PARADOX DIVERSITY STUDY – ORCHARD TRIALS 2007

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ABSTRACT

Paradox continues to be the most widely planted rootstock for walnuts in California. Although it tends to perform well throughout the state, differences in performance have been observed within and between orchards and nursery sources. These differences may be the result of genetic variation between source trees or from within a source tree. There is a need to identify superior Paradox rootstocks, clonally or from superior parents, that then can be propagated to produce superior orchards in the future. Evaluation of such traits as growth rate, transplantablility, resistance to crown gall, nematodes, and *Phytophthora* crown and root rot can be performed efficiently under laboratory and/or greenhouse conditions. Long term survival, growth and productivity under field conditions requires several additional years to evaluate.

Four orchard trials were planted in 1998 in Yolo and San Joaquin Counties and in 1999 in Tehama and Kings Counties. Approximately thirty Paradox rootstock sources are replicated four times with either three or six trees per replicate at each site. The Yolo and San Joaquin orchards were grafted to Chandler. The Tehama County orchard was grafted to Howard and the Kings County orchard was grafted to Tulare.

The fifth and final year of yield data was collected in 2005 for the Yolo trial. Yield was evaluated in the San Joaquin trials for the fifth and final year in 2007. Harvest yields were not taken in the Tehama County trial again due to the large variability in tree size resulting from regrafting required due to a scion mix-up followed by frost damage.. In 2007, overall yields were down at the San Joaquin County trial (Fig. S1). The highest yields for the Paradox rooted trees was 2.86 tons per acre for PZ (down from 3.56 tons per acre in 2006) and the lowest 2.29 tons per acre (CZ).

The four largest rootstocks across all sites at the end of the 2006 season (last season all sites were measured) were Vlach, OX, DX and PZ which all have *Juglans hindsii* (Jh) crossed with *J. regia* (Jr) as parents. The black rootstocks were generally small at all sites with YZ tending to be the largest of the blacks at all sites. Three of the four rootstocks containing all four (Jm, Jn, Jh, Jr) parents were consistently smaller than most others. Other rootstocks that were smaller were three of those containing the three (Jh, Jn, Jr) parents (PX, HX and OZ). Of the Jh x Jr crosses, JX, QZ and WX tended to be smallest at all sites.

Yield and trunk circumference data collection has now been completed at all trials. Final assessment of tree condition/survival will be made at all four sites in 2008.

OBJECTIVES

Seedlings were produced by the Paradox Diversity Study from 36 commercial Paradox sources and from controlled crosses made at UC Davis. Trees produced from these seedlings have been planted in 4 grower orchard trials, located in Yolo, San Joaquin, Tehama, and Kings Counties. The Yolo and San Joaquin trials were planted in 1998 and the Kings and Tehama trials in 1999. The farm advisor in each of the counties is the principal investigator for the trial in that county. The plan is to collect 5 years of yield data at each site. The seedling Walnut rootstocks were first grown for one year in three different commercial nurseries. All three nurseries are equally represented in each plot. A six tree plot included two trees from each of the three nurseries. A three tree plot included one tree from each nursery. The trees were then dug in early winter and handled and stored using acceptable commercial nursery practices. Trees were transported to the fields and planted with standard planting crews. Individual trees are marked and can be traced to the nursery. The two trials planted in 1998 are grafted to Chandler. The grower cooperators are responsible for the general farming of the trees. Tree identification, growth measurements and extra care is provided by the farm advisors. The main objective of the trial is to measure and quantify differences between Paradox sources and to identify superior Paradox trees. The Yolo trial was harvested starting in 2001 while the San Joaquin and Kings trials were harvested starting in 2003.

PROCEDURES FOR YOLO COUNTY TRIAL

For details of the Yolo County trial procedures, see Walnut Research Reports 2006.

RESULTS AND DISCUSSION FOR YOLO COUNTY TRIAL

Final yield and circumference data from the Yolo trial is available in the 2006 Walnut Research Reports. Final assessment of tree health/survival will be reported in 2008.

PROCEDURES FOR TEHAMA COUNTY TRIAL

For details of the procedures for the Tehama County trial, see Walnut Research Reports 2006.

RESULTS AND DISCUSSION FOR TEHAMA COUNTY TRIAL

Yields were not taken again in 2006 or in 2007 due to the great variability in trees size resulting from the grafting and frost problems. Final trunk circumference data is available in Walnut Research Reports 2006.

A final assessment of tree health/survival for the Tehama trial will be done in 2008.

PROCEDURES FOR SAN JOAQUIN COUNTY

The experimental plot is located in a commercial 26' X 26' walnut planting owned by Richard and Joseph Dondero near Farmington, California. The plot is configured as randomized complete block design, with four 3- or 6-tree plots, in fifteen adjacent rows within the orchard.

Ungrafted Paradox rootstocks from three nursery sources were planted June 2, 1998. Planting was delayed due to unseasonably late spring rains. All trees were grafted with Chandler scions in spring 1999. A small number of trees that died or made poor growth in 1998 were replaced with Paradox seedlings in spring 1999, and these were subsequently budded to Chandler in fall 1999. Buds on a few of these trees failed, and these trees were grafted in spring 2000. A few trees from the 1998 and 1999 plantings died during the 1999 season and were replaced with Chandler-grafted trees on the appropriate Paradox selections in spring 2000. Trees that died in 2001 and 2002 were replaced with Chandler-grafted trees on Paradox rootstock obtained by the grower.

Soil at the site is a clay loam. The orchard is sprinkler irrigated, and was formerly planted to field and row crops. Soil at the site was not fumigated prior to planting.

Tree growth through 2005 was evaluated by measuring the trunk diameter 12 inches above the graft union in late November.

The trial was commercially harvested for the first time in 2003. Prior to harvest, trees from the 1998 (budded in spring, 1999) and 1999 (budded in fall, 1999) appeared to have similar crop loads and were harvested together in 2003 and in 2004. Trees planted in 2000 and after were not harvested.

Nuts were shaken, windrowed and weighed separately from each 6- or 3-tree plot. A 20-30 pound sample was collected at random from nuts harvested in each of the 15 rows of the trial. These samples were weighed, hulled, dehydrated and weighed again to calculate a factor for converting the weight of field-harvested nuts from each plot to its equivalent dehydrated weight. A small (2.4 pounds) sub-sample of nuts each sample was dried completely to determine the dehydrated moisture content of each sample and the conversion factors adjusted in order to express all plot yields on an 8% (wet basis) moisture content basis.

RESULTS AND DISCUSSION FOR SAN JOAQUIN COUNTY TRIAL

There were no significant differences in trunk circumference among trees on rootstocks from different Paradox sources in 2000 or 2001 (data not shown). Statistically significant differences in trunk diameter began emerging among trees on the various stocks in 2002 and persisted in 2005 (Table SJ1).

In 2004, significant yield differences occurred for the first time and they continued in 2005 and 2006. Yields varied widely among Paradox sources, ranging from 2.56 (HX) to 3.56 (Vlach) tons per acre (Table SJ1). Trees on black rootstocks had the smallest trunk circumferences and yields (Table SJ1;Fig. SJ1). Overall, yield was closely related to trunk circumference in 2006 (Fig. SJ1). In 2007, yields were down significantly overall at the San Joaquin County trial (common in

Chandler statewide in 2007) and the relationship between trunk circumference and yield was not quite as strong as in 2006 (Fig. SJ1).

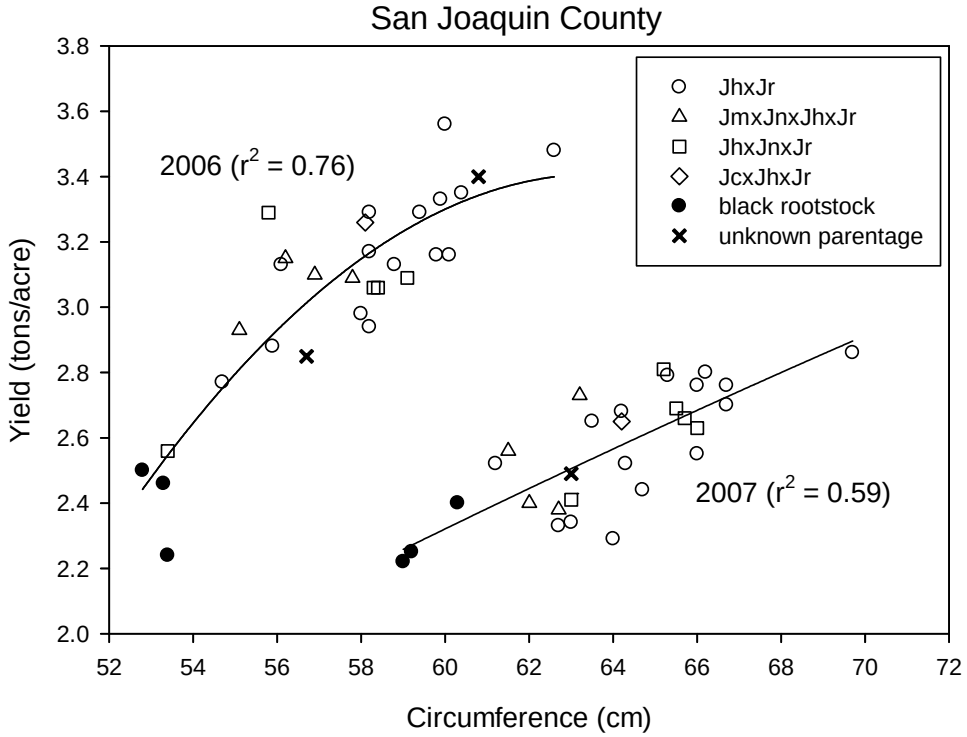

Fig. SJ1. Trunk circumference versus yield for San Joaquin County site in 2006 and 2007 seasons.

Table SJ1. Average trunk circumference and pounds per acre yield by seedling source[1] in 2007 for the San Joaquin County trial. The rank in relation to the other rootstocks is also shown.

Rootstock	Parents	Trunk circ (cm)		Rank	Yield (tons/acre)		Rank
PZ	JhxJr	69.7	a	1	2.86	ab	2
SZ	JhxJr	66.7	abc	3	2.70	abcde	9
SX	JhxJr	66.7	abc	4	2.76	abcde	6
VLACH	JhxJr	66.2	abcd	5	2.80	abc	4
UZ	JhxJr	66.0	abcde	6	2.55	abcde	17
OX	JhxJr	66.0	abcde	8	2.76	abcd	7
RZ	JhxJr	65.3	abcde	11	2.79	abc	5
DX	JhxJr	64.7	abcde	13	2.44	abcde	21
KX	JhxJr	64.3	abcde	14	2.52	abcde	19
JX	JhxJr	64.2	abcde	16	2.68	abcde	11
CZ	JhxJr	64.0	abcde	17	2.29	cde	28
VX	JhxJr	63.5	abcde	18	2.65	abcde	13
QZ	JhxJr	63.0	abcde	20	2.34	bcde	26
AW	JhxJr	62.7	bcde	24	2.33	bcde	27
WX	JhxJr	61.2	cde	27	2.52	abcde	18
OZ	JhxJnxJr	66.0	abcde	7	2.63	abcde	15
PX	JhxJnxJr	65.7	abcde	9	2.66	abcde	12
LX	JhxJnxJr	65.5	abcde	10	2.69	abcde	10
NX	JhxJnxJr	65.2	abcde	12	2.81	abc	3
HX	JhxJnxJr	63.0	abcde	22	2.41	abcde	22
XX	JcxJhxJr	64.2	abcde	15	2.65	abcde	14
AZ	JmxJnxJhxJr	63.2	abcde	19	2.73	abcde	8
MX	JmxJnxJhxJr	62.7	abcde	23	2.38	bcde	25
NZ	JmxJhxJnxJr	62.0	bcde	25	2.40	bcde	24
CX	JmxJnxJhxJr	61.5	cde	26	2.56	abcde	16
LZ		68.7	ab	2	2.93	a	1
BW						*not harvested*	
AW bl	Jh	60.3	cde	28	2.40	abcde	23
YZ bl	JnxJh	59.2	de	29	2.25	de	29
BX bl	JcxJn	59.0	e	30	2.22	e	30
WZ		63.0	abcde	21	2.49	abcde	20
LSD .05		*5.8*			*0.52*		

PROCEDURES FOR KINGS COUNTY TRIAL

For details of the Kings County trial procedures, see Walnut Research Reports 2006.

RESULTS AND DISCUSSION FOR KINGS COUNTY TRIAL

Final yield and trunk circumference data for the Kings County trial is available in Walnut Research Reports 2006. Final assessment of tree health/survival will be done in 2008.

RESULTS AND DISCUSSION, ALL FOUR TRIALS

Table S1 shows the average trunk circumference for the various sources at all four sites at the end of the 2005 season. The rootstocks that have Juglans hindsii (Jh) crossed with J. regia (Jr) included 4 rootstocks that were large in all four trials (DX, OX, PZ, and Vlach). There was considerable variation in size of most of the other rootstocks when comparing the four trials with some rootstocks performing quite differently among the trials. In general, trunk circumference tended to correlate pretty well with yield, particularly when the cumulative average yield is used as the comparison (see Figure Y1 earlier in report).

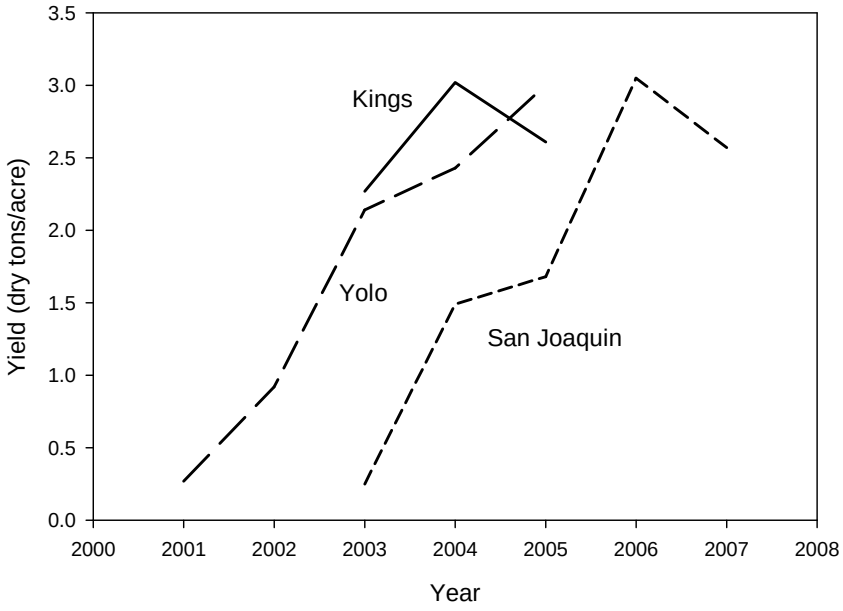

Fig. S1. Average overall dry tons per acre yield by site and year

The black rootstocks that were planted in all four trials were some of the smallest trees and tended to be low yielding. Three of the four rootstocks containing all four (Jm, Jn, Jh, Jr) parents were consistently smaller than most others (MX, NZ and AZ). There were also three Jh x Jr crosses that tended to be smaller at all four sites (JX, QZ and WX). Several rootstocks containing the three (Jh, Jn, Jr) parents also tended to be smaller at all sites (PX, HX and OZ).

Average yield for all rootstock sources is shown in Fig. S1. The yields at the San Joaquin, Kings, and Yolo sites all reached a maximum of about 3 dry tons per acre by the conclusion of data collection. The 2005 harvest was the last for the Yolo site, the 2006 the last for the Kings site and the 2007 season the last for the San Joaquin site. Although looking at Fig. S1, it appears that all three sites might not have reached maximum yield potential, the confounding factors thrown in by differential tree size in adjacent rows (each rootstock is planted in one individual row in each replication) makes yield data from this point on less reliable. This is because a large

rootstock next to a small one can take more than its allotted space and thus exaggerate yield potential.

Table S1. Trunk average trunk circumference for all four sites at end of 2006 growing season (final year data was collected at all four trials).

Rootstock	Parentage	circumference (cm)
VLACH	JhxJr	63.24
OX	JhxJr	62.59
DX	JhxJr	62.48
PZ	JhxJr	62.44
LX	JhxJnxJr	62.13
LZ	?	61.87
XX	JcxJhxJr	61.84
SX	JhxJr	61.76
UZ	JhxJr	61.68
CX	JmxJnxJhxJr	61.64
RZ	JhxJr	61.59
SZ	JhxJr	61.23
KX	JhxJr	60.99
NX	JhxJnxJr	60.74
AW	JhxJr	60.52
VX	JhxJr	60.44
CZ	JhxJr	60.43
PX	JhxJnxJr	60.09
HX	JhxJnxJr	59.96
OZ	JhxJnxJr	59.93
YZ bl	JnxJh	59.59
JX	JhxJr	59.51
QZ	JhxJr	59.16
WX	JhxJr	59.03
MX	JmxJnxJhxJr	58.43
NZ	JmxJhxJnxJr	57.07
AZ	JmxJnxJhxJr	56.98
BX bl	JcxJn	55.24
AW bl	Jh	50.94