Oregon Wine Advisory Board
Research Progress Report

1998 - 1999

Evaluation of varieties, clones, and rootstocks:

II. & III. Performance of Pinot noir and Chardonnay clones

Steve Castagnoli and M. Carmo Candolfi-Vasconcelos
Department of Horticulture

INTRODUCTION

Pinot noir and Chardonnay are the two main winegrape varieties in Oregon. In 1998, they comprised approximately 59% of the Oregon winegrape acreage, and 57% of the total production for a value of $10,803,000 (62% of total) (1). Internationally, clonal selection of Pinot noir and Chardonnay have made available, for each variety, an array of clones with wide ranging levels of productivity and fruit quality. In the Champagne region, clones were selected for increased yields; in Burgundy, the main criterion was high fruit quality; and in Switzerland, the Pinot noir clone Mariafeld was selected for disease resistance. In the U. S., clones selected here and elsewhere continue to be evaluated for their suitability to local growing conditions. The Pinot noir clones included in the trial at Woodhall III Vineyard (Table 1) include representatives of diverse types loosely classified into four groups: 1) Pinot fin, typically characterized by having small clusters and prostrate growth habit; 2) Mariafeld, most noted for having loose clusters; 3) Upright, known for their erect growth habit; and 4) Fertile, typically having large clusters and prostrate growth habit (2). The Chardonnay clones at Woodhall III Vineyard (Table 2), although not as numerous as clones in the Pinot noir trial, also represent a range of types with different levels of productivity and fruit quality.

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

Type	Clone	Name	Origin
Pinot fin	FPMS 2A	Wädenswil	Switzerland
	FPMS 4	Pommard	Burgundy
	FPMS 10	Beba	Spain
	FPMS 29	Jackson	France via California
	DJN 113	CTPS 113	Burgundy
	DJN 114	CTPS 114	Burgundy
	DJN 115	CTPS 115	Burgundy
Mariafeld	FPMS 17	Mariafeld	Wädenswil
	FPMS 23	Mariafeld	Wädenswil
Upright	FPMS 22	Gamay Beaujolais	California
	ESP 374	Espiguette 374	ENTAV, Espiguette
	DJN 60	Dijon 60	Burgundy
Fertile	FPMS 16	Jackson	France via California
	FPMS 31	CTPS 236	Roederer, Chouilly
	FPMS 32	CTPS 386	Roederer, Chouilly
	FPMS 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

Table 2. Chardonnay clones included in the trial at Woodhall III Vineyard, Alpine, OR.

	Clone	Name	Origin
France	DJN 75	CTPS 75	Burgundy
	DJN 76	CTPS 76	Burgundy
	DJN 78	CTPS 78	Loire
	DJN 95	CTPS 95	Burgundy
	DJN 96	CTPS 96	Burgundy
	ESP 352	ENTAV 352	ENTAV, Espiguette
United States	FPMS 4	Olmo # 66	Martini Vineyard, California
	FPMS 5	Olmo # 69	Martini Vineyard, California
	FPMS 6	Olmo # 68	Martini Vineyard, California
	FPMS 14	Olmo # 65	Martini Vineyard, California
	FPMS 15	Prosser	Washington

Abbreviations used are as follows:
COL = Colmar
CTPS = Committee Technique Permanent de la Selection
DJN = Dijon
ESP = Espiguette
ENTAV = Etablissement National technique pour l'Amelioration de la Viticulture
FPMS = Foundation Plant Materials Service, Davis, CA

Vines in the Woodhall III Vineyard Pinot noir and Chardonnay clonal trials were in the tenth leaf in the 1998 season. Both trials consist of own rooted vines, planted on a 1.8m x 2.7m (6 ft x 9 ft) spacing, and trained to an upright vertical trellis. At harvest in 1998, yield components and juice composition were measured in both trials. Additionally in the Pinot noir clones, fruit set, vegetative growth parameters, cluster architecture, and skin anthocyanins were measured. During budbreak, bloom, and veraison, the Pinot noir clones were rated for their stage of development, and starting at veraison, a ripening survey was conducted with sampling at twoweek intervals until harvest.

Demonstration wine lots are being made from the 1998 harvest by Barney Watson, OSU Department of Food Science and Technology, with the following Pinot noir clones: ESP 236, FPMS 2A, 4, 10, 29, 17, 23, and 32, and DJN 113, 114, and 115. Wine making results will be reported at a later date.

MATERIALS AND METHODS

Pinot noir clones

Canopy development and vine vigor - The Pinot noir clonal trial was pruned in February 1998. Pruning weights were measured, and 30 buds per kilogram of one-year-old wood were left. Shoot length, diameter, and leaf number were measured on three shoots per replicate on 7 July, prior to hedging.

Bud burst, bloom, and veraison phenology - Prior to budbreak, five canes per replicate were selected for estimating bud burst, bloom, and veraison phenology. During budbreak, the five uppermost buds of each cane were scored three times per week using the scale proposed by Johnson and Howell (3). At bloom, 25 clusters per replicate were rated three times per week for percentage of fallen caps. During veraison, the same clusters were scored three times per week for percentage of dark colored berries.

Fruit set and cluster architecture - Prior to bloom, three clusters per replicate were enclosed in mesh bags to retain all shed flowers. The bags were removed approximately four weeks after full bloom and all abscised flowers and fruitlets were counted. The previously bagged clusters were picked separately at harvest. The number of flowers was calculated as the sum of shed flowers and berries. Percent fruit set was calculated as the quotient of berries at harvest and total number of flowers per inflorescence. Cluster length, and volume were measured and the clusters were frozen for later determination of berry number.

Ripening survey - On August 24, at the onset of veraison, and at two-week intervals until harvest, a three- cluster sample was collected per replicate. Cluster weight was measured, and berry weights were measured on a 100-berry subsample randomly selected from the three clusters. The remaining berries were crushed for determination of soluble solids, pH, and titratable acidity.

Yield and fruit quality - The Pinot noir clonal trial was harvested on September 25. A sample of 10 clusters per replicate was crushed for determination of soluble solids, pH, and titratable acidity. A sample of five clusters per replicate was used to estimate number of berries per cluster. Cluster weight was calculated by averaging the pooled 15-cluster sample weight. Berry and skin weights were measured on a 100-berry subsample randomly selected from the five clusters. Skins were extracted in acidulated methanol. Anthocyanins were determined by absorbance at 530 nm and concentration was calculated using an extinction coefficient of E 1%=380 (4,5). Sugar per vine was calculated by multiplying must sugar concentration (°Brix/100) by total yield per vine.

Chardonnay clones

Pruning - The Chardonnay clonal trial was pruned in February 1998. Pruning weights were measured, and 30 buds per kilogram of one-year-old wood were left.

Yield and fruit quality - The Chardonnay clonal trial was harvested on October 16. A sample of 25 clusters per replicate was crushed for determination of soluble solids, pH, and titratable acidity. Berry weights were measured on a 100-berry subsample randomly selected from a fivecluster sample from each replicate. Cluster weight was calculated by averaging the pooled 30-cluster sample weight. Sugar per vine was calculated by multiplying must sugar concentration (°Brix/100) by total yield per vine.

RESULTS AND DISCUSSION

Pinot noir clones - 1998 season

Yield and yield components - Yield of the Pinot noir clones ranged from a high of 1.55 t/ac (DJN 10/18) to a low of 0.73 t/ac (FPMS 29) (Table 3). FPMS clones 2A, 4, and 10, all Pinot fin clones, had relatively high yields. Additionally, there were relatively high yielding Upright (DJN 60 and FPMS 22) and Fertile clones (DJN 375, FPMS 31, and 32). The overall average yield for the Pinot noir clones in 1998 was 1.15 t/ac. This represents a 50% reduction compared to that of 1997 (2.30 t/ac).

Table 3. Yield components of Pinot noir clones at Woodhall III Vineyard in 1998.

	Clone	Yield (kg/vine)	±	Yield (t/ac)	±	Berries/ cluster	±	Berry wt. (g)	±	Cluster wt. (g)	±	Shoots/ vine	±	Clusters/ shoot	±
Pinot fin															
	FPMS 2A	1.73	0.17	1.54	0.15	74	5	1.00	0.08	72.2	1.8	18	1	1.3	0.0
	FPMS 4	1.63	0.17	1.45	0.15	74	5	0.97	0.05	71.8	6.4	15	2	1.6	0.2
	FPMS 10	1.36	0.07	1.21	0.06	75	7	0.93	0.06	69.9	6.4	15	2	1.4	0.1
	FPMS 29	0.82	0.08	0.73	0.07	64	4	0.92	0.13	57.8	4.9	13	1	1.1	0.1
	DJN 113	1.10	0.27	0.97	0.24	65	3	1.00	0.07	65.2	6.9	15	2	1.1	0.1
	DJN 114	1.01	0.22	0.90	0.20	61	7	1.01	0.07	61.9	9.0	13	2	1.2	0.1
	DJN 115	1.02	0.12	0.91	0.11	64	4	0.98	0.05	62.4	3.6	14	1	1.2	0.1
Mariafeld															
	FPMS 17	0.85	0.08	0.76	0.07	75	4	0.91	0.09	67.3	4.1	12	2	1.1	0.1
	FPMS 23	1.25	0.12	1.11	0.11	81	6	0.92	0.04	75.2	8.7	13	1	1.3	0.0
Upright															
	FPMS 22	1.57	0.08	1.39	0.07	78	4	1.07	0.03	83.7	3.0	17	0	1.1	0.0
	ESP 374	1.03	0.15	0.91	0.14	86	5	0.98	0.10	84.4	10.0	13	1	0.9	0.1
	DJN 60	1.46	0.26	1.29	0.23	73	6	0.99	0.07	72.5	8.6	15	2	1.4	0.2
Fertile															
	FPMS 16	1.18	0.11	1.05	0.10	62	3	1.03	0.02	64.3	3.0	16	0	1.1	0.1
	FPMS 31	1.58	0.23	1.41	0.20	94	1	1.01	0.08	94.8	6.0	13	1	1.2	0.1
	FPMS 32	1.48	0.12	1.32	0.10	88	6	0.91	0.05	79.6	5.6	14	1	1.3	0.1
	FPMS 33	1.15	0.19	1.02	0.17	73	3	0.96	0.03	69.8	3.8	15	3	1.1	0.1
	ESP 236	1.20	0.13	1.06	0.11	90	2	0.98	0.07	88.0	4.6	12	1	1.2	0.1
	DJN 375	1.46	0.28	1.30	0.25	78	3	1.00	0.04	77.9	4.0	15	2	1.3	0.2
	DJN 10/18	1.75	0.14	1.55	0.12	85	5	1.00	0.09	84.4	6.3	17	1	1.3	0.0
	COL 538	1.29	0.23	1.15	0.21	70	5	1.01	0.05	71.0	7.6	16	1	1.1	0.1
	Significant F	**[1]		**		***		ns		***		ns		*	

[1] ns, *, **, and *** indicate not significant, and statistically significant at the 0.05, 0.01, and 0.001 levels of probability, respectively.

Berry weights ranged from 0.91 g (FPMS 17 and 32) to 1.07 g (FPMS 22) (Table 3). These differences were, however, not statistically significant. Cluster weights ranged from 57.8 g (FPMS 29) to 94.8 g (FPMS 31). In addition to FPMS 29, several other Pinot fin clones (DJN 113, 114, and 115) had relatively low cluster weights. Other clones with relatively high cluster weights included FPMS 22 and ESP 374 (Upright clones), and FPMS 32, ESP 236, and DJN 10/18 (Fertile type clones). Cluster weight was significantly correlated to yield (R^2=0.374). In 1998, all clones, with the exception of ESP 374 and FPMS 17 and 23, had lower cluster weights than in 1997. This can be attributed to lower berry weights and fewer berries per cluster in 1998 compared to those in 1997.

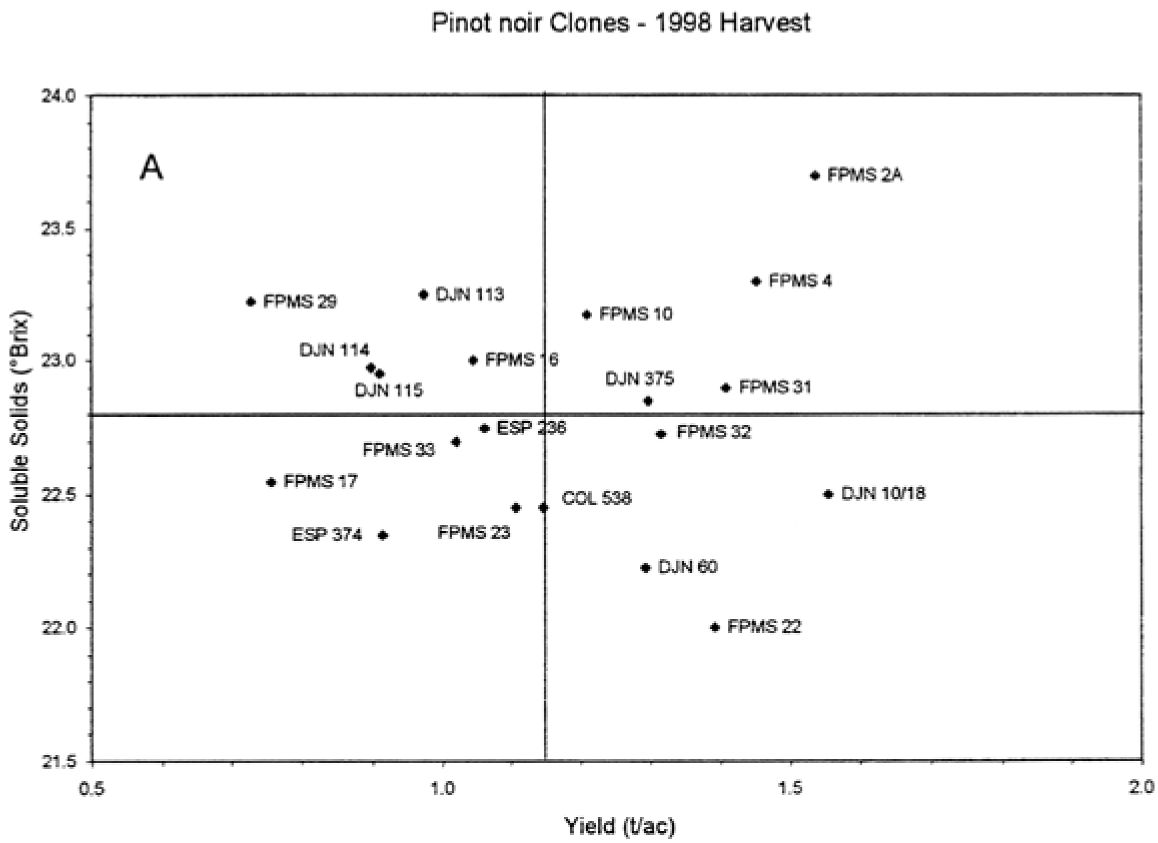
Fruit composition - Juice soluble solids at harvest ranged from 22.0 °Brix (FPMS 22) to 23.7 °Brix (FPMS 2A) (Table 4). The Pinot fin clones tended to have higher soluble solids than those of the other groups. The three Upright clones had the lowest soluble solids. The Pinot fin clones, with the exception of FPMS 2A, tended to have relatively high juice pH and correspondingly low titratable acidity levels compared to those of the other clones. Juice pH and titratable acidity at harvest were inversely correlated (R^2 = 0.827). Neither pH nor titratable acidity, however, was closely correlated to Brix.

Table 4. Fruit composition of Pinot noir clones at Woodhall III Vineyard in 1998.

	Clone	Soluble Solids (°Brix)	±	pH	±	Titratable acidity (g/L)	±	Sugar (kg/vine)	±	Skin Anthocyanin (mg/g berry)	±	Skin Anthocyanin (mg/berry)	±
Pinot fin													
	FPMS 2A	23.7	0.1	2.86	0.01	7.20	0.21	0.41	0.04	1.66	0.14	1.62	0.06
	FPMS 4	23.3	0.1	2.99	0.02	5.80	0.22	0.38	0.04	1.45	0.13	1.39	0.09
	FPMS 10	23.2	0.0	2.99	0.03	5.65	0.23	0.32	0.02	1.48	0.08	1.39	0.12
	FPMS 29	23.2	0.2	3.00	0.04	5.78	0.41	0.19	0.02	1.46	0.06	1.32	0.13
	DJN 113	23.3	0.3	3.02	0.05	5.80	0.42	0.25	0.06	1.48	0.07	1.48	0.09
	DJN 114	23.0	0.1	3.01	0.05	5.70	0.21	0.23	0.05	1.62	0.16	1.60	0.04
	DJN 115	23.0	0.1	2.95	0.04	6.13	0.42	0.23	0.03	1.39	0.03	1.35	0.03
Mariafeld													
	FPMS 17	22.6	0.6	2.82	0.02	7.14	0.12	0.19	0.02	1.94	0.14	1.74	0.13
	FPMS 23	22.5	0.2	2.86	0.01	6.91	0.12	0.28	0.03	2.24	0.18	2.05	0.17
Upright													
	FPMS 22	22.0	0.3	2.82	0.02	7.96	0.18	0.34	0.02	1.39	0.10	1.49	0.13
	ESP 374	22.4	0.3	2.90	0.03	6.78	0.28	0.23	0.04	1.41	0.11	1.34	0.04
	DJN 60	22.2	0.4	2.89	0.02	7.13	0.31	0.32	0.06	1.29	0.11	1.29	0.15
Fertile													
	FPMS 16	23.0	0.3	2.98	0.02	6.26	0.24	0.27	0.02	1.51	0.06	1.53	0.06
	FPMS 31	22.9	0.2	2.89	0.03	7.17	0.34	0.36	0.05	1.48	0.11	1.48	0.06
	FPMS 32	22.7	0.1	3.01	0.01	6.31	0.13	0.34	0.03	1.74	0.15	1.55	0.05
	FPMS 33	22.7	0.4	2.88	0.01	7.12	0.19	0.26	0.04	1.53	0.02	1.47	0.05
	ESP 236	22.8	0.2	2.94	0.04	6.72	0.49	0.27	0.03	1.55	0.06	1.54	0.15
	DJN 375	22.9	0.3	2.88	0.03	7.17	0.31	0.33	0.06	1.51	0.12	1.51	0.14
	DJN 10/18	22.5	0.2	2.85	0.03	7.51	0.30	0.39	0.03	1.67	0.12	1.66	0.17
	COL 538	22.5	0.2	2.94	0.02	6.56	0.22	0.29	0.05	1.23	0.09	1.23	0.03
	Significant F	**[1]		***		***		***		***		***	

[1] **, and *** indicate statistically significant at the 0.01, and 0.001 levels of probability, respectively.

FPMS clones 2A, 4, and 10, Pinot fin type clones, had above average juice soluble solids, as well as above average yields (Figure 1A). Two Fertile type clones, DJN 375 and FPMS 31, also had above average juice soluble solids and above average yields. Clones DJN 113, 114, and 115, and FPMS 29, also Pinot fin type clones, had above average soluble solids but below average yields. DJN 60 and FPMS 22 (Upright clones) and DJN 10/18 and FPMS 32 (Fertile type clones) had above average yields but below average soluble solids. The Mariafeld clones FPMS 17 and FPMS 23 had below average yields and, in contrast to 1997, had below average juice soluble solids. In 1998, all twenty clones had higher soluble solids but lower yields than in 1997.


Pinot noir Clones - 1998 Harvest
A
Soluble Solids (°Brix)
Yield (t/ac)
24.0
23.5
23.0
22.5
22.0
21.5
0.5
1.0
1.5
2.0
FPMS 2A
FPMS 4
FPMS 29
DJN 113
FPMS 10
DJN 114
FPMS 16
DJN 115
DJN 375
FPMS 31
ESP 236
FPMS 32
FPMS 33
FPMS 17
COL 538
DJN 10/18
ESP 374
FPMS 23
DJN 60
FPMS 22

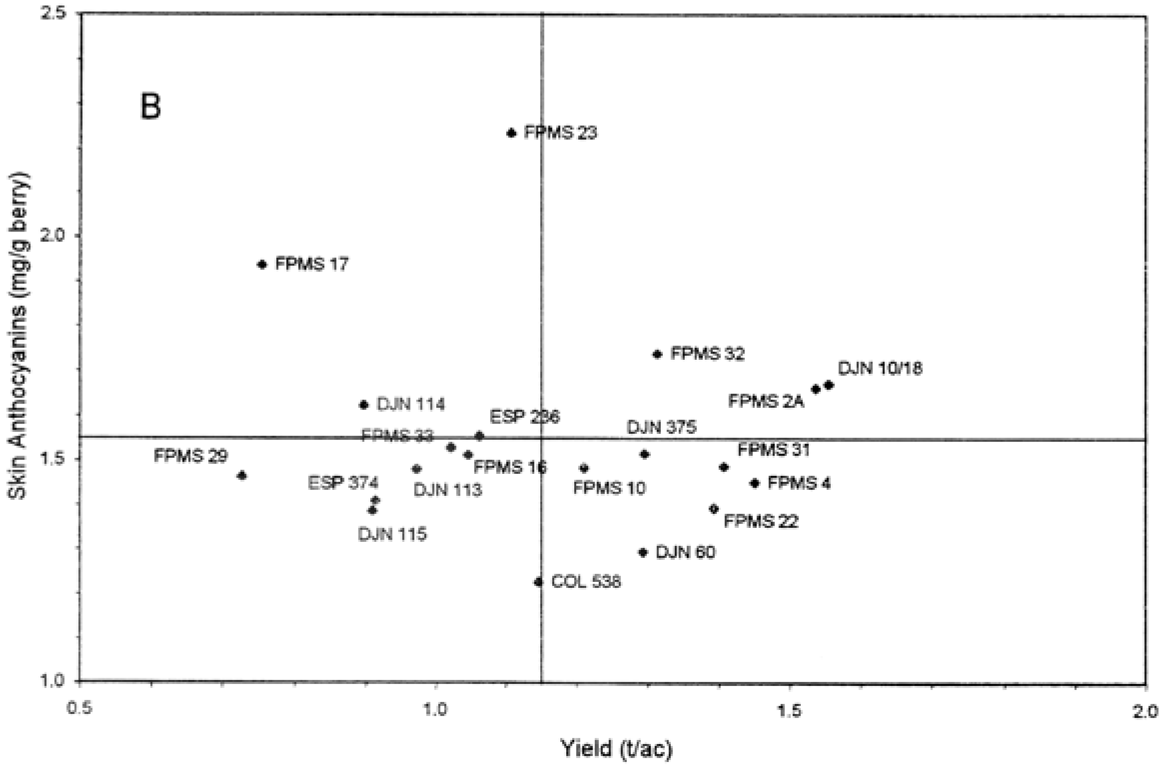


Figure 1. A Juice soluble solids, and B skin anthocyanins vs. yield of Pinot noir clones at Woodhall III Vineyard in 1998. Horizontal and vertical lines indicate the overall seasonal averages of soluble solids, skin anthocyanins, and yield.

FPMS 23 and FPMS 17, both Mariafeld clones, had the two highest skin anthocyanin concentrations (2.05 mg/g berry and 1.94 mg/g berry, respectively). These two clones have consistently had the highest skin anthocyanin concentrations. There was a relatively narrow range in anthocyanin concentration among the other clones, from 1.23 mg/g berry (COL 538) to 1.74 mg/g berry (FPMS 32). The values reported here are generally comparable to those reported by Price and Watson (2) for wines produced in 1994 from the Pinot noir clones at Woodhall.

The relationship between skin anthocyanin concentration and yield is shown in Figure 1B. Although DJN 10/18, FPMS 2A, and FPMS 32 had above average anthocyanins and above average yields, none of the clones had both high anthocyanins and high yield. The clones with the two highest anthocyanin content, FPMS 23 and FPMS 17, both had below average yields.

Fruit set and cluster architecture - Fruit set was generally even among the clones with the exception of FPMS 2A which had relatively high fruit set, and FPMS 17 and 23 (both Mariafeld clones), which had relatively low fruit set (Table 5). The overall average for flowers per inflorescence was lower in 1998 than in 1997 (290 and 394, respectively). Fruit set was 29% in both seasons.

Table 5. Fruit set and cluster architecture of Pinot noir clones at Woodhall III Vineyard in 1998.

	Clone	Flowers/ Inflorescence	±	Fruit Set (%)	±	Cluster Length (cm)	±	Cluster Volume (cm^3)	±	Cluster Compactness (berries/cm)	±
Pinot fin											
	FPMS 2A	257	23	40	3	11.8	0.5	87	5	8.6	0.4
	FPMS 4	255	16	27	4	10.2	0.9	63	5	6.6	0.6
	FPMS 10	257	9	33	1	11.0	0.2	72	6	7.7	0.2
	FPMS 29	206	11	32	5	10.1	0.3	61	6	6.7	1.2
	DJN 113	208	19	26	3	9.4	0.5	42	4	5.7	0.4
	DJN 114	259	7	25	1	10.1	0.3	51	7	6.3	0.5
	DJN 115	246	22	33	3	10.0	0.7	66	14	8.2	1.0
Mariafeld											
	FPMS 17	368	26	19	2	13.0	0.5	53	8	5.3	0.5
	FPMS 23	411	33	20	1	12.8	0.6	69	13	6.4	0.4
Upright											
	FPMS 22	348	23	25	1	11.9	0.3	83	9	7.4	0.5
	ESP 374	285	34	32	2	10.5	1.0	80	20	8.6	0.6
	DJN 60	295	12	31	2	11.1	0.4	80	10	8.2	0.5
Fertile											
	FPMS 16	231	23	32	1	9.5	0.3	64	8	7.6	0.5
	FPMS 31	392	44	28	4	12.2	0.5	81	16	8.8	1.3
	FPMS 32	282	15	27	3	10.0	0.1	62	6	7.6	0.6
	FPMS 33	319	13	28	3	11.4	0.2	72	6	7.7	0.4
	ESP 236	352	30	30	1	11.4	0.6	90	4	9.2	0.5
	DJN 375	310	23	32	2	11.2	0.4	81	6	8.9	0.5
	DJN 10/18	284	26	30	1	10.5	0.6	80	13	8.1	0.3
	COL 538	242	24	31	2	9.6	0.6	65	9	7.8	0.6
	Significant F	***		***		***[1]		***		***	

[1] *** indicates statistically significant at the 0.001 level of probability.

Cluster volume was correlated to cluster weight (R^2 = 0.381). Those clones noted above as having lower weight clusters had low volume clusters (Tables 3 and 5). The two Mariafeld clones, FPMS 17 and 23, had relatively low weight, low volume clusters. And, characteristically, they had relatively long clusters with few berries, resulting in low cluster compactness (loose clusters). In general, clusters were shorter, had lower volume, and were less compact in 1998 than in 1997. In contrast to the other clones, the Mariafeld clones had clusters in 1997 and 1998 that were roughly equal in length and volume, but in 1998 were slightly more compact.

Vine vigor - Pruning weights are an index of vine vigor and may help to explain some of the differences in yield. In 1998, pruning weights ranged from 0.32 kg/vine (FPMS 17) to 0.59 kg/vine (FPMS 2A), but these differences were not statistically significant (Table 6). Yield was, however, correlated to pruning weight (R^2 = 0.298). And, clones noted earlier as having higher yields, tended to have higher pruning weights.

Table 6. Vegetative growth, pruning weight and cane weight of Pinot noir clones at Woodhall III Vineyard in 1998.

	Clone	Shoot Length 7 July (cm)	±	Shoot Diameter 7 July (mm)	±	Leaves/ Shoot 7 July	±	Pruning wt.[2] (kg/vine)	±	Cane wt.[3] (g)	±	Ravaz Index[4]	±
Pinot fin													
	FPMS 2A	114	2	7.62	0.25	18	1	0.59	0.08	32.5	2.5	5.64	0.39
	FPMS 4	142	2	7.54	0.19	18	0	0.47	0.06	26.1	3.6	9.22	1.95
	FPMS 10	126	3	7.15	0.20	17	1	0.45	0.07	27.9	4.3	6.99	1.15
	FPMS 29	127	8	6.78	0.30	18	0	0.37	0.03	30.7	4.5	4.77	0.63
	DJN 113	129	5	6.93	0.27	19	1	0.41	0.09	27.2	2.0	6.47	0.49
	DJN 114	144	6	8.06	0.08	18	1	0.39	0.06	26.8	3.3	5.99	0.90
	DJN 115	134	5	7.37	0.26	18	0	0.40	0.03	35.4	5.2	4.72	0.93
Mariafeld													
	FPMS 17	127	2	7.79	0.40	17	1	0.32	0.06	35.4	7.9	4.10	0.78
	FPMS 23	137	6	8.33	0.43	18	0	0.36	0.02	31.9	2.2	4.30	0.48
Upright													
	FPMS 22	141	3	7.86	0.24	18	0	0.52	0.05	29.2	2.0	4.99	0.67
	ESP 374	140	5	7.53	0.25	18	0	0.31	0.03	26.0	4.0	5.24	1.30
	DJN 60	135	4	7.85	0.31	18	0	0.53	0.06	32.0	2.0	5.07	0.65
Fertile													
	FPMS 16	137	5	7.56	0.34	19	0	0.46	0.05	32.0	1.4	5.40	0.45
	FPMS 31	119	4	8.87	0.31	17	1	0.40	0.05	23.4	2.5	7.37	1.07
	FPMS 32	141	10	7.99	0.66	17	1	0.36	0.06	22.6	4.1	7.06	1.30
	FPMS 33	135	6	8.85	0.36	18	0	0.50	0.11	25.9	2.7	6.42	0.70
	ESP 236	120	6	7.97	0.08	18	0	0.34	0.04	29.7	3.3	6.19	0.29
	DJN 375	124	8	7.78	0.06	18	0	0.43	0.08	29.7	2.0	5.89	0.40
	DJN 10/18	132	5	8.05	0.31	18	1	0.49	0.03	26.8	1.6	7.57	1.04
	COL 538	129	3	7.27	0.06	18	0	0.49	0.10	24.7	4.0	8.40	1.34
	Significant F	**[1]		***		ns		ns		ns		**	

[1] ns, **, and *** indicate not significant, and statistically significant at the 0.01, and 0.001 levels of probability, respectively.

[2] Pruning weight from February 1998.

[3] Cane weight from February 1998.

[4] The Ravaz Index is the ratio of yield from October 1997 to pruning weight from February 1998.

Phenology and ripening - Bud burst of the different clones took place during the three day period from Julian day 114 to 116 (April 24 to April 26) (Table 7). Most clones, including representatives from all types, had bud burst on Julian day 114. Col 538 was last to reach bud burst on Julian day 116. Full bloom occurred during the four day period from Julian day 179 (June 28) to Julian day 182 (July 1). The time elapsed between bud burst and full bloom ranged from 65 to 67 days, averaging 66 days. Bud burst was 3 days earlier but full bloom was 15 days later in 1998 than in 1997.

Table 7. Julian days[1] to bud burst, full bloom, and veraison for 20 Pinot noir clones at Woodhall III Vineyard, Alpine, Oregon in 1998.

	Clone	Bud burst	Full bloom	Veraison	Bud burst to bloom	Bloom to veraison	Bud burst to veraison
Pinot fin							
	FPMS 2A	115	182	241	67	60	126
	FPMS 4	114	179	240	65	61	126
	FPMS 10	114	181	241	67	60	126
	FPMS 29	114	181	240	66	60	126
	DJN 113	115	180	240	65	59	125
	DJN 114	115	182	240	66	58	124
	DJN 115	115	182	240	67	58	125
Mariafeld							
	FPMS 17	115	180	242	66	62	128
	FPMS 23	114	181	242	67	61	127
Upright							
	FPMS 22	114	182	242	67	60	127
	ESP 374	114	181	242	67	61	127
	DJN 60	114	181	241	67	60	127
Fertile							
	FPMS 16	114	180	241	66	61	127
	FPMS 31	114	181	241	67	60	127
	FPMS 32	114	181	242	67	61	128
	FPMS 33	114	181	241	67	61	127
	ESP 236	114	181	240	67	59	126
	DJN 375	114	181	241	67	60	127
	DJN 10/18	114	180	241	66	60	126
	COL 538	116	182	241	67	59	126
	Significant F	**[2]	**	***			

[1] The Julian calendar runs from January 1 to December 31 (Julian day 1 and Julian day 365, respectively).

[2] ** and *** indicate statistically significant at the 0.01 and 0.001 levels of probability, respectively.

Veraison took place from Julian day 240 to 242 (August 28 and 30, respectively). Most Pinot fin type clones reached veraison on Julian day 240. Most other clones with the exception of FPMS 17 and 23 (Mariafeld clones), ESP 374 and FPMS 22 (Upright clones), and FPMS 32 (Fertile type) reached veraison on Julian day 241. These clones reached veraison last, on Julian day 242. The time elapsed between bloom and veraison ranged from 58 to 61 days, averaging 60 days. 124 to 128 days were required from bud burst to veraison, with an average across all clones of 126 days. Veraison was five days later in 1998 than in 1997.

On August 24, at the beginning of veraison, soluble solids ranged from 5.6 to 7.7 °Brix (FPMS 22 and 4, respectively) (Table 8). pH ranged from 2.69 to 2.81 (FPMS 2A and 10, respectively). Titratable acidity ranged from 43.91 to 55.03 g/L (DJN 115 and FPMS 17, respectively). In the two week period from 24 August to 8 September, the twenty clone average for juice soluble solids increased 12.7 Brix, and titratable acidity decreased 37.2 g/L. Differences in rates of sugar accumulation and acid reduction among selected clones that appeared to be present in 1997 were absent in 1998 (Figures 2 & 3). FPMS 22 (Gamay Beaujolais) lagged behind the other clones throughout the ripening period.

Table 8. Fruit composition of Pinot noir clones at Woodhall III Vineyard during ripening in 1998.

	Clone	Soluble Solids 24-Aug (°Brix)	Soluble Solids 8-Sep (°Brix)	Soluble Solids 21-Sep (°Brix)	pH 24-Aug	pH 8-Sep	pH 21-Sep	Titratable acidity 24-Aug (g/L)	Titratable acidity 8-Sep (g/L)	Titratable acidity 21-Sep (g/L)
Pinot fin										
	FPMS 2A	6.1	19.6	23.2	2.69	2.85	3.12	50.75	12.34	8.86
	FPMS 4	7.7	19.6	23.1	2.77	2.93	3.27	44.44	10.63	6.89
	FPMS 10	6.8	19.7	22.3	2.81	2.91	3.15	50.47	10.26	8.41
	FPMS 29	6.9	19.4	23.0	2.77	2.98	3.31	49.44	10.83	7.50
	DJN 113	6.9	19.9	22.8	2.80	2.94	3.23	46.69	10.76	8.45
	DJN 114	7.1	19.6	23.3	2.77	2.89	3.21	44.44	11.28	7.38
	DJN 115	7.3	20.0	22.6	2.78	2.92	3.21	43.91	10.36	7.58
Mariafeld										
	FPMS 17	6.1	19.4	22.4	2.73	2.82	3.13	55.03	12.39	8.46
	FPMS 23	6.0	19.1	22.2	2.71	2.78	3.11	54.44	13.64	8.90
Upright										
	FPMS 22	5.6	17.6	21.5	2.72	2.83	3.12	51.59	13.81	9.38
	ESP 374	6.3	18.4	22.0	2.76	2.86	3.17	48.66	11.80	8.41
	DJN 60	5.9	18.2	21.4	2.72	2.88	3.18	50.16	11.89	8.83
Fertile										
	FPMS 16	6.2	19.1	23.0	2.77	2.89	3.21	49.47	11.76	8.01
	FPMS 31	6.3	19.0	22.8	2.75	2.86	3.14	50.66	12.31	8.85
	FPMS 32	5.7	18.1	22.6	2.72	2.83	3.17	50.66	14.59	9.00
	FPMS 33	5.8	19.1	22.1	2.78	2.85	3.16	48.50	12.25	8.46
	ESP 236	6.5	19.0	23.1	2.75	2.87	3.15	47.25	12.48	8.31
	DJN 375	6.3	19.1	22.5	2.73	2.86	3.14	48.50	12.10	8.40
	DJN 10/18	6.5	19.8	22.4	2.74	2.84	3.15	49.75	12.19	8.85
	COL 538	6.1	18.8	21.8	2.79	2.88	3.23	46.50	12.14	8.14
Significant F	Clone	***[1]			***			***		
	Date	***			***			***		
	Clone x Date	*			ns			***		

[1] ns, *, and *** indicate not significant, and statistically significant at the 0.05, and 0.001 levels of probability, respectively.

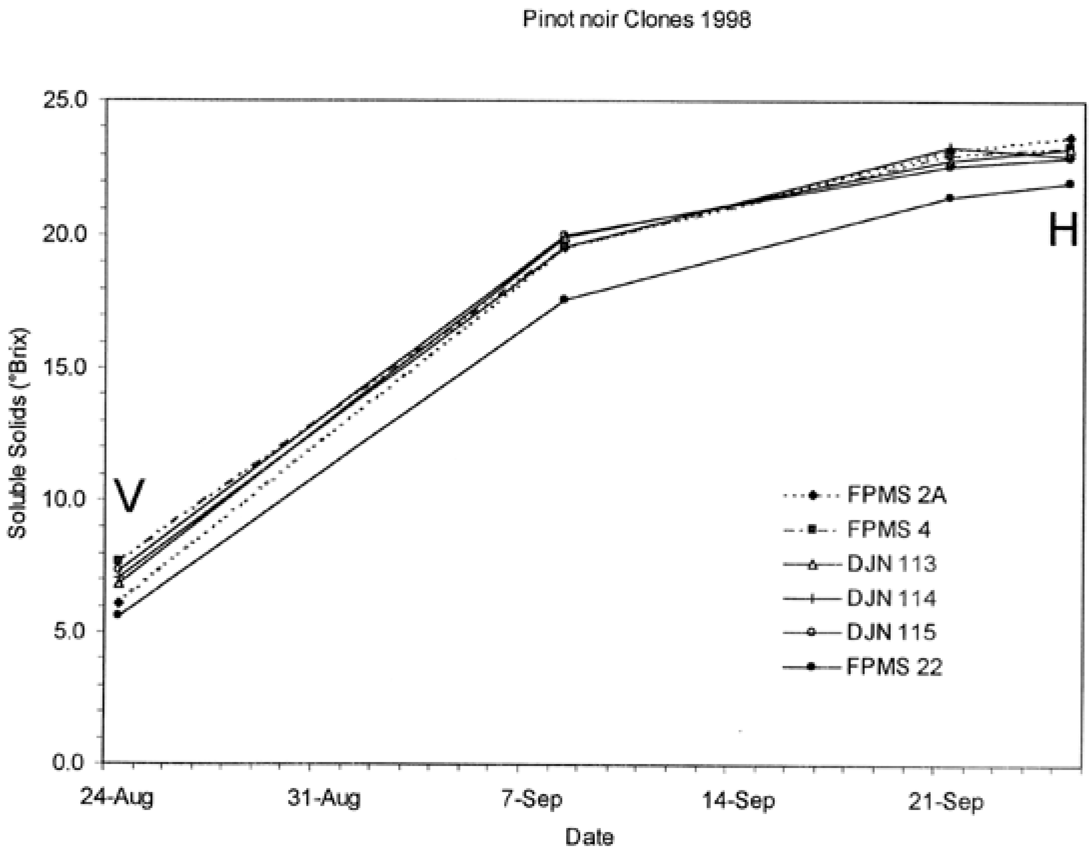


Figure 2. Trends in sugar accumulation during ripening of selected Pinot noir clones at Woodhall III Vineyard. V = veraison; H = harvest.

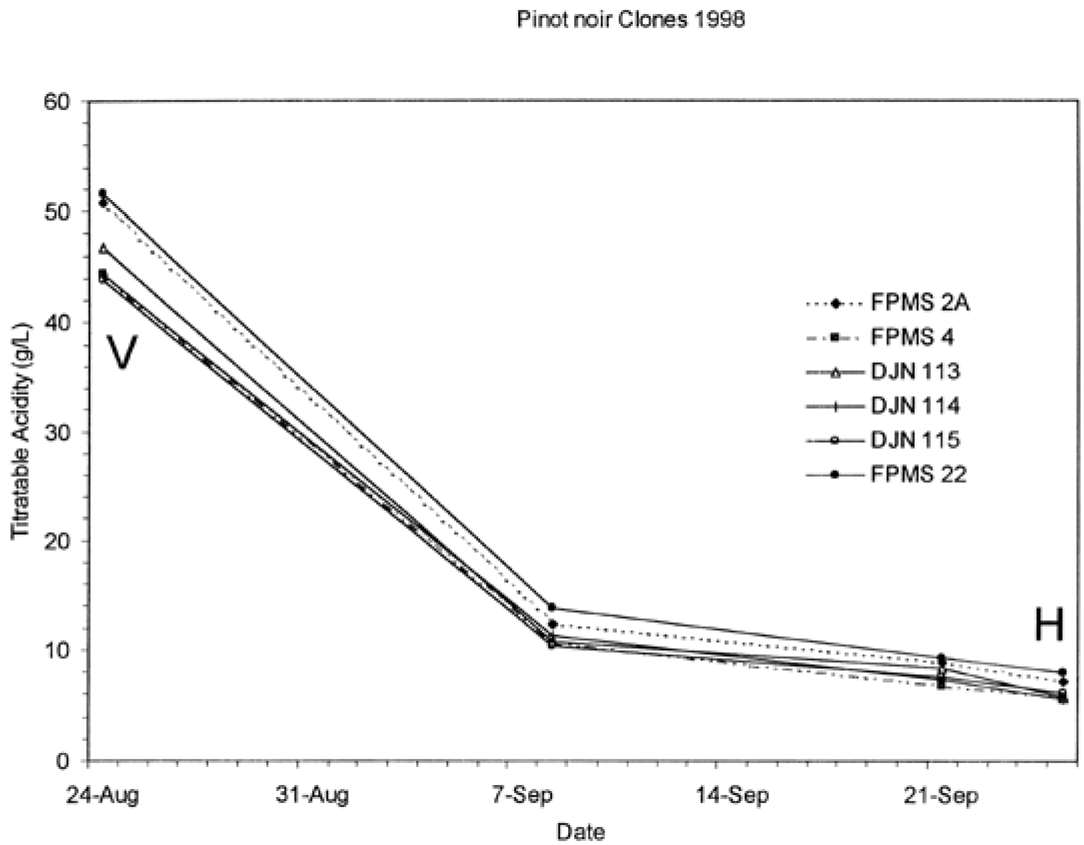


Figure 3. Changes in titratable acidity during ripening of selected Pinot noir clones at Woodhall III Vineyard. V = veraison; H = harvest.

Pinot noir clones - multi-season averages

Multi-season averages of yield, berry weight, cluster weight, juice soluble solids, pH, titratable acidity, and skin anthocyanin concentration are listed in Tables 9, 10, 11, and 12. For each parameter measured, the clones are listed in descending order in groups of five clones. The values for the multi-season averages are followed by the rank of the particular clone relative to the other clones in a given season. These tables allow one to judge the average performance of the clones over several seasons and gain some perspective of how consistent their performance is relative to the other clones from year to year.

Table 9. Yield and berry weight of Pinot noir clones at Woodhall III Vineyard. The clones are listed in descending order for each parameter measured. The values are four season averages followed by the rank in a particular year.

Clone	Type	Yield (t/ac)	95	96	97	98	Clone	Type	Berry wt. (g)	95	96	97	98
COL 538	Fertile	2.42	2	1	3	10	FPMS 22	Upright	1.13	3	1	1	1
DJN 10/18	Fertile	2.30	3	6	2	1	FPMS 2A	Pinot fin	1.10	2	5	4	8
FPMS 4	Pinot fin	2.27	7	10	1	3	FPMS 32	Fertile	1.09	1	4	3	20
FPMS 2A	Pinot fin	2.10	10	2	4	2	FPMS 4	Pinot fin	1.07	12	6	2	14
FPMS 22	Upright	2.03	1	12	9	5	FPMS 16	Fertile	1.05	4	12	5	2
FPMS 31	Fertile	1.97	9	5	6	4	DJN 10/18	Fertile	1.04	7	3	20	7
DJN 60	Upright	1.86	5	13	10	8	FPMS 33	Fertile	1.04	5	8	8	15
FPMS 10	Pinot fin	1.83	11	9	7	9	FPMS 31	Fertile	1.03	15	7	12	4
FPMS 16	Fertile	1.82	6	4	12	13	ESP 236	Fertile	1.03	10	9	9	11
DJN 375	Fertile	1.82	12	3	11	7	COL 538	Fertile	1.03	18	2	17	3
FPMS 33	Fertile	1.78	13	8	5	14	DJN 60	Upright	1.02	13	15	7	10
FPMS 32	Fertile	1.77	8	7	14	6	DJN 375	Fertile	1.02	11	10	15	9
ESP 236	Fertile	1.56	14	11	15	12	FPMS 23	Mariafeld	1.01	6	13	13	17
DJN 113	Pinot fin	1.51	16	14	8	15	ESP 374	Upright	1.00	14	17	10	13
ESP 374	Upright	1.49	4	15	19	16	DJN 114	Pinot fin	1.00	8	20	16	5
DJN 114	Pinot fin	1.45	15	16	13	18	DJN 113	Pinot fin	1.00	17	14	14	6
DJN 115	Pinot fin	1.15	20	17	16	17	FPMS 17	Mariafeld	0.99	9	18	6	19
FPMS 23	Mariafeld	1.13	18	18	18	11	DJN 115	Pinot fin	0.99	19	11	18	12
FPMS 29	Pinot fin	1.06	17	19	17	20	FPMS 29	Pinot fin	0.98	16	16	11	18
FPMS 17	Mariafeld	0.92	19	20	20	19	FPMS 10	Pinot fin	0.94	20	19	19	16
Significant F	Clone	***[1]							*				
	Year	***							***				
	Clone x Year	***							ns				

[1] ns, *, and *** indicate not significant, and statistically significant at the 0.05, and 0.001 levels of probability, respectively.

Table 10. Cluster weight and soluble solids of Pinot noir clones at Woodhall III Vineyard. The clones are listed in descending or for each parameter measured. The values are four season averages followed by the rank in a particular year.

Clone	Type	Cluster wt. (g)	95	96	97	98	Clone	Type	Soluble Solids (°Brix)	95	96	97	98
FPMS 31	Fertile	109.01	8	1	6	1	FPMS 2A	Pinot fin	23.6	2	1	4	1
DJN 10/18	Fertile	104.90	2	4	1	3	FPMS 10	Pinot fin	23.1	3	2	8	5
ESP 236	Fertile	101.98	5	2	11	2	DJN 115	Pinot fin	23.1	1	5	6	8
FPMS 22	Upright	99.04	1	3	14	5	DJN 113	Pinot fin	23.1	5	4	10	3
DJN 60	Upright	98.06	3	6	8	9	FPMS 29	Pinot fin	23.0	7	6	7	4
COL 538	Fertile	96.39	7	10	3	12	DJN 114	Pinot fin	22.9	6	7	9	7
ESP 374	Upright	93.83	4	11	17	4	ESP 236	Fertile	22.8	8	11	3	11
FPMS 4	Pinot fin	92.67	11	7	5	11	FPMS 23	Mariafeld	22.8	15	3	2	17
DJN 375	Fertile	92.57	10	9	12	7	FPMS 4	Pinot fin	22.8	14	8	5	2
FPMS 33	Fertile	91.54	12	8	10	14	FPMS 17	Mariafeld	22.8	10	12	1	14
FPMS 32	Fertile	91.49	6	5	16	6	FPMS 32	Fertile	22.7	4	14	12	12
FPMS 16	Fertile	89.33	9	14	9	17	FPMS 31	Fertile	22.6	9	16	13	9
FPMS 2A	Pinot fin	88.33	13	18	4	10	DJN 375	Fertile	22.6	11	17	11	10
FPMS 10	Pinot fin	87.56	14	12	7	13	FPMS 16	Fertile	22.6	12	15	16	6
FPMS 23	Mariafeld	83.14	15	13	19	8	FPMS 33	Fertile	22.4	16	13	15	13
DJN 113	Pinot fin	81.87	18	19	2	16	DJN 10/18	Fertile	22.3	17	10	19	15
DJN 114	Pinot fin	79.88	17	17	13	19	FPMS 22	Upright	22.2	18	9	17	20
DJN 115	Pinot fin	76.15	20	15	15	18	COL 538	Fertile	22.2	13	18	20	16
FPMS 17	Mariafeld	74.83	16	16	20	15	DJN 60	Upright	21.9	20	19	18	19
FPMS 29	Pinot fin	73.78	19	20	18	20	ESP 374	Upright	21.9	19	20	14	18
Significant	Clone	***[1]							***				
	Year	***							***				
	Clone x Year	***							**				

[1] **, and *** indicate statistically significant at the 0.01, and 0.001 levels of probability, respectively.

Table 11. Juice pH, and titratable acidity of Pinot noir clones at Woodhall III Vineyard. The clones are listed in descending order for each parameter measured. The values are four season averages followed by the rank in a particular year.

Clone	Type	pH	95	96	97	98	Clone	Type	Titratable acidity (g/L)	95	96	97	98
DJN 115	Pinot fin	3.13	2	1	2	8	FPMS 22	Upright	7.76	1	1	3	1
DJN 113	Pinot fin	3.13	1	4	5	1	DJN 10/18	Fertile	7.47	3	2	5	2
FPMS 29	Pinot fin	3.12	4	3	7	4	FPMS 31	Fertile	7.39	4	3	1	5
FPMS 10	Pinot fin	3.12	6	2	6	6	FPMS 2A	Pinot fin	7.39	2	6	2	3
FPMS 4	Pinot fin	3.11	5	7	1	5	ESP 374	Upright	7.10	5	4	9	10
DJN 114	Pinot fin	3.10	10	8	4	2	DJN 375	Fertile	7.10	11	10	4	4
FPMS 32	Fertile	3.09	8	12	3	3	ESP 236	Fertile	7.06	6	5	6	11
FPMS 16	Fertile	3.07	16	6	8	7	FPMS 17	Mariafeld	7.03	8	7	11	6
COL 538	Fertile	3.06	7	10	11	9	FPMS 23	Mariafeld	7.01	10	8	7	9
FPMS 33	Fertile	3.05	3	11	13	14	DJN 60	Upright	6.95	7	13	10	7
FPMS 23	Mariafeld	3.04	11	5	18	17	FPMS 33	Fertile	6.95	13	9	8	8
ESP 236	Fertile	3.03	9	18	12	10	COL 538	Fertile	6.70	12	12	12	12
DJN 60	Upright	3.02	17	13	9	12	FPMS 16	Fertile	6.52	9	15	13	14
DJN 375	Fertile	3.02	15	9	14	15	FPMS 32	Fertile	6.22	18	11	18	13
ESP 374	Upright	3.02	12	19	10	11	DJN 113	Pinot fin	6.12	19	14	14	16
FPMS 31	Fertile	3.00	14	16	19	13	FPMS 29	Pinot fin	5.99	14	18	15	18
DJN 10/18	Fertile	2.99	18	14	16	18	DJN 114	Pinot fin	5.97	15	17	16	19
FPMS 17	Mariafeld	2.98	13	20	15	19	FPMS 4	Pinot fin	5.95	16	16	20	17
FPMS 2A	Pinot fin	2.98	19	15	20	16	DJN 115	Pinot fin	5.80	20	19	17	15
FPMS 22	Upright	2.96	20	17	17	20	FPMS 10	Pinot fin	5.73	17	20	19	20
Significant F	Clone	***[1]							***				
	Year	***							*				
	Clone x Year	ns							*				

[1] ns, *, and *** indicate not significant, and statistically significant at the 0.05, and 0.001 levels of probability, respectively.

Table 12. Skin anthocyanins of Pinot noir clones at Woodhall III Vineyard. The clones are listed in descending order for each parameter measured. The values are three season averages followed by the rank in a particular year.

Clone	Type	Skin Anthocyanin mg/g berry	96	97	98
FPMS 23	Mariafeld	2.00	2	1	1
FPMS 17	Mariafeld	1.92	1	2	2
FPMS 2A	Pinot fin	1.37	8	10	5
FPMS 31	Fertile	1.37	6	7	11
FPMS 29	Pinot fin	1.37	4	3	14
FPMS 32	Fertile	1.36	5	12	3
DJN 114	Pinot fin	1.35	3	16	6
FPMS 10	Pinot fin	1.34	7	5	12
ESP 236	Fertile	1.33	15	4	7
DJN 10/18	Fertile	1.33	16	14	4
ESP 374	Upright	1.31	10	6	16
DJN 375	Fertile	1.30	14	8	9
FPMS 33	Fertile	1.30	12	11	8
DJN 115	Pinot fin	1.29	9	9	18
FPMS 22	Upright	1.23	13	13	17
DJN 113	Pinot fin	1.22	17	18	13
DJN 60	Upright	1.22	11	17	19
FPMS 16	Fertile	1.19	18	15	10
FPMS 4	Pinot fin	1.15	19	20	15
COL 538	Fertile	1.07	20	19	20
Significant F	Clone	***[1]			
	Year	*			
	Clone x Year	ns			

[1] ns, *, and *** indicate not significant, and statistically significant at the 0.05, and 0.001 levels of probability, respectively.

Yield - There is a wide range in the four-year averages for yield. COL 538 and DJN 10/18 had the two highest four-year average yields. Additionally, these two clones were in the first yield group in three of the four seasons, indicating that they have been consistently high yielding in relation to the other clones. FPMS 4, 2A, and 22 had the next three highest average yields. FPMS 2A has been in the first yield group in three of the four seasons and FPMS 4 and 22 have been in the first yield group in two of the four seasons. These last two clones, therefore, have been less regularly high yielding in relation to the other clones. The five clones in the first yield group include two Fertile clones, two Pinot fin clones and an Upright clone. Several other clones have ranked in the first yield group in one season, but no others have done so in two or more seasons. Consistently low yielding clones include DJN 114 and 115, and FPMS 23, 29, and 17. There are representatives of each clone type, except Mariafeld, in the first, second, and third yield groups. The last yield group includes only Pinot fin and Mariafeld clones.

Berry weight - There is a relatively small range in the four-year averages for berry weight. Clones ranking consistently in the low berry weight group include FPMS 10 and 29. Other clones with low berry weight ranks in two or more seasons but moderate weight ranks in other seasons are DJN 114 and 115, and FPMS 17. Several other clones have ranked in the low berry weight group in one season but ranked in the moderate or higher berry weight groups in the other seasons. Clones consistently ranking in the high berry weight group include FPMS 22, 2A, and 32. As indicated by the statistical summary, season to season variation plays a greater role in the overall variation in berry weight than does clonal variation.

Cluster weight - There is a wide range in the four-year averages for cluster weight. Clones ranking consistently in the low cluster weight group include FPMS 29 and 17, and DJN 115, 114, and 113, all of which are Pinot fin clones, except for FPMS 17. As noted in the introduction, Pinot fin clones have been characterized as having small clusters. Cluster weight is an index of cluster size. All of the Pinot fin clones, including FPMS 4, which ranked eighth in the four year averages for cluster weight, ranked in one of the two lower cluster weight groups in at least two of the four seasons. When the four-year averages are considered, Pinot fin clones are the predominant type represented in the lowest cluster weight group. Clones consistently ranking in the high cluster weight group include DJN 10/18, ESP 236, and FPMS 22. When the four-year averages are considered, Fertile and Upright clones are the only types represented in the highest cluster weight groups. The Fertile clones have been characterized as having large clusters. All of the Fertile clones ranked in one of the two higher cluster weight groups in at least two of the four seasons.

Juice soluble solids - There appears to be a relatively narrow range in the four-year averages for soluble solids. FPMS 2A and 10, and DJN 113 ranked in the high Brix group in at least three of the four seasons. Additionally, Pinot fin clones are the only type in the highest Brix group. With the exception of ESP 236, all Fertile and Upright clones had four-year averages for soluble solids in one of the two lowest groups. Clones that ranked in the low Brix group in at least three of the four seasons include ESP 374, DJN 60, COL 538, and FPMS 22.

Juice pH - As was the case with soluble solids, there is a relatively narrow range in the four-year averages for juice pH. Furthermore, Pinot fin clones are the only type in the highest pH group. DJN 115 and 113, and FPMS 29 and 4 ranked in the high pH group in at least three of the four seasons. One Pinot fin clone, FPMS 2A, however, along with FPMS 22 and 17, and DJN 10/ 18, ranked in the low pH group in at least three of the four seasons.

Juice titratable acidity - The four year averages for juice titratable acidity largely reflect what would be expected from those of soluble solids and pH. Clones ranking in the higher Brix and pH group generally ranked in the lower TA groups. FPMS 10 and 4 ranked in the lowest TA group in all four seasons. DJN 115 and 114 ranked in the lowest group in three of four seasons. FPMS 29 and DJN 113 ranked in the lowest group in two of four seasons. Conversely, FPMS 22 and 3 1, and DJN 10/18 ranked in the highest TA group in all four seasons. FPMS 2A ranked in the highest TA group in three of four seasons.

Skin anthocyanins - There is a wide range in the four-year averages for skin anthocyanins. If the two highest ranking clones (FPMS 23 and 17) and the two lowest ranking clones (COL 538 and FPMS 4) are excluded, however, this range would be narrowed considerably. These four clones ranked first or second and nineteenth or twentieth, respectively, in at least two of three seasons. Among the remaining clones, FPMS 29 and 32 ranked in the highest anthocyanin group in two of three seasons. DJN 60 and 113 ranked in the lowest anthocyanin group in two of three seasons.

The relationship between Juice soluble solids and yield - The relationship between juice soluble solids and yield is shown graphically using the multi-year averages (Figure 4). The figure is divided into four quadrants: clones having above average yield and juice soluble solids are distributed in quadrant 1 (upper right); clones having below average yield but above average juice soluble solids are distributed in quadrant 2 (upper left); clones having above average yield but below average juice soluble solids are distributed in quadrant 3 (lower right); and finally, clones having below average yield and juice soluble solids are distributed in quadrant 4 (lower left). The clones are listed by quadrant in Table 13.

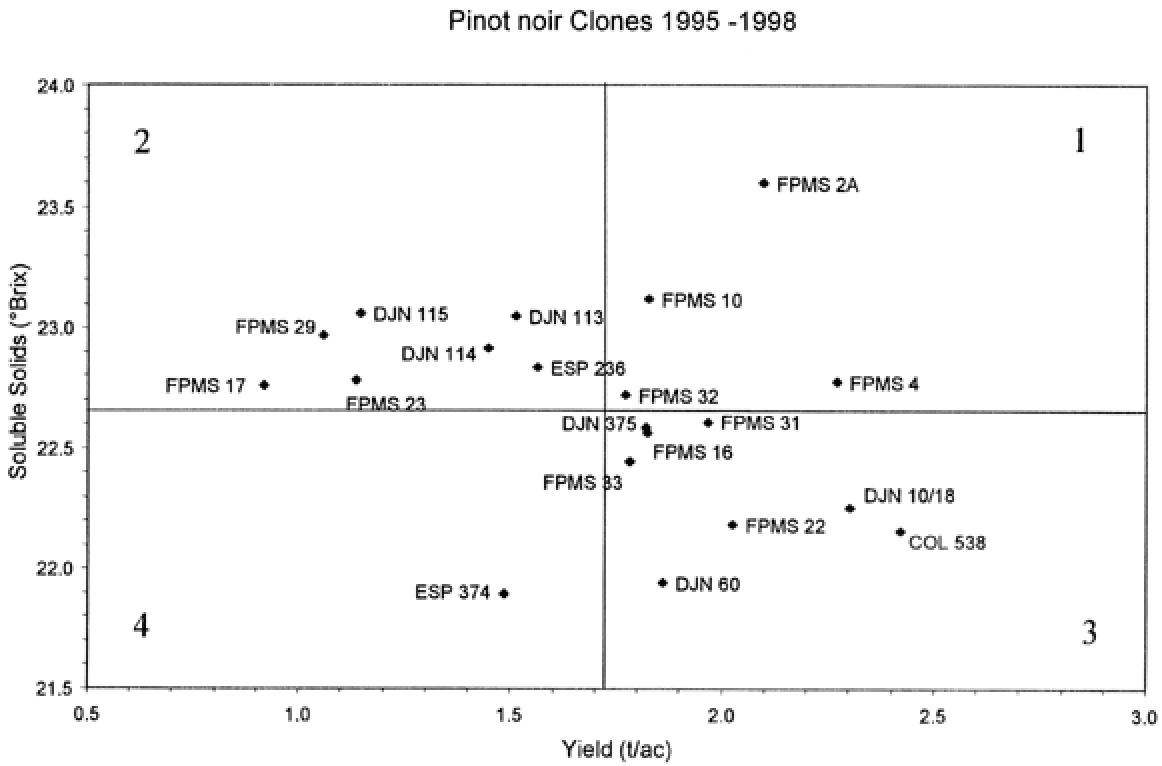


Figure 4. Juice soluble solids vs. yield of Pinot noir clones at Woodhall III Vineyard using four-year averages (1995-1998). Horizontal and vertical lines indicate the overall averages of soluble solids and yield.

Table 13. The position of Pinot noir clones relative to the seasonal averages in comparisons of soluble solids and yield. The clones are listed by quadrant position of four-year averages followed by the position in a particular year.

		Position by Quadrant				
Clone	Type	4yr	95	96	97	98
FPMS 10	Pinot fin	1	2	1	1	1
FPMS 2A	Pinot fin	1	1	1	1	1
FPMS 32	Fertile	1	1	3	4	3
FPMS 4	Pinot fin	1	3	1	1	1
DJN 113	Pinot fin	2	2	2	1	2
DJN 114	Pinot fin	2	2	2	2	2
DJN 115	Pinot fin	2	2	2	2	2
ESP 236	Fertile	2	2	3	2	4
FPMS 17	Mariafeld	2	2	4	2	4
FPMS 23	Mariafeld	2	4	2	2	4
FPMS 29	Pinot fin	2	2	2	2	2
COL 538	Fertile	3	3	3	3	4
DJN 10/18	Fertile	3	3	3	3	3
DJN 375	Fertile	3	2	3	3	1
DJN 60	Upright	3	3	4	3	3
FPMS 16	Fertile	3	3	3	4	2
FPMS 22	Upright	3	3	3	3	3
FPMS 31	Fertile	3	1	3	3	1
FPMS 33	Fertile	3	4	3	3	4
ESP 374	Upright	4	3	4	4	4

Clones having four-year averages in quadrant 1 are FPMS 10, 2A, 32, and 4. Of these four clones, only the three Pinot fin clones were positioned in this quadrant in at least three of the four seasons. Clones having four-year averages in quadrant 2 are more numerous. Pinot fin clones are, however, the only type positioned there in at least three of the four seasons. The two Mariafeld clones (FPMS 17 and 23) and the Fertile clone (ESP 236) with four year averages in quadrant 2 were positioned in this quadrant in only two of the four seasons. Fertile and Upright clones are the only types with four-year averages in quadrant 3. COL 538, DJN l0/l8 and 60, and FPMS 22 were positioned in quadrant 3 in at least three of the four seasons. DJN 375 and FPMS 31 were positioned there in two seasons but were in quadrants 1 or 2 in the other two seasons. ESP 374, the only clone with a four-year average in quadrant 4, was located there in three of the four seasons.

Chardonnay clones

Yield and yield and components - Yields of the Chardonnay clones ranged from a high of 3.29 t/ac (ESP 352) to a low of 0.28 t/ac (FPMS 15) (Table 14). All of the Chardonnay clones had lower yield in 1998 than in 1997. The overall average yield in 1998 was 1.94 t/ac, which was down 31% from that of 1997 (2.82 t/ac). Berry weights were also wide ranging, although most clones had berry weights near the overall average of 1.21 g. Cluster weights ranged from 45.1 g (FPMS 15) to 145.2 g (FPMS 4) and were highly correlated to the number of berries per cluster (R^2 = 0.894). Shoots per vine and pruning weights are both indexes of vine size. Yield was correlated to both shoots per vine and pruning weight (R^2 = 0.772 and R^2 = 0.773, respectively), indicating that vine size is an important factor in yield differences among the clones.

Table 14. Yield components of Chardonnay clones at Woodhall III Vineyard in 1998.

Clone[1]	Yield (kg/vine)	±	Yield (t/ac)	±	Berries/ cluster	±	Berry wt. (g)	±	Cluster wt. (g)	±	Shoots/ vine	±	Clusters/ shoot	±
DJN 75	2.92	0.26	2.60	0.23	107	4	1.01	0.04	108.1	5.1	17	1	1.6	0.1
DJN 76	2.39	0.42	2.12	0.38	78	6	1.07	0.03	82.9	5.0	18	2	1.6	0.0
DJN 78	2.53	0.14	2.25	0.12	83	4	1.14	0.03	93.9	5.4	19	1	1.5	0.1
DJN 95	1.22	0.34	1.09	0.30	69	8	1.08	0.03	74.4	9.5	11	1	1.3	0.1
DJN 96'	2.19	0.26	1.94	0.23	92	9	1.12	0.05	102.4	7.7	15	1	1.4	0.1
DJN 96"	2.02	0.42	1.80	0.37	93	12	1.13	0.10	102.7	6.0	14	1	1.4	0.2
ESP 352	3.70	0.32	3.29	0.28	86	3	1.13	0.03	97.4	3.6	20	1	1.9	0.1
FPMS 4	2.47	0.29	2.19	0.25	136	10	1.07	0.05	145.2	11.2	15	1	1.1	0.0
FPMS 5	1.97	0.36	1.75	0.32	107	7	1.14	0.01	122.3	8.0	13	1	1.2	0.1
FPMS 6	2.97	0.35	2.64	0.31	84	5	1.18	0.07	99.1	6.9	21	2	1.4	0.1
FPMS 14	1.48	0.16	1.32	0.15	140	8	0.93	0.04	130.2	4.7	8	0	1.4	0.1
FPMS 15	0.32	0.01	0.28	0.01	32	5	1.45	0.07	45.1	4.4	8	0	0.9	0.1
Significant F	***[2]		***		***		***		***		***		***	

[1] Clones DJN 95 and DJN 96" were planted in 1991. All others were planted in 1989.

[2] *** indicates statistically significant at the 0.001 level of probability.

Table 15. Fruit composition of Chardonnay clones at Woodhall III Vineyard in 1998.

Clone[1]	Soluble Solids (°Brix)	±	pH	±	Titratable acidity (g/L)	±	Sugar (kg/vine)	±
DJN 75	22.7	0.2	3.21	0.01	5.37	0.17	0.66	0.06
DJN 76	23.0	0.1	3.15	0.01	5.82	0.12	0.55	0.10
DJN 78	22.6	0.1	3.12	0.01	6.18	0.12	0.57	0.03
DJN 95	22.8	0.2	3.20	0.02	5.33	0.16	0.28	0.07
DJN 96'	22.3	0.1	3.19	0.02	5.41	0.17	0.49	0.06
DJN 96"	22.1	0.2	3.20	0.03	5.61	0.17	0.44	0.09
ESP 352	22.5	0.2	3.13	0.02	6.38	0.16	0.83	0.07
FPMS 4	21.9	0.2	3.08	0.02	7.14	0.16	0.54	0.06
FPMS 5	22.2	0.2	3.07	0.02	6.97	0.19	0.43	0.08
FPMS 6	22.4	0.1	3.11	0.02	6.28	0.18	0.67	0.08
FPMS 14	22.4	0.1	3.13	0.03	5.85	0.23	0.33	0.04
FPMS 15	23.4	0.3	3.22	0.01	6.22	0.10	0.07	0.00
Significant	***[2]		***		***		***	

[1] Clones DJN 95 and DJN 96" were planted in 1991. All others were planted in 1989.

[2] *** indicates statistically significant at the 0.001 level of probability.

Table 16. Pruning weight, cane weight, and yield to pruning weight ratio of Chardonnay clones at Woodhall III Vineyard in 1998.

Clone[1]	Pruning wt.[2] (kg/vine)	±	Cane wt.[3] (g)	±	Ravaz Index[4]	±
DJN 75	0.70	0.04	42.61	0.77	5.65	0.39
DJN 76	0.65	0.08	39.40	3.72	5.70	0.50
DJN 78	0.71	0.05	38.37	1.93	5.61	0.22
DJN 95	0.32	0.05	41.84	5.96	3.77	1.07
DJN 96'	0.60	0.04	41.87	0.40	4.61	0.15
DJN 96"	0.50	0.07	38.08	4.11	5.30	0.71
ESP 352	0.82	0.05	48.09	1.21	5.51	0.46
FPMS 4	0.57	0.04	43.20	1.72	7.09	0.61
FPMS 5	0.47	0.07	39.94	6.67	7.13	1.22
FPMS 6	0.89	0.09	43.56	4.09	5.52	0.32
FPMS 14	0.21	0.02	30.57	4.95	8.54	0.51
FPMS 15	0.24	0.02	33.89	3.94	3.95	0.66
Significant	***[5]		ns		**	

[1] Clones DJN 95 and DJN 96" were planted in 1991. All others were planted in 1989.

[2] Pruning weight from February 1998.

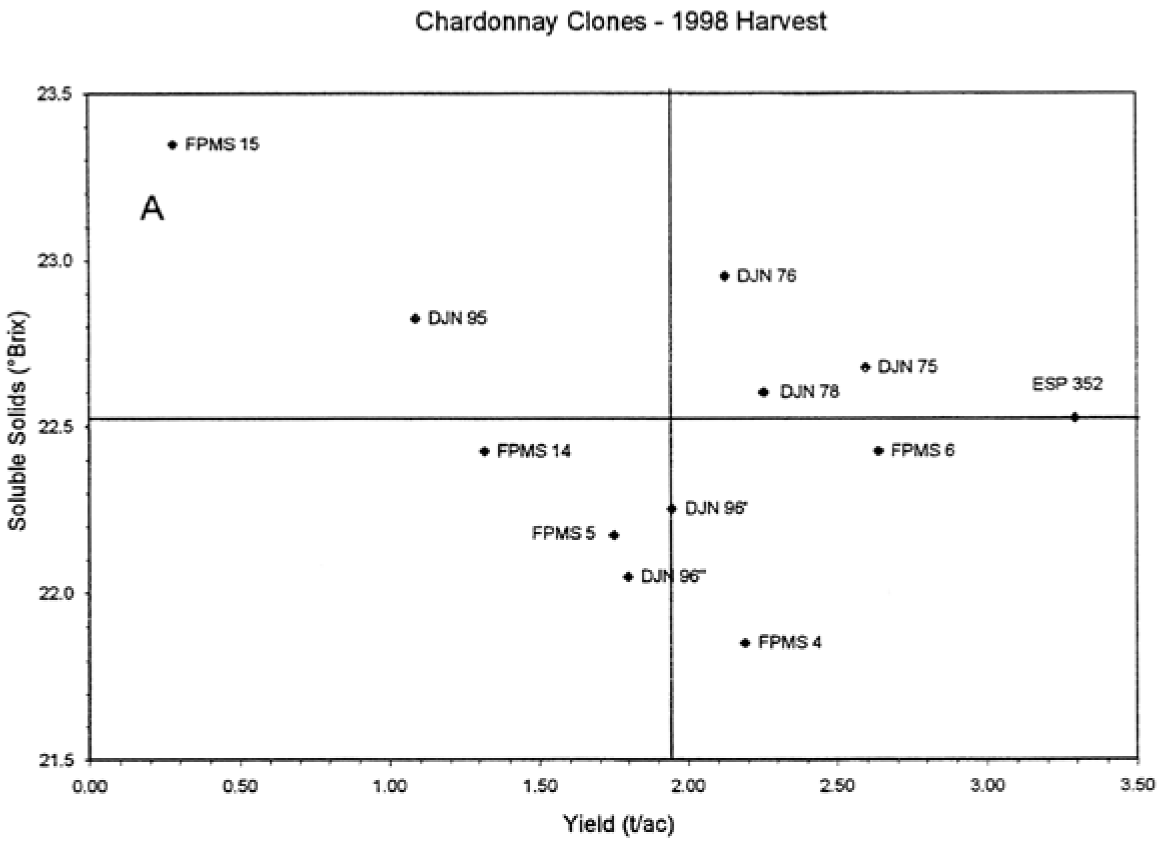
[3] Cane weight from February 1998.

[4] The Ravaz Index is the ratio of yield from October 1997 to pruning weight from February 1998.

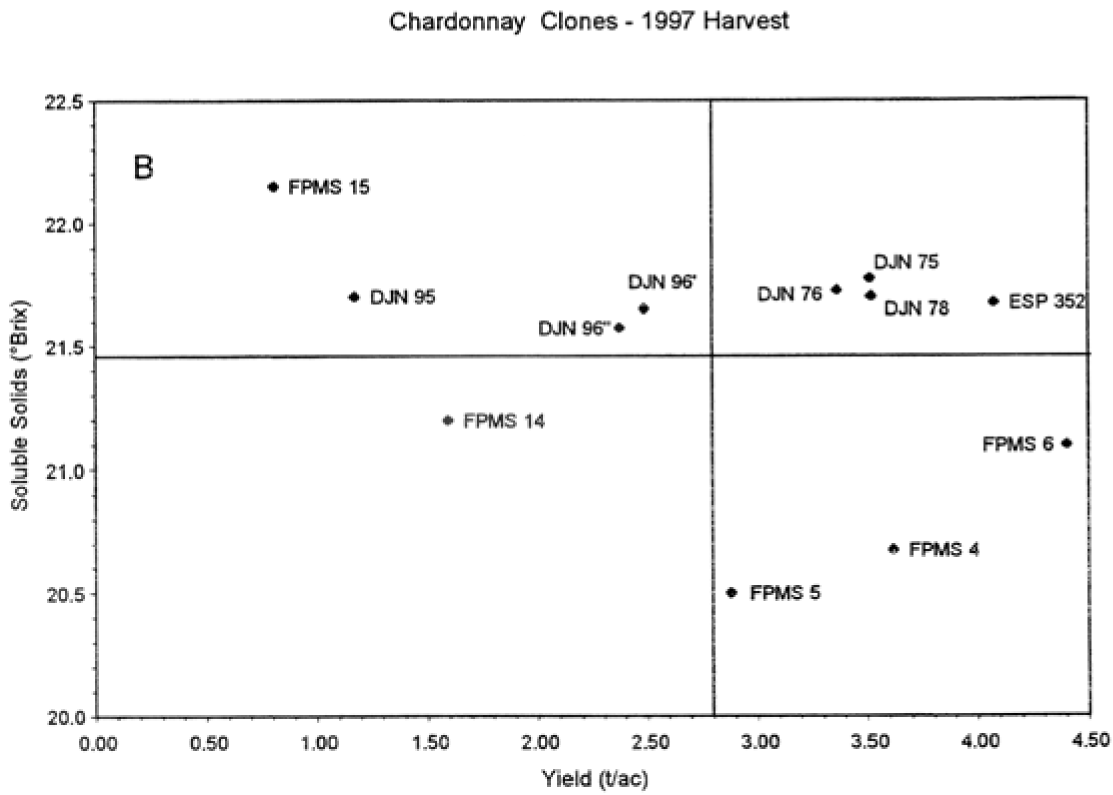
[5] ns, **, and *** indicate not significant and statistically significant at the 0.01, and 0.001 levels of probability, respectively.

Fruit composition - FPMS 15 had the highest juice soluble solids (23.4 °Brix), and FPMS 4 had the lowest (21.9 °Brix). Other clones with relatively high soluble solids were DJN 76 and 95 (23.0 and 22.8 °Brix, respectively). In 1998, all clones had soluble solids that were higher than their corresponding values from 1997. Furthermore, in 1998, all clones had soluble solids that were higher than the overall average in 1997. Juice pH ranged from 3.07 (FPMS 5) to 3.22 (FPMS 15). pH was moderately correlated to soluble solids ($R^2 = 0.309$). Those clones with relatively high pH also tended to have higher soluble solids. Titratable acidity, however, was not significantly correlated to soluble solids.

The relationship between Juice soluble solids and yield - Juice soluble solids vs. yield of the Chardonnay clones for the 1998 and 1997 harvests is shown in Figures 5A and B, respectively. As was noted earlier, the overall yield for Chardonnay was lower in 1998 than in 1997. The overall average for soluble solids was higher in 1998. The relative position of the Chardonnay clones in 1998 and 1997 are, with some exceptions, generally similar. In 1998, FPMS 5, although still near the average for yield, moved from the lowest rank for soluble solids to within half of a degree Brix from the average. DJN 96 moved from slightly above average soluble solids and slightly lower than average yield in 1997 to below average soluble solids and average yield in 1998. DJN 75, 76, and 78 each had above average soluble solids and yield, and DJN 95 had above average soluble solids but below average yield in both seasons.



Chardonnay Clones - 1998 Harvest
A
FPMS 15
DJN 76
DJN 95
DJN 75
DJN 78
ESP 352
FPMS 14
FPMS 6
DJN 96'
FPMS 5
DJN 96"
FPMS 4
Soluble Solids (°Brix)
Yield (t/ac)
23.5
23.0
22.5
22.0
21.5
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50



Figures 5 A & B. Juice soluble solids vs. yield of Chardonnay clones at Woodhall III Vineyard in 1998 and 1997, respectively. Horizontal and vertical lines indicate overall seasonal average of soluble solids and yield, respectively.

ACKNOWLEDGEMENTS We would like to thank the Oregon Wine Advisory Board for funding this project. Additionally, numerous people have participated in various aspects of this study. Notable among them are Matt Compton, Alex Haulman, Kathi Hintermann, Jessica Howe, Natalia Imelli, Melissa Ivan, Arnaud Joncour, Geraldine Legentil, Suzanne Lovelady, Michael McAuley, Patrik Schonenberger, Joey Ratliff-Peacock, Scott Robbins, Patrick Taylor, and Aurelius Wespi. Finally, we would like to thank Dr. David R. Thomas, OSU Department of Statistics, for his assistance with the statistical analysis.

LITERATURE CITED

1. Oregon Agricultural Statistics Service. 1998 Oregon Vineyard Report. Portland, Oregon (1999).
2. Price S. F., and B. T. Watson. Preliminary results from an Oregon Pinot noir clonal trial. In: Proceedings of the International Symposium on Clonal Selection. Rantz, J., M. (Ed.). pp40-44. American Society for Enology and Viticulture, Davis, California (1995).
3. Johnson, D. E., and G. S. Howell. Factors influencing critical temperatures for spring freeze damage to developing primary shoots on *Vitis labruscana* cvar. Concord grapevines. Am. J. Enol. Vitic. 32: 144-149 (1981).
4. Singleton, V. L. Grape and wine phenolics: Background and prospects. In: University of California Davis Grape and Wine Centennial Symp. Proc. 1880-1980. A. D. Webb, Ed. pp 219-227. Dept. of Viticulture and Enology, University of California, Davis (1982).
5. B. T. Watson personal communication (1998).