis, Department of Viticulture and Enology, and funded by UCD and Zinfandel Advocates and Producers (ZAP). ZAP is a trade association organized in 1991 and composed of producers and consumers devoted to Zinfandel wine produced primarily in the coastal valleys, Sierra foothills and the Lodi area of California.

In 1995, Dr. Wolpert and his colleagues began collecting budwood from certain well-known California Zinfandel vines which were more than sixty years old. Budwood

from twenty of those vines was sent to FPS under code names to commence the registration and certification process. The heritage clone Oakville trials were designed for both field performance and wine tasting comparisons; however, they were interrupted this year when the original heritage selections were removed from the Oakville vineyard due to concerns about the spread of leafroll virus from these vines. These twenty selections are currently not available to the public, but testing and virus indexing continue. It is hoped that a subset of the collection (selections testing negative for virus, freed from infection by therapy, and receiving positive recommendations from ZAP wine tasting trials) will be available in the future for public distribution.

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BIBLIOGRAPHY

- Alley, L. and D. Golino. 2000. The Origins of the Grape Program at Foundation Plant Materials Service. *In: Proceedings of the ASEV 50th Anniversary Meeting*, pp. 222-230. Seattle, Washington.
- Anderson, M.M., R.J. Smith, E.A. Weber, G.T. McGourty and P.A. Verdegaal, D.J. Hirschfeld, A.N. Kasimatis, J.A. Wolpert. 1999. Comparison of Yield Components, Cluster Measurements and Fruit Composition of Sixty-three Zinfandel Clones and Field Selections. Unpublished.
- Anonymous, Foundation Plant Materials Service, Grape Program Newsletter, October, 2002.
- Bedolla, Hector, Vineyard Manager, La Crema Winery, e-mail communication (2007).
- 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.
- California Agricultural Statistics Service. 2007. California Grape Acreage 2006.
- California Department of Food and Agriculture, Sacramento, CA.
- Calò, Antonio, Attilio Scienza, Angelo Coastacurta. 2001. *Vitigni d' Italia*. Calderini edagricole. Bologna, Italia. (in Italian).
- Christensen, L. Peter, Nick K. Dokoozlian, M. Andrew Walker, and James A. Wolpert. 2003. *Wine Grape Varieties in California*. Agriculture and Natural Resources Communication Services, University of California.
- Bureau of Alcohol, Tobacco and Firearms [now Alcohol and Tobacco Tax and Trade Bureau], Department of the Treasury. Proposal to Recognize Synonyms for Petite Sirah and Zinfandel Grape Varieties (2001R-251P). Federal Register. Vol. 67, No. 69, p. 17312. April 10, 2002.
- Fidelibus, Matthew W., L.P. Christensen, D.G. Katayama, and P-T. Verdenal. 2005. Performance of Zinfandel and Primitivo Grapevine Selections in the Central San Joaquin Valley, California. *Am. J. Enol. Vitic.* 56(3): 284-286.
- Galet, Pierre. 1998. *Grape Varieties and Rootstock Varieties*. Oenoplurimedia sarl. France.
- Gates, David, Vice-president, Ridge Vineyards, e-mail communication (2007).
- Golino, Deborah, Susan T. Sim, Raymond Gill, and Adib Rowhani. 2002. California mealybugs can spread grapevine leafroll disease. *California Agriculture* 56(6): 196-201.
- Hartford, Don, Hartford Family Winery, e-mail communication (2007).
- Howie, Millie. 1999. Romancing the Clone. *Wines & Vines*, p. 39, June, 1999.
- Maletić, E., I. Pejić, J. Karoglan Kontić, J. Piljac, G.S. Dangl, A. Vokurka, T. Lacombe, N. Mirošević, and C.P. Meredith. 2004. Zinfandel, Dobricic, and Plavac mali: The genetic relationship among three cultivars of the Dalmatian Coast of Croatia. *Am. J. Enol. Vitic.* 55: 174-180.
- Maletić, E., I. Pejić, J. Karoglan Kontić, J. Piljac, G.S. Dangl, A. Vokurka, T. Lacombe, N. Mirošević, and C.P. Meredith. 2003. The Identification of Zinfandel on the Dalmatian Coast of Croatia. *In: VIII International Conference on Grape Genetics and Breeding*. E. Hajdu & E. Borbás (Eds.), pp.251-254. Acta Hort 603, ISHS.
- Martelli, Giovanni. Professor, Istituto di Patologia Vegetale, Bari, Italy, e-mail communication (2007).
- Mirošević, Nikola, and Carole P. Meredith. 2000. A review of research and literature related to the origin and identity of the cultivars Plavac mali, Zinfandel and Primitivo (*V. vinifera* L.), *Agriculturae Conspectus Scientificus* 65 (1):45-49.
- Piljac, Jasenka. 2004. *Zinfandel: A Croatian-American Wine Story*. Zrinski d.d. Cakovec, Croatia.
- Robinson, Jancis. 2006. *The Oxford Companion to Wine*. 3rd ed. Oxford University Press. Oxford, England.
- Smith, Jim, personal communication (2007).
- Sullivan, Charles L. 2003. *Zinfandel: A History of a Grape and Its Wine*. University of California Press. Berkeley, Los Angeles, London.
- Verdegaal, Paul S., Farm Advisor, UCCE San Joaquin County, e-mail communication to Susan Nelson-Kluk (1997).
- Verdegaal, Paul S., Farm Advisor, UCCE San Joaquin County, e-mail to Nancy Sweet (2007).
- 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.
- Vierra, Tina. 2005. Old Vine Zinfandel clone tested and available for planting. *Practical Winery & Vineyard*, May/June, p. 80.
- Walker, M. Andrew, Professor, University of California, Davis, personal communication (2007).
- Wente, Philip, Wente Vineyards, e-mail communication (2007).
- Wolpert, J.A. 1996. Performance of Zinfandel and Primitivo clones in a warm climate. *Am. J. Enol. Vitic.* 47: 124-126. 

Summary of FPS Zinfandel and Primitivo selections; their sources, status and where they are available.

Variety	FPS sel #	Reported source	Reg. status	Available from	Disease test status	Treatment
Zinfandel	01A	Leon Handel Vineyard, Lodi, CA, in 1961	Registered 1962	FPS	All tests negative	None
Zinfandel	02	Leon Handel Vineyard, Lodi, CA, in 1961	Registered 1962	FPS	All tests negative	None
Zinfandel	03	Reutz Vineyard, Livermore, CA in 1964	Registered 1965	FPS	All tests negative	None
Zinfandel	06	Zinfandel 01A in 1966	Registered 1967	FPS	All tests negative	Heat treated 117 days
Zinfandel	08	Vineyard in Fulton, Sonoma County, in 1996	Registered 1998	Dempel Ranch Vineyards	All tests negative	None
Zinfandel	13	Vineyard in Kelseyville, Lake County, in 1999	Registered 2006	NovaVine, Inc.	All tests negative	None
Zinfandel	16	Wood Road in Forestville, Sonoma County, in 1997	Registered 2006	Kendall-Jackson Nurseries	All tests negative	Shoot tip culture
Zinfandel	29	Zinfandel 08	Provisional	Dempel Ranch Vineyards	All tests negative	Shoot tip culture
Primitivo	03	Dr. Austin Goheen brought from Bari, Italy, in 1968	Registered 1984	FPS	RSP+	Heat treated 59 days
Primitivo	05	Dr. Antonio Calò, Conegliano, Italy, in 1987	Registered 1994	FPS	All tests negative	None
Primitivo	06	Dr. Antonio Calò, Conegliano, Italy, in 1987	Registered 1994	FPS	RSP+	None