

WALNUT ROOTSTOCK

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The standard and generally used rootstock for commercial walnut orchards in California during the period from 1910 to 1950 was the Northern California Black Walnut, *Juglans hindsii*. Since 1950 there has been increasing interest in Paradox hybrids (mainly *J. hindsii* x *J. regia*) and a few plantings have been made on *J. regia* in districts where Blackline (delayed incompatibility) is an overriding problem in mature orchards.

The reasons for favoring Paradox over *J. hindsii* in some areas are usually: (1) greater vigor and faster growth especially in mountain districts and on poorer soils and in replant situations; (2) greater tolerance of root lesion nematodes (*Pratylenchus vulnus*); (3) greater tolerance of high lime content in soil, excess water, or very heavy soil texture; (4) resistance to crown rot (*Phytophthora cactorum*). There is considerable evidence indicating better average uptake of zinc, phosphorus and iron by the Paradox than *J. hindsii* roots. On the other hand, Paradox roots seem on the average somewhat more susceptible to attack by crown gall (*Bacterium tumefaciens*) and oak root fungus (*Armillaria mellea*), and are just as subject to Blackline development at the unions in mature trees as are *J. hindsii* rootstocks.

There is a need for clonal propagation of Paradox rootstocks because: (1) it is difficult to get enough first generation (F₁) Paradox hybrids to meet demands, due to yearly fluctuations in percentage of natural hybrids found in seedlings from *J. hindsii* trees which have been selected as seed trees because of the usually good percentage of hybrids found among their seedlings and because of their average good vigor; (2) there are known to be marked fluctuations between Paradox clones in vigor, root lesion nematode resistance, and timber value and some clones also seem probably resistant to oak root fungus. Some Paradox clones have been propagated vegetatively in U.C. nurseries at Davis during the past twelve years, mainly for use in test plantings.

Various methods of clonal propagation of Paradox walnuts have been tried. These are listed below with brief notes on methods, results, and time required.

Trench layerage — The desired rootstock clones are budded or grafted into nurse stocks and grown for one year in the nursery row. Resulting trees are planted almost horizontal, then whitewashed and staked down in the bottom of a trench about six inches deep. Soil is filled in gradually as shoots grow from the horizontal stems. There is great variation among clones regarding numbers of roots produced. Roots grow mainly from the parent stem and seldom from the upright shoots. This gives odd shaped root systems. Usually two years are required after planting grafted trees in a horizontal position before suf-

ficient root develop to allow digging and cutting parent stem into sections, with roots and an upright shoot as close together as possible. These must normally be replanted and grown in the nursery row another year before planting in the orchard.

Halma-Frolich method (developed first for avocado rootstocks) — Clones are budded or grafted on nurse stocks growing in cans. They are cut back and placed in a warm dark chamber in late winter after chilling requirements are met. Etiolated shoots develop quickly. When these are 12 to 18 inches long the individual shoots are girdled near their base by removal of a ring of bark about one-eighth inch wide. This area is then wrapped with woolen yarn to prevent rapid regrowth of bark. A collar of roofing paper or wood extending well above the girdles is placed around the plant resting on top of the soil in the can and filled with a rooting medium such as vermiculite. The plants are then placed in the greenhouse and rooting medium kept moist. Shoots soon turn green and roots develop above the girdles. Individual rooted shoots can be cut off and planted in the nursery the following winter. Orchard plantable stocks are produced in two years after girdling etiolated shoots.

Piece root grafting — Plantable rootstocks with a good root system can be produced in one year if root pieces are available. Best results were obtained with root pieces nine inches or more in length on which scions of the same clone were whip-grafted. There was 50% survival with grafts made March 31, using roots and scions held in cold storage, and planted directly in the nursery, covered even with the tops of the scions.

Hardwood cuttings — We have had best results by starting in late December or January. Cuttings are given a 24 hour basal soak in 225 ppm IBA, then packed upright in lug boxes in damp peat moss with only the top third exposed. The boxes are placed over the bottom heat source which holds the temperature at about 75° F. at the base of the cuttings. The hot bed is in an open sided shed where normal winter temperatures hold the exposed buds dormant. After four weeks, all cuttings are examined individually at weekly intervals during the following four week period. Those which show actual roots beginning to develop (not just callus tissue) are potted in Aiken loam soil in peat pots. They are then placed in the greenhouse or over a heat source in the open shed with the temperature of the soil around the roots held preferably at about 65° F. They are transferred to the lathhouse for hardening in late April (if held in greenhouse previously) and planted out in the nursery row after danger of frost is ended and soil warms in early May. Plantable rootstock trees can be produced in one year by this method with most of the Paradox clones we have tried but some clones will not produce roots.

In some districts of California, especially in the vicinity of the San Francisco Bay, as well as in most of the walnut produc-

ing areas of Oregon and in France, delayed failure at the union (Blackline) has been a serious problem. It causes death of the tops of mature Persian walnut trees propagated on several common species of black walnut and Paradox and Royal hybrids. It can be avoided by using *Juglans regia* itself as the rootstock, but in California this species is subject to attack by oak root fungus (*Armillaria mellea*). In Oregon the prevalence of an apparently different so-called "fir strain" of this fungus, generally less injurious to walnuts, and possibly other factors, have made oak fungus, less important than Blackline in the main producing areas and use of Manregian, a variety of *J. regia* from Manchuria, as a seed parent for rootstocks is recommended. Efforts to root cuttings of this variety have been unsuccessful so far.

In California the so-called "oak strain" of *Armillaria mellea* predominates in most walnut districts and causes such serious losses to orchards on *J. regia* rootstocks that growers in most cases have continued to use the Blackline resistant *J. hindsii* or Paradox stocks. Neither of these stocks is entirely immune to *Armillaria* attack, but *J. hindsii* is highly resistant and Paradox seem variable. Tests of individual clones of Paradox are in progress.

Tests at Davis of effects of using weak growing clones of several species and hybrids of *Juglans* as interstocks between *J. regia* tops, and Paradox hybrid rootstocks have shown two of the clones of *J. nigra* and three of *J. ailantifolia cordiformis* to be decidedly dwarfing. Dwarfed trees produced several times as many flowers, both pistillate and staminate, as comparable normal trees of the similar age.