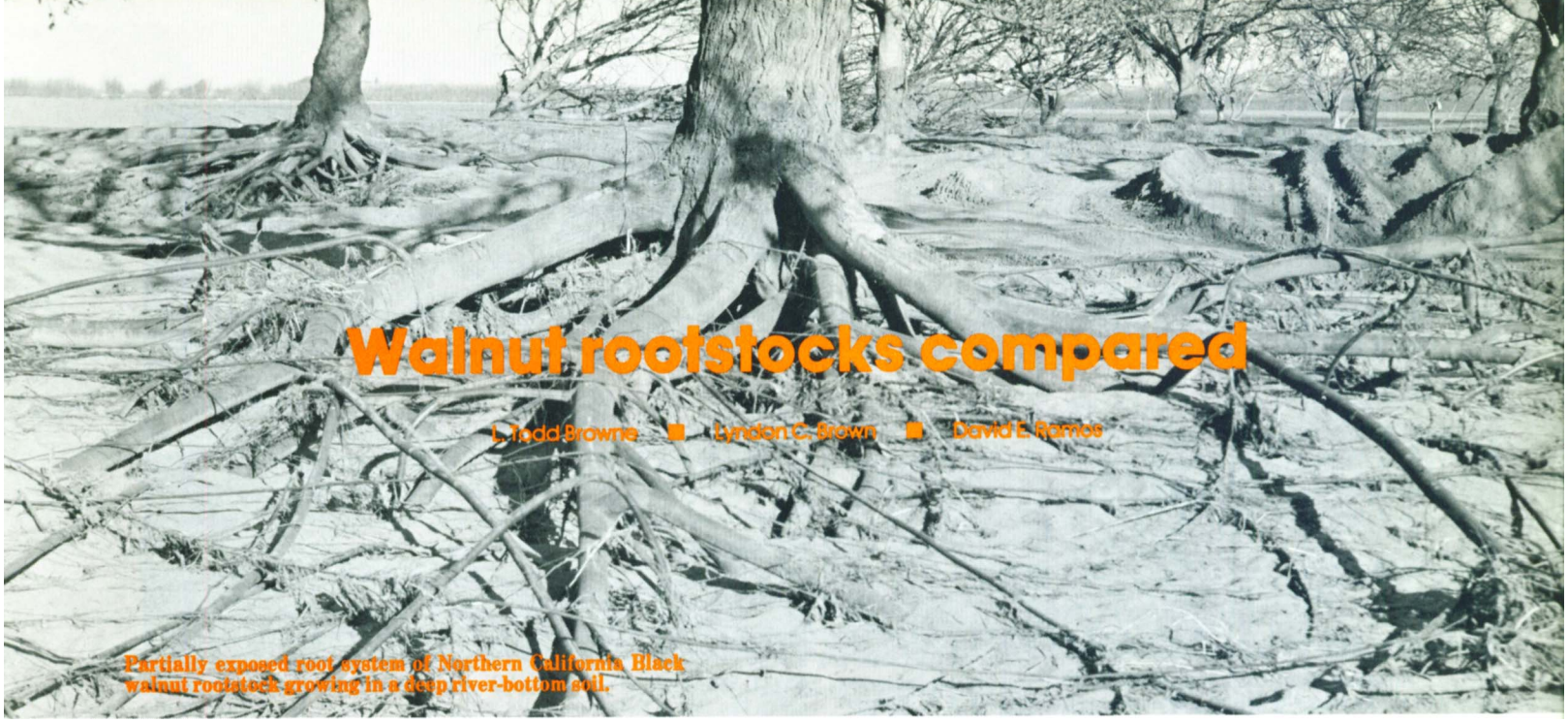

Walnut rootstocks compared

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Partially exposed root system of Northern California Black walnut rootstock growing in a deep river-bottom soil.

Two trials, begun in the mid-1960s to compare growth and yield of Serr walnut trees on several different rootstocks, have been completed. The trials were established by the late E. F. Serr, Professor of Pomology, and consisted of rootstocks thought to have merit at the two respective locations—University of California Kearney Horticultural Field Station (KHFS), Parlier, and U.C. West Side Field Station (WSFS), Five Points. Although the two locations are no more than 40 miles apart, contrasting results were obtained—probably as a result of soil and climatic differences.

The KHFS trial established in 1963 contained eight rootstocks all topworked to the Serr variety. Trees are spaced 25 feet x 25 feet in a Latin square (an experimental design grouping treatments into rows and columns so that each treatment occurs the same number of times in each row and column). The soil is mapped as Hanford sandy loam, silty substratum. At WSFS, seven rootstock selections planted in 1966 were also spaced 25 feet x 25 feet in a Latin square, and all were topworked to the Serr variety. Soil at the WSFS is Panoche clay loam.

Rootstocks

Northern California Black Walnut, *J. hindsii*, has been the standard rootstock for California walnuts since about 1900. It is considered to be resistant to oak root fungus and somewhat tolerant of saline conditions. It grows rapidly and quite uniformly in the nursery and is less susceptible to crown gall than some other stocks.

Paradox Hybrid, *J. hindsii* x *J. regia*, has been in greater use in the past 25 years, because varieties grafted to it grow more rapidly than those grafted on Northern California Black, particularly under poor soil conditions. Further, Paradox is more tolerant of root lesion nematode and shows more resistance to crown rot.

The Paradox seedlings used in these tests were obtained from germinated seed from a black walnut tree on the Rawlins property in Glenn County. The Boyce Paradox cutting, used only in the KHFS trial, was a rooted cutting from a Paradox tree growing in an oak root fungus area near Winters.

English Walnut, *J. regia*, has not been a popular rootstock in the past but was included in these trials, because it is the only rootstock resistant to blackline. At KHFS, two *J. regia* seed sources were used—Manregian (PI 18256) and Eureka.

Manregian is recommended and used in Oregon because of blackline. Eureka was included to test another source of *J. regia* seedlings. Only Manregian was used in the WSFS trial.

Eastern Black Walnut, *J. nigra*, included in the WSFS trial, has been used as a rootstock in France and in the eastern United States.

Royal Hybrid, *J. nigra* x *J. hindsii*, has not been used to any extent, but it was known to be extremely vigorous.

Arizona Black, *J. major*, grows wild in Arizona, Colorado, New Mexico, and Mexico, where it is often a small tree because of limited water and poor soil conditions. Under good conditions, however, it grows much the same as Northern California Black.

Texas Black, *J. rupestris* (also called *J. microcarpa*), is known as the Texas rock walnut and grows wild in Texas and New Mexico. The trees tend to be smaller, making closer planting possible.

Methods

To assess tree size, trunk circumference was measured annually at each station. When the first trunk measurement was taken, a nail was driven into the trunk at a height of approximately three feet. All subsequent measurements were taken at the same location.

Beginning in 1972, individual tree yields were measured. Trees were shaken by a custom shaker, and the nuts were hand picked, machine hulled, and weighed wet. A representative wet sample was weighed, dried, and reweighed to obtain the drying ratio for each tree. This ratio was applied to the wet weight to obtain a dry weight per tree.

Leaf analysis was made of leaf samples from the Serr top on each rootstock selection in both trials. Soil analysis was also performed.

KHFS trial

In general, at KHFS, differences in tree size were closely related to yield (table 1). Trees on Paradox roots were the largest and produced consistently greater yields per tree than all others in each of the three years tested. Trees on Manregian and Texas Black roots were the smallest and produced consistently lower yields than any other selection and significantly less than Paradox, Royal, and Northern California Black.

Eureka was significantly lower yielding than both Paradox selections. Eureka also yielded consistently less than Northern California Black. Eureka was intermediate in size—slightly smaller than Northern California Black and significantly smaller than the Paradox cutting.

Yield efficiency—the amount of walnuts produced in relation to trunk cross-sectional area—is of prime interest to the producer. The best rootstock choice is usually the one consistently producing the highest yield for the tree space required.

Both Paradox selections and Arizona Black had high yield efficiencies that were somewhat better than those of all other selections. Texas Black was significantly lower than Paradox, Northern California Black, and Arizona Black. Manregian and Eureka rootstocks were consistently lower than Paradox and Northern California Black, but the difference was not significant.

Observations from the KHFS trial suggest that, at age 10 and under these conditions, the Boyce Paradox cutting would need a spacing of 40 feet; the Paradox seedling and Royal seedling need 35 feet; Northern California Black, Arizona Black, and Eureka need 30 feet; Manregian and Texas Black need only 25 feet. Such a planting arrangement would put the various selections on a comparative basis. In such an arrangement, the six stocks listed first would probably perform best.

WSFS trial

At WSFS, use of the various rootstocks has resulted in decided differences in yield, tree size, and yield efficiency (table 2). Some of the trees became two to three times larger than other trees. Three rootstocks—Royal Hybrid, Manregian, and Eastern Black—were significantly smaller and lower yielding. Paradox seedling was significantly smaller and lower yielding than Northern California Black. The largest trees were those on Arizona Black and Northern California Black.

During the first five years, the WSFS plot was irrigated with water from deep wells that was high in chloride and boron. Since 1972, the plot has been irrigated with water from the California Aqueduct. When well water was used, the trees consistently showed leaf scorch during the latter part of the growing seasons. However, with the use of the aqueduct water, these toxic leaf symptoms were greatly reduced by 1975. Walnuts may accumulate as much as 0.3 percent chloride or 300 ppm boron in the leaves before toxicity symptoms appear.

The walnut rootstocks differed in chloride and boron uptake from the soil, as shown by leaf sampling in 1970 and 1975 (table 3). The chloride content in leaves from Paradox, Royal hybrid, Manregian, and Eastern Black in 1970 was well beyond the 0.3 percent critical level and several times greater than that of Northern California, Arizona, and Texas Black rooted trees. These differences may account for the inconsistent behavior of the rootstocks at WSFS as compared with KHFS, where there were no nutrients in toxic concentrations.

Two sites compared

Table 4 compares the performance of the rootstocks used at WSFS with those at KHFS at the same stage of development. The data represent the tenth leaf but not the same calendar year, since the trials were established in different years.

The black walnut rootstocks (Northern California, Arizona, and Texas) grew larger at WSFS and, with the exception of Texas Black, produced about the same amount of crop per tree at the two locations. In contrast, the Paradox and Royal hybrids were smaller and yielded substantially less at WSFS than at KHFS. Manregian did poorly at both locations. The overall depression in yields at WSFS may be partly due to poor pollination conditions at this site, which is isolated from any major concentration of walnut trees.

Conclusion

In conclusion, growth and yield comparisons show that Northern California Black and Arizona Black rootstocks performed well, but Manregian did poorly in both areas. Paradox hybrid was an outstanding performer at KHFS but did poorly at WSFS. The reverse was true of Texas Black; it did poorly at KHFS but performed well at WSFS.

On the basis of the results at KHFS, Eureka seedlings appear to offer some potential as a rootstock for future walnut plantings. They performed nearly as well as Northern California Black and have the advantage of providing immunity to blackline disease of walnuts. However, the high chloride and boron levels associated with Paradox hybrid and with another English walnut cultivar (Manregian) at WSFS raise a serious question as to the adaptability of the Eureka rootstock to some of the soils on the west side of the San Joaquin Valley.

TABLE 1. Yield, Tree Size, and Yield Efficiency of English Walnuts (Serr) on Various Rootstocks, Kearney Horticultural Field Station*

Rootstock	Yield per tree	Trunk cross-section	Fruit weight per sq cm trunk cross-section
	lb	sq cm	gm
Boyce Paradox cutting	98 a	494 a	89 a
Rawlins Paradox seedling	88 ab	442 ab	86 ab
Royal Hybrid	76 abc	409 abc	74 abc
Northern California Black	62 bc	366 abc	77 ab
Arizona Black	59 bcd	289 cd	90 a
Eureka	52 cd	345 bc	68 bc
Manregian PI 18256	28 d	178 d	68 bc
Texas Black	29 d	210 d	56 c

*Each figure represents the mean of eight trees measured over a three-year period, 1972-1974 (10th to 12th leaf). Numbers in the same column followed by a common letter are not significantly different at the 5% level (LSD test).

TABLE 2. Yield, Tree Size, and Yield Efficiency of English Walnuts (Serr) on Various Rootstocks, West Side Field Station*

Rootstock	Yield per tree	Trunk cross-section	Fruit weight per sq cm trunk cross-section
	lb	sq cm	gm
Northern California Black	38 a	356 a	45 a
Arizona Black	34 ab	396 a	41 a
Texas Black	31 ab	276 b	52 a
Paradox Seedling	25 b	263 b	42 a
Royal Hybrid	9 c	135 c	28 b
Manregian PI 18256	9 c	129 c	28 b
Eastern Black	7 c	106 c	27 b

*Each figure represents the mean of six, seven, or eight trees measured over a three-year period, 1973-1975 (8th to 10th leaf). Numbers in the same column followed by a common letter are not significantly different at the 5% level (LSD test).

TABLE 3. Chloride and Boron Content (dry weight basis) in Leaves of English Walnuts (Serr) on Various Rootstocks, West Side Field Station*

Rootstock	Chloride 1970	Chloride 1975	Boron 1970	Boron 1975
	%	%	ppm	ppm
Northern California Black	.21 a	.08 a	951 bc	355 a
Arizona Black	.15 a	.09 a	1007 c	397 a
Texas Black	.16 a	.09 a	819 ab	381 a
Paradox seedling	.45 b	.21 c	941 bc	414 a
Royal hybrid	.40 b	.14 b	772 a	351 a
Manregian (PI 18256)	.62 c	.37 d	988 c	499 b
Eastern Black	.41 b	.15 b	895 abc	379 a

*Mean separation within columns by Duncan's multiple range test, 5% level.

TABLE 4. Yield, Tree Size, and Yield Efficiency of Ten-Year-Old English Walnuts (Serr) on Various Rootstocks at Two Locations*

Rootstock	Yield per tree		Trunk cross-section		Fruit weight per sq cm trunk cross-section	
	KHFS	WSFS	KHFS	WSFS	KHFS	WSFS
	lb	lb	sq cm	sq cm	gm	gm
Northern California Black	58 a	56 a	322 ab	436 ab	83 ab	55 a
Arizona Black	49 ab	43 ab	258 bc	459 a	88 a	44 ab
Texas Black	16 c	40 ab	174 c	347 bc	36 c	54 a
Paradox seedling	70 a	29 bc	388 a	316 c	77 ab	40 ab
Royal hybrid	54 a	18 c	354 ab	178 d	56 bc	46 ab
Manregian	22 bc	14 c	152 c	175 d	70 ab	36 b

*Each figure represents the mean of six, seven, or eight trees. Numbers in the same column followed by a common letter are not significantly different at the 5% level (LSD test).

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