YIELD PERFORMANCE OF OWN-ROOTED 'CHANDLER' WALNUT VERSUS 'CHANDLER' WALNUT ON PARADOX ROOTSTOCK

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Abstract

A trial planted in 1991 compares micropropagated ungrafted 'Chandler' to those conventionally grafted onto seedling Paradox rootstock. From 1995 through 1999, own-rooted 'Chandler' had significantly greater trunk circumference and yield than did 'Chandler' on Paradox rootstock. Low vigor and dieback was observed in 1998 on some own-rooted trees. Lesion nematode (*Pratylenchus vulnus*) was extracted from root samples from the tree with dieback. *Pratylenchus vulnus* has been detected in soil samples taken from all the trees in the trial with the exception of a single own-rooted tree and on half of the corresponding root samples. Overall, soil nematode populations on own-rooted trees were higher (P = 0.05) than on Paradox. The relationship between nematode populations and their effect on growth and yields will continue to be investigated. Although six 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. Productivity of micropropagated 'Chandler' suggests the commercial feasibility of growing this English cultivar on its own roots.

Résumé

Dans un essai planté en 1991 sont comparés des arbres de Chandler micropropagés sur leurs propres racines et des arbres de cette même variété greffés sur des semis de Paradox. Les observations réalisées entre 1995 et 1999 montrent que les arbres de Chandler sur leurs propres racines ont une circonférence de tronc et des récoltes supérieures à celles des arbres greffés sur Paradox. Une vigueur faible et des dépérissement ont été observés en 1998 sur quelques arbres issus de micropropagation. Des lésions dues à Pratylenchus vulnus furent identifiées sur un échantillon de racines prélevé sur un des arbres dépérissants. L'année suivante, ce nématode fut détecté dans tous les échantillons de sol prélevés au pied des arbres de l'essai à l'exception d'un arbre sur ses propres racines et sur la moitié des échantillons de racines. Globalement, les populations de nématodes du sol étaient plus élevées pour les arbres sur leurs propres racines que pour ceux greffés sur Paradox (P = 0.05). La relation entre les populations de nématodes rencontrées et leur effet sur la croissance et la production des arbres continue d'être étudiée. Six arbres greffés sur Paradox ont présenté des symptômes de galles du coll*et al.*ors qu'aucune infection n'a été décelée sur les arbres auto-racinés. De tels noyers micropropagés sur leurs propres racines peuvent ainsi avoir un intérêt dans les zones ou les porte-greffe généralement utilisés (*J. hindsii* et *J. hindsii* x *J. regia*) ne peuvent être choisis à cause de leur hypersensibilité au virus du Cherry leaf roll. La productivité des arbres de Chandler micropropagés permet de penser qu'il est commercialement possible de cultiver cette

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variété de noyer commun *sur* ses propres racines.

1. 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 problem can be overcome by using either English walnut rootstocks 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).

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

2. Materials and methods

The study site is located in Sutter County in northern California on a 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.. Galltrol® was applied at planting to prevent crown gall. Trees are 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.

2.1. Tree growth, yield and quality measurements

Tree trunk circumference was measured at planting and annually to evaluate growth. Trunks were measured at 60 cm above the ground. Field observations were taken periodically, and harvest yield and quality data have been measured annually since the fifth leaf.

2.2. Nematode sampling procedure

2.2.1. Orchard sampling

Soil was excavated from an own-rooted tree with dieback and root and soil samples were taken on October 15, 1998. Samples were submitted for nematode and *Phytophthora* analysis. A 5 cm bucket auger was used to sample soil and roots to a depth of 60 cm midway between the dripline and tree trunk on the east side of each tree. Samples were taken in 1999 on July 29 and October 23 and submitted for analysis.

2.2.2. Nematode extraction and identification

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 which were weighed and placed in an intermittent mist chamber for 72 hours (Ayoub, 1977). Extracted nematodes were identified and counted at x45 magnification.

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2.3. *Phytophthora* identification

Walnut root pieces were assayed on culture plates. Firm green pears were used to bait the soil samples.

3. Results

3.1. 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 1999 (table 1). Yields have been significantly higher in own-rooted 'Chandler' from 1995 through 1999 (table 2). Yields for 1998 and 1999 produced a regression with a positive slope ($y = 21 + 1.1x$, $r^2 = 0.86$, $P < 0.0001$) where y = 1999 yield and x = 1998 yield. Yield efficiency was significantly higher in own-rooted 'Chandler' from 1995 through 1997 but not significantly different from trees on Paradox in 1998 and 1999 (data not shown). There have been no significant differences in nut quality between the two treatments from 1995 through 1999 with one exception. In 1995, nuts from own-rooted trees had 51.8 percent light kernels compared to 48.8 percent for nuts from 'Chandler' on Paradox (data not shown).

3.2. Nematode diagnosis

The own-rooted tree with dieback sampled on October 15, 1998 had visible lesions on the larger roots. There were 9,300 *P. vulnus* extracted from the soil per liter and 3.4 extracted per gram of root. When sampled on July 29, 1999, *P. vulnus* extracted from soil ranged from 300 to 8,500 per liter with a mean of 2,303 on Paradox and from 0 to 15,000 per liter with a mean of 5,278 on own-rooted trees. On October 23, 1999, soil populations ranged from 300 to 5,100 per liter with a mean of 2,324 on Paradox and from 0 to 18,000 per liter with a mean of 9,270 on own rooted. On both sampling dates, soil nematode populations on own -rooted trees were higher ($P = 0.05$) than on Paradox. On July 29, 1999, *P. vulnus* populations extracted from roots ranged from 0 to 294 per gram of root on Paradox with a mean of 41 and from 0 to 1,891 per gram on own-rooted with a mean of 162. On October 23, 1999, *P. vulnus* populations extracted from roots ranged from 0 to 1,080 per gram on Paradox with a mean of 15 and from 0 to 240 per gram on own-rooted with a mean of 21. No significant differences were evident ($P = 0.05$) among nematode populations on roots on either sampling date. Soil nematode populations on the two sampling dates produced a regression with a positive slope ($y = 1745 + 0.70x$, $r^2 = 0.43$, $P < 0.0001$) where y = nematode soil populations on October 23 and x = nematode soil populations on July 29. A similar regression for root samples was not significant nor were regressions relating nematode population levels in soil or roots to yield.

3.3. *Phytophthora* diagnosis

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

3.4. Observational data

Own-rooted 'Chandler' trees did not produce catkins until 1997 and then only a few. More catkins were produced in 1998 and 1999 on own-rooted trees but generally less than did '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. No crown gall has been observed on own-rooted trees.

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4. Discussion

Own-rooted 'Chandler' trees have out performed the 'Chandler' trees on Paradox rootstock in size and yield for five years. Although yield from the own-rooted trees has been two or three times greater than for trees on Paradox rootstock, there has been a high amount of variability among individual tree yields. Most of the own-rooted trees are extremely vigorous but those with low vigor, stunting or dieback had very low yields. The non-significant yield efficiency in 1998 and 1999 is believed to be due to this yield variability in own-rooted trees. Also, there are some very poorly performing trees on Paradox rootstock. Two of these low yielding trees have crown gall disease. The positive regression among 1998 and 1999 yields indicates that individual tree yields were consistent for both years. The lack of catkin production on own-rooted trees has not affected yield 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.

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* (Lownsbery, 1956). 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. However, the cause of the dieback in the one own-rooted tree is attributed to *P. vulnus*; apparently this tree was unable to withstand the high nematode populations.

The positive regression among soil samples taken on two different dates indicates the samples provide a reliable estimation of the relative numbers of nematodes present on each tree. With a single exception, nematodes were recovered from either soil or roots of all trees in the trial on at least one of the two sampling dates. Samples from both own-rooted and Paradox trees adjacent to this single own-rooted tree yielded abundant nematodes. *P. vulnus* populations and their effect on growth and yields will continue to be investigated.

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). This study will be continued for several more years to determine the full extent that *P. vulnus* or other problems may have on the productivity of own-rooted trees. Trials investigating the effect of the graft union on tree growth have also been initiated.

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Tables

1. Trunk circumference (cm) of own-rooted ‘Chandler’ versus ‘Chandler’ on Paradox measured at 60 cm from 1995-99.

Treatment	1995	1996	1997	1998	1999
Own-rooted	38.2 a	50.0 a	59.8 a	64.3 a	68.1 a
On Paradox	27.3 b	32.7 b	37.9 b	41.4 b	45.1 b

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

2. Yield in kg/tree of own-rooted ‘Chandler’ versus ‘Chandler’ on Paradox from 1995-99 and cumulative yield.

Treatment	1995	1996	1997	1998	1999	1995-99
Own-rooted	10.8 a	23.4 a	43.2 a	29.1 a	41.9 a	148.4
On Paradox	4.2 b	7.9 b	14.2 b	10.1 b	19.8 b	56.2

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

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