

# Long-term Performance of Own-Rooted ‘Chandler’ Walnut Compared to ‘Chandler’ Walnut on Paradox Rootstock

J.K. Hasey  
University of California  
Cooperative Extension  
142-A Garden Highway  
Yuba City, CA  
USA

B.B. Westerdahl and B. Lampinen  
University of California  
One Shields Avenue  
Davis, CA  
USA

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## Abstract

A trial planted in 1991 compared micropropagated un-grafted ‘Chandler’ to those conventionally grafted onto seedling Paradox (*J. hindsii* x *J. regia*) rootstock. From 1995 through 2002, own-rooted ‘Chandler’ had significantly greater 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 significantly higher than on Paradox. Although seven trees on Paradox rootstock were found to 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.

## INTRODUCTION

When English walnut trees are grown on commonly-used rootstocks (*J. hindsii* and *J. hindsii* x *J. regia*), a black line forms at the graft union in trees infected with cherry leaf roll virus. This necrosis of cambium and phloem tissues at the graft union of the English scion and the rootstock is due to the rootstock’s hypersensitive reaction to the virus (Mircetich et al., 1998). This disease is known as walnut blackline and although it is most damaging to walnuts growing in California’s coastal valleys, it can also cause problems in the major walnut production areas of the San Joaquin and Sacramento Valleys. The disease can be overcome by using either English walnut rootstocks (*J. regia*) or English walnut cultivars growing on their own roots. Micropropagation techniques can be used to produce own-rooted English walnut cultivars (McGranahan et al., 1988).

*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).

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

## MATERIALS AND METHODS

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 7.6 m x 7.6 m. Data were analyzed using analysis of variance followed by least significant difference for mean separation. Galltrol<sup>®</sup> 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 Growth, Yield and Quality Measurements**

Tree trunk circumference was measured at planting and annually thereafter to evaluate growth. Trunks were measured at 60 cm above the ground. Field observations on crown gall incidence and catkin production were taken periodically. Harvest yield and quality data (percent light kernel, percent large nut, percent edible kernel completed by Diamond Walnut of California) were measured annually from the fifth leaf.

### **Nematode Sampling Procedure, Extraction and Identification**

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 5 cm bucket auger to a depth of 60 cm midway between the dripline and tree trunk nine times from 1999 to 2001. Nematodes were extracted from a 400 cm<sup>3</sup> 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.

## **RESULTS AND DISCUSSION**

### **Tree Growth, Yield and Nut Quality**

Trunk cross sectional area 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). 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 generally been no significant differences in nut quality between the two treatments from 1995 through 2002. However 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. In 2001, 'Chandler' on Paradox trees had significantly higher percent large nuts than did own-rooted trees (data not shown).

### **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 (Fig. 2). Despite the presence of high nematode populations no negative correlations between nematode infestation and yield were observed. Rather there was a trend for higher nematode populations to be correlated with higher yields. This may 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, higher nematode populations are correlated with lower yields ( $P = 0.07$ ). 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.

### **Observational Data**

Own-rooted 'Chandler' trees did not produce catkins until 1997 and then only a few, whereas 'Chandler' trees on Paradox produced catkins from 1994. Increasing numbers of 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 grew larger than 'Chandler' trees on Paradox rootstock over eight years and were more productive over six years. 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 many showed effects of nematode infestation causing decline which negatively affected 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 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 be due to the 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. Pollenisers with early catkin production may be needed where own-rooted 'Chandler' trees are grown in areas isolated from other walnuts or 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.

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## **Tables**

Table 1. Trunk cross sectional area (TCSA) of own-rooted 'Chandler' versus 'Chandler' on Paradox. Trees were measured at 60 cm from 1995-2002.

Treatment	1995	1996	1997	1998	1999	2000	2001	2002
Own-rooted	122a	206a	244a	340a	381a	419a	457a	481a
On Paradox	63 b	90. b	123b	146b	173b	208b	227b	270b

Means followed by the same letter in a column are not significantly different (LSD P = 0.05).

Table 2. Yield in kg/tree of own-rooted 'Chandler' versus 'Chandler' on Paradox from 1995-2002.

Treatment	1995	1996	1997	1998	1999	2000	2001	2002	1995-02
Own-rooted	10.8 a	23.4 a	43.2 a	29.1 a	41.9 a	33.2 a	46.4 a	25.0 a	253.0
On Paradox	4.2 b	7.9 b	14.2 b	10.1 b	19.8 b	19.7 b	31.6 a	23.3 a	130.8

Means followed by the same letter in a column are not significantly different (LSD P = 0.05).

Table 3. Yield Efficiency (kg per cm<sup>2</sup> TCSA) of own-rooted 'Chandler' versus 'Chandler' on Paradox from 1995-2002.

Treatment	1995	1996	1997	1998	1999	2000	2001	2002
Own-rooted	.089a	.114a	.177a	.086a	.110a	.079a	.102a	.052a
On Paradox	.067b	.088b	.115b	.069a	.114a	.095a	.139b	.086b

Means followed by the same letter in a column are not significantly different (LSD P = 0.05).

## Figures

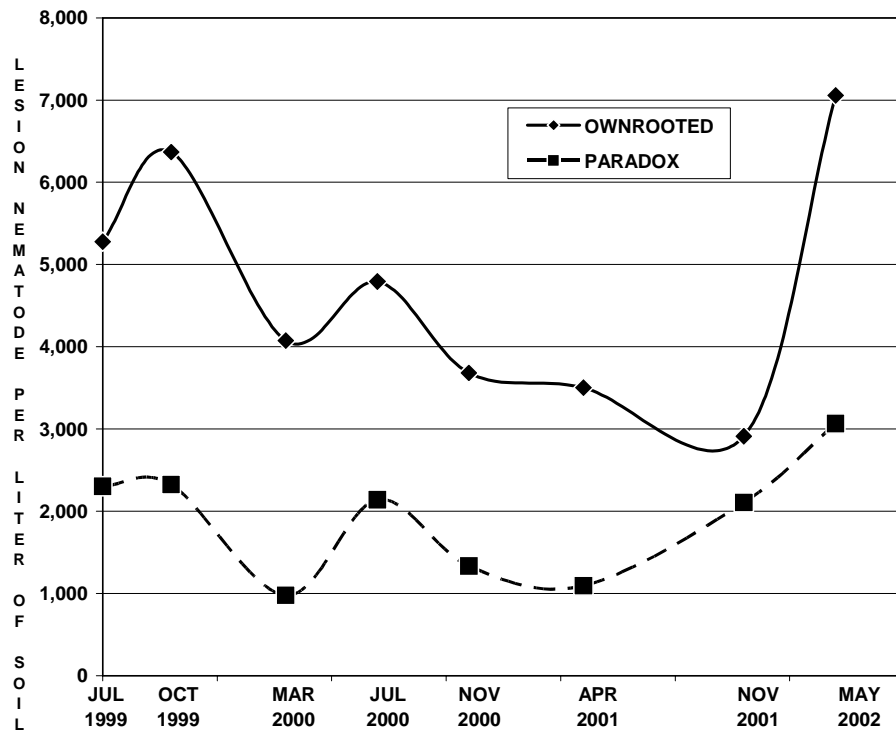


Fig. 1. Populations of lesion nematode per litre of soil sampled periodically over the course of the trial. On all sampling dates, except November 2001, soil nematode populations on own-rooted trees were higher ( $P = 0.05$ ) than on Paradox.

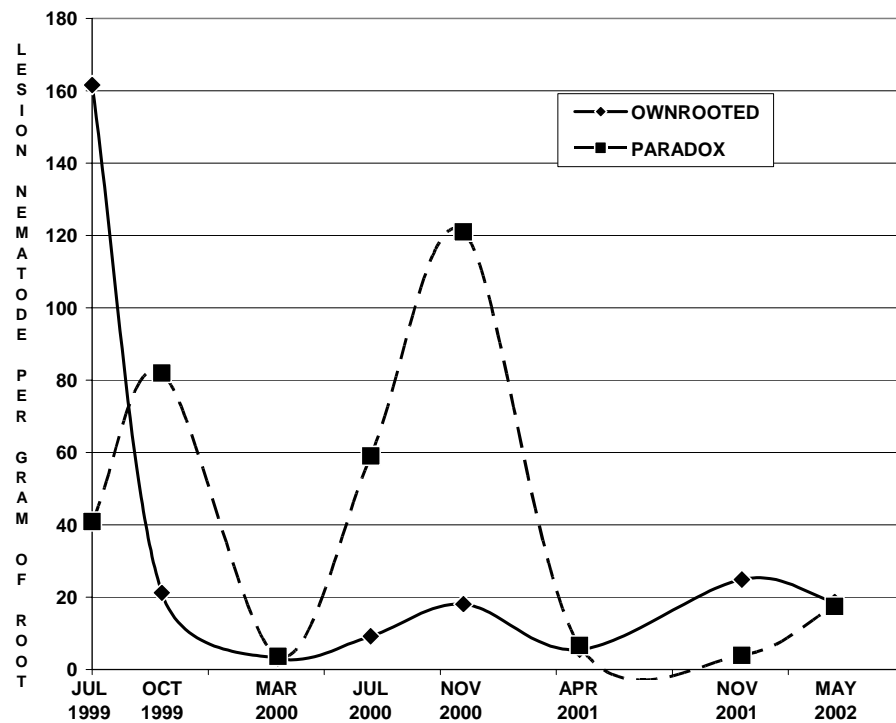


Fig. 2. Populations of lesion nematode per gram of root sampled periodically over the course of the trial. No significant differences were evident ( $P = 0.05$ ) among nematode populations on roots on any sampling date.