# The Use and Propagation of Wingnut (*Pterocarya* spp.) as a *Phytophthora*-Resistant Rootstock for Walnut (*Juglans* spp.)©

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**Walnut (*Juglans* spp.) is a widely grown nut crop in California. Many of the plantings of walnut are on marginal soils in California that are plagued by various types of *Phytophthora* root rot. Once established, *Phytophthora* can weaken a tree and reduce its productive life. It can also eventually kill the tree. The current commercial rootstocks used for walnuts are Northern California black (*J. hindsii)* and paradox walnut *(J. hindsii* × *J. regia*). Both of these rootstocks are susceptible to *Phytophthora*. The use of wingnut (*Pterocarya stenoptera*) as a rootstock for walnut was investigated beginning in 1998 because it is resistant to *Phytophthora*.**

**Wingnut seeds were planted and sprouted and eventually grafted to various walnut varieties. Six different sources of wingnut seed were collected at the University of California, Davis campus and germinated. Under a controlled stratification procedure, germination ranged from 80% to 95% for the different sources. This was compared to field germination without stratification that ranged from 2% to 10%.**

**The seedlings were grafted in the following spring to six different commercial walnut varieties. The grafting success ranged from 57% to 100%. The grafted trees were then dug and planted in an orchard to study the long-term compatibility of wingnut rootstock.**

## INTRODUCTION

The walnut (*Juglans* spp.) is an important commercial crop in California. In 2001 there were 224,000 acres of walnuts in the state (Tolomeo et al., 2001). As California continues to grow, however, more of the walnut plantings are going on marginal soils. Some of the soils do not have adequate drainage and water will stand around trees for days at a time following irrigation. This is an optimum environment for *Phytophthora,* a water mold, to grow and develop.

*Phytophthora* root and crown rots are a series of water molds that live in wet soil. Several different *Phytophthora* species are associated with root and crown rots in walnut trees: *P. cactorum, P. citricola, P. cinnamomi, P. megasperma, P. cryptogea, P. citrophthora, P. nicotianae* (syn. *P. parasitica*), and *P. drechsleri. Phytophthora cinnamomi, P. citrophthora,* and *P. nicotianae* have been isolated from only a few California walnut orchards, but these orchards had a high incidence of dying and dead trees as a result of the disease (Ramos et al., 1998). There may be as many as 14 different *Phytophthora* species that infect walnut trees in California and often more than one species is isolated in the same orchard. Once a walnut tree becomes infected with one or more *Phyophthora* species it begins to lack vigor and overall health. Leaves wilt and terminal growth stops as the disease develops. As the roots slowly die in the soil, cankers appear on the bark and crown area around the trunk. The cankers decay the bark and further weaken the tree to the point where it dies.

Factors that determine if an infected tree will eventually die include population of the *Phytophthora* spores, presence of one or more *Phytophthora* species, soil moisture status, temperature, and the relative resistance of the rootstock.

Because of the severity of the *Phytophthora* disease and the use of more marginal soils for walnut trees, a search was conducted to find a rootstock resistant to *Phytophthora*. In a University of California Cooperative Extension publication, *Walnut Rootstocks* (publication AXT-120, now out of print), it lists *J. hindsii* seedlings as susceptible to *Phytophthora*; paradox (*J. hindsii* × *J. regia*) as highly susceptible; *J. regia* as resistant and wingnut (*Pterocarya stenoptera*) as resistant. In a 1997 study by U.S.D.A. scientist Greg Browne it was found that only wingnut was highly resistant to six *Phytophthora* species tested under greenhouse conditions (Browne et al., 1998). The other rootstocks, *J. hindsii, J. regia* and paradox were highly susceptible. It was proposed that the wingnut rootstock be used as an alternative rootstock for walnuts.

## MATERIALS AND METHODS

In 1997 scientists at the University of California at Davis, under the direction of USDA scientist Greg Browne, sprouted several seedling selections of wingnut for trial as a walnut rootstock. In April 1997, 2400 wingnut seedlings were planted at the Burchell Nursery in Oakdale, California In September 1997 a majority of the seedlings were budded with eight different commercial walnut varieties using the traditional patch budding method as described in the Hartmann and Kester book on plant propagation (Hartmann and Kester, 1997.). In the spring of 1998 the trees were examined and the bud take was calculated. Unfortunately, none of the buds took. It was determined that another method of budding or grafting must be employed to make a successful union between the wingnut rootstock and a walnut variety.

In Fall 1998 more wingnut seeds were collected at University of California (UC), Davis. Again, several selections of seed were collected. The seeds were fall-planted directly to a field at Burchell Nursery in Oakdale, California. The soil was a Hanford series of sandy loam with adequate moisture. A total of 3750 seeds were planted of 25 different wingnut seed sources. Unfortunately, only 112 seeds (2%) sprouted in the spring of 1999. It was thought that the lack of stratification, a deep planting depth and soil crusting, contributed to the poor germination.

The wingnut trees that were budded in Sept. 1997 were used in the spring of 1999 for a grafting trial. The trees were removed from their location in Dec. 1998 and planted in a new location at Burchell Nursery in Jan. 1999. The trees were topped and planted in a single row. A total of 341 seedlings were planted and then grafted in April of 1999. The particular method of whip grafting was unique and never tried before on walnuts. First, the seedling was cut back at about 3 ft high and allowed to "bleed" until the sap stopped oozing out the top. Next, scion wood from six different walnut varieties was collected. The scion wood was about the same diameter as the rootstocks. After the rootstock had a considerable amount of growth (April 1999) they were grafted 2 ft high from the ground. A scion piece, about 10 to 12 inches long, was used for grafting. The scion was whip grafted to the rootstock and then wrapped with white plastic tape to completely cover the graft. Then the top of the scion was sealed with grafting wax and the whole tree was painted white to protect from sunburn.

In Sept. 1999 more wingnut seeds were prepared for germination. This time the seeds were stratified using a specific procedure. The seeds were first soaked in clean, cool tap water for 2 to 3 days. During the soaking process the water was changed at least 2 to 3 times per day to keep it clean. The seeds were rinsed each time the water was changed. Immediately after the final rinse and drain, the seeds were mixed into moist (not wet) peat moss. The peat moss was moistened by adding and mixing in 1 weight of water to 2 weights of peat moss. The peat moss felt moist and cool to the touch. After the peat moss preparation the hydrated seed was mixed in. The seed-peat mixture was stored in polyethylene bags. The bags were then stored at about 36 to 38°F for 3 months. After the 3-month seed stratification period, the seeds were removed from the bag and planted in flats filled with a peat moss and perlite (1 : 1, v/v) soil mix. The seeds were lightly covered with the same mix to a depth of no more than 1 in. The flats were then placed in a warm greenhouse where they sprouted in 10 to 20 days.

After the seeds sprouted they were allowed to grow until mid-spring (April) or when the field soil temperature began to rise. The seedlings were then transplanted at about 6 inches tall to the field in rows spaced 52 inches between the beds and 6 inches between the plants. The plants required little care through the summer although some suckering was necessary to ensure a straight, central leader.

The following spring (March) the seedlings reached a height of about 4 ft. Late in the spring (April) grafting was done to the selected scion varieties.

**Table 1.** Percent stand of different wingnut varieties planted to the field.

| Wingnut | Number planted selection on 3/31/00 | Number growing on 10/21/00 | Fieldstand (%) |
|---|---|---|---|
| Dairy Road | 454 | 432 | 95% |
| 10.01 | 835 | 824 | 98% |
| 11.2 | 285 | 283 | 99% |
| 2.08 | 635 | 613 | 96% |
| 1.01 | 610 | 581 | 95% |
| Minicenter | 259 | 209 | 80% |
| Total | 3078 | 2942 | 95% |

## RESULTS

In 2000, six wingnut seed selections were stratified using the procedure described above. Table 1 presents the results. The results show an impressive stand after 1 year of growth in the field. This is compared to a 2% stand when the seeds were directly planted in the field without stratification.

The wingnut seedlings were then grafted in 2001 to six different walnut varieties using the procedure described in the materials and methods section. When the trees were dug in Dec. 2001, they were scored for percent take. If the grafts had any growth it was scored a successful graft.

The results in Table 2 show that only the 17.01 seed source had a significantly lower graft take at 68%. 'Vina' was the walnut variety with the lowest graft take but it was not statistically significant.

The early results would indicate that certain wingnut seed sources are more compatible with certain walnut varieties in comparison to others. Also, while all of the

**Table 2.** Graft take of English walnut on wingnut rootstock.

| Walnut | Wingnut seed source | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cultivar | Dairy Road | 11.2 | 17.01 | 1.01 | 2.08 | Minicenter | 10.01 | Average |
| Chandler | 90% | 95% | 75% | 90% | 75% | 80% | 89% | 85% |
| Hartley | 100% | 100% | 100% | 100% | 100% | 94% | 93% | 98% |
| Howard | 70% | 100% | 65% | 90% | 80% | 80% | 83% | 81% |
| Serr | 77% | 85% | 75% | 90% | 85% | 100% | 57% | 81% |
| Tulare | 75% | 90% | 55% | 95% | 90% | 90% | 89% | 83% |
| Vina | 75% | 90% | 35% | 100% | 90% | 85% | 78% | 79% |
| Average | 81% | 93% | 68% | 94% | 87% | 88% | 82% | |

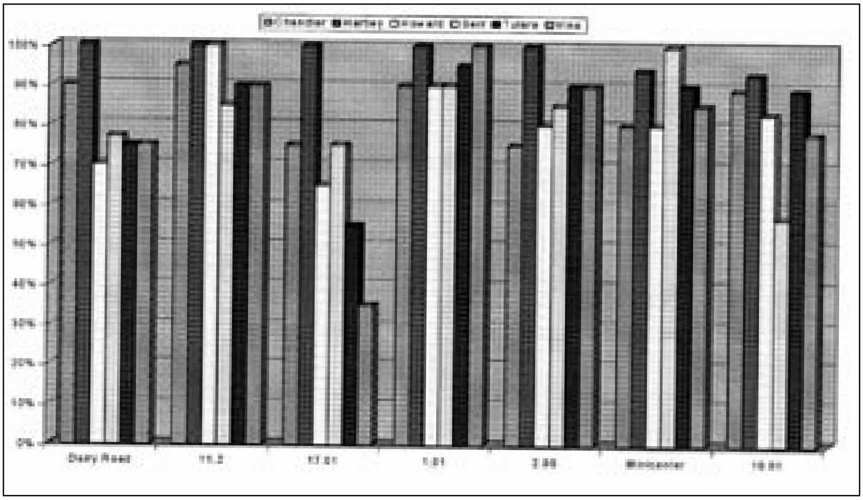

**Figure 1.** Percent graft take of walnut on several different wingnut sources.

walnut varieties tested grew, a long-term study will be conducted to determine if there is any delayed incompatibility problems with wingnut.

## DISCUSSION

There is a need in the walnut industry in California for a *Phytophthora*-resistant rootstock. With growers continuing to plant walnut orchards on more marginal soils, *Phytophthora* will become an even bigger problem. The use of wingnut as a rootstock for walnut has been tested and shown positively resistant to certain *Phytophthora* species. A new propagation method was then developed to commercially produce wingnut seedlings for grafting with English (*J. regia*) varieties. It was found that fall planting seeds without stratification in the field resulted in a poor germination (2%). A specific stratification protocol was developed the following year and found to result in a much higher (95%) seed germination and field stand. Seedlings in the field were, at first, patch budded in the fall the way commercially produced walnuts are grown. This resulted in none of the buds growing. The following year the seedlings were grafted in late spring. The seedlings were grafted high (20 to 24 inches) and a long walnut scion piece (6 to 10 inches) was used. The modified whip graft produced a better stand (79% to 98% takes) as compared to patch budding the year before. Knowing that there were incompatibility issues, several walnut varieties were grafted onto wingnut and then later planted to a test orchard where their growth is being tracked. In the future, walnut growers will know what varieties are compatible on wingnut rootstock and which are not so they can plant orchards on soil known to have *Phytophthora* and not lose trees due to root or crown rot.

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# Effect of Bifentrhin (Talstar®) on Mycorrhizal Colonization of California Native Plants in Containers©

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**The insecticide bifenthrin (Talstar®) is a synthetic pyrethroid required by regulation for the production of nursery crops to suppress the red imported fire ant in Orange and Riverside Counties in California. However, there are no published studies on the consequences of the application of this chemical on the mycorrhizal symbiosis.**

**We've initiated research to determine the effects of bifenthrin on mycorrhizal colonization by *Glomus intraradices,* a vesicular arbuscular mycorrhizal fungi used to inoculate California native plant hosts at the Tree of Life Nursery. Greenhouse experiments were conducted with *Apium graveolens*, *Encelia californica*, and *Salvia apiana*. The percentage of mycorrhizal colonization was compared in plants grown without bifenthrin and with bifenthrin at different concentrations.**

**This study showed that the application of bifenthrin had no detrimental effects on root colonization by *Glomus intraradices* in the nursery practices at the Tree of Life Nursery.**

## INTRODUCTION

An assessment of the impact of pesticides on the functioning of mycorrhizas is crucial for the development of horticultural management practices. The symbiotic association of plants with arbuscular mycorrhizal (AM) fungi has been widely recognized for its beneficial effects on plant quality. Mycorrhizal colonization increases plant growth by enhancing nutrient uptake, increasing plant tolerance to drought, and salt stress and resistance to transplant shock and soil pathogens (Smith and Read, 1997). Inoculation with AM fungi has been shown to improve the growth response of California native plants that are grown for landscaping, revegetation, and ecological restoration at the Tree of Life Nursery (Louise Egerton-Warburton and Edith B. Allen, unpublished results). However, despite the increasing use of certain chemicals on horticultural practices, not much is known about their impact on the mycorrhizal symbiosis.

The effects of pesticides on mycorrhizal colonization vary from beneficial to detrimental. While several chemicals inhibit the mycorrhizal development, others do not affect the symbiosis and the use of certain pesticides stimulate root colonization by AM fungi and increase their sporulation (Menge, 1982; Pattinson et al., 1997; Trappe et al., 1984).