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Pinot noir Clonal Trial

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Introduction

Pinot noir is Oregon's most important wine grape variety, representing 38% of the state's total wine production. Oregon State University began importing Pinot noir clones from California and France in the 1970's to insure that Oregon growers had access to the full range of clonal types. Almost all of the Pinot noir then planted in Oregon consisted of two clones from California, FPMS 2A and FPMS 4, known as WAdenswil and Pommard. Initial French importations were from INRA (Institut National de la Recherche Agronomique) at Colmar and ANTAV (Association Nationale pour I'Am6lioration de la Viticulture) at Domaine I'Espiguette. French clones were indexed for virus status and clones free from damaging viruses were released to the industry. Evaluation of these clones and clones available from the Foundation Plant Materials Service (FPMS) at the University of California at Davis began in two trials planted in 1979 in commercial vineyards. Neither of these trials were replicated and there were apparently some mis-identified material in the trials, however, the range of clonal variation and the potential value of some of the clones were clearly apparent (5,7). Additional material was imported from ONIVINS (Office National Interprofessionnel des Vins) at Dijon in 1984. This group of clones was well characterized in French trials and was in commercial use in Burgundy (1,4). Some of the FPMS clones were also introductions from ONIVINS (Table 1). Several of the clones from Dijon are currently being planted in Oregon, particularly DJN 113, 114, and 115. A new, replicated trial was planted in Oregon State University's vineyard to evaluate this material. The primary objective of the trial was to compare the Dijon clones to the large, but less well characterized, collection of clones from FPMS as well as to the results from our earlier trials. This trial was intended to describe and characterize a large group of clones and to compliment information obtained in commercial vineyard trials. The data presented here is from the first full crop from the trial.

Materials and Methods

Twenty clones were planted in 1989 at Oregon State University's Woodhall Vineyard near Alpine, Oregon. The site is a south facing slope, around 150 m in elevation with a Bellpine silty clay loam soil. It is a warm site and is representative of many Willamette Valley vineyards. The clones and their sources are shown in Table 1. No rootstocks were used and clones were planted as mist propagated, green growing plants. Plant spacing is 9 by 6 feet. Drip irrigation was installed at the time of planting to aid in vine establishment. In 1994, each vine received 68 L of water split between three irrigations. The 1994 precipitation from bud break to harvest was 148 mm. Vines were trained to an upright vertical trellis and cane pruned to two canes per vine. In 1994, vines were pruned to a maximum of 20 nodes per vine (4.1 nodes/m). The trial is a complete randomized block design with four replicates of five vines each.

Table 1. Sources of the 20 clones in the Oregon State University Pinot noir clonal evaluation trial. Names in quotes are common names used in the Oregon wine industry.

	Agency, Identification Numbers, "Common Name"
Pinot fin	
FPMS 2A	FPMS, FV D2V6, Wädenswil 5306-2 Sel. BI 10/16, "Wädenswil"
FPMS 4	FPMS, FV D4V1a, OF 9V9, Quar. 820, "Pommard"
FPMS 10	FPMS, FV D3V8-9, Quar. 804 "Beba"
FPMS 16	FPMS, FV I8V1-2, Jackson B Blk. Cln. 1
FPMS 29	FPMS, FV H11V11-12, Jackson L3V5, "Jackson"
DJN 113	ONIVINS, Dijon, CTPS 113
DJN 114	ONIVINS, Dijon, CTPS 114
DJN 115	ONIVINS, Dijon, CTPS 115
Mariafeld	
FPMS 17	FPMS, FV I5V15, PI 312435-C-1 Switzerland "Mariafeld"
FPMS 23	FPMS, FV F16V1, PI 321435-D-1 Switzerland "Mariafeld"
Upright	
FPMS 22	FPMS, FV H7V15-16, #105 "Gamay Beaujolais"
ESP 374	ANTAV, Domaine l'Espiguette
DJN 60	ONIVINS, Dijon, CTPS 60
Fertile	
FPMS 31	FPMS, FV H2V1, CTPS 236
FPMS 32	FPMS, FV H2V3-4, CTPS 386
FPMS 33	FPMS, FV H2V5-6, CTPS 388
ESP 236	ANTAV, Domaine l'Espiguette, CTPS 236
DJN 375	ONIVINS, Dijon, CTPS 375
DJN 10/18	ONIVINS, Dijon, CTPS 10/18
COL 538	INRA, Colmar, CTPS 162

Harvest of all clones was on September 26. A fifty berry sample of each replicate was taken at harvest, and cluster number and weight recorded. Fruit from all four replicates was pooled for wine making. Wine grape lots ranged from 24 to 50 kg (50 to I 10 lbs).

Results and Discussion

The clones represented in this trial could be differentiated by yield, plant growth habit, and cluster morphology into four distinct types: Pinot fin, small clustered clones with a drooping or prostrate growth habit; Mariafeld types with loose clusters; upright clones (Pinot droit in France, Gamay Beaujolais in California) with an erect plant habit; and fertile types (Pinot fertile and Pinot fructif6re in France) with large clusters and prostrate growth. Clones were placed in groups based on our own observations and published descriptions (1). Mariafeld and upright types were easily differentiated in our trial. The differences between Pinot fin and fertile types were less apparent. We were not able to find published descriptions of Clones Col 538 and DJN 10/18. They have been included in the fertile group based on this year's yields and cluster weights.

Weather during bloom in 1994 contributed to low fruit set in most Oregon vineyards and resulted in low yields in this trial (Table 2). Pinot noir cluster weights in 1994 were only 50% of 1993 levels in many

Willamette Valley vineyards. Yields in this trial in 1994 ranged from 1.23 to 2.95 kg/vine (1.09 to 2.62 tons/acre). Average yields were 1.63 kg/vine for Pinot fin clones, 1.72 kg/vine for Mariafeld clones, 2.07 kg/vine for upright clones, and 2.5 kg/vine for fertile clones. Statistically, there were significant differences only between the lowest and highest yielding clones (p=0.05). Within the Pinot fin group, there were no statistically significant differences in yield. Generally, high yielding clones were characterized by having more clusters per vine and greater cluster weights. Larger cluster weights were due primarily to more berries per cluster. Average berry weights ranged from 0.63 to 1.12 g. There was no clear relationship between berry weights and clonal type. Mariafeld clones have been reported to have larger berries than other Pinot noir types but that was not the case this year (3, 7). The higher yields in the fertile clones helped compensate for the poor set this year. Their yields in this trial were close to typical yields for Pinot fin clones in Oregon in a year with average set. In France they are often included in vineyard clonal mixes just for this purpose (1).

Table 2. Yield components of 20 Pinot noir clones. Alpine, Oregon, 1994.

	Yield (kg vine^{-1})	Cluster Number (vine^{-1})	Cluster Weight (g)	Berry Weight (g)	Berry Number (cluster^{-1})
Pinot fin					
FPMS 2A	1.99	33.2	59.9	0.77	58.7
FPMS 4	2.05	33.8	59.7	0.92	67.3
FPMS 10	1.86	33.4	55.3	1.00	55.3
FPMS 16	1.70	28.3	58.9	1.08	54.7
FPMS 29	1.28	21.8	56.5	0.65	86.5
DJN 113	1.23	22.5	53.9	0.75	72.1
DJN 114	1.59	31.1	51.0	0.78	65.6
DJN 115	1.35	26.1	51.6	0.92	56.3
Mariafeld					
FPMS 17	1.74	31.5	55.0	0.74	74.1
FPMS 23	1.70	30.8	55.3	0.63	88.3
Upright					
FPMS 22	2.21	30.9	71.4	1.03	69.2
ESP 374	2.16	29.8	66.7	1.12	59.7
DJN 60	1.84	26.6	68.3	0.95	072.1
Fertile					
FPMS 31	2.95	38.7	76.4	0.92	83.2
FPMS 32	2.49	35.4	70.2	0.81	86.2
FPMS 33	2.36	37.5	62.5	0.72	86.5
ESP 236	2.52	37.3	68.3	0.80	85.4
DJN 375	2.23	35.9	62.6	0.84	74.6
DJN 10/18	2.43	38.2	63.6	0.84	76.1
COL 538	2.49	34.3	72.5	0.91	80.0
significance	***	***	**	n/a	***
std error	0.241	2.33	4.57	n/a	5.09

The must and wine composition of the clones is shown in Table 3. Pinot fin clones at harvest averaged 23. 1 * Brix compared to the fertile clones which averaged 21.7*. The Mariafeld and upright clones were intermediate between the two. Pinot fin titratable acidity and pH at harvest averaged 6.9 g/L and

3.21, respectively, compared to 8.34 g/L and 3.10 for the fertile clones. The Mariafeld clones had the highest titratable acidity and the lowest pH. Wine alcohol content, titratable acidity, and pH reflected must composition at harvest.

Table 3. Must and wine composition of 20 Pinot noir clones, Alpine, Oregon, 1994. Must sample was from a 50 berry sample from each replicate; wine analysis is from a pooled wine lot combining all four replicates.

	Berry Sample			Wine		
	°Brix	Titratable Acidity ($g\ L^{-1}$)	pH	Alcohol (%)	Titratable Acidity ($g\ L^{-1}$)	pH
Pinot fin						
FPMS 2A	22.8	7.64	3.09	14.4	6.13	3.54
FPMS 4	23.0	6.89	3.20	14.3	5.25	3.62
FPMS 10	23.3	6.56	3.19	14.4	5.40	3.69
FPMS 16	22.8	8.14	3.12	14.4	5.75	3.61
FPMS 29	23.8	6.95	3.28	14.2	5.50	3.68
DJN 113	23.3	6.68	3.21	14.4	5.40	3.71
DJN 114	22.8	6.70	3.27	14.0	5.70	3.60
DJN 115	23.2	6.31	3.29	14.4	5.20	3.76
Mariafeld						
FPMS 17	22.1	8.89	2.99	13.4	6.40	3.48
FPMS 23	21.9	10.00	2.99	13.2	6.20	3.51
Upright						
FPMS 22	22.1	8.29	3.14	13.9	5.60	3.64
ESP 374	21.9	9.23	3.12	13.4	5.95	3.51
DJN 60	22.3	7.30	3.18	13.8	5.65	3.66
Fertile						
FPMS 31	21.6	8.65	3.07	13.3	5.95	3.47
FPMS 32	21.6	7.65	3.15	13.9	5.50	3.59
FPMS 33	21.2	9.20	3.04	12.9	5.90	3.37
ESP 236	21.4	8.56	3.10	13.0	5.85	3.45
DJN 375	21.8	8.55	3.10	13.3	5.85	3.45
DJN 10/18	22.3	8.20	3.08	13.6	6.30	3.48
COL 538	22.1	7.60	3.18	13.6	5.65	3.52
significance	***	***	***	n/a	n/a	n/a
std error	0.22	0.318	0.028	n/a	n/a	n/a

Wine color intensity and anthocyanin content ranged from 6.81 to 13.68 absorbance units and 362 to 644 mg/L, respectively (Table 4). Average wine color intensity and anthocyanin content for the two Mariafeld clones was more than 50% greater than the average of all the other clones. They were no clear differences between the Pinot fin and fertile types in wine color intensity although color varied between individual clones within each group. Wine color did not seem to be related to grape yield or sugar content. The Mariafeld clones had high total phenolics but the difference between the these clones and the others was not as great as for color and anthocyanins.

Table 4. Wine color and phenolic analysis.

	Wine Color Intensity (A 420 + 520 nm)	Anthocyanins (mg L^{-1})	Total Phenols (mg L^{-1} gallic acid equiv.)	Anthocyanin: Total Phenol Ratio
Pinot fin				
FPMS 2A	9.28	456	1476	0.31
FPMS 4	8.78	418	1466	0.29
FPMS 10	8.17	418	1621	0.26
FPMS 16	7.88	433	1315	0.33
FPMS 29	7.65	421	1550	0.27
DJN 113	7.84	416	1563	0.27
DJN 114	8.97	420	1360	0.30
DJN 115	8.06	422	1745	0.24
Mariafeld				
FPMS 17	13.68	602	1869	0.32
FPMS 23	13.61	644	1743	0.37
Upright				
FPMS 22	8.60	416	1384	0.30
ESP 374	7.89	394	1430	0.28
DJN 60	8.53	436	1444	0.30
Fertile				
FPMS 31	8.63	414	1357	0.31
FPMS 32	9.23	475	1596	0.30
FPMS 33	6.73	365	1124	0.33
ESP 236	11.38	500	1669	0.30
DJN 375	8.95	415	1387	0.30
DJN 10/18	9.54	469	1567	0.30
COL 538	6.81	362	1165	0.31

DJN 115 had average color and anthocyanin concentration but it was notable in having total phenolics second only to Mariafeld clone FPMS 17. DJN 115 had the lowest ratio of anthocyanins to total phenols of all the clones indicating that a greater proportion of the phenolic compounds in DJN 115 were non-anthocyanins. HPLC analysis of wine phenolic composition showed DJN 115 to have the highest catechin levels in the trial (Table 5). Wine catechin levels appeared to be related to wine polymeric phenols measured at 280 nm with the wines with the highest catechin levels having high polymer content and wine with the lowest catechin content having the lowest polymer content. The primary source of catechin in Pinot noir wines is seeds (Valladao, unpublished data). The differences observed in this trial could be related to either a difference in extractable seed phenolic content or to a difference in the ratio of seeds to juice. No seed parameters were measured in this trial.

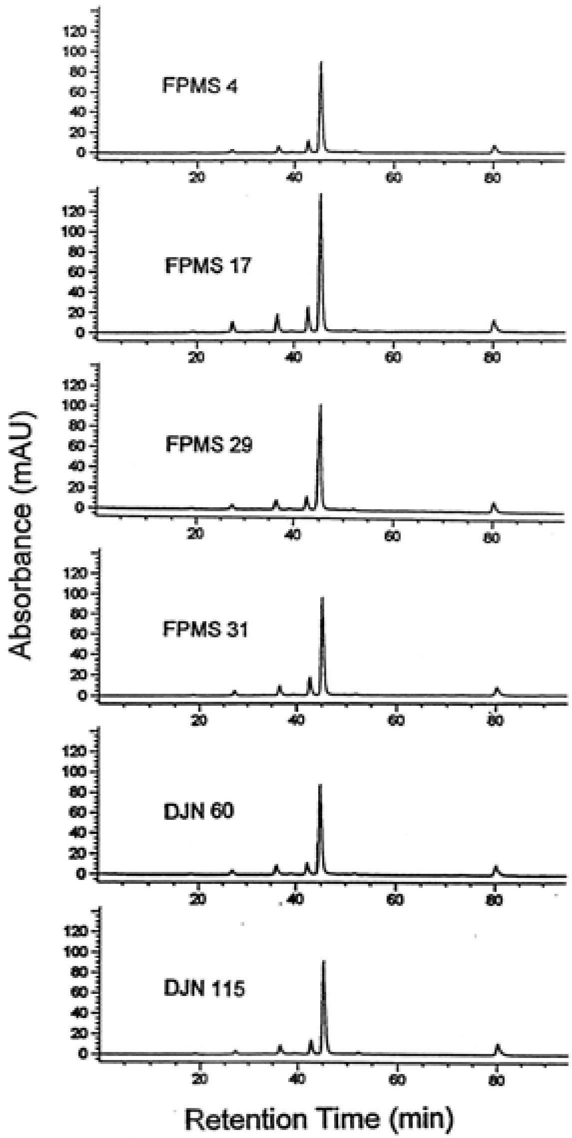

Figure 1. HPLC chromatograms of wine anthocyanins from six Pinot noir clones. Clones FPMS 4, FPMS 29, and DJN 115 are small clustered Pinot fin types; FPMS 17 is a Mariafeld type; DJN 60 is an upright type; and FPMS 31 is a fertile type. Peaks, from left to right, are delphinidin-3-glucoside, petunidin-3-glucoside, peonidin-3-glucoside, malvidin-3-glucoside, and polymeric anthocyanins.

Quercetin in wines is related to grape berry sun exposure with highly exposed grape clusters having higher skin and wine quercetin concentrations (6). Changes in cluster sun exposure through canopy variation and cluster morphology can significantly affect wine quercetin concentrations. The Mariafeld clones had the highest wine quercetin concentrations in this trial, most likely due to their distinct cluster morphology (Table 5). Mariafeld clusters are loose with long rachis and pedicils (5). As a result, a larger proportion of the berTy surface is potentially sun exposed as there are fewer interior berries within the cluster. It is likely that loose clusters in Mariafeld clones may also be responsible for their high anthocyanin content, as anthocyanin accumulation is also light responsive. The loose clusters of Mariafeld clones have been reported to enhance botrytis resistance (2,3) Other clones with high wine quercetin concentrations, FPMS 32 and ESP 236, did not have a distinctly loose cluster type. It may be that these clones had more open canopies in 1994. Canopy density information will be obtained when these clones are pruned later this season. Malvidin, the primary anthocyanin in Pinot noir grape skins, and polymeric pigments absorbing at 520 nrn generally correlated with the data for wine color intensity (Table 4 and 5).

Table 5. HPLC analysis of wine phenolic composition of twenty Pinot noir clones, Alpine Oregon, 1994. All values are peak areas (mAU s).

	Catechin	Total Quercetin	Malvidin	Polymeric Compounds (280 nm)	Polymeric Compounds (520 nm)
Pinot fin					
FPMS 2A	460	751	3438	5027	431
FPMS 4	465	740	3749	4804	418
FPMS 10	509	801	3741	5269	418
FPMS 16	305	806	4201	4358	328
FPMS 29	532	816	4230	4961	448
DJN 113	457	792	3894	5289	439
DJN 114	350	808	3986	5150	465
DJN 115	656	909	3892	6370	482
Mariafeld					
FPMS 17	498	1306	5623	5971	580
FPMS 23	436	1306	5388	6098	562
Upright					
FPMS 22	311	854	4329	4740	391
ESP 374	359	759	3554	5436	451
DJN 60	352	667	3728	5122	429
Fertile					
FPMS 31	366	738	3837	4604	383
FPMS 32	507	1128	4350	5440	414
FPMS 33	316	721	3519	4275	377
ESP 236	615	1010	4256	6557	481
DJN 375	513	748	3524	5079	348
DJN 10/18	447	745	4286	4787	376
COL 538	369	771	3384	4270	326

Pinot noir is unique among wine varieties in having no acylated anthocyanins (8). Figure 1 shows chromatograms at 520nm for six of the clones representing Pinot fin, Mariafeld, upright, and fertile clones. There were no acylated anthocyanin pigments present in any of the wines. There were quantitative differences in total anthocyanin concentrations among clones, however, all the clones shared a common profile of anthocyanin peaks. Analysis of gape skin extracts found similar results (data not shown). Wenzel et al. (8) found similar results in a comparison of six German Pinot noir selections. Questions have been raised in the past about the authenticity of clone FPMS 29, identified as "Franc Pinot" in some lists (FPMS unpublished), and the Mariafeld clones. This data clearly shows all these clones are Pinot noir.

Conclusions

Most Pinot noir clones could be clearly grouped within types based on cluster and plant morphology and yield. Pinot fin types generally had lower yields, higher Brix, lower titratable acidity, and higher pH than the other clones, indicating earlier maturity, however they had average wine color and phenolic content. The higher yielding fertile clones had an acceptable degree of maturity this season with moderate yields in a year of poor fruit set. Mariafeld clones were outstanding for their high color and could be a valuable resource for blending and for botrytis resistance. The new Dijon Pinot fin clones 113, 114, 115 appear to be high quality, low yielding, and early maturing. This season, they did not appear to be significantly different from the standard commercial clones now grown in Oregon . In yield, canopy managment, and rootstock trials at the same vineyard using a single clone, we observed differences in grape composition and wine quality equal to or greater than the clonal differences reported here. We expect greater variation among the clones in cool seasons with later maturity or in seasons with higher yields.

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