LONG-TERM PERFORMANCE OF OWN-ROOTED ‘CHANDLER’ WALNUT COMPARED TO ‘CHANDLER’ WALNUT ON PARADOX ROOTSTOCK

Janine Hasey, Becky Westerdahl, Bruce Lampinen, Joe Conant

ABSTRACT

A trial planted in 1991 compares micropropagated un-grafted ‘Chandler’ to those conventionally grafted onto seedling Paradox rootstock. From 1995 through 2002, own-rooted ‘Chandler’ had significantly greater trunk circumference and trunk cross sectional area than did ‘Chandler’ on Paradox rootstock. Yield was significantly greater on own-rooted ‘Chandler’ from 1995 through 2000, but not in 2001 and 2002. Low vigor and dieback were first observed in 1998 on some own-rooted trees. *Pratylenchus vulnus* was detected in soil and root samples taken from every tree in the trial on at least one of the sampling dates. Overall, soil nematode populations on own-rooted trees were higher (*P* = 0.05) than on Paradox. Although seven trees on Paradox rootstock have crown gall, no infections have been found on own-rooted trees. Own-rooted English walnut trees may have potential in areas where commonly used rootstocks (*J. hindsii* and *J. hindsii x J. regia*) are undesirable because of hypersensitivity to cherry leaf roll virus. Although the micropropagated ‘Chandler’ has been productive under the conditions in this trial, root-lesion nematode susceptibility may limit usefulness where soil populations exist.

OBJECTIVES

This study compares the performance of micropropagated ‘Chandler’ on its own-roots to ‘Chandler’ grafted on seedling Paradox (*J. hindsii x J. regia*) rootstock.

PROCEDURES

The study site is located in Sutter County in northern California on Holillipah loamy sand. The treatments compare micropropagated ‘Chandler’ on its own-roots to nursery grafted ‘Chandler’ on seedling Paradox rootstock. Twenty single tree replicates per treatment were planted on April 2, 1991 in a randomized complete block design spaced at 25’ x 25’. Galltrol® was applied at planting to prevent crown gall. Trees were irrigated using microsprinklers. After the initial training, pruning was continued where needed to stimulate growth and increase size of trees on Paradox and poorly growing own-rooted trees.

Tree trunk circumference was measured at planting and annually thereafter to evaluate growth. Trunks were measured at 24 inches above the ground. Field observations on crown gall incidence and catkin production were taken periodically. Harvest yield and quality data were measured annually since the fifth leaf.

*Pratylenchus vulnus*, a migratory endoparasitic nematode, reduces walnut tree yields and vigor through root damage from direct feeding and by placing trees under stress (Lownsbery, 1956). When low vigor and stunting on some trees and dieback on one own-rooted tree became evident
in 1998, a series of soil samples were taken to determine if plant-parasitic nematodes were present. Root and soil samples were taken by two methods: 1) After soil was pneumatically excavated around upper large roots in October 1998 and in May 2002 (Harris, 1998) and 2) Using a 2 inch bucket auger to a depth of 2 feet midway between the dripline and tree trunk nine times from 1999 to 2001. Nematodes were extracted from a 400 cm$^3$ soil sub-sample with a modified semiautomatic elutriator and sucrose centrifugation technique (Byrd et al., 1976). Nematodes were also extracted from roots that were weighed and placed in an intermittent mist chamber for 72 hours (Ayoub, 1977). Extracted nematodes were identified and counted at x45 magnification. Walnut root pieces were also assayed on culture plates for *Phytophthora*.

**RESULTS AND DISCUSSION**

**Tree Growth, Yield and Nut Quality.** Trunk circumference was significantly greater for own-rooted ‘Chandler’ compared to ‘Chandler’ on seedling Paradox rootstock from 1995 through 2002 (Table 1). Yields were significantly higher in own-rooted ‘Chandler’ from 1995 through 2000 and not significantly different for 2001 and 2002 (Table 2). Yields for all years, from 1998 to 2002, showed significant positive pairwise correlations with each other, whether examined for all trees, Paradox alone, or own-rooted alone (P ≤ 0.05). Yield efficiency was significantly higher in own-rooted ‘Chandler’ compared to ‘Chandler’ on Paradox from 1995 through 1997, but not in 1998 through 2000. In 2001 and 2002, yield efficiency was significantly higher in trees on Paradox (Table 3). The decreased yield efficiency for own-rooted trees may be due to individual tree yield variability resulting from reduced vigor on nematode affected trees. There have been no significant differences in nut quality between the two treatments from 1995 through 2002 with three exceptions. In 1995, nuts from own-rooted trees had 97.0 percent light kernels compared to 91.0 percent for nuts from ‘Chandler’ on Paradox and 98.2 vs. 92.8 respectively in 1998 (Table 4). In 2001, ‘Chandler’ on Paradox trees had significantly higher percent large nuts than did own-rooted trees.

**Nematode Diagnosis.** The own-rooted tree with dieback sampled on October 15, 1998 had visible lesions on the larger roots. Lesions were again visible on the larger roots of several own-rooted trees when soil was excavated in May 2002.

*Pratylenchus vulnus* was detected in soil and root samples taken from every tree in the trial on one or more sampling dates. On all sampling dates, soil nematode populations on own-rooted trees were higher (P ≤ 0.05) than on Paradox except in November 2001 (Fig.1). No significant differences were evident (P ≤ 0.05) among nematode populations on roots on any sampling date.

On the following sampling dates, soil nematode populations for own-rooted trees were positively correlated with soil nematode populations on at least one previous sampling date (P ≤ 0.05): 23 October 1999, 14 January 2000, 29 March 2000, 27 July 2000, and 23 May 2002. For Paradox, this type of correlation occurred only on 27 July 2000. For own-rooted trees, a positive correlation was found between populations in soil and in roots (P ≤ 0.05) for 23 May 2002 and 29 March 2000. For Paradox, this type of correlation was found for 23 May 2002 and 29 March 2000. For own-rooted trees, populations in roots were positively correlated for 28 April 01 with 23 October 1999 (P ≤ 0.05). For Paradox, this type of correlation was found for 23 May 2002 with 29 March 2000; 14 January 2000 with March 29 2000; 19 January 2001 with 23 October
1999; and 29 March 2000 with 23 October 1999. These correlations indicate that soil and root samples were providing a reproducible picture of nematode populations.

Although intuitively, one would expect to see negative correlations between nematode populations and yields, in general, these were not observed. If anything, there was a trend for higher nematode populations to be correlated with higher yields. This could be explained by more vigorous, higher yielding trees having a more vigorous root system and thus being able to support higher populations of nematodes. However, if one separates out the own-rooted trees with the lowest 2002 yields, dieback, and/or low vigor, increasing nematode populations are correlated with lower yields ($P \leq 0.07$). This indicates that the decline in yield of own-rooted trees that has been observed for the past few years is likely due to nematode damage.

**Phytophthora Diagnosis.** Root pieces and soil samples were negative for *Phytophthora*.

**Observational Data.** Own-rooted ‘Chandler’ trees did not produce catkins until 1997 and then only a few, whereas ‘Chandler’ trees on Paradox produced catkins starting in 1994. More catkins were produced in 1998 and 1999 on own-rooted trees but generally less than were produced by ‘Chandler’ trees on Paradox. A crown gall (*Agrobacterium tumefaciens*) evaluation was made after a flood left scour holes around the trees in 1997. Five of the trees on Paradox had crown gall; one more infected tree was found in 1999 and another in 2002. No crown gall has been observed on own-rooted trees.

**CONCLUSIONS**

Own-rooted ‘Chandler’ trees outperformed ‘Chandler’ trees on Paradox rootstock in size for eight years and in yield for six years (Fig. 2). Yield from the own-rooted trees was 1.5 – 3 times greater than for trees on Paradox rootstock up until 2002 but variability existed among individual tree yields. Many of the own-rooted trees remained quite vigorous but those showing the effects of nematode infestation have continued to decline affecting yield. The lack of significant differences in yield efficiency for 1998 through 2000 and the higher yield efficiency for trees on Paradox in 2001 and 2002 may be due to this yield variability from declining own-rooted trees. The positive regression among yields for all years indicates that individual tree yields were consistent and provided a reliable measure of yield.

The greater yields of own-rooted trees compared to Paradox is even more striking considering they appear to be supporting higher populations of the pathogenic root-lesion nematode, *P. vulnus* than trees on Paradox. This could indicate an overall greater vigor of own-rooted trees compared to Paradox. Similarly, greater vigor of Paradox trees is used to explain their apparent tolerance to lesion nematode compared to Northern California Black walnut (Lownsbery, 1956). The reduced yields of own-rooted stunted trees or those with low vigor or dieback compared to vigorous trees are attributed to root-lesion nematodes. Trees on Paradox infected with crown gall disease also had reduced yields.

The lack of catkin production on own-rooted trees has not affected yield most likely because of the high density of walnuts and pollen in the study area. Pollenizers with early catkin production
may need to be used where own-rooted ‘Chandler’ trees are grown in areas isolated from other walnuts and in large orchards.

This study is being concluded after eleven years. The more vigorous growth and higher yield of micropropagated ‘Chandler’ to those conventionally grafted onto seedling Paradox rootstock suggests the commercial feasibility of growing this English cultivar on its own roots (McGranahan et al., 1988). However, own-rooted ‘Chandler’ trees should only be considered where there are no root-lesion nematodes present or the soil is properly fumigated to eliminate nematodes before planting.

ACKNOWLEDGMENTS

We are grateful to the grower cooperator Joe Conant of the Whitney Warren Ranch for his assistance and long-term cooperation, Jim Yeager and Cindy Anderson for field and laboratory assistance, and the Walnut Marketing Board for financial support.

Literature Cited


Tables

Table 1. Trunk circumference (cm) of own-rooted ‘Chandler’ versus ‘Chandler’ on Paradox measured at 60 cm from 1995-2002.

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<td>Own-rooted</td>
<td>38.2 a</td>
<td>50.0 a</td>
<td>59.8 a</td>
<td>64.3 a</td>
<td>68.1 a</td>
<td>71.4 a</td>
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<td>On Paradox</td>
<td>27.3 b</td>
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<td>41.4 b</td>
<td>45.1 b</td>
<td>49.4 b</td>
<td>51.7 b</td>
<td>54.1 b</td>
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Means followed by the same letter in a column are not significantly different (LSD P# 0.05).

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<td>Own-rooted</td>
<td>23.9 a</td>
<td>51.6 a</td>
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Means followed by the same letter in a column are not significantly different (LSD P# 0.05).

Table 3. Yield Efficiency 1995-2002

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<td>Own-rooted</td>
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<td>.317 a</td>
<td>.175 a</td>
<td>.234 a</td>
<td>.167 a</td>
<td>.216 a</td>
<td>.113 a</td>
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<td>On Paradox</td>
<td>.127 b</td>
<td>.497 b</td>
<td>.241 b</td>
<td>.138 a</td>
<td>.257 a</td>
<td>.204 a</td>
<td>.311 b</td>
<td>.202 b</td>
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Means followed by the same letter in a column are not significantly different (LSD P# 0.05).

Table 4. 1995-2001 Percent Light Kernels¹ and 2002 Nut Quality

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<tbody>
<tr>
<td>Own-rooted</td>
<td>97.0 a</td>
<td>96.5 a</td>
<td>88.4 a</td>
<td>98.2 a</td>
<td>99.4 a</td>
<td>91.2 a</td>
<td>93.4 a</td>
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<td>87.2 a</td>
<td>49.1 a</td>
<td></td>
</tr>
<tr>
<td>On Paradox</td>
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<td>88.7 a</td>
<td>93.5 a</td>
<td>51.0 a</td>
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Means followed by the same letter in a column are not significantly different (LSD P# 0.05).

¹ Percent light kernel data replaces prior reported data in previous Walnut Research Reports.
**Figures**

![Bar chart showing lesion nematode per liter of soil over time.](image1)

**Figure 1.** Lesion Nematode per Liter of Soil

![Bar graph showing cumulative yield over eight years.](image2)

**Figure 2.** Eight year Cumulative Yield