Variety Trials

Field Performance of 20 'Pinot noir' Clones in the Willamette Valley of Oregon

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SUMMARY. Clonal selection of European winegrapes (*Vitis vinifera*) allows the exploitation of an important source of genetic diversity. In the 1980s, many 'Pinot noir' clones, previously unavailable in the U.S., were imported from France. To provide information on their performance under Oregon soil and climate conditions, 20 'Pinot noir' clones were established in a replicated trial in Alpine, Ore., planted in 1989. In this study, yield components, pruning weight, and juice composition of the 20 clones were measured for the 1995 through 1999 seasons. Skin anthocyanin concentration was measured for the 1996 through 1999 seasons. Clones included in the trial were Colmar (COL) 538, Dijon (DJN) 10/18, DJN 113, DJN 114, DJN 115, DJN 375, DJN 60, Espiguette (ESP) 236, ESP 374, Foundation Plant Services (FPS) 2A, FPS 4, FPS 10, FPS 16, FPS 17, FPS 22, FPS 23, FPS 29, FPS 31, FPS 32, and FPS 33. For all responses except juice pH and skin anthocyanin concentration, there were significant clone by year interactions. COL 538 had the highest 5-year mean yield (2.93 kg/vine); FPS 29 had the lowest (1.21 kg/vine). DJN 10/18, FPS 4, FPS 22, and FPS 31 were among the five highest-yielding clones. Other low-yielding clones included DJN 115, ESP 374, FPS 17, and FPS 23. Pruning weights were generally correlated with yields. COL 538 had the highest 5-year mean pruning weight (0.81 kg/vine) and FPS 17 had the lowest (0.48 kg/vine). Other clones with relatively high pruning weights were FPS 2A, FPS 4, and FPS 22. Other clones with low pruning weights were FPS 23 and FPS 29. FPS 22 and FPS 17 had the highest (1.13 g/berry) and lowest (0.93 g/berry) 5-year mean berry weights, respectively. Clones with 5-year mean cluster weights >100 g included DJN 10/18, ESP 236, and FPS 31. Those with cluster weights <80 g were DJN 115, FPS 17, and FPS 29. FPS 2A had the highest 5-year mean juice soluble solids concentration (SSC) at harvest (23.8%). FPS 10, FPS 29, DJN 113, and DJN 115 also had relatively high SSC. DJN 60 had the lowest 5-year mean SSC at harvest (22.0%). FPS 22, FPS 33, COL 538, and ESP 374 also had relatively low 5-year mean SSC at harvest. DJN 115 had the highest 5-year mean juice pH (3.15). DJN 113, FPS 29, and FPS 10 also had relatively high juice pH. FPS 22 had the lowest 5-year mean juice pH at harvest (2.97), and DJN 10/18, FPS 2A, and FPS 17 also had relatively low pH. Clones with higher SSC and pH generally had lower titratable acidity. FPS 2A had both high SSC and high titratable acidity. FPS 23 and FPS 17 had the highest skin anthocyanin concentration (2.10 and 2.07 mg·g⁻¹ berry, respectively). The range of skin anthocyanin concentration among the other clones was relatively narrow (1.17–1.47 mg·g⁻¹ berry). FPS 2A, FPS 4, and FPS 10 generally had above mean SSC and yield. FPS 29, DJN 113, DJN 114, and DJN 115 consistently had above mean SSC but below mean yield.

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Several factors contribute to the importance of the evaluation of clonal selections of winegrape cultivars. Because of resistance to change from consumers, modern wine production is largely based on traditional cultivars. Additionally, winegrapes are highly heterozygous outcrossers that do not breed true from seed. Breeding and selection, from crossing through sensory analysis, is a very long term and costly process. Clonal selection, therefore, allows for the exploitation of genetic variation with lower risk and investment than a traditional breeding program (Mullins et al., 1992).

Internationally, clonal selection of 'Pinot noir' has made available an array of clones with wide-ranging levels of productivity and fruit quality. In the Champagne region of France, clones are selected for their suitability to sparkling wine production (Barillere et al., 1995). In Burgundy, the main criterion is high fruit quality for red table wine (Bernard, 1995). The Mariafeld clones, selected in Switzerland, have been shown to have partial resistance to botrytis bunch rot (*Botrytis cinerea*) (Becker et al., 1988). Additionally, clonal selection or evaluation of 'Pinot noir' has been carried out in Australia (Cirami and Ewart, 1995; Ewart et al., 1986; Whiting and Hardie, 1990), Italy (Stefanini et al., 1995), Germany (Becker et al., 1988; Schmid et al., 1995), and Canada (Reynolds, 2004). In the U.S., clones selected here and elsewhere continue to be evaluated under local growing conditions for their suitability to the production of red table wine and sparkling wine (Mochizuki et al., 1995; Pool et al., 1995; Price and Watson, 1995; Wolpert 1995).

'Pinot noir' is the main winegrape cultivar in Oregon. In 2004, 'Pinot noir' comprised about 56% of the Oregon winegrape acreage, with 48% of the total production, and 61% of the total value of production (Oregon

Units	To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
	29.5735	fl oz	mL	0.0338
	0.3048	ft	m	3.2808
	2.5400	inch(es)	cm	0.3937
	0.4536	lb	kg	2.2046
	0.5	lb/ton	kg·t ⁻¹	2
	28.3495	oz	g	0.0353
	0.001	ppm	g·L ⁻¹	1000
	0.001	ppm	mg·g ⁻¹	1000
	1	ppm	mg·L ⁻¹	1
	2.2417	ton/acre	t·ha ⁻¹	0.4461
	(°F - 32) ÷ 1.8	°F	°C	(1.8 × °C) + 32

Agricultural Statistics Service, 2005). The modern Oregon winegrape industry was established with relatively few clones of 'Pinot noir' (Adelsheim, 1988). In the 1980s, many 'Pinot noir' clonal selections were imported from France to the U.S. through a cooperative effort of the Oregon winegrape industry and Oregon State University. Information on the performance of these selections in Europe was limited and their performance under U.S. viticultural conditions could not be predicted. The purpose of this study was to evaluate the performance of these newly available clones and several already available in the U.S., which had been identified as having potential value to the Oregon wine industry, in order to provide objective information on their performance under Oregon soil and climate conditions.

Materials and methods

The 20 'Pinot noir' clones evaluated in this trial (Table 1) included representatives of diverse types previously classified into four groups: 1) Pinot fin, typically characterized by having small clusters and prostrate growth habit with leaves thick and lobed to deeply lobed; 2) Mariafeld, most noted for having loose clusters; 3) Upright (Pinot droit), known for their erect shoot growth habit; 4) Fertile, typically having large clusters and prostrate growth habit with leaves thin, smooth, and not deeply lobed (Bernard, 1995; Bernard and Leguay 1984; Price and Watson, 1995).

The trial was established in 1989 at Woodhall III Vineyard in Alpine, Ore., which is located in the Willamette Valley Appellation. The region has a mean annual precipitation of about 42 inches, with most of the precipitation occurring from October through June, and typically dry summers. The vineyard has a southern aspect on a well-drained red soil containing 27% to 40% clay, with a pH of 5.5 and a mean depth of about 32 inches. The soil is a member of the Jory-Bellpine association with sandstone as the underlying bedrock. The vines were own-rooted [grape phylloxera (*Daktulosphaira vitifoliae*) was not present at the site] and were trained to a double Guyot system with trunk height of 32 inches. The spacing was 6 × 9 ft (vines × rows). Powdery mildew (*Uncinula necator*) was controlled with periodic fungicide applications according to Oregon State

University Extension Service guidelines. No insecticide applications, other than micronized sulfur applied primarily for powdery mildew control, were made. Nitrogen was applied annually at about 10 lb/ton of fruit harvested based on the overall trial mean from the preceding harvest. No irrigation was applied during the 5-year evaluation period reported here.

The trial was arranged in a randomized complete-block design with four five-vine replicates per clone. Yield components, pruning weights, and juice composition of the 20 'Pinot noir' clones were measured for the 1995 through 1999 seasons. Skin anthocyanins were measured for the 1996 through 1999 seasons.

During some vintages in Oregon, fall rains may be an important consideration in determining harvest date. In this trial, the harvest dates were based on fruit maturity and weather conditions. Harvest dates were 4 Oct. 1995, 12 Oct. 1996, 7 Oct. 1997, 25 Sept. 1998, and 15 Oct. 1999. Corresponding degree day values (base 50 °F from 1 Apr.) were 2133, 2138, 2228, 2091, and 1916. Immediately prior to harvest, a random sample of 10 clusters per replicate was collected for determination of juice composition, and another random sample of

five clusters per replicate was collected and frozen for later determination of berry weight and skin anthocyanins. The 10-cluster samples were manually crushed and filtered through a single layer of Miracloth (Calbiochem, San Diego). Juice soluble solids concentration (SSC) was measured using a digital refractometer (Atago, Tokyo). Juice pH and titratable acidity (TA) were measured on a 50-mL aliquot using an automatic titrator (Mettler-Toledo, Hightstown, N.J.). The juice was titrated to an endpoint of pH 8.2 using 0.1 N sodium hydroxide standardized with potassium hydrogen thalate. The SSC to TA ratio, which provides an index of winegrape maturity, was calculated as the ratio between SSC and TA (Amerine and Winkler, 1940; Winkler et al., 1974).

Total yield was determined by harvesting and weighing all fruit on a per replicate basis. Cluster weight was calculated by averaging the combined weights of the 10- and five-cluster samples. Berry weights were measured on a 100-berry subsample randomly selected from the five-cluster samples. Skin anthocyanin concentration was determined on the 100-berry sample from each experimental unit by separating the skins from the pulp and extracting them in acidulated methanol as

Table 1. 'Pinot noir' clones included in the trial at Woodhall III Vineyard, Alpine, Ore.

Type	Clone ^a	Name	Origin
Pinot fin	FPS 2A	Wädenswil	Switzerland
	FPS 4	Pommard	Burgundy
	FPS 10	Beba	Spain
	FPS 29	Jackson	France via California
	DJN 113	CTPS 113	Burgundy
	DJN 114	CTPS 114	Burgundy
	DJN 115	CTPS 115	Burgundy
Mariafeld	FPS 17	Mariafeld	Wädenswil
	FPS 23	Mariafeld	Wädenswil
Upright	FPS 22	Gamay Beaujolais	California
	ESP 374	Espiguette 374	ENTAV, Espiguette
	DJN 60	Dijon 60	Burgundy
Fertile	FPS 16	Jackson	France via California
	FPS 31	CTPS 236	Roederer, Chouilly
	FPS 32	CTPS 386	Roederer, Chouilly
	FPS 33	CTPS 388	Roederer, Chouilly
	ESP 236	ENTAV 236	ENTAV, Espiguette
	DJN 375	CTPS 375	Burgundy
	DJN 10/18	CTPS 1018	Alsace
	COL 538	CTPS 538	Alsace

^aCOL = Colmar; CTPS = Committee Technique Permanent de la Selection; DJN = Dijon; ESP = Espiguette; ENTAV = Etablissement National technique pour l'Amelioration de la Viticulture; FPS = Foundation Plant Services, Davis, Calif.

described by Candolfi-Vasconcelos and Koblet (1990). Anthocyanin concentration of the extract was determined by absorbance at 530 nm (A_{530}) on a Shimadzu UV 1601 spectrophotometer (Shimadzu, Columbia, Md.) and calculated as anthocyanin ($\text{mg}\cdot\text{L}^{-1}$) = $A_{530}/0.038$ (Singleton, 1980). At the time of dormant pruning, the 1-year-old canes were separated from the previous season's fruiting cane and weighed on a vine-by-vine basis. Bud number was set by leaving 30 buds per kilogram of 1-year-old wood. The Ravaz index (Ravaz, 1903) was calculated by dividing the total yield per vine by the pruning weight recorded during the winter following each season.

The multi-season data were analyzed using the SAS MIXED procedure (Littell et al., 1996). Block and all block interactions were treated as random effects. Clone and year were treated as fixed effects. Repeated measures analysis was carried out for each response variable using a repeated statement for year. The covariance structure (correlation between measurements in different seasons and the within clone variance for individual seasons) for each response variable was modeled using several options and then the choice of covariance structure was made as described by Littell et al. (1998). Single season data were analyzed using the SAS GLM procedure with the minimum significant difference generated by Waller-Duncan k-ratio *t* test (SAS Institute, 1989).

Results and discussion

For all responses except juice pH and skin anthocyanin concentration, there were significant clone by year interactions. This indicates that even though differences among the clones were significant, the performance of the clones relative to each other was not consistent from year to year. The clones are listed in the tables in descending order based on the 5-year means, followed by the means of each clone in a given season. This allows one to assess the performance of the clones over several seasons and gain some perspective of how consistent their performance was from year to year relative to the other clones.

YIELD. COL 538 and DJN 10/18 had the two highest 5-year mean yields (Table 2). These two clones, among the five highest-yielding clones in four of the five seasons, were consistently

high yielding in relation to the other clones. FPS 2A and FPS 31 were among the five highest-yielding clones in three of the five seasons. Consistently low-yielding clones were DJN 115, FPS 23, FPS 17, and FPS 29. There are representatives of each clone type, except Mariafeld, among the high- and moderate-yielding clones. The lowest-yielding clones included only Pinot fin and Mariafeld types.

PRUNING WEIGHT. Pruning weight provides an index of vegetative vigor and vine size. COL 538, FPS 2A, FPS 4, and FPS 22 had pruning weights among the five highest in at least three of the five seasons (Table 3). FPS 17, FPS 23, FPS 29, ESP 236, and DJN 115 had pruning weights among the five lowest in at least three of the five seasons. Pruning weights were generally correlated with yields, suggesting that vine size was an important factor determining yield.

RAVAZ INDEX. The Ravaz index provides an indicator of vine balance. All of the 'Pinot noir' clones evaluated in this trial had 5-year means below the 5 to 7 range recognized by Ravaz

(1903) as optimal (Table 4). Only in 1997 did the Ravaz index of most of the clones fall within that range. The Fertile clones tended to have higher Ravaz indices than the other clones. The Upright clones had intermediate Ravaz indices, and the two Mariafeld clones had relatively low Ravaz indices. Some of the Pinot fin clones such as FPS 4 and FPS 10 had relatively high Ravaz indices, whereas others such as FPS 29 and DJN 115 were among the lowest-ranking clones. The genetic diversity of the 'Pinot noir' clones, which is expressed morphologically, may also be reflected in different strategies for the allocation of resources between vegetative and reproductive sinks.

BERRY WEIGHT. Berry weight provides an index of berry size. Red wines made from smaller berries have a higher proportion of skin and seed derived compounds which are very important to wine characteristics (Kennedy, 2002). FPS 22 had the highest 5-year mean berry weight and was among the five highest clones in all five seasons (Table 5). FPS 16 and FPS 2A had berry weights among the highest

Table 2. Yields of 'Pinot noir' clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 5-year mean yield.

Clone ^a	Type	Yield (kg/vine) ^a					
		5-year	1995	1996	1997	1998	1999
COL 538	Fertile	2.93	2.59	3.19	3.83	1.29	3.76
DJN 10/18	Fertile	2.87	2.64	2.44	3.84	1.75	3.91
FPS 4	Pinot fin	2.71	1.85	2.33	4.41	1.63	3.33
FPS 31	Fertile	2.61	1.86	2.49	2.92	1.58	4.21
FPS 22	Upright	2.55	2.79	2.21	2.65	1.57	3.56
FPS 2A	Pinot fin	2.50	1.67	2.66	3.37	1.73	3.04
DJN 375	Fertile	2.34	1.50	2.62	2.62	1.46	3.51
FPS 16	Fertile	2.30	2.02	2.58	2.42	1.18	3.29
DJN 60	Upright	2.29	2.17	2.11	2.64	1.46	3.06
FPS 33	Fertile	2.28	1.52	2.36	2.99	1.15	3.36
FPS 10	Pinot fin	2.26	1.59	2.36	2.91	1.36	3.06
FPS 32	Fertile	2.23	1.77	2.39	2.34	1.48	3.18
ESP 236	Fertile	2.15	1.38	2.33	2.13	1.20	3.73
DJN 114	Pinot fin	1.86	1.29	1.86	2.36	1.01	2.80
DJN 113	Pinot fin	1.86	1.04	1.92	2.75	1.10	2.50
ESP 374	Upright	1.83	2.17	1.92	1.57	1.03	2.44
DJN 115	Pinot fin	1.58	0.75	1.50	1.89	1.02	2.76
FPS 23	Mariafeld	1.57	0.83	1.45	1.58	1.25	2.75
FPS 17	Mariafeld	1.28	0.78	1.27	1.22	0.85	2.28
FPS 29	Pinot fin	1.21	0.89	1.33	1.71	0.82	1.30
MSD ^x		---	0.95	1.01	1.56	1.30	1.00
Significant F							
Clone (C)		0.0001	0.0001	0.0026	0.0010	0.0013	0.0001
Year (Y)		0.0016	---	---	---	---	---
C × Y		0.0001	---	---	---	---	---

^a1 kg = 2.2046 lb.

^bCOL = Colmar; DJN = Dijon; ESP = Espiguettes; FPS = Foundation Plant Services, Davis, Calif.

^cMinimum significant difference using Waller-Duncan k-ratio ≤ 0.05 .

five clones in four and three of the five seasons, respectively. Clones with relatively consistent low-ranking berry weights were FPS 10, FPS 29, and FPS 17. High-ranking clones included Upright, Fertile, and Pinot fin types. Representatives of the Mariafeld, Pinot fin, and Upright clones were among the low-ranking clones.

CLUSTER WEIGHT. The Fertile clones have been previously characterized as having large clusters. Clones with the highest 5-year mean cluster weights included Fertile and Upright types only (Table 6). FPS 31, ESP 236, DJN 10/18, and FPS 22 had 5-year mean cluster weights among the five highest in at least three of the five seasons. All Fertile clones ranked among the 10 highest cluster weight clones in at least three of the five seasons. Clones with relatively consistent low-ranking cluster weights were from the Mariafeld or Pinot fin types. Low cluster weight clones were FPS 17, FPS 23, FPS 29, DJN 113, DJN 114, and DJN 115. Pinot fin clones have been characterized as having small clusters. All Pinot fin clones ranked among the 10 lowest cluster weight clones in at least three of the five seasons.

JUICE SOLUBLE SOLIDS, pH, AND TA. With the exception of FPS 4, all Pinot fin clones ranked among the 10 highest clones for soluble solids in all five seasons (Table 7). Low soluble solids clones were represented exclusively by Upright and Fertile type clones. Generally, the results for juice pH and TA were similar to those for soluble solids (Tables 8 and 9). Pinot fin clones dominated the higher pH, lower TA ranks, and Upright and Fertile clones dominated the lower pH, higher TA ranks. FPS 2A, a Pinot fin clone, appears to be an exception to this pattern. This clone had the highest 5-year mean juice soluble solids but had the fourth lowest pH and third highest TA.

SSC TO TA RATIO. This ratio provides an objective index for the assessment of winegrape maturity with higher values corresponding to more advanced maturity. DJN 115, FPS 10, DJN 114, FPS 29, FPS 4, and DJN 113 had the six highest 5-year means for SSC to TA ratio, and each ranked among the top five clones for SSC to TA ratio in at least three of five seasons (Table 10). Consistently low-ranking clones included FPS 22, FPS 31, and DJN 10/18. The other clones had

Table 3. Pruning weight of 'Pinot noir' clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 5-year mean pruning weight.

Clone ^y	Type	Pruning wt (kg/vine) ^z					
		5-year	1995	1996	1997	1998	1999
COL 538	Fertile	0.81	0.89	0.79	0.49	0.90	1.01
FPS 2A	Pinot fin	0.81	0.70	0.72	0.59	0.98	1.04
FPS 22	Upright	0.79	0.79	0.75	0.52	0.93	0.98
FPS 4	Pinot fin	0.76	0.70	0.72	0.47	0.94	0.97
DJN 10/18	Fertile	0.73	0.72	0.66	0.49	0.86	0.94
DJN 60	Upright	0.73	0.69	0.63	0.53	0.86	0.93
FPS 33	Fertile	0.72	0.68	0.70	0.50	0.82	0.91
FPS 16	Fertile	0.70	0.76	0.58	0.46	0.82	0.89
FPS 32	Fertile	0.69	0.63	0.61	0.36	0.91	0.94
DJN 375	Fertile	0.67	0.63	0.55	0.43	0.81	0.92
FPS 31	Fertile	0.67	0.60	0.61	0.40	0.84	0.89
FPS 10	Pinot fin	0.67	0.67	0.61	0.45	0.74	0.87
DJN 113	Pinot fin	0.65	0.59	0.61	0.41	0.79	0.87
DJN 114	Pinot fin	0.65	0.58	0.57	0.39	0.74	0.94
DJN 115	Pinot fin	0.61	0.51	0.46	0.40	0.78	0.89
ESP 374	Upright	0.58	0.64	0.50	0.31	0.69	0.74
ESP 236	Fertile	0.57	0.56	0.48	0.34	0.69	0.76
FPS 29	Pinot fin	0.55	0.47	0.42	0.37	0.70	0.80
FPS 23	Mariafeld	0.55	0.42	0.46	0.36	0.69	0.81
FPS 17	Mariafeld	0.48	0.40	0.40	0.32	0.59	0.69
MSD ^x		---	0.19	0.22	NS	0.29	NS
Significant F							
Clone (C)		0.0034	0.0001	0.0018	0.0558	0.0418	0.119
Year (Y)		0.0001	---	---	---	---	---
C × Y		0.0266	---	---	---	---	---

^x1 kg = 2.2046 lb.

^yCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.

^zMinimum significant difference using Waller-Duncan k-ratio ≤ 0.05.

Table 4. Ravaz index of 'Pinot noir' clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 5-year mean Ravaz index.

Clone ^y	Type	Ravaz index					
		5-year	1995	1996	1997	1998	1999
FPS 31	Fertile	4.20	3.02	3.96	7.37	1.93	4.69
COL 538	Fertile	4.08	2.87	4.01	8.40	1.41	3.73
ESP 236	Fertile	4.07	2.50	4.99	6.19	1.76	4.89
FPS 4	Pinot fin	4.06	2.54	3.35	9.22	1.75	3.45
DJN 10/18	Fertile	4.04	3.64	3.68	7.57	2.04	4.17
DJN 375	Fertile	3.81	2.30	5.30	5.89	1.76	3.80
FPS 32	Fertile	3.76	2.79	3.92	7.06	1.67	3.36
FPS 10	Pinot fin	3.70	2.31	3.84	6.99	1.90	3.49
FPS 16	Fertile	3.55	2.65	4.47	5.40	1.47	3.74
FPS 33	Fertile	3.46	2.14	3.58	6.42	1.47	3.69
FPS 2A	Pinot fin	3.43	2.38	4.39	5.64	1.76	2.97
ESP 374	Upright	3.34	2.97	3.78	5.24	1.51	3.20
FPS 22	Upright	3.28	3.52	3.00	4.99	1.70	3.63
DJN 60	Upright	3.28	3.11	3.27	5.07	1.67	3.26
DJN 114	Pinot fin	3.14	2.10	3.34	5.99	1.33	2.94
DJN 113	Pinot fin	3.03	1.56	2.99	6.47	1.32	2.80
FPS 23	Mariafeld	2.89	1.89	3.11	4.30	1.80	3.34
DJN 115	Pinot fin	2.75	1.34	3.19	4.72	1.32	3.19
FPS 17	Mariafeld	2.75	1.79	3.17	4.10	1.46	3.22
FPS 29	Pinot fin	2.51	1.69	3.21	4.77	1.17	1.73
MSD ^y		---	1.11	NS	3.87	0.42	0.76
Significant F							
Clone (C)		0.0001	0.0004	0.0632	0.0013	0.0005	0.0001
Year (Y)		0.0001	---	---	---	---	---
C × Y		0.0001	---	---	---	---	---

^yCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.

^zMinimum significant difference using Waller-Duncan k-ratio ≤ 0.05.

Table 5. Berry weight of 'Pinot noir' clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 5-year mean berry weight.

Clone ^y	Type	Berry wt (g) ^z					
		5-year	1995	1996	1997	1998	1999
FPS 22	Upright	1.13	1.05	1.11	1.31	1.07	1.12
FPS 2A	Pinot fin	1.08	1.10	1.08	1.23	1.00	1.02
FPS 16	Fertile	1.08	1.04	0.98	1.17	1.03	1.19
FPS 32	Fertile	1.08	1.11	1.08	1.27	0.91	1.02
FPS 4	Pinot fin	1.08	0.97	1.07	1.28	0.97	1.10
DJN 10/18	Fertile	1.04	1.00	1.09	1.06	1.00	1.07
FPS 31	Fertile	1.04	0.95	1.05	1.13	1.01	1.05
ESP 236	Fertile	1.03	0.99	1.00	1.14	0.98	1.05
FPS 33	Fertile	1.02	1.03	1.01	1.15	0.96	0.95
DJN 375	Fertile	1.02	0.98	0.99	1.11	1.00	1.01
COL 538	Fertile	1.02	0.90	1.10	1.10	1.01	0.98
DJN 114	Pinot fin	1.01	1.00	0.89	1.10	1.01	1.07
DJN 60	Upright	1.01	0.97	0.96	1.16	0.99	0.94
DJN 113	Pinot fin	1.00	0.92	0.96	1.11	1.00	1.02
ESP 374	Upright	1.00	0.97	0.93	1.14	0.98	0.97
DJN 115	Pinot fin	0.99	0.89	0.99	1.08	0.98	1.01
FPS 23	Mariafeld	0.98	1.02	0.97	1.12	0.92	0.86
FPS 10	Pinot fin	0.97	0.87	0.89	1.06	0.93	1.09
FPS 29	Pinot fin	0.97	0.93	0.93	1.14	0.92	0.93
FPS 17	Mariafeld	0.96	1.00	0.91	1.16	0.91	0.83
MSD ^x		---	NS	NS	0.20	NS	0.17
Significant F							
Clone (C)		0.0224	0.1632	0.1154	0.0487	0.5684	0.0013
Year (Y)		0.0001	---	---	---	---	---
C × Y		0.0086	---	---	---	---	---

^z1 g = 0.0353 oz.

^yCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.

^xMinimum significant difference using Walter-Duncan k-ratio ≤ 0.05.

Table 6. Cluster weight of 'Pinot noir' clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 5-year mean cluster weight.

Clone ^y	Type	Cluster wt (g) ^z					
		5-year	1995	1996	1997	1998	1999
FPS 31	Fertile	107.8	115.2	120.3	105.8	94.8	103.0
ESP 236	Fertile	104.4	100.6	119.7	99.6	88.0	114.0
DJN 10/18	Fertile	102.8	103.7	108.8	122.7	84.4	94.5
FPS 22	Upright	98.6	114.0	109.5	89.1	83.7	96.8
DJN 60	Upright	95.8	111.1	105.7	102.9	72.5	87.0
COL 538	Fertile	94.0	98.4	104.2	111.9	71.0	84.3
DJN 375	Fertile	92.5	93.4	104.5	94.5	77.9	92.4
ESP 374	Upright	92.4	104.5	103.3	83.1	84.4	86.8
FPS 33	Fertile	90.7	90.7	105.1	100.5	69.8	87.5
FPS 4	Pinot fin	89.6	86.6	105.6	106.6	71.8	77.2
FPS 32	Fertile	89.5	95.0	106.5	84.8	79.6	81.8
FPS 16	Fertile	89.3	95.6	95.4	102.1	64.3	89.3
FPS 2A	Pinot fin	86.8	80.7	89.7	110.8	72.2	80.5
FPS 10	Pinot fin	86.1	75.9	99.6	104.8	69.9	80.2
DJN 113	Pinot fin	81.6	64.6	85.6	112.2	65.2	80.4
FPS 23	Mariafeld	81.1	84.1	98.7	74.6	75.2	73.2
DJN 114	Pinot fin	81.1	76.4	90.5	90.7	61.9	85.8
DJN 115	Pinot fin	77.7	62.1	94.5	85.6	62.4	84.1
FPS 29	Pinot fin	73.1	73.5	83.2	80.6	57.8	70.3
FPS 17	Mariafeld	72.7	71.1	93.7	67.3	67.3	64.1
MSD ^x		---	24.40	22.30	20.90	12.0	20.1
Significant F							
Clone (C)		0.0001	0.0001	0.0064	0.0001	0.0001	0.0006
Year (Y)		0.0203	---	---	---	---	---
C × Y		0.0001	---	---	---	---	---

^z1 g = 0.0353 oz.

^yCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.

^xMinimum significant difference using Walter-Duncan k-ratio ≤ 0.05.

intermediate mean SSC to TA ratios and had variable rankings from season to season. Of note was FPS 2A, the only Pinot fin clone with a relatively low SSC to TA ratio. As noted above, this clone had high soluble solids but low pH and high TA.

SKIN ANTHOCYANINS. There is a wide range in the 4-year means for skin anthocyanin concentration (Table 11). FPS 23 and FPS 17 had the highest or second highest skin anthocyanin concentration in all four seasons. Their 4-year means for skin anthocyanin concentrations were almost double that of the lowest-ranking clone. COL 538 and FPS 4 ranked 19 or 20 in at least three of four seasons. If the two highest- and the two lowest-ranking clones were excluded, the range in skin anthocyanins would be narrowed considerably. Among the remaining clones, FPS 29 ranked in the highest anthocyanin group in three of four seasons. FPS 16 ranked in the lowest anthocyanin group in three of four seasons.

RELATIONSHIP BETWEEN JUICE SSC AND YIELD. The 5-year means were used to show the relationship between juice SSC and yield (Fig. 1). The figure was divided into four quadrants. Clones having above mean yield and juice SSC were distributed in quadrant I (upper right); clones having above mean yield but below mean juice SSC were distributed in quadrant II (lower right); clones having below mean yield and juice SSC were distributed in quadrant III (lower left); clones having below mean yield but above mean juice SSC were distributed in quadrant IV (upper left).

Clones having 5-year means in quadrant I were FPS 2A, FPS 4, FPS 10, FPS 16, and FPS 32. Of these five clones, only the three Pinot fin clones were positioned in this quadrant in at least four of the five seasons (Table 12). Fertile and Upright clones were the only types with 5-year means in quadrant II. COL 538, DJN 10/18 and 60, and FPS 22 were positioned in quadrant II in at least four of the five seasons. DJN 375, FPS 31, and FPS 33 were positioned there in three seasons. ESP 374, the only clone with a 5-year mean in quadrant III, was located there in four of the five seasons. Several clones had 5-year means in quadrant IV. DJN 113, DJN 114, and DJN 115, and FPS 29, all Pinot fin clones, were positioned there in at

Table 7. Soluble solids concentration (SSC) of 'Pinot noir' clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 5-year mean juice SSC.

Clone ^a	Type	SSC (%)					
		5-year	1995	1996	1997	1998	1999
FPS 2A	Pinot fin	23.8	24.4	24.7	21.6	23.7	24.6
FPS 10	Pinot fin	23.3	24.2	23.9	21.3	23.2	24.0
DJN 115	Pinot fin	23.2	24.5	23.6	21.3	23.0	23.7
DJN 113	Pinot fin	23.2	24.1	23.7	21.2	23.3	23.6
FPS 29	Pinot fin	23.1	23.9	23.5	21.3	23.2	23.8
DJN 114	Pinot fin	23.1	24.0	23.5	21.2	23.0	23.9
FPS 4	Pinot fin	23.0	23.3	23.3	21.3	23.3	23.7
FPS 32	Fertile	22.9	24.1	23.0	21.0	22.7	23.5
ESP 236	Fertile	22.8	23.9	23.1	21.6	22.8	22.9
FPS 23	Mariafeld	22.8	23.2	23.7	21.7	22.5	22.9
FPS 16	Fertile	22.8	23.5	23.0	20.9	23.0	23.7
FPS 17	Mariafeld	22.8	23.6	23.1	21.8	22.6	22.9
DJN 375	Fertile	22.6	23.6	22.9	21.1	22.9	22.7
FPS 31	Fertile	22.5	23.7	22.9	21.0	22.9	22.2
DJN 10/18	Fertile	22.5	23.1	23.2	20.3	22.5	23.2
FPS 33	Fertile	22.4	23.2	23.1	20.9	22.7	22.4
COL 538	Fertile	22.3	23.3	22.8	20.1	22.5	23.1
FPS 22	Upright	22.3	22.8	23.2	20.8	22.0	22.6
ESP 374	Upright	22.1	22.5	21.8	20.9	22.4	23.0
DJN 60	Upright	22.0	22.5	22.7	20.4	22.2	22.5
MSD ^b		---	1.21	1.13	0.70	0.87	0.59
Significant F							
Clone (C)		0.0001	0.0030	0.0018	0.0001	0.0035	0.0001
Year (Y)		0.0004	---	---	---	---	---
C × Y		0.0004	---	---	---	---	---

^aCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.^bMinimum significant difference using Walter-Duncan k-ratio ≤ 0.05 .**Table 8. Juice pH of 'Pinot noir' clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 5-year mean juice pH.**

Clone ^a	Type	pH					
		5-year	1995	1996	1997	1998	1999
DJN 115	Pinot fin	3.15	3.16	3.29	3.14	2.95	3.20
DJN 113	Pinot fin	3.13	3.16	3.22	3.12	3.03	3.14
FPS 29	Pinot fin	3.13	3.14	3.26	3.10	3.00	3.14
FPS 10	Pinot fin	3.13	3.12	3.26	3.10	3.00	3.15
FPS 4	Pinot fin	3.11	3.13	3.19	3.14	2.98	3.13
DJN 114	Pinot fin	3.11	3.08	3.19	3.12	3.00	3.15
FPS 32	Fertile	3.08	3.09	3.13	3.13	3.00	3.05
FPS 16	Fertile	3.07	3.02	3.19	3.07	3.00	3.07
COL 538	Fertile	3.06	3.10	3.15	3.06	2.93	3.05
FPS 33	Fertile	3.04	3.14	3.13	3.03	2.90	3.00
FPS 23	Mariafeld	3.02	3.07	3.20	3.01	2.88	2.97
DJN 375	Fertile	3.02	3.03	3.15	3.03	2.88	3.03
ESP 236	Fertile	3.02	3.08	3.06	3.04	2.93	3.00
DJN 60	Upright	3.02	3.02	3.12	3.06	2.88	3.01
ESP 374	Upright	3.02	3.06	3.04	3.06	2.90	3.02
DJN 10/18	Fertile	3.00	2.98	3.11	3.01	2.88	3.01
FPS 2A	Pinot fin	2.99	2.98	3.09	2.98	2.90	3.02
FPS 31	Fertile	2.99	3.04	3.08	3.00	2.90	2.93
FPS 17	Mariafeld	2.98	3.05	3.03	3.02	2.83	2.96
FPS 22	Upright	2.97	2.94	3.08	3.01	2.85	2.97
MSD ^b		0.04	0.16	0.12	0.05	0.09	0.07
Significant F							
Clone (C)		0.0001	0.0150	0.0002	0.0001	0.0001	0.0001
Year (Y)		0.0001	---	---	---	---	---
C × Y		0.0635	---	---	---	---	---

^aCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.^bMinimum significant difference using Walter-Duncan k-ratio ≤ 0.05 .

least four of the five seasons. The two Mariafeld clones (FPS 17 and FPS 23) and the Fertile clone (ESP 236) with 5-year means in quadrant IV were positioned in this quadrant in three of the five seasons.

Price and Watson (1995) reported results from the first full cropping season from this trial. Their results for yield, yield components, and fruit composition are in general agreement with those in this study. Comparing the results of this trial to those of others is difficult because most trials have only a few clones in common, or clonal designation is sometimes uncertain. A few comparisons of yield and other parameters are, however, possible.

Reynolds (2004) reported generally higher, although also wider ranging, yields and SSC for seven 'Pinot noir' clones evaluated over three seasons in the Okanagan Valley in British Columbia. Two of those, 'Gamay Beaujolais' (FPS 22) and DJN 375, were also in this trial. In British Columbia and Oregon 'Gamay Beaujolais' tended to be higher yielding than DJN 375, and the inverse was true for SSC, although these differences were not statistically significant in either trial in most seasons. 'Gamay Beaujolais' tended to have higher berry weights than DJN 375, with similar values for each clone in both trials.

Pool et al. (1995) also reported generally higher yields for 10 'Pinot noir' clones evaluated in Geneva, N.Y. Five of those, 'Gamay Beaujolais' (FPS 22), FPS 29, 'Mariafeld' (FPS 17 or 23), ESP 236, and 'Pommard' (FPS 4), were also in this trial. With the exception of FPS 29 and 'Mariafeld', these clones had similar relative yield in the two trials. In New York, FPS 29 and 'Mariafeld' were intermediate in yield; in Oregon, they were low yielding. SSC was generally lower in New York with similar ranking of individual clones. However, ESP 236 and 'Pommard' (FPS 4), which had intermediate SSC in Oregon, had low SSC in New York.

Wolpert (1995) reported on the performance of 13 'Pinot noir' clones in a trial in Sonoma County, Calif., including nine clones in this trial. Yields and cluster weights were generally much higher in the Sonoma County trial, and because these were evaluated for sparkling wine production, fruit maturity at harvest was less advanced compared to those in this

Table 9. Titratable acidity (TA) of ‘Pinot noir’ clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 5-year mean juice TA.

Clone ^a	Type	TA (g·L ⁻¹) ^b					
		5-year	1995	1996	1997	1998	1999
FPS 22	Upright	8.03	7.58	8.05	7.43	7.96	9.15
FPS 31	Fertile	7.79	7.10	7.73	7.55	7.17	9.41
FPS 2A	Pinot fin	7.71	7.48	7.35	7.52	7.20	9.03
DJN 10/18	Fertile	7.57	7.36	7.83	7.17	7.51	8.00
ESP 236	Fertile	7.35	6.98	7.43	7.11	6.72	8.53
FPS 33	Fertile	7.35	6.51	7.16	6.99	7.12	8.96
FPS 17	Mariafeld	7.31	6.91	7.35	6.73	7.14	8.44
DJN 375	Fertile	7.29	6.86	7.11	7.26	7.17	8.06
FPS 23	Mariafeld	7.26	6.88	7.24	7.01	6.91	8.28
ESP 374	Upright	7.23	7.03	7.72	6.89	6.78	7.73
DJN 60	Upright	7.19	6.93	7.01	6.74	7.13	8.16
COL 538	Fertile	6.89	6.56	7.01	6.64	6.56	7.65
FPS 16	Fertile	6.72	6.91	6.39	6.49	6.26	7.55
FPS 32	Fertile	6.56	5.84	7.02	5.72	6.31	7.90
DJN 113	Pinot fin	6.24	5.81	6.69	6.17	5.80	6.74
FPS 29	Pinot fin	6.23	6.14	6.05	5.98	5.78	7.23
FPS 4	Pinot fin	6.14	6.09	6.26	5.67	5.80	6.91
DJN 114	Pinot fin	6.05	6.14	6.14	5.91	5.70	6.36
FPS 10	Pinot fin	5.88	5.89	5.65	5.72	5.65	6.50
DJN 115	Pinot fin	5.83	5.49	5.76	5.80	6.13	5.97
MSD ^c		---	0.68	0.66	0.51	0.66	0.84
Significant F							
Clone (C)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Year (Y)		0.0001	---	---	---	---	---
C × Y		0.0020	---	---	---	---	---

^a1 g·L⁻¹ = 1000 ppm; titratable acidity expressed as g·L⁻¹ tartaric acid.

^bCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.

^cMinimum significant difference using Walter–Duncan k-ratio ≤ 0.05.

Table 10. The ratio of soluble solids concentration (SSC) to titratable acidity (TA) of ‘Pinot noir’ clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 5-year mean SSC to TA ratios.

Clone ^a	Type	SSC (%) to TA (g·L ⁻¹) ^b ratio					
		5-year	1995	1996	1997	1998	1999
DJN 115	Pinot fin	4.03	4.52	4.15	3.70	3.79	4.01
FPS 10	Pinot fin	4.01	4.17	4.24	3.73	4.13	3.77
DJN 114	Pinot fin	3.85	3.95	3.85	3.60	4.05	3.78
FMS 29	Pinot fin	3.79	3.95	3.95	3.59	4.08	3.39
FMS 4	Pinot fin	3.79	3.88	3.79	3.76	4.03	3.47
DJN 113	Pinot fin	3.77	4.24	3.59	3.45	4.07	3.53
FMS 32	Fertile	3.54	4.14	3.29	3.67	3.61	2.99
FMS 16	Fertile	3.44	3.43	3.68	3.22	3.69	3.16
COL 538	Fertile	3.28	3.60	3.26	3.04	3.43	3.05
FMS 23	Mariafeld	3.16	3.38	3.29	3.11	3.25	2.77
FMS 17	Mariafeld	3.15	3.45	3.14	3.25	3.16	2.74
ESP 236	Fertile	3.14	3.44	3.12	3.04	3.43	2.69
DJN 375	Fertile	3.14	3.46	3.24	2.92	3.21	2.87
FMS 2A	Pinot fin	3.13	3.31	3.38	2.91	3.30	2.74
ESP 374	Upright	3.11	3.29	2.86	3.07	3.31	3.02
FMS 33	Fertile	3.09	3.57	3.22	2.99	3.19	2.51
DJN 60	Upright	3.09	3.25	3.25	3.04	3.13	2.76
DJN 10/18	Fertile	2.98	3.15	2.97	2.84	3.01	2.91
FMS 31	Fertile	2.95	3.39	2.99	2.79	3.22	2.37
FMS 22	Upright	2.79	3.01	2.89	2.80	2.77	2.48
MSD ^c		---	0.48	0.43	0.29	0.41	0.40
Significant F							
Clone (C)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Year (Y)		0.0001	---	---	---	---	---
C × Y		0.0058	---	---	---	---	---

^a1 g·L⁻¹ = 1000 ppm; titratable acidity expressed as g·L⁻¹ tartaric acid.

^bCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.

^cMinimum significant difference using Walter–Duncan k-ratio ≤ 0.05.

trial. For yield, the relative ranking of most clones was similar in both trials. Notable differences included FPS 23, which was among the higher-yielding clones in California, and COL 538, which was relatively low yielding in California. FPS 23 had relatively high cluster weights in California. In a trial in Napa County, Calif., Mochizuki et al. (1995) also reported that FPS 23 had relatively high cluster weights and berry size, in contrast to our results.

Conclusions

In a cool-climate viticulture region such as Oregon, production of high quality table wine is dependent on early-maturing clones. The Pinot fin clones tended to be earlier maturing than the other clones in the trial. This group includes two clones (FPS 2A and FPS 4) thought to be the most widely planted in Oregon as well as several clones that are most often selected when establishing new vineyards. When choosing clones for vineyard establishment, one must consider winemaking goals. And, although we do not report on winemaking from this trial, anecdotal evidence from Oregon wineries as well as from other regions suggests that complex wines are most often made by blending wine from several clones rather than with fruit from a single clone.

Mariafeld selections have been reported to be vigorous and high yielding in some other locations (Becker et al., 1988; Maigre et al., 1998; Mochizuki et al., 1995; Wolpert 1995). In Germany and Switzerland, these selections are usually planted in areas with high humidity or soil moisture where botrytis bunch rot pressure is high. With low vigor and very low yields exhibited in this trial, FPS 17 and FPS 23 did not seem to be well adapted to the dry summer conditions of the Willamette Valley. Their high extractable color and botrytis bunch rot resistance imparted by loose cluster architecture may, however, make them candidates for inclusion in a multi-clonal vineyard. The higher-yielding, later-maturing clones located in quadrant II of Figure 1 may be suitable for sparkling wine production.

The previous classifications of ‘Pinot noir’ clones into the four groups were based on observations of several morphological and viticultural characteristics of significance to grape growers and winemakers. Based on our data,

Table 11. Skin anthocyanin concentration of 'Pinot noir' clones in the trial at Woodhall III Vineyard, Alpine, Ore. Clones are ranked by 4-year mean skin anthocyanin concentration.

Clone ^y	Type	Skin anthocyanin concn (mg·g ⁻¹ berry) ^z				
		5-year	1996	1997	1998	1999
FPS 23	Mariafeld	2.10	2.02	1.75	2.24	2.39
FPS 17	Mariafeld	2.07	2.11	1.73	1.94	2.51
FPS 29	Pinot fin	1.47	1.30	1.34	1.46	1.78
FPS 2A	Pinot fin	1.46	1.23	1.24	1.66	1.73
ESP 374	Upright	1.44	1.26	1.27	1.41	1.84
DJN 114	Pinot fin	1.42	1.29	1.14	1.62	1.64
FPS 31	Fertile	1.42	1.33	1.30	1.48	1.57
DJN 10/18	Fertile	1.42	1.15	1.17	1.67	1.67
FPS 32	Fertile	1.41	1.26	1.19	1.74	1.53
FPS 33	Fertile	1.40	1.16	1.22	1.53	1.71
FPS 10	Pinot fin	1.40	1.25	1.28	1.48	1.59
DJN 115	Pinot fin	1.39	1.20	1.27	1.39	1.71
ESP 236	Fertile	1.39	1.13	1.32	1.55	1.57
DJN 375	Fertile	1.38	1.11	1.28	1.51	1.62
DJN 113	Pinot fin	1.34	1.08	1.09	1.48	1.72
DJN 60	Upright	1.33	1.22	1.14	1.29	1.68
FPS 22	Upright	1.29	1.14	1.16	1.39	1.48
FPS 16	Fertile	1.22	1.02	1.13	1.51	1.28
FPS 4	Pinot fin	1.20	1.02	0.97	1.45	1.35
COL 538	Fertile	1.17	0.94	1.06	1.23	1.48
MSD ^x		0.15	0.26	0.33	0.30	0.34
Significant F						
Clone (C)		0.0001	0.0001	0.0003	0.0001	0.0001
Year (Y)		0.0001	---	---	---	---
C × Y		0.1080	---	---	---	---

^x1 mg·g⁻¹ = 1000 ppm.

^yCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.

^zMinimum significant difference using Walter-Duncan k-ratio ≤ 0.05 .

these classifications seem reasonable, although there is considerable overlap among groups for many characteristics we evaluated in this study. Therefore, these groupings should not be considered to be definitive, but they do provide a useful framework for discussing attributes of the different clones.

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Fig. 1 (left). Juice soluble solids concentration (SSC) vs. yield of 'Pinot noir' clones in the trial at Woodhall III Vineyard, Alpine, Ore., using 5-year means (1995–99). The horizontal and vertical lines indicate the overall means of SSC and yield, respectively (COL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.; 1 ton/acre = 2.2417 t·ha⁻¹).

Table 12. The position of ‘Pinot noir’ clones in the trial at Woodhall III Vineyard, Alpine, Ore., relative to the seasonal means in comparisons of soluble solids concentration (SSC) and yield. The clones are listed by quadrant position of 5-year means followed by the position in each of the 5 years.

Clone ^y	Type	Quadrant position ^z					
		5-year	1995	1996	1997	1998	1999
FPS 2A	Pinot fin	I	I	I	I	I	IV
FPS 4	Pinot fin	I	II	I	I	I	I
FPS 10	Pinot fin	I	IV	I	I	I	IV
FPS 16	Fertile	I	II	II	III	IV	I
FPS 32	Fertile	I	I	II	III	II	I
COL 538	Fertile	II	II	II	II	III	II
DJN 10/18	Fertile	II	II	II	II	II	I-II
DJN 375	Fertile	II	IV	II	II	I	II
DJN 60	Upright	II	II	III	II	II	III
FPS 22	Upright	II	II	II	II	II	II
FPS 31	Fertile	II	I	II	II	I	II
FPS 33	Fertile	II	III	II	II	III	II
ESP 374	Upright	III	II	III	III	III	III
DJN 113	Pinot fin	IV	IV	IV	I	IV	IV
DJN 114	Pinot fin	IV	IV	IV	IV	IV	IV
DJN 115	Pinot fin	IV	IV	IV	IV	IV	IV
ESP 236	Fertile	IV	IV	II	IV	III	II
FPS 17	Mariafeld	IV	IV	III	IV	III	III
FPS 23	Mariafeld	IV	III	IV	IV	III	III
FPS 29	Pinot fin	IV	IV	IV	IV	IV	IV

^zQuadrant I = above mean yield and juice SSC; II = above mean yield but below mean juice SSC; III = below mean yield and juice SSC; IV = below mean yield but above mean juice SSC.

^yCOL = Colmar; DJN = Dijon; ESP = Espiguette; FPS = Foundation Plant Services, Davis, Calif.

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