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Choosing Phylloxera-Resistant Rootstocks for Oregon Vineyards: The Impact on Vine Performance and Productivity

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ABSTRACT

Five replicated rootstock trials established in Oregon's three main viticultural. regions were evaluated for the effect of rootstock on Pinot noir performance. All the trials except Alpine included the following seven rootstocks: ungrafted Pinot noir, 3309 Couderc, 101-14 Millardet et De Grasset, 44-53 Mal6gue, 420 A Millardet et De Grasset, 5 C Teleki, and Harmony. At Alpine, the rootstock selection included ungrafted Pinot noir, 3309 Couderc, 101-14 Millardet et De Grasset, Riparia Gloire, Selection Oppenheim. 4 (SO 4) and Kober 5BB.

Rootstock effect on scion performance varied greatly with site, and the responses typically were not consistent from site to site. At Newberg, Pinot noir grafted to 420 A and 44-53 had the best yields but there were no rootstock difference in must soluble solids. At Lafayette no rootstock differences in yields could be observed but soluble solids in the juice were better with 44-53. At Umpqua, the most vigorous site, no rootstock differences in yield or must soluble solids could be detected. At Eagle Point, a site with low vigor due to overcropping, yields were better when vines were grafted to 44-53 and must soluble solids was improved when grafted to 3309 C. At Alpine, with a different selection of rootstocks, yields were better when the stock was SO 4 but there was no rootstock effect on Brix.

INTRODUCTION

The advent of phylloxera in Oregon led to an urgent need of evaluating viticultural characteristics of rootstocks with potential adaptation to different sites in Oregon, a cool climate grape production zone. Five replicated rootstock trials established in Oregon's three main viticultural regions were evaluated for the effect of rootstock on canopy development, fruit set, yield and fruit composition.

MATERIALS AND METHODS

Experimental design

The following rootstock trials, planted in 1992, were followed in this study: Winters Hill Vineyard, Whistling Ridge Vineyard, Woodhall Vineyard, Henry Estate Vineyard, and Ousterhout Vineyard. All the trials except Alpine include five replicated blocks of five Pinot noir vines grafted onto the following seven stocks: Pinot noir, 3309 Couderc, 101-14 Millardet et De Grasset, 44-53 Mal&gue, 420 A Millardet et De Grasset, 5 C Teleki, and Harmony. At Alpine, the rootstock selection includes ungrafted Pinot noir, 3309 Couderc, 101-14 Millardet et De Grasset, Riparia Gloire, Selection Oppenheim 4 (SO

4) and Kober 5BB. All of these rootstocks except Harmony are characterized by a high resistance to phylloxera. Harmony has V. vinifera in the parentage (which is usually associated with insufficient phylloxera resistance) and showed low resistance to phylloxera in Australia (Cirami et al., 1984) and South Africa (Southey, 1992).

Site description

Table 1 summarizes geographical, climatical and pedological. information as well as choice of trellis systems and spacing of each site included in this study. Soil samples were taken at each vineyard and analyzed for macro and micronutrients. Results are shown in table 2.

Table 1: Geographical and pedological characterization and cultural choices of the vineyards under study

Vineyard	Location	County	Soil Series and Type	Topo-graphy	Rows
Whistling Ridge	Newberg	Yamhill	Willakenzie silty clay loam	Hill	N-S
Winters Hill	Lafayette	Yamhill	Jory clay loam	Hill	N-S
Henry Estate	Umpqua	Douglas	clay loam	Valley floor	N-S
Ousterhout	Eagle Point	Jackson	Agate and Carney clay	Hill	N-E
Woodhall	Alpine	Benton	Bellpine, Jory silty clay loam, clay loam	Hill	N-S

Vineyard	Exposure	Training System	Spacing	Overall Vigor	Irrigation
Whistling Ridge	South	Double Guyot	5 x 7' 1.52 x 2.13 m	Moderate	No
Winters Hill	South	Double Guyot	5 x 8' 1.52 x 2.44 m	Low	No
Henry Estate	—	Scott Henry	6 x 12' 1.88 x 3.66 m	Vigorous	No
Ousterhout	NE	Lyre	6 x 12' 1.88 x 3.66 m	Low	Yes
Woodhall	South	Double Guyot	6 x 9' 1.88 x 2.74 m	Moderate	No

Table 2: Soil pH, organic matter, macro and micronutrient content at 0-30cm depth in the 5 vineyards

located at Alpine, Eagle Point, Lafayette, Newberg, and Umpqua.

	Alpine		Eagle Point		Lafayette	
	Mean	SE[1]	Mean	SE	Mean	SE
pH	4.70	±0.00	5.67	±0.03	5.53	±0.12
%OM	10.13	±0.21	7.68	±0.21	10.73	±0.15
P (ppm)	14.00	±0.00	21.33	±0.67	23.33	±1.45
K (ppm)	151.00	±10.12	118.33	±7.42	313.33	±19.10
Ca (meq/100g)	2.60	±0.10	16.07	±0.43	7.27	±0.47
Mg (meq/100g)	0.47	±0.03	4.50	±0.06	1.13	±0.07
B (ppm)	0.48	±0.01	1.20	±0.04	0.86	±0.04
NH_4-N (ppm)	34.50	±0.20	34.37	±0.89	35.43	±0.79
NO_3-N (ppm)	3.23	±0.35	11.20	±1.70	1.87	±0.77
Fe (ppm)	64.00	±1.15	185.33	±7.69	45.33	±0.67
Mn (ppm)	64.67	±2.67	70.33	±16.17	135.00	±9.29
Cu (ppm)	0.96	±0.07	3.92	±0.34	1.69	±0.05
Zn (ppm)	0.42	±0.06	2.17	±0.13	2.17	±0.10

	Newberg		Umpqua	
	Mean	SE	Mean	SE
pH	4.97	±0.03	5.23	±0.03
%OM	3.80	±0.36	5.40	±0.13
P (ppm)	14.00	±1.73	39.00	±1.15
K (ppm)	158.67	±15.81	264.00	±19.86
Ca (meq/100g)	2.50	±0.10	9.83	±0.34
Mg (meq/100g)	0.66	±0.01	1.83	±0.15
B (ppm)	0.46	±0.06	0.65	±0.03
NH_4-N (ppm)	18.23	±1.77	18.37	±0.17
NO_3-N (ppm)	3.53	±0.95	9.00	±1.18
Fe (ppm)	59.33	±2.91	124.00	±7.21
Mn (ppm)	131.67	±12.60	34.67	±2.85
Cu (ppm)	2.18	±1.13	2.15	±0.14
Zn (ppm)	0.85	±0.09	1.04	±0.07

[1] Standard error, n=3

Fruit set

Prior to bloom, 105 inflorescence clusters per vineyard (three per replicate) were enclosed into pollination bags to retain all shed flowers. The bags were removed at the end of July, four weeks after full boom and all the abscised flowers and fruitlets were counted. At harvest, these clusters were picked separately and frozen and the number of berries was counted. Number of flowers was calculated as the sum of shed flowers and berries. Percent fruit set was calculated as the quotient between number of berries at harvest and the total number of flowers per inflorescence.

Yield and fruit quality

The vineyards were harvested at commercial ripening. The vineyard at Alpine was harvested on October 2, at Umpqua on October 3, at Lafayette and Newberg on October 7 and at Eagle Point on October 17.

A sample of 25 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 berry weights and number of berries per cluster. Cluster weight was calculated averaging the pooled 30 cluster sample. Number of clusters was calculated using yield per replicate and average cluster weight. Sugar per vine was calculated multiplying must sugar content in 'Brix (equivalent to percentage by weight of sucrose) by total yield per vine.

Canopy development and vine vigor

Five shoots per replicate were collected approximately 2 weeks prior to harvest at each location for growth analysis. Shoot length and diameter were measured, number of main and lateral leaves were counted, and primary and lateral leaf area was measured.

RESULTS AND DISCUSSION

Yield and yield components

Table 3 summarizes the rootstock effect on yield and yield components of Pinot noirgrapevines at the 5 different sites. There were no significant differences in yield per square meter at Lafayette and Umpqua. At Newberg, Pinot noir grafted on 420 A or 44-53 had the highest yields. At Eagle Point, 44-53 generated the best yields. SO 4 induced better yields than the other rootstocks at Alpine. There was a significant site effect on percentage of fruit set. At Newberg, 44%, Lafayette, 32%, Umpqua, 46%, Eagle Point, 59%, and at Alpine, 47% of the flowers set into fruits. The weather during the weeks preceding and during bloom was warmer at Eagle Point, compared to the other sites (data not shown). The low overall vine vigor at Lafayette may have contributed to the lower fruit set rate. There were no rootstock differences at the Yamhill county vineyards and at Eagle Point. At Umpqua, scion fruit set was better when grafted on 420 A or 44-53. At Alpine, the least vigorous rootstocks, Riparia and 101-14, induced the highest fruit set rates. Final number of berries per cluster varied with site, and within site, by rootstock. At Newberg and Lafayette, vines grafted to Harmony had significantly lower number of berries per cluster. At Lafayette, the Riparia X Rupestris hybrids induced the highest number of berries per cluster. At Umpqua, clusters from vines grafted to 44-53 had significantly more berries as compared with other stocks. At Alpine, Riparia X Berlandieri hybrids had clusters with more berries and surprisingly, vines grafted to Riparia, the least vigorous rootstock in that trial, had the lowest number of berries per cluster. No rootstock effect on berry number could be observed at Eagle Point. Mean berry weight was highest for vines grafted to Harmony at Newberg, to 3309 at Lafayette and to SO 4 at Alpine. No rootstock response in berry weights could be observed at Umpqua or Eagle Point. There

were significant site differences in cluster weight but there was no consistent response to rootstock: 3309 gave the heaviest clusters at Lafayette and Eagle Point and the Riparia X Berlandieri hybrids had higher cluster weights at Alpine.

Table 3: Effect of rootstock on yield and yield components of Pinot noir grapevines at five different locations in Oregon.

Vineyard Location	Rootstock	Yield (kg/m^2)	Fruit Set %	Berry wt. (g)	Clusters/ m^2	Cluster wt. (g)	Berries/ cluster
Newberg	Harmony	0.47 c[1]	38 a	0.99 a	8 bcd	59.9 a	60 b
	5C	0.63 ab	51 a	0.83 bc	9 abc	67.9 a	83 a
	420A	0.69 a	44 a	0.88 ab	10 ab	72.3 a	84 a
	3309C	0.47 c	43 a	0.86 bc	8 cd	61.9 a	72 ab
	101-14	0.43 c	43 a	0.84 bc	7 d	62.5 a	75 ab
	44-53	0.70 a	49 a	0.89 ab	10 a	72.0 a	82 a
	Ungrafted	0.52 bc	42 a	0.75 c	8 bcd	64.4 a	87 a
	Significant F	***	ns	*	*	ns	*
Lafayette	Harmony	0.16 a	29 a	0.68 ab	4 a	40.7 c	58 c
	5C	0.18 a	28 a	0.62 bc	4 a	40.4 c	65 bc
	420A	0.18 a	35 a	0.58 c	5 a	39.7 c	67 bc
	3309C	0.29 a	36 a	0.72 a	5 a	60.6 a	84 a
	101-14	0.23 a	32 a	0.61 bc	5 a	46.9 bc	76 ab
	44-53	0.24 a	34 a	0.64 abc	4 a	54.4 ab	84 a
	Ungrafted	0.21 a	31 a	0.69 ab	4 a	46.9 bc	68 bc
	Significant F	ns	ns	*	ns	**	**
Umpqua	Harmony	0.66 a	46 ab	0.96 a	6 a	108.9 a	115 b
	5C	0.70 a	44 ab	0.97 a	6 a	106.9 a	111 b
	420A	0.71 a	55 a	0.89 a	7 a	103.7 a	118 b
	3309C	0.53 a	44 ab	0.88 a	5 a	94.9 a	107 b
	101-14	0.52 a	36 b	0.89 a	6 a	89.1 a	101 b
	44-53	0.56 a	54 a	0.75 a	5 a	111.5 a	150 a
	Ungrafted	0.57 a	37 b	0.95 a	6 a	98.6 a	104 b
	Significant F	ns	**	ns	ns	ns	**
Eagle Point	Harmony	0.80 c	60 a	0.71 a	14 b	57.5 b	83 a
	5C	0.83 bc	57 a	0.70 a	15 ab	56.8 b	83 a
	420A	0.75 c	66 a	0.76 a	13 b	59.0 b	80 a
	3309C	1.11 ab	55 a	0.90 a	15 ab	75.9 a	87 a
	101-14	0.95 abc	61 a	0.80 a	14 b	68.9 ab	89 a
	44-53	1.15 a	58 a	0.84 a	17 a	65.9 ab	79 a
	Ungrafted	0.92 abc	60 a	0.83 a	15 ab	62.4 ab	76 a
	Significant F	*	ns	ns	*	*	ns
Main Effects							
Vineyard		***	***	***	***	***	***
Rootstock		ns	*	ns	ns	ns	***
Vineyard x Rootstock		**	ns	**	**	*	***
Alpine	SO 4	0.66 a	47 ab	1.01 a	5 a	115.6 a	115 a
	5BB	0.38 b	43 b	0.89 b	4 ab	99.2 a	113 a
	3309C	0.22 b	44 ab	0.77 c	3 b	74.0 b	98 ab
	101-14	0.21 b	53 a	0.78 c	3 b	67.8 bc	87 bc
	Riparia	0.13 b	54 a	0.75 c	2 b	54.6 c	73 c
	Ungrafted	0.25 b	41 b	0.95 ab	3 b	73.5 b	78 bc
	Significant F	**	*	***	*	***	**

[1] ns, *, **, *** indicate not significant and statistically significant at the 0.05, 0.01, and 0.001 levels within location. Values followed by the same letters do not differ significantly.

Fruit composition

There were significant site and rootstock differences on must soluble solids but rootstock performance varied from site to site (Table 4). At Lafayette, Pinot noir grafted to 44-53 had the highest sugar content in the juice. There were no rootstock responses at Newberg, Umpqua, or Alpine. At Eagle Point, 3309 induced the highest soluble solids and pH on the scion's juice. There were no rootstock differences on fruit pH in the other trials. Among all the measured fruit quality parameters, titratable acidity of the must was the only one that responded to rootstock similarly in all sites. However, significant differences were only observed at Newberg: 420 A and 44-53 had the highest and ungrafted Pinot noir the lowest titratable acidity in the must.

Total sugar produced per square meter of ground, which encompasses yield and soluble solids, is a good estimate of the vine performance. At Alpine, vines grafted to SO 4 produced more sugar. At Newberg, grafting to 420 A and 44-53 resulted in more sugar produced on an area basis. At Eagle point, 3309 and 44-53 gave the best results. There were no rootstock differences at Lafayette or Umpqua on total sugar produced.

Table 4 : Effect of rootstock on total sugar accumulated in the fruit, soluble solids, titratable acidity and pH in the juice of Pinot noir grapevines at five different locations in Oregon.

Vineyard Location	Rootstock	Sugar (kg/vine)		Soluble Solids °Brix		pH		Titratable Acidity (g/L)	
Newberg	Harmony	0.35	c[1]	22.5	a	3.20	a	6.8	bc
	5C	0.47	ab	23.0	a	3.17	a	7.2	abc
	420A	0.51	a	22.8	a	3.13	a	7.8	a
	3309C	0.35	c	22.9	a	3.17	a	7.6	ab
	101-14	0.33	c	23.2	a	3.20	a	6.8	bc
	44-53	0.54	a	23.4	a	3.14	a	7.8	a
	Ungrafted	0.39	bc	23.0	a	3.19	a	6.6	c
	Significant F	***		ns		ns		*	
Lafayette	Harmony	0.14	a	23.2	a	3.47	a	4.6	a
	5C	0.15	a	23.3	a	3.41	a	5.0	a
	420A	0.16	a	23.3	a	3.43	a	5.1	a
	3309C	0.25	a	23.1	a	3.35	a	5.4	a
	101-14	0.19	a	23.1	a	3.45	a	4.9	a
	44-53	0.22	a	23.8	a	3.38	a	5.4	a
	Ungrafted	0.19	a	23.6	a	3.40	a	5.1	a
	Significant F	ns		ns		ns		ns	
Umpqua	Harmony	1.03	a	23.4	a	3.20	a	6.8	a
	5C	1.10	a	23.7	a	3.22	a	6.4	a
	420A	1.13	a	23.7	a	3.18	a	6.8	a
	3309C	0.83	a	23.4	a	3.18	a	6.9	a
	101-14	0.83	a	23.6	a	3.18	a	6.5	a
	44-53	0.88	a	23.6	a	3.18	a	6.7	a
	Ungrafted	0.91	a	23.9	a	3.19	a	6.4	a
	Significant F	ns		ns		ns		ns	
Eagle Point	Harmony	0.90	b	17.0	bc	3.25	ab	5.7	a
	5C	0.90	b	16.4	c	3.16	b	7.0	a
	420A	0.85	b	17.0	bc	3.16	b	6.2	a
	3309C	1.43	a	19.1	a	3.32	a	5.7	a
	101-14	1.16	ab	18.4	ab	3.20	ab	5.5	a
	44-53	1.44	a	18.6	ab	3.14	b	6.1	a
	Ungrafted	1.14	ab	18.4	ab	3.25	ab	5.9	a
	Significant F	**		*		*		ns	
Main Effects									
Vineyard		***		***		***		***	
Rootstock		*		**		ns		*	
Vineyard x Rootstock		***		**		ns		ns	
Alpine	SO 4	0.79	a	23.6	a	3.17	a	6.3	a
	5BB	0.45	b	23.4	a	3.14	a	7.0	a
	3309C	0.27	b	23.8	a	3.23	a	6.4	a
	101-14	0.25	b	24.1	a	3.19	a	6.2	a
	Riparia	0.16	b	23.4	a	3.18	a	6.9	a
	Ungrafted	0.29	b	23.3	a	3.18	a	7.3	a
	Significant F	**[1]		ns		ns		ns	

[1] ns, *, **, *** indicate not significant and statistically significant at the 0.05, 0.01, and 0.001 levels within location. Values followed by the same letters do not differ significantly.

Canopy development

Shoot length varied considerably from vineyard to vineyard but significant rootstock response could only be ascertained at Eagle Point where the heavy crop load competed with vegetative growth (tables 3 and 5). Shoot diameter was highest at the most vigorous site (Umpqua) and lowest at Eagle Point. There were no consistent rootstock differences from site to site. At Alpine, 5BB had the thickest shoots and the Riparia X Rupestris hybrids, the thinnest.

Total leaf area did not respond to rootstock except at Alpine, where the Riparia X Berlandieri hybrids had the largest leaf area. The percentage of leaf area arising from lateral shoots was independent of rootstock but was greater at the more vigorous sites.

Table 5: Effect of rootstock on vegetative growth and leaf area of Pinot noir grapevines at five different locations in Oregon.

Vineyard Location	Rootstock	Leaf Area Index (m^2 / m^2)		Lateral Leaf Area % of total		Shoot Length (cm)		Shoot Diameter (mm)	
Newberg	Harmony	1.51	a[1]	37.1	a	144	a	7.97	bc
	5C	1.73	a	37.9	a	119	a	8.52	a
	420A	1.49	a	39.4	a	127	a	8.39	ab
	3309C	1.52	a	41.8	a	122	a	7.73	c
	101-14	1.23	a	41.9	a	135	a	8.35	ab
	44-53	1.87	a	34.5	a	117	a	8.33	ab
	Ungrafted	1.13	a	31.7	a	118	a	7.60	c
	Significant F			ns		ns		**	
Lafayette	Harmony	0.31	a	45.0	a	116	a	6.94	a
	5C	0.41	a	32.8	a	116	a	7.61	a
	420A	0.32	a	28.2	a	119	a	7.53	a
	3309C	0.53	a	35.1	a	133	a	7.55	a
	101-14	0.38	a	37.4	a	128	a	7.64	a
	44-53	0.47	a	40.6	a	127	a	7.62	a
	Ungrafted	0.59	a	34.3	a	141	a	8.24	a
	Significant F			ns		ns		ns	
Umpqua	Harmony	1.98	a	57.3	a	160	a	9.25	a
	5C	1.92	a	56.0	a	149	a	9.96	a
	420A	1.82	a	52.4	a	144	a	9.56	a
	3309C	1.63	a	54.1	a	141	a	9.65	a
	101-14	1.90	a	51.4	a	147	a	9.83	a
	44-53	1.55	a	55.1	a	164	a	10.01	a
	Ungrafted	1.57	a	61.2	a	142	a	10.38	a
	Significant F	ns		ns		ns		ns	
Eagle Point	Harmony	—		—		104	bc	7.12	bcd
	5C	—		—		106	bc	7.01	bcd
	420A	—		—		91	c	6.96	cd
	3309C	—		—		124	a	7.64	a
	101-14	—		—		123	a	7.44	ab
	44-53	—		—		111	ab	6.70	d
	Ungrafted	—		—		116	ab	7.25	abc
	Significant F	—		—		**		**	
Main Effects									
Vineyard		***		***		***		***	
Rootstock		ns		ns		ns		ns	
Vineyard x Rootstock		*		ns		ns		*	
Alpine	SO 4	0.73	a	35.2	a	129	a	7.84	bc
	5BB	0.79	a	38.4	a	151	a	8.58	a
	3309C	0.42	c	35.0	a	130	a	7.70	c
	101-14	0.48	bc	36.6	a	125	a	7.79	c
	Riparia	0.35	c	34.9	a	136	a	7.90	bc
	Ungrafted	0.70	ab	39.3	a	155	a	8.35	ab
	Significant F	**		ns		ns		*	

[1] ns, *, **, *** indicate not significant and statistically significant at the 0.05, 0.01, and 0.001 levels within location. Values followed by the same letters do not differ significantly.

CONCLUSIONS

In this study, site differences were more important than those induced by the selected rootstocks. Rootstock effect on scion performance varied greatly with site and typically, the responses were not consistent from site to site. Another important observation from these trial is that at each site, ungrafted vines were never the best performers in yield or fruit quality. This implies that post-phylloxera Oregon viticulture has great potential for improvement by using appropriate rootstocks.

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LITERATURE CITED

Cirami, R.M., McCarthy, M.G., and Glenn, T. (1984). Comparison of effects of rootstock on crop, juice and wine composition in a replanted, nematode infested Barossa Valley vineyard. Aust. J. Exp. Agric. Anim. Husb. 24: 283-289.

Southey, J. M. (1992). Grapevine rootstock performance under diverse conditions in South Africa. Pp 27-51 In: Rootstock Seminar: A Worldwide Perspective. Wolpert, J.A., Walker, M. A., Weber, E. (eds.) Reno, Nevada, 24 June 1992.