Evaluation of the Performance of Pinot noir Grafted to Five Rootstocks

Final Report
1995-2001

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INTRODUCTION

The advent of phylloxera in Oregon led to an urgent need for the evaluation of the viticultural characteristics of rootstocks with the potential for adaptation to Oregon, a cool climate grape production zone with low pH soils. The research reported here is a long-term study on the effect of rootstock on vine vigor, yield, and fruit composition. This final report summarizes the data of seven years.

MATERIALS AND METHODS

Experimental design

The vines in the "old rootstock trial" were planted in 1990. The experimental design consists of four replicated blocks of five Pinot noir vines ungrafted or grafted onto the following five stocks: 3309 Couderc, 101-14 Millardet et De Grasset, Riparia Gloire, Selection Oppenheim 4 (SO4) and Kober 5BB. The trial is located on a red hill slope with southern exposure. The soil is a silty clay loam classified as Bellpine (pH-H_2O: 5.00). Rows are oriented North-South and vines are spaced 6x9 ft (1.88 x 2.74m) and trained as double Guyot. Vines were not irrigated or crop thinned during the seven years of evaluation.

Yield and fruit composition

The experiment was harvested on October 5th, 2001. A sample of 25 clusters per replicate was crushed and the juice was analyzed for soluble solids, pH, and titratable acidity. A sample of five clusters per replicate was used to estimate berry weights and the number of berries per cluster. Cluster weight was calculated by averaging the pooled 30-cluster sample. The number of clusters was calculated using yield per replicate and average cluster weight. Sugar per vine was calculated multiplying juice sugar concentration (°Brix/100) by total yield per vine. Skin anthocyanin content was determined using the procedures described by Candolfi-Vasconcelos and Koblet (1990) and Vasconcelos and Castagnoli (2000).

Vine vigor

Vines were balance pruned to 30 buds / kg wood in February 2002 and previous seasons. The weight of the one-year old prunings, including woody laterals, was recorded during pruning.

Cane weight was obtained by dividing pruning weight by number of canes. The Ravaz Index is equivalent to the ratio of yield to pruning weights (Ravaz, 1903).

RESULTS

Yield and yield components

Table 1 summarizes the rootstock effect on yield and yield components of Pinot noir grapevines during the past seven seasons. Both rootstock and year means are presented. The year means were included to provide additional information on the general trends of each season.

Table 1: Effect of rootstock on yield and yield components of Pinot noir ungrafted or grafted to five different rootstocks at Woodhall III OSU research vineyard. Seven-year average.

	Fruit Yield (Ton/Ac)		Berries/ Cluster		Berry Weight (g)		Cluster Weight (g)		Clusters/ Shoot		Shoots/ Vine	
Rootstock												
SO4	5.1	a	121	a	1.02	a	121	a	1.84	a	24	a
5BB	3.4	b	104	b	1.03	a	106	b	1.76	ab	21	bc
3309C	2.2	c	99	bc	0.92	b	89	bc	1.56	c	17	d
101-14	2.4	c	98	bc	0.91	b	89	bc	1.61	bc	18	cd
Riparia	1.0	d	89	d	0.79	c	70	d	1.56	c	11	e
Ungrafted	2.6	c	93	cd	0.98	a	90	cd	1.65	bc	19	bcd
p-value	<0.0001		<0.0001		<0.0001		<0.0001		0.0041		<0.0001	
Year												
1995	1.4		94		0.86		81		1.57		11	
1996	2.2		124		0.84		102		1.55		15	
1997	3.2		127		0.90		115		1.65		18	
1998	2.1		78		0.95		74		1.64		19	
1999	2.9		83		0.93		77		1.65		25	
2000	3.3		100		0.98		98		1.79		20	
2001	4.3		98		1.16		114		1.80		21	
p-value	<0.0001		<0.0001		<0.0001		<0.0001		0.0475		<0.0001	
RS x Year												
p-value	ns		ns		ns		ns		ns		ns	

ns, *, **, and ***, indicate not significant and statistically significant at the 0.05, 0.01, and 0.001 levels respectively. Values followed by the same letters do not differ significantly.

Vines grafted to SO4 had the highest yields and produced twice as much fruit as ungrafted vines and five fold the amount of fruit produced by vines grafted on Riparia Gloire (Table 1

and Figure 1). Ungrafted vines or those grafted on 3309C and 101-14, generated comparable crop sizes and similar yield components. Berry weights ranged between 0.79g and (Riparia Gloire) and 1.02 g (SO4). Vines grafted to SO4, 5BB or ungrafted had the highest berry weights. Vines grafted to Riparia gloire had the smallest yields averaging one ton/acre resulting from fewer berries of very small size, a lot smaller than is typical for Pinot noir. Bud fertility (number of clusters per shoot) was highest on vines grafted to the more vigorous and higher yielding rootstocks (Table 1). Number of shoots per vine reflects the number of buds left at pruning, based on pruning weights (Table 4). Number of shoots per vine was highest for vines on SO4 and 5BB, twice the number of shoots that vines grafted on Riparia had the capacity of producing (Table 1).

Table 2: Effect of rootstock on total sugar accumulated in the fruit, soluble solids, titratable acidity and pH in the juice and skin anthocyanins of Pinot noir ungrafted or grafted to five different rootstocks at Woodhall III OSU research vineyard. Seven-year average.

	Sugar (g/m^2)		Soluble Solids °Brix		Juice pH		Titratable Acidity (g/L)		Anthocyanins mg/berry		mg/g	
Rootstock												
SO4	125	a	22.8	e	3.06	d	7.2	a	1.14	c	1.17	c
5BB	113	b	23.1	de	3.08	cd	7.2	a	1.30	ab	1.24	c
3309C	177	c	23.5	bcd	3.12	b	6.4	b	1.38	a	1.51	b
101-14	53	c	23.4	bcd	3.12	bc	6.5	b	1.35	ab	1.50	b
Riparia	252	d	23.8	ab	3.18	a	6.0	c	1.36	ab	1.75	a
Ungrafted	133	c	23.3	cd	3.10	bcd	6.6	b	1.25	bc	1.29	c
p-value	<0.0001		<0.0001		<0.0001		<0.0001		0.0051		<0.0001	
Year												
1995	73		23.6		3.18		6.7		—		—	
1996	115		23.3		3.17		6.7		1.17		1.43	
1997	149		21.0		3.20		7.0		1.11		1.25	
1998	109		23.1		2.99		6.4		1.31		1.40	
1999	160		24.2		3.08		6.9		1.57		1.78	
2000	174		23.9		3.07		6.2		1.42		1.52	
2001	213		24.1		3.08		6.9		1.23		1.09	
p-value	<0.0001		<0.0001		<0.0001		0.0017		<0.0001		<0.0001	
RS x Year												
p-value	ns		0.0007		ns		ns		ns		0.019	

ns, *, **, and ***, indicate not significant and statistically significant at the 0.05, 0.01, and 0.001 levels respectively. Values followed by the same letters do not differ significantly.

Fruit composition

Despite the wide range of yields, rootstock differences in soluble solids during the seven years of the study were not always significant (Tables 2 and 3). The seven year averages showed that rootstock induced 1° Brix range between the highest and lowest readings (Figure 1). Juice soluble solids and pH varied in opposite direction with the size of the crop and juice pH changed in the same direction with crop size (Table 1, 3, and Figure 1). Lower yielding vines grafted on Riparia Gloire, 3309C, or 101-14 had the highest juice soluble solids and pH and the lowest titartable acidity (Table 2). Differences in juice soluble solids within each season prior to 2001 were too small to achieve statistical significance (Table 3). 2001 was a high yielding year and the additional crop load may have amplified the small differences in fruit composition induced by rootstock. Skin anthocyanins per berry and per unit fruit weight varied with rootstock (Tables 2 and 3), mainly reflecting the ratio of surface to volume and individual berry size. Vines grafted on SO4 or ungrafted had the lowest and those on 3309 had the highest level of anthocyanins per berry, respectively. Vines grafted to Riparia Gloire did not rank in the top levels of anthocyanins per berry but had the highest amount of color in the skin on a weight basis, due to the very small berries with a higher surface to volume ratio. Lower than average anthocyanins per unit of weight were observed on ungrafted or on vines grafted on SO4 and 5BB (Table 2). During the seasons of 1997 and 1998 there was no measurable effect of rootstock on skin anthocyanins per unit of fruit weight (Table 3)

Table 3: Effect of rootstock on juice soluble solids and skin anthocyanins of Pinot noir ungrafted or grafted to five different rootstocks at Woodhall III OSU research vineyard during the period of 1995-2001.

	1995	1996	1997	1998	1999	2000	2001	
Juice Soluble Solids (°Brix)								
SO4	23.6	22.9	20.3	22.7	24.3	23.6	22.1	c
5BB	23.4	23.0	21.3	22.9	24.3	22.7	24.0	bc
3309 C	23.8	23.5	21.1	23.5	24.1	24.3	24.4	ab
101-14	24.1	23.6	20.9	23.5	23.9	23.7	24.3	b
Riparia	23.4	23.3	21.3	23.2	24.0	25.0	26.3	a
Ungrafted	23.3	23.7	21.0	22.6	24.8	24.3	23.5	bc
P-Value	ns	ns	ns	ns	ns	ns	0.0082	
Anthocyanins (mg/g fruit)								
SO4		1.19 b	1.06	1.20	1.35 b	1.65 ba	0.80	c
5BB		1.31 b	1.08	1.40	1.54 b	1.20 b	0.94	bc
3309 C		1.50 ba	1.28	1.44	2.02 a	1.62 ba	1.12	bac
101-14		1.56 ba	1.40	1.52	2.12 a	1.25 b	1.17	ba
Riparia		1.85 a	1.40	1.48	2.26 a	2.05 a	1.43	a
Ungrafted		1.20 b	1.31	1.38	1.39 b	1.38 b	1.07	bc
P-Value		0.0146	ns	ns	0.0002	0.0130	0.0265	

ns, *, **, and ***, indicate not significant and statistically significant at the 0.05, 0.01, and 0.001 levels respectively. Values followed by the same letters do not differ significantly.

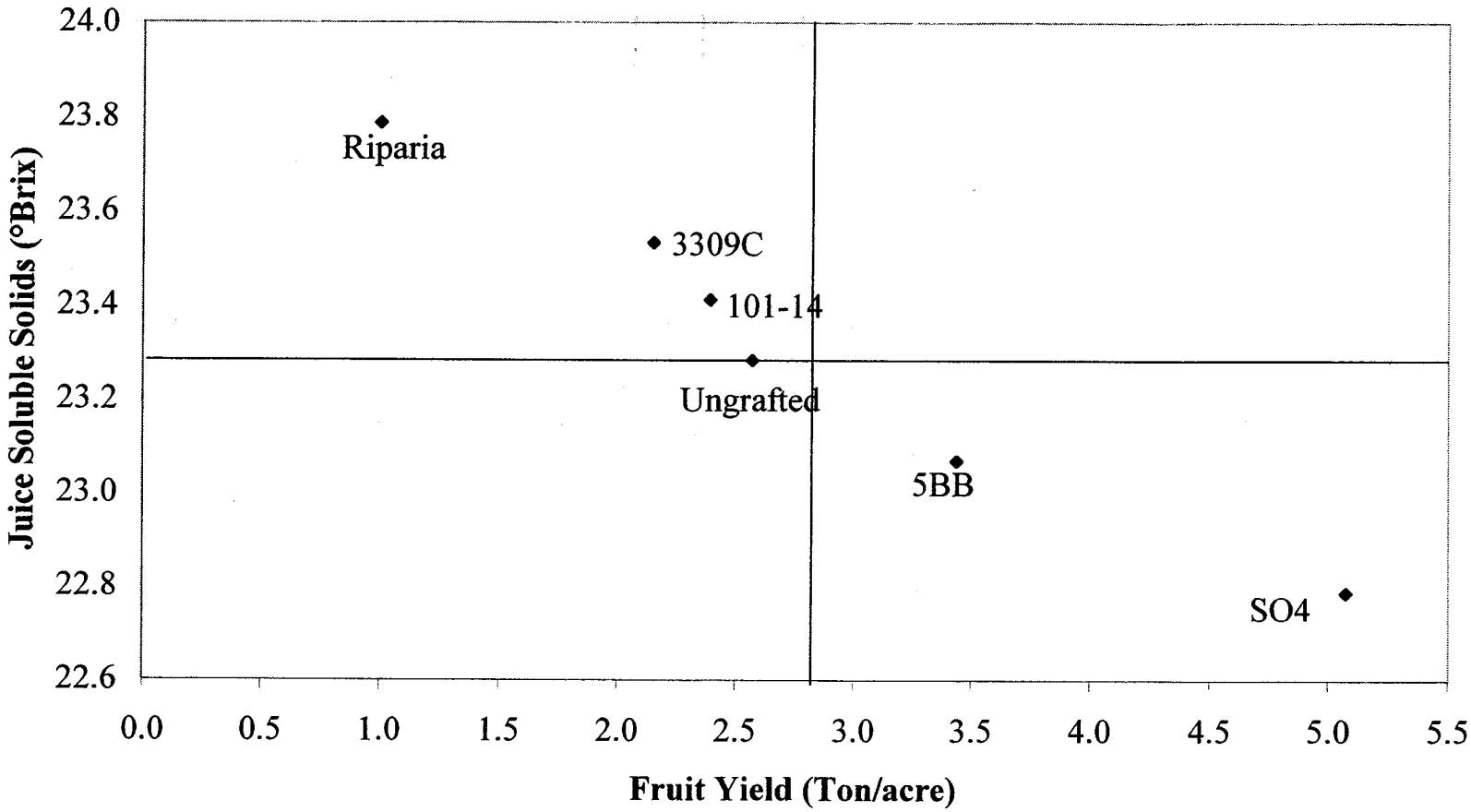

Figure 1: Relationship between fruit yield and juice soluble solids of Pinot noir grapevines grafted on different rootstocks at Woodhall III OSU research vineyard in Alpine, Oregon during the period of 1995 to 2001. Each point is the average of 28 measurements (seven years x 4 replicates).

Vine vigor

Vine vigor as assessed by pruning weight varied considerably with rootstock (Table 4). SO4 and Riparia Gloire were the two extremes. Vines have been balanced pruned during the entire seven year period of evaluation. The Ravaz Index (yield to pruning ratio) reflects the tendency of a given genotype to allocate resources to reproductive (fruit yield) rather than to vegetative growth (estimated by pruning weights). Ideally, a rootstock should induce the scion to maximizing fruit yield with minimal investment in growth of leaves and permanent structure. SO4 and 5BB were the best performing rootstocks in this respect (Table 4).

Table 4: Effect of rootstock on pruning weights and Ravaz Index (kg fruit/kg prunings) of Pinot noir ungrafted or grafted to five different rootstocks at Woodhall III OSU research vineyard. Seven-year average.

	Pruning Weight (kg/vine)		Cane Weight (g)		Ravaz Index	
Rootstock						
SO4	1.20	a	56	a	4.9	a
5BB	0.86	b	50	b	4.7	ab
3309C	0.63	d	45	bc	3.9	c
101-14	0.68	cd	44	c	4.0	bc
Riparia	0.33	e	41	c	3.5	c
Ungrafted	0.77	bc	46	bc	3.8	c
p-value	<0.0001		<0.0001		0.0002	
Year						
1995	0.49		43		3.0	
1996	0.61		58		3.9	
1997	0.72		48		4.8	
1998	1.03		60		2.4	
1999	0.91		38		3.7	
2000	0.70		41		5.4	
2001	0.76		40		5.7	
p-value	<0.0001		<0.0001		<.0001	
RS x Year						
p-value	ns		ns		ns	

ns, *, **, and *** indicate not significant, and statistically significant at the 0.05, 0.01, and 0.001 levels of probability, respectively. Values followed by the same letters do not differ significantly

DISCUSSION

Our results do not agree with previously published results on some of the rootstocks under evaluation. Previous rootstock reviews always rank 5BB as superior in vigor to SO4, which was not the case at this trial. Interestingly, in other rootstock trials at our research vineyard where both these rootstocks are compared side by side (Taylor and Vasconcelos, 2001 and Shaffer and Vasconcelos, 2001), 5BB is more vigorous than SO4, in agreement with the international literature on rootstock evaluation (reviewed by Candolfi-Vasconcelos, 1995). Similarly, within the group of *riparia x rupestris* crosses, 3309 has been considered more vigorous than 101-14. In our experiment, they behave very similarly.

The choice of rootstock has a major impact on crop size but a smaller impact on fruit composition. Differences in fruit composition due to rootstock do not occur every year. In our study, Pinot noir yields varied between 1 t/ac and more than 5 t/ac but soluble solids varied within one °Brix in response to rootstock.

LITERATURE CITED

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