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Pinot noir Maturity Research:
A Comparison of the 1987 and 1988 Harvest Seasons

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INTRODUCTION

Our Pinot noir maturity research at OSU has several objectives all related to better understanding the development of varietal character and the compositional changes that occur during ripening. We are trying to develop commercially useful tools to monitor changes in fruit composition and character in order to establish harvest indices better related to wine quality. It is clear that Pinot noir can mature differently in different years and that conventional maturity indices such as Brix, titratable acidity, and pH are not always adequate predictors of "optimal" maturity. Changes in anthocyanin and phenolic content in the skins, organic acid and potassium levels in the juice, berry size and fruit condition, vine condition, and subjective assessments of flavor are all important for evaluating maturity.

Some of the questions we hope our research will address are related to Oregon industry experiences in recent years. In 1987, an abnormally hot and early season, was it better to harvest Pinot noir at lower Brix in order to maintain the acid and pH balance and then to add sugar to the desired level, or was it better to harvest at the desired Brix and add acid to bring the acidity and pH back into balance. In 1988, a cool and late season in which Pinot noir matured unevenly due to a poor fruit set, was it better to harvest as soon as the desired Brix was reached, or was wine quality improved by letting the fruit "hang on" the vine longer to achieve more uniform ripening.

In our Pinot noir maturity trials we are evaluating the aroma, flavor and compositional differences of wines produced from fruit harvested at different levels of maturity during several harvest seasons. Because the fruit composition at harvest influences winemaking decisions, we are also evaluating how commercial processing practices affect wine composition and quality. Different processing practices may be needed to optimize wine quality of Pinot noir harvested at different levels of maturity. Processing parameters under evaluation include chaptalization (sugar addition), tartaric acid addition to reduce pH, extended maceration, and use of whole clusters during fermentation.

In 1987 and 1988 Pinot noir was harvested from our experimental block at the Woodhall III Vineyard in Alpine. Fifty cluster samples were taken at random every 3-5 days and were weighed and analyzed for berry size, Brix, TA, pH, malate, tartrate, potassium, anthocyanin, and phenolic content. Replicated wine lots were produced from fruit harvested every 5-6 days from "early" season to "late" season during each year.

ANALYSIS AT HARVEST

The must analysis at harvest for 1987 and 1988 is shown in Tables 1 and 2, as mean values for replicated lots. In 1987, Pinot noir at our experimental site was harvested as early as September 4 with a Brix of 19.3, a titratable acidity (TA) of 11.3 g/L and a pH of 3.17. By September 11, however, the Brix had only increased to 20.4, while the TA had dropped to 7.9 g/L and the pH had increased to 3.4. The pH increase was accompanied by an increase in potassium and a decrease in both malate and tartrate. The weather during this period was hot and dry and the increase in Brix was slower than might have been expected possibly due to heat stress. The decrease in acidity and the increase in pH were abnormal for Pinot noir which had only reached about 20 degrees Brix. By September 16 the Brix had increased to 21.0, the TA had dropped slightly to 7.2 g/L, but the pH had dropped from 3.4 to 3.27. Curiously, this harvest date corresponded to the only time during the ripening season when there was any measurable rainfall. After September 16 the Brix increased rapidly to 24.4 degrees by September 29 and the pH rose sharply to 3.6. This pH increase was accompanied by a large increase in juice potassium to over 2 g/L.

DATE	°Brix g/100	TA g/L	pH	K g/L	MAL g/L	TAR g/L
9/4	19.3	11.3	3.17	1.50	5.7	7.8
9/11	20.4	7.9	3.40	1.87	4.2	6.8
9/16	21.0	7.2	3.27	1.79	4.1	7.2
9/22	22.8	7.3	3.34	1.68	3.4	6.4
9/29	24.4	6.2	3.60	2.07	3.2	7.3

Table 1 1987 Pinot noir Must Analysis at harvest.

DATE	°BRIX g/100	TA g/L	pH	K g/L	MAL g/L	TAR g/L
9/29	21.8	10.2	3.23	1.58	4.7	7.6
10/5	22.8	9.0	3.32	1.51	4.2	7.4
10/10	23.1	7.9	3.38	1.24	3.7	6.4
10/13	23.0	8.2	3.34	1.34	3.6	6.9
10/19	23.6	7.0	3.41	1.43	3.6	7.3
10/25	24.7	7.6	3.37	1.34	3.3	6.0

Table 2 1988 Pinot noir Must Analysis at harvest.

In 1988 the harvest season began nearly a month later than in 1987. Ripening was slower and perhaps more typical for western Oregon. Although many considered this season to be later than "normal," the average harvest dates for Pinot noir over the ten year period prior to 1985 were almost always in early to mid October and rarely in September. Fruit from our experimental site was harvested in 1988 from September 29 to October 25. Optimal maturity by conventional standards with respect to Brix, TA, and pH was probably reached by early to mid October. After mid October, however, the fruit continued to increase in Brix in a slow and steady manner at about 1 degree Brix every 6 days while maintaining

moderate acidity and pH. The rapid increase in pH at the end of the ripening period in 1987 did not occur in 1988 (Figure 1). At similar sugar levels the TA in the must at harvest was also higher in 1988 than 1987.

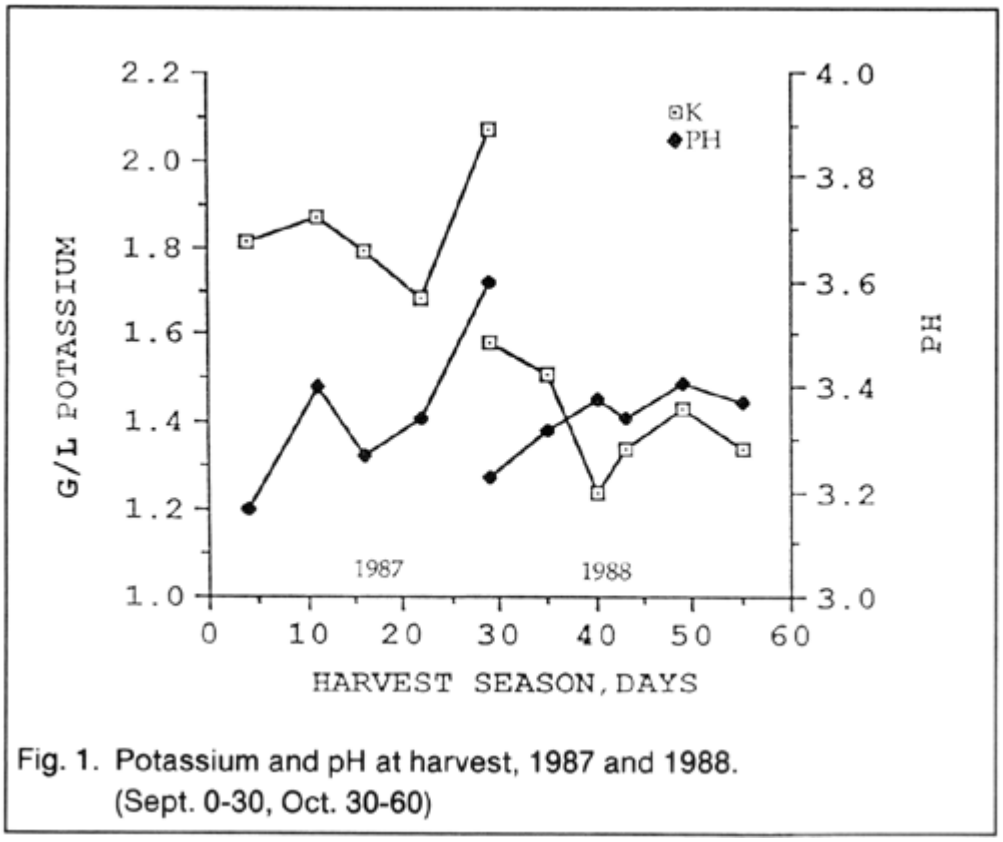

Fig. 1. Potassium and pH at harvest, 1987 and 1988. (Sept. 0-30, Oct. 30-60)

For example, at 22 degrees Brix the TA was less than 8 g/L in 1987 compared to 10 g/L in 1988 (Figure 2). The overall changes in malic and tartaric acid content, however, were remarkably similar for both years despite the differences in weather during maturation. Malic acid decreased from about 5.5 to 3.0 g/L and tartaric acid fluctuated during both seasons from about 6.0 to 7.5 g/L (Figure 3).

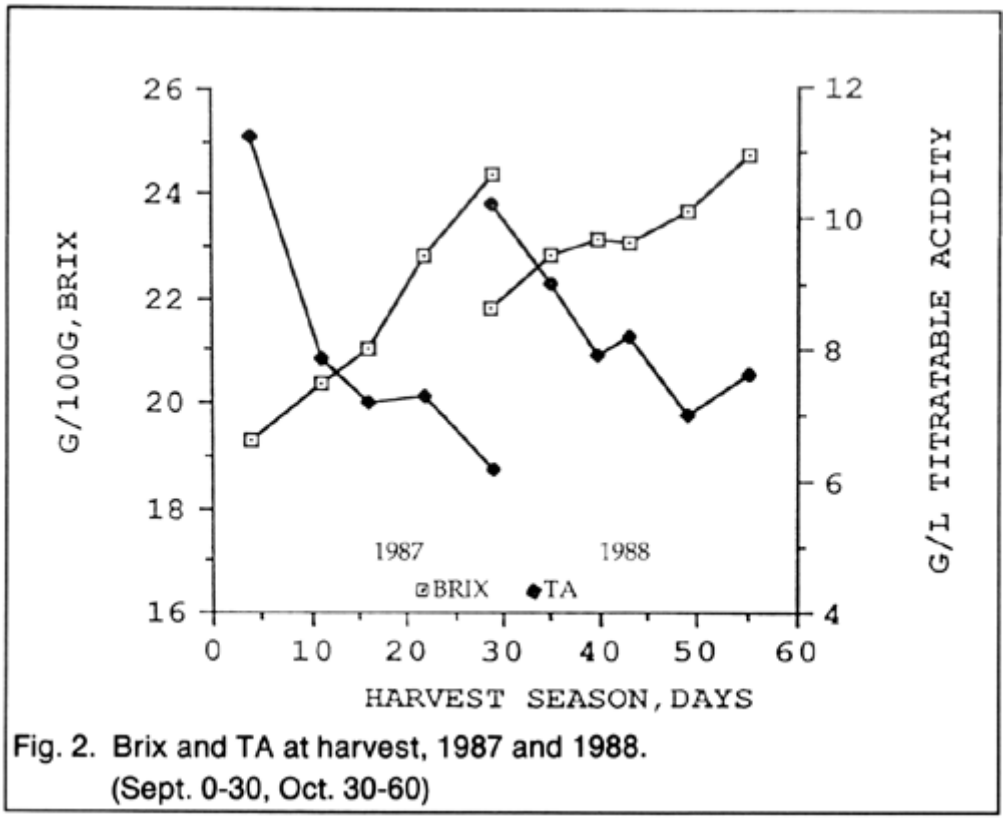

Fig. 2. Brix and TA at harvest, 1987 and 1988.
(Sept. 0-30, Oct. 30-60)

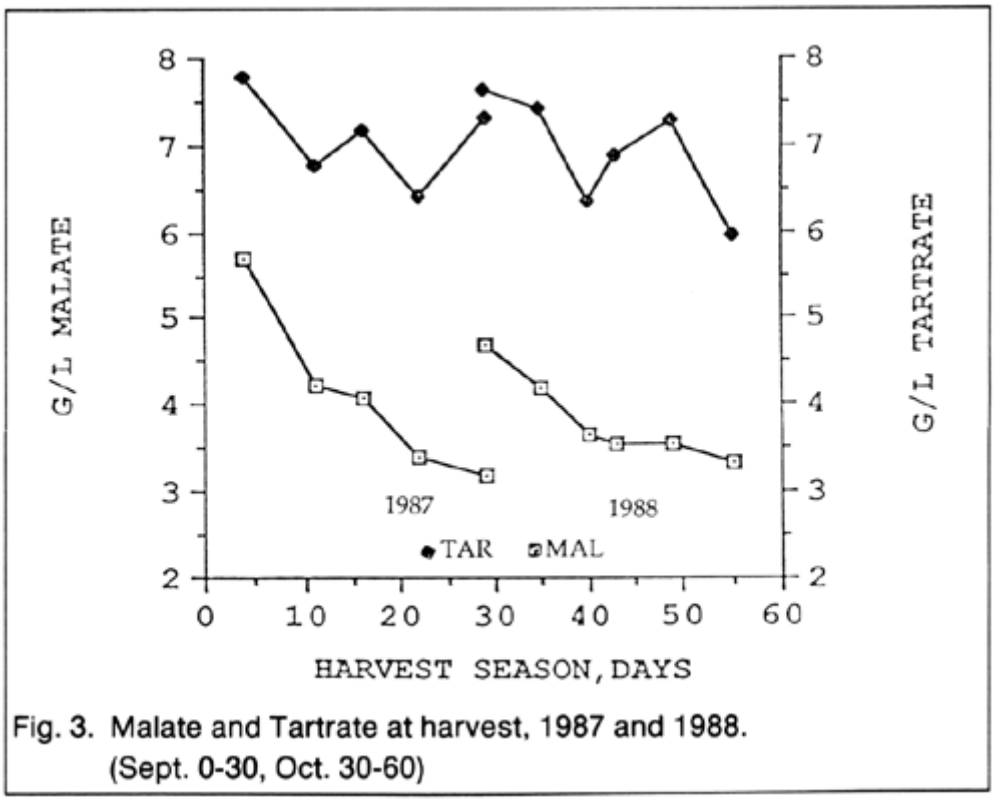

Fig. 3. Malate and Tartrate at harvest, 1987 and 1988.
(Sept. 0-30, Oct. 30-60)

A comparison of the increase in degrees Brix with the changes in berry weight helps to illustrate the considerable differences in the overall ripening patterns between the two harvest seasons (Figure 4). In 1987, the sugar accumulation was abnormally high by early September, the increase in Brix through mid

September was slow, and this was followed by a very rapid increase in Brix. Berry weight reached a maximum by mid September and then decreased steadily. The Brix at maximum berry size was only about 20 degrees, and the subsequent increase in Brix was apparently due to berry shrivelling and dehydration rather than an import of sugar into the berry. By contrast, in 1988 the maximum berry weight was reached in earIy October rather than September. The Brix increase more steadily and evenly than in 1987 to about 23 degrees at maximum berry size. Although berry weight loss due to softening and dehydration also occurred after maximum berry size was reached, the net effect on the fruit composition at harvest was less dramatic than in 1987. The Brix increased moderately, the TA decreased slightly, and the pH and the potassium concentration remained relatively low. Whereas, in 1987, high Brix levels were achieved primarily through berry shrivelling and dehydration, in 1988 desirable Brix levels were obtained during the berry growth phase before dehydration occurred. Monitoring the average berry weights or cluster weights during ripening could be a very important tool for differentiating the effects of berry development on fruit composition from the effects of dehydration.

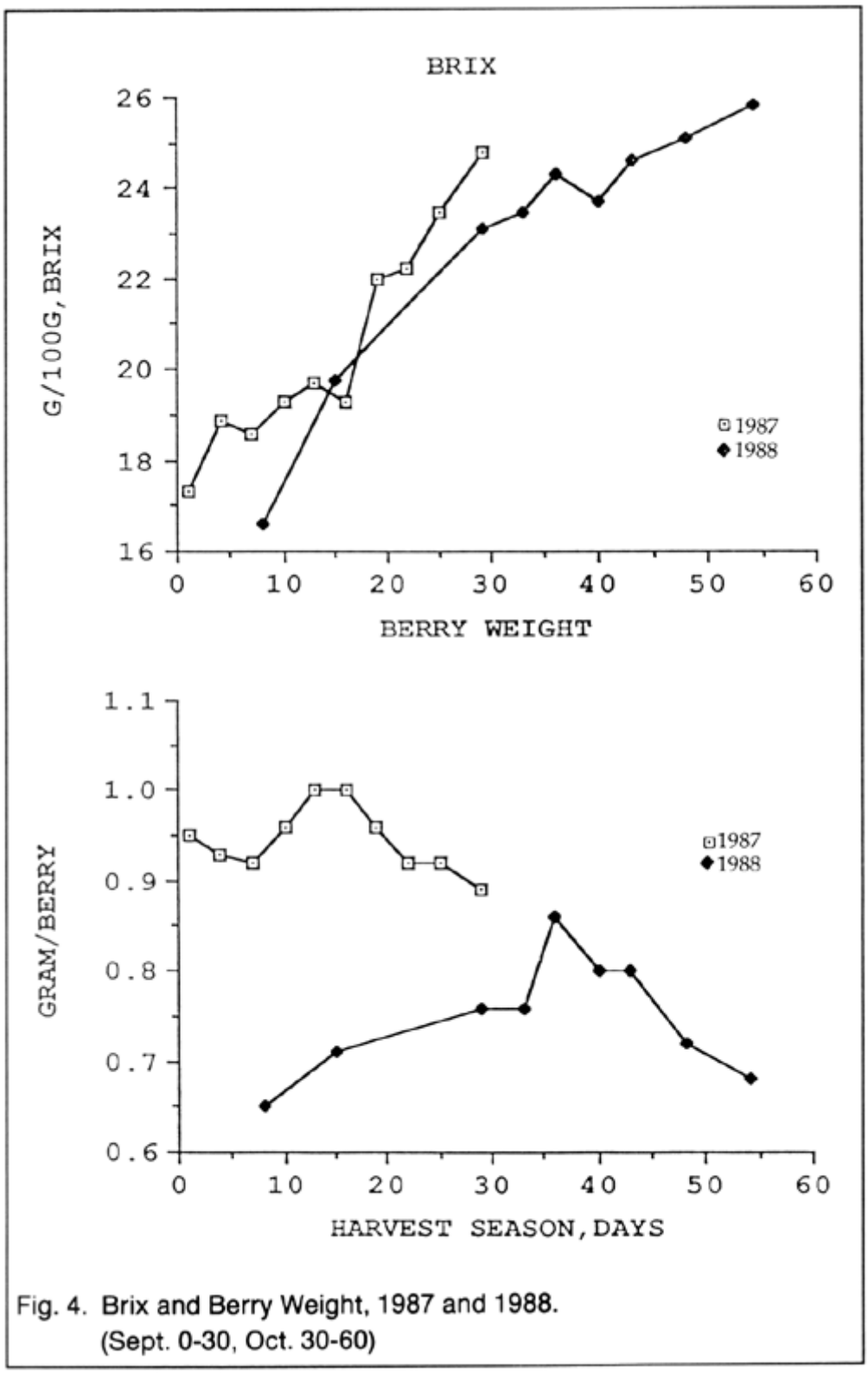

Fig. 4. Brix and Berry Weight, 1987 and 1988.
(Sept. 0-30, Oct. 30-60)

The anthocyanin content expressed as pigment per gram of berry increased much more rapidly and reached a level approximately twice as great in 1988 compared to 1987. This may be partially attributed to the smaller average berry size in 1988 but may also be due to a greater accumulation of pigment in the skins during a prolonged and relatively cool harvest season compared to a hot and early harvest season (Figure 5). In both years the anthocyanin per gram of berry increased to an initial maximum during berry

growth followed by additional increases during berry softening and dehydration. By contrast, the phenolic content per gram weight of berry fluctuated up and down during both seasons but did not increase substantially from the "early" to "late" harvest dates. The phenolic content, like the anthocyanin content, was however considerably greater on a berry weight basis in 1988 than in 1987 (Figure 6).

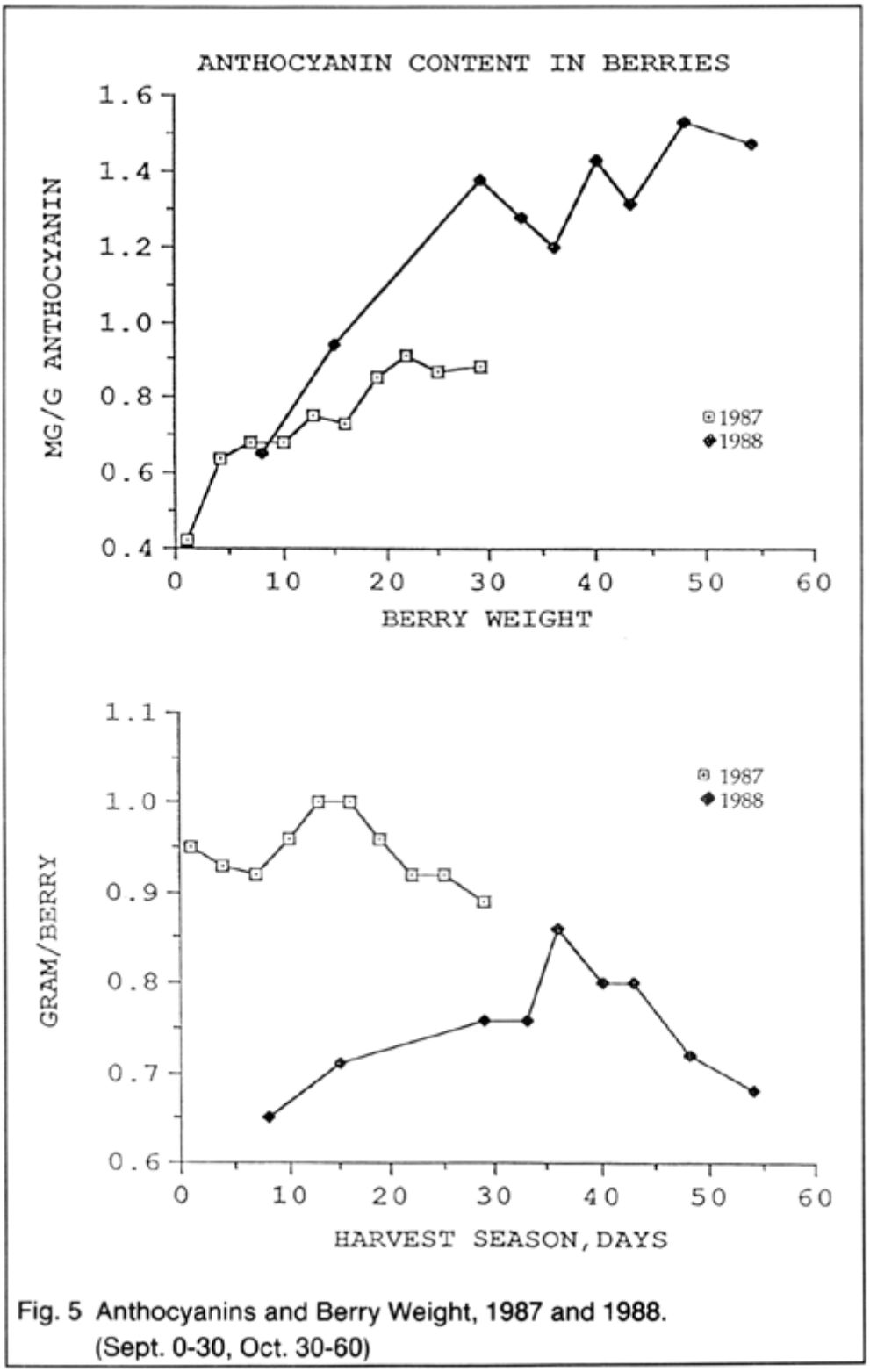

Fig. 5 Anthocyanins and Berry Weight, 1987 and 1988.
(Sept. 0-30, Oct. 30-60)

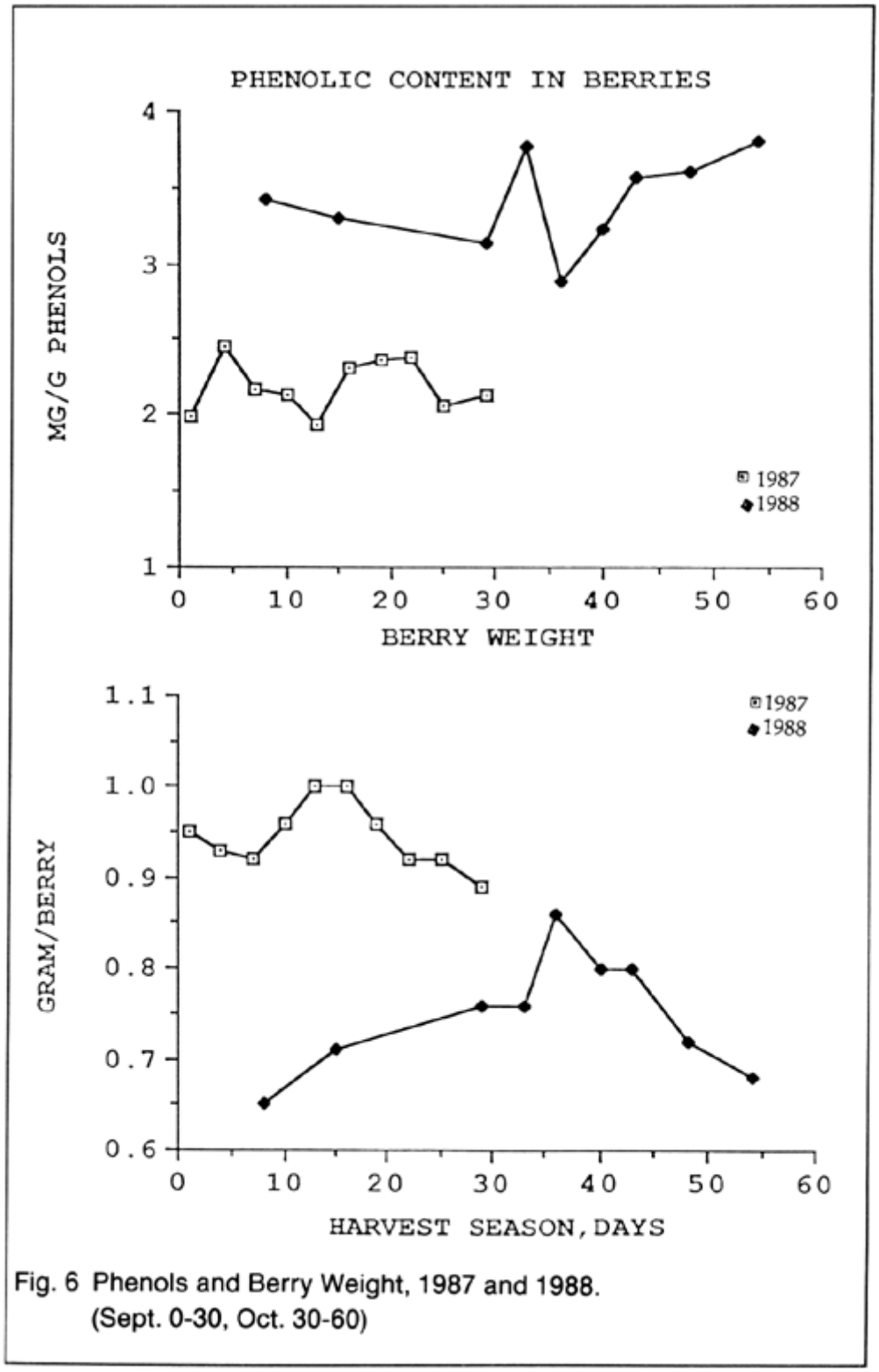

Fig. 6 Phenols and Berry Weight, 1987 and 1988.
(Sept. 0-30, Oct. 30-60)

The anthocyanin and phenol content of the berries was determined by extracting the skins with ethanol. We are interested in whether or not skin extracts from berry samples will reflect the differences that we observe in wines produced from different harvest dates. Interestingly, a decrease in phenols and a plateau in anthocyanin content occurred in mid September in both our berry samples and in our new wines in 1987 (Figure 7). Coincidentally, the only measurable rainfall during the 1987 harvest season

was during this period suggesting berry swelling and dilution occurred. The pigment and phenols on a berry weight basis also appeared to correlate fairly well with the new wine composition in 1988. Similar up and down fluctuations were observed in anthocyanin and phenolic content in both the berry samples and the new wines (Figure 8). Once again these fluctuations corresponded roughly to the only periods in which rainfall occurred during the harvest season. Skin extracts of berries samples taken during ripening may be useful tools for monitoring both increases in anthocyanins and possible fluctuations which may occur during maturation. We are currently working on a simplified alcoholic extract for color evaluation which can be used by growers and winemakers during harvest to help assess color potential.

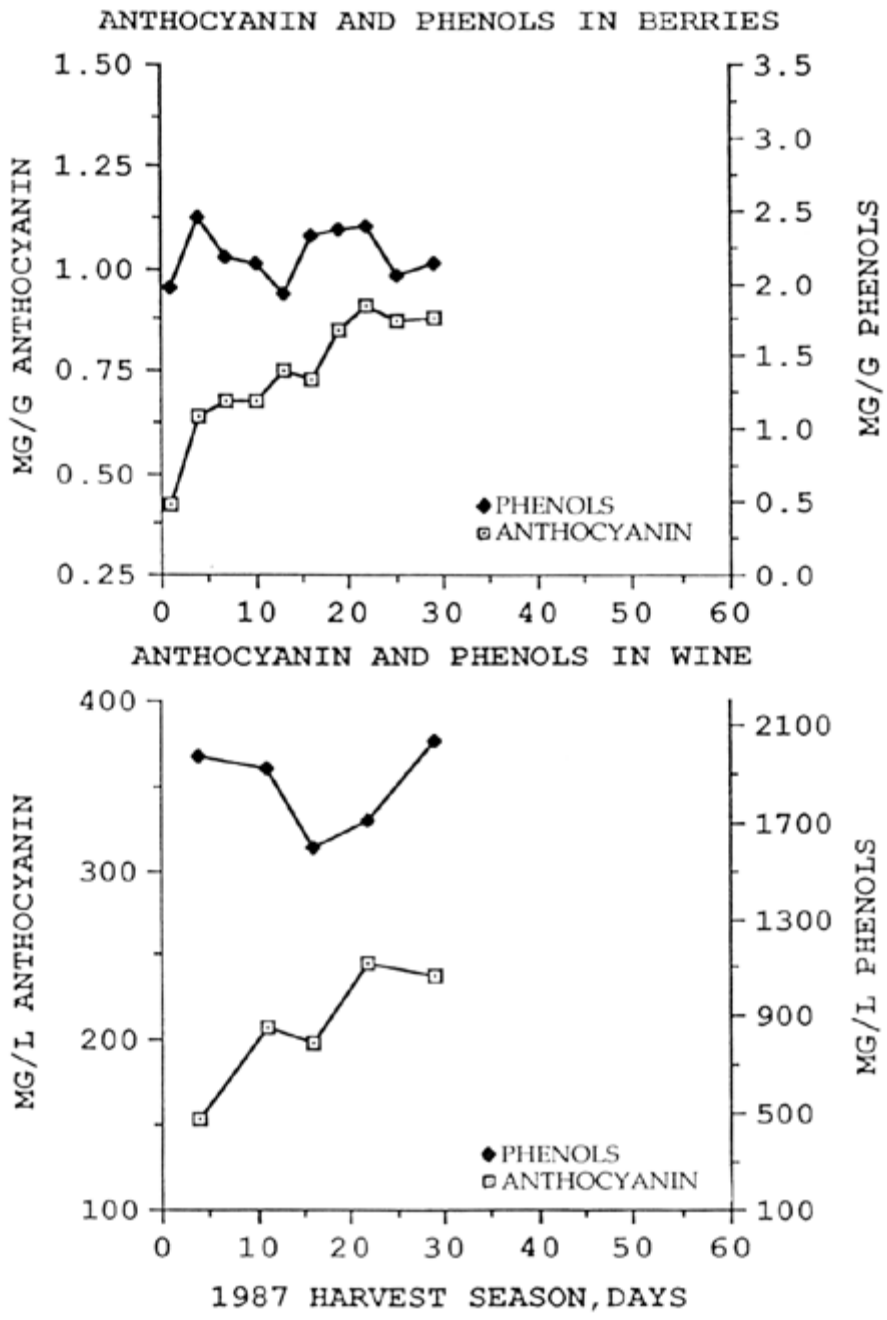

Fig. 7 Anthocyanin and Phenols in Berries and Wine in 1987. (Sept. 0-30, Oct. 30-60)

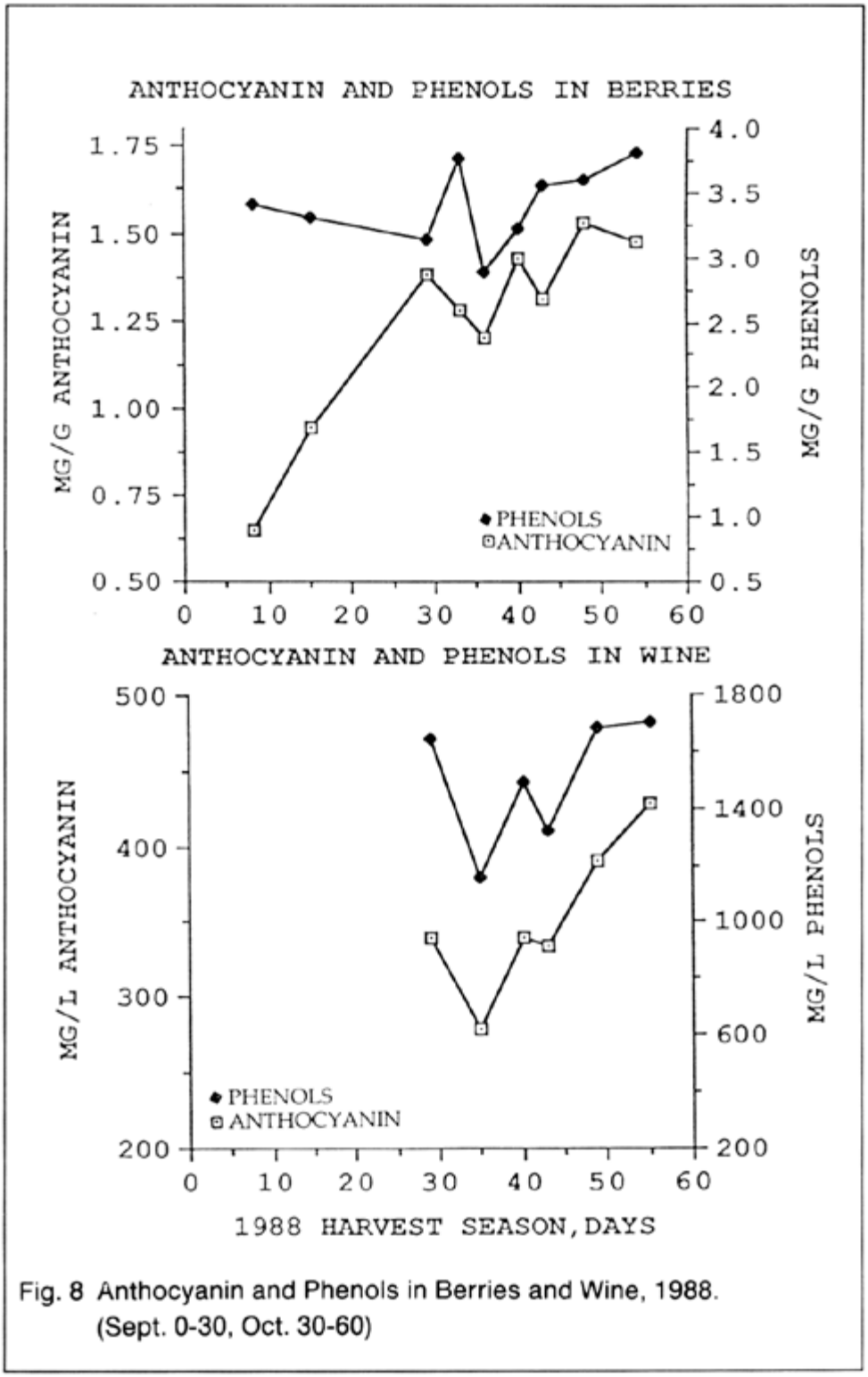

Fig. 8 Anthocyanin and Phenols in Berries and Wine, 1988. (Sept. 0-30, Oct. 30-60)

PROCESSING TRIALS AND WINE COMPOSITION

In 1987 wine lots were harvested every five days from September 4 to September 29. For the first three harvest dates duplicate chaptalized wines were reduced in addition to the controls. Sugar additions were made to raise the degrees Brix to approximately 22.5. The sugar was added at approximately 0 degrees

Brix and this prolonged the fermentation on the skins by an average of 3 days compared to the controls. The chaptalized wines were lower in unpolymerized anthocyanin content and higher in phenolic content than the control wines at all three harvest dates (Table 3). This raised the question as to whether these compositional differences were due to addition of sugar or to increased skin contact time and to whether or not these differences would be reflected in the perceived color or sensory character of the wines compared to the controls.

DATE	LOT	°BRIX g/100g	%ETOH	ANTH mg/L	PHEN g/L
9/4	Control	19.4	10.0	153	1.97
	+35 g/L[1]	19.2	11.3	125	2.71
9/11	Control	20.5	11.1	208	1.97
	+24 g/L[1]	20.3	12.0	142	2.64
9/16	Control	21.0	11.3	198	1.60
	+15 g/L[1]	21.0	11.9	149	1.90
9/22	Control	22.8	12.9	245	1.71
9/29	Control	24.4	13.6	238	2.04

[1]g/L sucrose added during fermentation at 0° Brix, wine on skins average of three days longer than controls.

Table 3 1987 Pinot noir Processing Trials.

In 1988 processing lots were included in the maturity trial to separate the effects of chaptalization from extended maceration time on the skins. Chaptalized lots were included on September 29 and October 5 but the wines were pressed from the skins at the same time as the controls. In addition extended maceration lots were fermented on the skins 12 days compared to 6 days for the control wines. The effects of partial whole cluster fermentation were also evaluated. The chaptalized lots were slightly lower in anthocyanin content than the controls but the total phenolic content was not appreciably higher. By contrast, the extended maceration lots were about 25% lower in anthocyanin content and about 18% higher in total phenols. The use of 25% whole clusters did not change the anthocyanin content compared to the controls but did appear to increase the phenolic content (Table 4).

DATE	LOT	BRIX g/100g	%ETOH	ANTH mg/L	PHEN g/L
9/29	Control	21.9	11.8	341	1.65
	+10 g/L[1]	21.7	11.8	328	1.59
10/5	Control	23.1	12.5	279	1.16
	+5 g/L[1]	22.5	12.4	245	1.20
	Ext.Mac[2]	22.8	12.4	210	1.70
	25% Cl[3]	22.8	12.5	271	1.37
10/10	Control	23.1	13.5	341	1.49
10/13	Control	23.0	13.6	335	1.33
10/19	Control	23.6	13.6	390	1.69
10/25	Control	24.7	14.0	429	1.70

[1]g/L sucrose added during fermentation at 0 Brix, wine on skins same as controls.
[2]Extended maceration, five days longer than controls.
[3]25% whole clusters.

Table 4 1988 Pinot noir Processing Trials.

CONCLUSION

The 1987 and 1988 seasons have demonstrated a need for more harvest indices than Brix, TA and pH. A better understanding of the maturation process of Pinot noir in Oregon could help in determining optimum harvest date as well as selecting appropriate processing techniques.