EVALUATION OF 'CHANDLER' WALNUT ON ITS OWN ROOTS AND GRAFTED TO VARIOUS ROOTSTOCKS – 2008

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ABSTRACT

Reports that "own rooted" 'Chandler' walnuts out performed grafted trees stimulated the creation of this replicated trial. The performance of own rooted 'Chandler' trees, 'Chandler' grafted to own rooted 'Chandler', and 'Chandler' grafted to three paradox selections and to a vigorous English selection is investigated in this trial. Rootstock trees were planted in March 1999 at the California State University Farm in Chico. Scions were grafted using wood collected from mature 'Chandler' trees in the spring of 2000. Initial survival, yield and trunk cross sectional area (TCSA) data collection began in 2001. Yield, nut quality, trunk circumference, and crown gall severity data was collected in 2008 and is reported here.

OBJECTIVES

The objectives of this trial are to investigate the following questions:

a) Does a graft union have a limiting effect on tree growth and productivity?
b) Is 'Chandler' a superior English rootstock?
c) Do trees on clonal paradox show less variation than those on paradox seedling rootstocks?
d) Are own rooted 'Chandler' trees superior to 'Chandler' on paradox?

PROCEDURES

The following six treatments are being evaluated:

1. 'Chandler' own rooted via tissue culture (not grafted).
2. 'Chandler' grafted on own rooted 'Chandler' rootstock.
3. 'Chandler' grafted on English 'Waterloo' rootstock.
4. 'Chandler' grafted on common paradox rootstock.
5. 'Chandler' grafted on 'Trinta' paradox rootstock.
6. 'Chandler' grafted on 'Px1' paradox rootstock tissue cultured from the "Rawlins" tree.

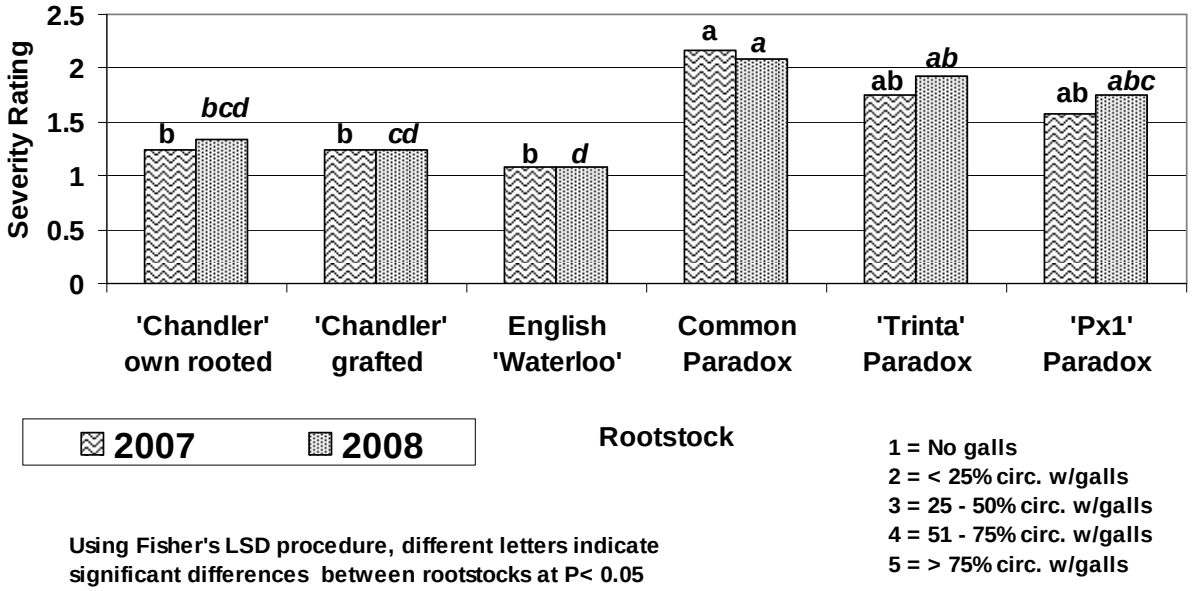
Small (3/8" diameter) rootstocks for these six treatments were planted on March 19, 1999 in a randomized block design with six replicates made up of two trees per replicate. Top working (grafting) took place in the spring of 2000 with wood collected from mature 'Chandler' trees. Initial tree survival and catkin abundance as affected by rootstock has been reported previously. In 2008, severity of crown gall, measurements of tree growth expressed as trunk cross sectional area (TCSA), and yield and quality data was collected. Yield efficiency was calculated and is also presented.

RESULTS

Presence of crown gall:

In 2006, Janine Hasey surveyed this trial for crown gall as part of her sabbatical leave project but those data are not reported here. In November 2007 and October 2008 we did additional surveys rating the trial for crown gall severity using a scale of: 1=no crown gall visible; 2=crown gall affecting <25% of the circumference; 3=crown gall affecting 25 to 50% of the circumference; 4=crown gall affecting 51 to 75% of the circumference; and 5= >75% of the circumference affected. Ratings in the trial ranged from 1 to 5 with treatment means and significance presented in figure 1. Rootstock contributes to the degree of crown gall but tree source is almost certainly a factor as well.

Figure 1. Mean crown gall severity by rootstock.



Tree growth - trunk cross sectional area (TCSA):

Trunk circumference measurements are made on all trees approximately 36 inches above the ground. Prior to 2006, own rooted 'Chandler' not grafted had a significantly larger TCSA than all other treatments. Since 2006, 'Px1' and common paradox gained on the own rooted 'Chandler' and the trees on these stocks were not significantly smaller than own rooted 'Chandler'. Trees on 'Trinta' paradox rootstock are numerically smaller than all other treatments (Table 1) but they have not been significantly smaller than trees on 'Waterloo' or the grafted 'Chandler' for the past four years.

Table 1. Mean trunk cross-sectional area (cm2)

Treatment	2002	2003	2004	2005	2006	2007	2008
'Chandler' own rooted	150.7 a	253.1 a	348.4 a	421.5 a	528.7 a	583.7 a	653.6 a
'Chandler' grafted	82.8 b	163.7 bc	252.7 b	316.7 bc	402.9 bc	449.6 bcd	506.3 bc
English 'Waterloo'	76.8 b	148.4 cd	225.6 bc	299.2 bc	388.5 bc	439.5 cd	506.5 bc
Common Paradox	89.4 b	177.5 bc	263.9 b	337.7 b	445.1 b	495.5 abc	562.8 ab
'Trinta' Paradox	47.4 c	111.8 d	187.2 c	259.3 c	337.6 c	390.0 d	429.8 c
'Px1' Paradox	93.4 b	197.6 b	257.7 b	354.4 b	460.3 ab	531.7 ab	598.9 ab

Using Fisher's LSD procedure, different letters indicate significant differences between rootstocks at P< 0.05

Harvest timing:

Husk split ratings for comparative maturity were not made this season. Rain occurred on October 3rd this year and the actual harvest date was October 24, 2008.

Yield:

The 2008 season was the ninth growing season for scions in this trial. Although TCSA is still significantly different between treatments there was only a significant difference in yield in 2004 with the smaller 'Trinta' paradox trees having a significantly lower yield than all other treatments that year. In all other years the differences seen between treatments are not significant at the 5% level (Table 2).

Table 2. Mean yield per tree (pounds inshell), 3rd through 9th scion growing season.

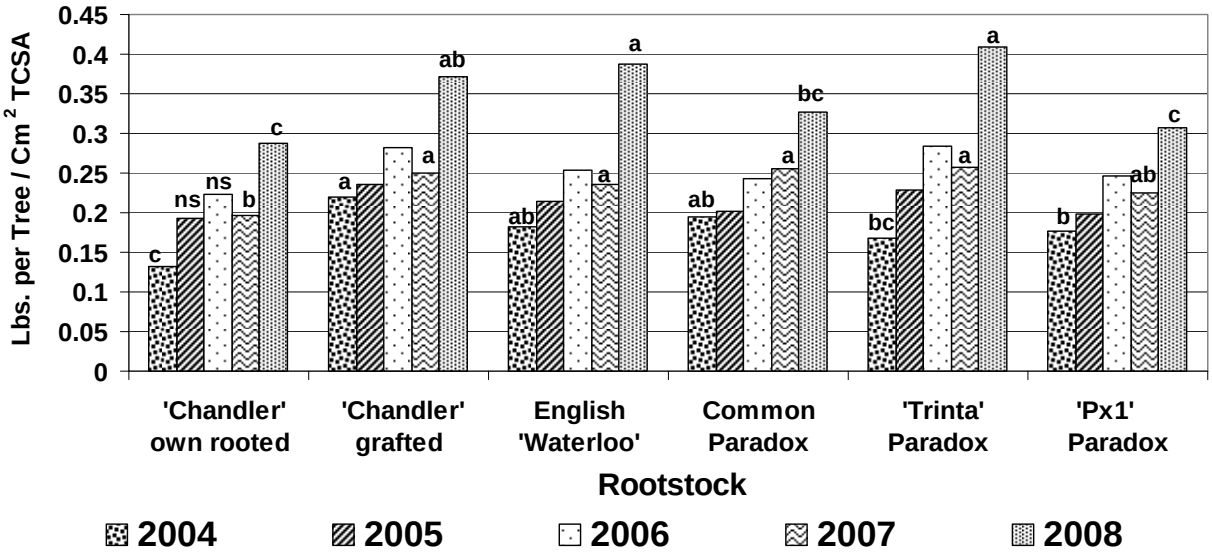
Treatment	2002	2003	2004	2005	2006	2007	2008	Cumulative Yield
'Chandler' own rooted	3.3 ns	16.7 ns	46.1 a	82.0 ns	117.5 ns	115.3 ns	187.3 ns	568.3
'Chandler' grafted	2.8	14.9	52.1 a	72.3	112.6	112.2	188.1	554.9
English 'Waterloo'	3.2	12.6	41.8 a	62.1	98.2	102.4	193.8	514.1
Common Paradox	3.5	13.8	52.0 a	70.4	107.5	124.8	179.6	551.7
'Trinta' Paradox	2.7	14.2	29.8 b	58.6	96.5	100.2	171.7	473.7
'Px1' Paradox	2.4	13.8	45.7 a	70.2	113.6	118.6	183.0	547.3

Using Fisher's LSD procedure, different letters indicate significant differences between rootstocks at P< 0.05

Yield efficiency:

Yield efficiency is tree yield divided by TCSA. Despite significant differences each year in TCSA, there were no significant differences in yield efficiencies in 2005 and 2006. When significant differences occur, yield efficiency is often lowest on treatments with the largest trees (Figure 2 & Table 1). Highest yield efficiencies have been attained most recently on grafted 'Chandler', English 'Waterloo', and 'Trinta' paradox.

Figure 2. Mean yield efficiency (pounds per tree / cm2 trunk cross-sectional area).



Using Fisher's LSD procedure, different letters within the same year indicate significant differences between rootstocks at P< 0.05

Nut quality -- % edible kernel, % large, % extra light, and relative value

Edible kernel, mold, and offgrade:

The percentage of edible kernel has shown no significant differences between rootstocks in two out of the past four years. In 2006 and 2008 differences were significant between rootstocks with the own rooted 'Chandler' treatment having a similar edible kernel percentage to most other treatments in one year or the other with the English 'Waterloo' rootstock the only treatment that was significantly lower in edible kernel in both years (Table 3). Although low in all treatments, there were significant differences in the percentage of mold and offgrade by rootstock in 2008 (Table 3a). The own rooted 'Chandler' treatment is grouped with rootstocks having the lowest mold and offgrade while the English 'Waterloo' and 'Trinta' Paradox were significantly higher in mold and offgrade than the own rooted 'Chandler' treatment.

Table 3. Walnut quality -- percentage of edible kernel by rootstock

Treatment	2004 % Edible Kernels	2006 % Edible Kernels	2007 % Edible Kernels	2008 % Edible Kernels
1) 'Chandler' own rooted	50.7 NS	46.6 a	49.0 NS	50.0 ab
2) 'Chandler' grafted	50.6	45.9 ab	49.1	49.5 bc
3) English 'Waterloo'	51.6	44.9 bc	48.7	48.9 c
4) Common Paradox	49.6	44.2 cd	48.6	50.2 ab
5) 'Trinta' Paradox	49.6	43.6 d	47.9	49.9 ab
6) 'Px1' Paradox	50.3	45.7 ab	48.5	50.6 a

Using Fisher's LSD procedure, different letters indicate significant differences between rootstocks at P< 0.05

Table 3a. Walnut quality -- percent mold and offgrade by rootstock.

	2008	
Treatment	**% Mold**	**% Offgrade**
1) 'Chandler' own rooted	0.34 c	0.50 bc
2) 'Chandler' grafted	0.54 abc	0.70 bc
3) English 'Waterloo'	1.27 a	1.51 a
4) Common Paradox	0.39 bc	1.10 ab
5) 'Trinta' Paradox	1.19 ab	1.57 a
6) 'Px1' Paradox	0 c	0.13 c

Using Fisher's LSD procedure, different letters indicate significant differences between rootstocks at P< 0.05

Nut size:

Nut size does not appear to be affected consistently by rootstock treatment. Although there have been statistically significant results in individual years the significance seems to be contradictory when comparing treatments across years. Rootstock has shown no significantly consistent effects on the percentage of large and jumbo nuts although in three of the past four years the own rooted 'Chandler' treatment has had the numerically lowest percentage of large and jumbo nuts (Table 4).

Table 4. Walnut quality -- percentage of large and jumbo nuts by rootstock.

	2004	2006	2007	2008
	% Large	% Large	% Large	% Large
Treatment	**Nuts**	**Nuts**	**Nuts**	**Nuts**
1) 'Chandler' own rooted	99.8 a	91.4 NS	88.2 b	89.5 NS
2) 'Chandler' grafted	98.2 bc	92.6	93.4 a	91.2
3) English 'Waterloo'	98.0 c	93.5	93.9 a	91.8
4) Common Paradox	98.8 abc	97.0	94.6 a	93.8
5) 'Trinta' Paradox	100.0 a	93.4	91.4 ab	93.3
6) 'Px1' Paradox	99.7 ab	95.6	94.2 a	92.8

Using Fisher's LSD procedure, different letters indicate significant differences between rootstocks at P< 0.05

Kernel color:

Rootstock has had a significant effect on kernel color in only two of the past four years. The own rooted 'Chandler' treatment tends to have a higher numerical percentage of extra light colored kernels compared to the majority of other rootstocks in any given year although the kernel color differences between treatments were not significantly different in two of the past four years (Table 5).

Table 5. Walnut quality -- percentage of extra light kernels by rootstock.

Treatment	2004 % Extra Light		2006 % Extra Light		2007 % Extra Light		2008 % Extra Light	
1) 'Chandler' own rooted	23.7	a	10.91	a	50.8	NS	71.9	NS
2) 'Chandler' grafted	22.3	a	6.41	ab	43.0		66.6	
3) English 'Waterloo'	24.3	a	6.97	ab	55.5		62.2	
4) Common Paradox	14.2	b	0	b	44.6		70.0	
5) 'Trinta' Paradox	14	b	0	b	43.1		59.7	
6) 'Px1' Paradox	17.3	ab	0	b	41.2		71.9	

Using Fisher's LSD procedure, different letters indicate significant differences between rootstocks at P< 0.05

Relative value:

The relative nut value tends to be greater in treatments on English roots than in treatments on paradox roots. Differences between treatments in relative value have been statistically significant in each of the past three years (Table 6).

Table 6. Walnut quality -- relative value by rootstock.

Treatment	2004 Relative Value		2006 Relative Value		2007 Relative Value		2008 Relative Value	
1) 'Chandler' own rooted	0.970	ab	0.939	a	0.987	a	0.992	ab
2) 'Chandler' grafted	0.965	ab	0.923	ab	0.979	ab	0.973	bc
3) English 'Waterloo'	0.996	a	0.904	bc	0.979	ab	0.954	c
4) Common Paradox	0.931	b	0.882	cd	0.957	bc	0.994	ab
5) 'Trinta' Paradox	0.922	b	0.855	d	0.945	c	0.985	abc
6) 'Px1' Paradox	0.934	b	0.899	bc	0.958	bc	1.020	a

Using Fisher's LSD procedure, different letters indicate significant differences between rootstocks at P< 0.05

DISCUSSION

The tissue cultured own rooted ‘Chandler’ trees are now ten years old and these trees tend to be larger and their yield efficiency tends to be lower. Nut quality and value from trees in this treatment has been good. Differences between treatments have been diminishing most recently and in all but one year there have been no significant yield differences between treatments.

In all parameters measured there is no evidence that the English ‘Chandler’ rootstock is superior to the English ‘Waterloo’ rootstock used in this trial. ‘Px1’ paradox appears to be similar to the common paradox rootstock in nearly all respects. Common and ‘Trinta’ paradox rootstocks had greater initial mortality compared to the ‘Px1’ paradox. Both common and ‘Px1’ paradox rootstocks produced larger tree size (TCSA) than the ‘Trinta’ paradox rootstock.

There has been no tree mortality in ‘Chandler’ on its own roots either in grafted or own rooted trees or in trees on ‘Px1’ paradox rootstock. Rootstock contributed to the severity of crown gall but tree source is almost certainly a factor as well.

Fewer catkins and larger trees at a young age is a possible advantage for own rooted ‘Chandler’ trees. Since an over abundance of pollen contributes to pistillate flower abscission (PFA), cultivars having significant PFA such as ‘Serr’ might benefit from being own rooted although this benefit disappeared by the ninth growing season. Another advantage might be usefulness on soils with good drainage in areas with a high incidence of blackline virus. Without a graft union, English walnut would tolerate the disease.