

Crown Gall Incidence: Seedling Paradox Walnut Rootstock versus Own-Rooted English Walnut Trees

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Abstract

Seedling ‘Paradox’ (*Juglans hindsii* × *J. regia*) has been the rootstock of choice for English walnut in California because of its vigor and greater tolerance of wet soil conditions. However, seedling ‘Paradox’ rootstock is highly susceptible to crown gall, a disease caused by the soil-borne bacterium *Agrobacterium tumefaciens*. In regions where tree death from walnut blackline disease (cherry leafroll virus) is prevalent, seedling English rootstock is used to avoid the hypersensitive response at the graft union associated with ‘Paradox’. Own-rooted English walnut trees have replaced seedling English in the nursery trade and are now often used in counties where walnut blackline disease is severe. Early observations revealed no crown gall on own-rooted trees. In 2006-2007, we conducted a systematic statewide crown gall survey of own-rooted English walnut trees and ‘Paradox’ rooted walnut trees at five rootstock research sites and 14 commercial orchards planted in 2003 or earlier. Crown gall incidence was determined by visual inspection, and rated as present or absent at the crown level. Every own-rooted tree site was compared to 100 English trees on ‘Paradox’ rootstock growing within or near each site. Across the five research sites, seedling ‘Paradox’ had significantly more crown gall (20.5%) compared to the own-rooted trees (0.9%). The commercial orchards had a similar pattern with seedling ‘Paradox’ exhibiting 22.2% crown gall versus 0.3% in the own-rooted trees.

INTRODUCTION

Seedling ‘Paradox’ (*Juglans hindsii* × *J. regia*) has been the rootstock of choice for English walnut (*Juglans regia* L.) in California because of its vigor and greater tolerance of wet soil conditions and *Phytophthora* infection. However, seedling ‘Paradox’ rootstock is highly susceptible to crown gall, a disease caused by the soil-borne bacterium

Agrobacterium tumefaciens (Catlin, 1998). Crown gall will reduce walnut yields proportionally based on extent of gall; cumulative nut yield was decreased 12% for every 25% of trunk circumference galled over the first four years of production (Epstein et al., 2008). Walnut growers ranked crown gall disease the third most important industry problem in California out of a list of 47 industry issues in a 2002 statewide survey (Hasey, unpublished, CA Walnut Board).

In regions where tree death from walnut blackline disease (cherry leaf roll virus) is prevalent, English rootstock is often used to avoid the hypersensitive response at the graft union associated with 'Paradox' that ultimately girdles the tree (Mircetich et al., 1998). Micropropagated, own-rooted English walnut trees (i.e., no graft union) have been commercially available since 1999 in California and are now often used in counties where walnut blackline disease is severe to avoid the hypersensitive response. In early performance studies comparing 'Paradox' rooted to own-rooted English walnut trees, crown gall was observed on several 'Paradox' rooted trees but none on own-rooted trees (Hasey et al., 2004, 2006).

The early observation that own-rooted English walnut trees did not develop crown gall disease, was limited to two sites in California. The objective of this study was to conduct a systematic statewide survey of crown gall incidence comparing own-rooted English walnut trees to 'Paradox' rooted walnut trees at five rootstock research sites and at 14 commercial orchards planted prior to 2004.

MATERIALS AND METHODS

The systematic statewide crown gall survey of own-rooted English walnut trees and 'Paradox' rooted walnut trees was conducted in 2006-2007 in the central valley of California. The survey included five rootstock research sites containing own-rooted English walnut trees and seedling 'Paradox' rootstock as treatments and 14 commercial orchards planted to own-rooted trees prior to 2004. The research sites planted from 1991 to 2002 were all randomized complete block design and located in Sutter, Butte, San Joaquin, and Stanislaus Counties. The commercial orchards were located in Contra Costa, Stanislaus, San Joaquin, Kings, Fresno and Yuba Counties. Crown gall incidence was determined by visual inspection, and rated as present or absent after 360° visual inspection of the crown of the tree. General observations also were made on gall size, tree growth and vigor of own-rooted trees in relation to the soil type.

At the research sites, all of the treatment trees were surveyed. At the commercial orchards, every own-rooted tree was examined. Own-rooted cultivars surveyed included 'Chandler', 'Vina' and 'Serr'. In addition to surveying own-rooted trees, we also surveyed crown gall susceptible 'Paradox' rooted trees grafted to English walnut located within or adjacent to the own-rooted orchards to rule out the possibility of avirulent native *A. tumefaciens* populations that could account for a lack of galls on own-rooted trees. Based on statistical requirements, 100 comparison trees, i.e., 'Paradox' rootstocks, adjacent to the own-rooted trees, were examined for crown gall incidence.

Crown gall incidence on own-rooted English walnut trees compared to 'Paradox' rooted trees at several locations was assessed using mixed binary regression. Fixed effects were included for location, rootstock type, and their interaction. A random effect for site was included in the model. Pair wise comparisons were conducted using the Tukey-Kramer adjustment for multiple testing. The statistical level of significance was set at the 0.05 level. All analyses were performed using SAS version 9.1 for Windows (SAS Institute, Inc., Cary, NC).

RESULTS AND DISCUSSION

Crown gall incidence was significantly lower in the own-rooted English walnut trees compared to the 'Paradox' rooted trees at the five research sites (Table 1). There was no crown gall in own-rooted trees at three of the rootstock research sites (data not shown). Excluding replants, the number of own-rooted trees surveyed in the 14 commercial orchards represented 72% of all own-rooted English walnut trees planted in California

through 2003. Only 28 of 9,611 own-rooted trees in commercial plantings surveyed had crown gall visible at the crown (Table 2).

The research sites and commercial orchards had a similar pattern: significantly higher crown gall incidence in seedling ‘Paradox’, 20.0 and 22.2% crown gall versus 0.9 and 0.3% on the own-rooted trees respectively (Table 3).

Crown galls that were observed on own-rooted trees were small and more contained than the large and massive galls that often occur on seedling ‘Paradox’ at the crown. Own-rooted English walnut trees were observed to have more vigor on loam type soils than trees grown on sand or clay soils (Hasey et al., 2008).

CONCLUSIONS

Our results suggest that own-rooted English walnut cultivars ‘Chandler’, ‘Vina’ and ‘Serr’ have a low susceptibility to crown gall disease in the field in California. Own-rooted English walnut trees should be considered where crown gall is a problem and where walnut blackline disease is severe and other criteria for growing these trees are met, i.e., soil is adequate to support vigorous growth (Hasey et al., 2008), free of nematodes (Hasey et al., 2004; Buzo et al., 2006) and *Phytophthora citricola* (Hasey et al., 2006).

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Tables

Table 1. Percent crown gall across five rootstock research sites.

Rootstock	Crown gall (%)
Seedling Paradox	20.5 a ¹
Own-rooted English walnut	0.9 b

¹ Mean separation at 5% level (Tukey-Kramer)

Table 2. Number of trees surveyed and diseased with crown gall in 14 commercial orchards.

Rootstock	Trees surveyed (n)	Trees with crown gall (n)
Seedling Paradox	1190	255
Own-rooted English walnut	9611	28

Table 3. Percent crown gall on total trees surveyed in five research trials and 14 commercial orchards.

Rootstock	Research sites (%)	Commercial orchards (%)
Seedling Paradox	20.0 a ¹	22.2 a
Own-rooted English walnut	0.9 b	0.3 b

¹ Mean separation in a column at 5% level (Tukey-Kramer)