

WALNUT CULTIVAR NUTRITIONAL EVALUATION

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ABSTRACT:

Leaf samples were collected and analyzed from three replicated walnut variety trials. The Tulare trial has 15 varieties that were grafted in 1983. The Yolo trial has 13 varieties grafted in 1985 and the Guinda trial has 10 varieties grafted in 1989. The first two trials have a production history reported under the high density management systems chapter. The last trial had limited production in 1992.

Data shows that rootstocks can have an influence on the leaf concentration of several nutrients. Leaf levels were higher for phosphorus, calcium, magnesium, chloride, boron and manganese and lower for potassium and zinc on Paradox rootstock.

Comparing leaf samples of different cultivars consistent differences were shown for nitrogen, calcium, magnesium, chloride and boron. Nitrogen levels were highest in Chandler variety while Ashley, Payne and Tulare were usually the lowest. While it cannot be concluded by these experiments that Chandler would produce better than other varieties if nitrogen was limited, these tests do suggest that differences do exist. If the nitrogen critical value is the same for all varieties then Chandler very well could do better under limited nitrogen applications.

OBJECTIVES

Walnut producers need to be concerned with maximum production and economics to stay in business but also recent trends toward environmental restraints that may be imposed in the future. Growers need to be concerned with ground water pollution, nitrate contamination and salt accumulation. Farmers may not have the luxury of applying unlimited fertilizer or water without accountability. Regulation may dictate application rates. If only a regulated amount of nitrogen could be applied to a walnut orchard what cultivar might be the most profitable to grow? Is there differences between cultivars on their ability to exclude toxic salts?

Compare different cultivars on their ability to utilize nitrogen and other elements for crop production. Another objective is to evaluate the cultivars ability to exclude potential toxic micronutrients if present at high levels.

PROCEDURE

Evaluate the 16 cultivars in the Tulare hedgerow walnut trial, 13 cultivars in the Yolo (Fukumoto) hedgerow trials, and 10 cultivars in the Guinda hedgerow trial by leaf analysis. Elements to be evaluated are N, P, K, Ca, Mg, Cl, B, Zn and Mn.

A total of 182 leaf samples were collected from the three hedgerow walnut trials in July 1991 and again in 1992. These samples were dried, ground and analyzed for 10 elements in 1991 and 9 elements in 1992 using standard analytical procedures by the UC Diagnostic Laboratory. A leaf sample was collected from each replicate and each cultivar in three hedgerow walnut

experiments. The Tulare Co. trial contains three replicates of 9 trees per variety and the Winters orchard contains 4 replicates of 10 trees. Both trials are randomized complete block design. The Guinda trial is a randomized complete block with three replicates of 4 trees of 10 cultivars on Northern California Black walnut rootstock and the same combination on Paradox walnut. Data from the first two trials was analyzed by using an analysis of variance whereas the Guinda trial being analyzed as a factorial with two independent variables.

RESULTS

Table 1 shows the analysis where significant differences exist between cultivars. While certain years gave some samples significance, primarily the only elements that showed differences in several locations and years were nitrogen, calcium and magnesium although boron and manganese showed significant differences in 4 and 3 of the 6 experiments. Nitrogen was not significant in the Winters 1991 trial where nitrogen was low or marginal in all leaf samples in 1990. When more nitrogen was applied in 1991 and 1992 the nitrogen level improved and showed differences in 1992.

The calcium was the highest in the Tulare Co. trial showing the high calcium low Magnesium type soils present. The lowest averages were in the Winters orchard which also had the highest Magnesium. Soils in that location are extremely high in magnesium which can mask the calcium and probably caused the non significance. Magnesium was not significant only in 1991 in the Tulare Co. orchard. Again the high calcium at that site probably mask the magnesium.

Table 1. Shows where significant differences were found in leaf samples between cultivars from three different replicated walnut variety trials.

	<u>Year</u>	<u>N</u>	<u>P</u>	<u>K</u>	<u>Ca</u>	<u>Mg</u>	<u>Cl</u>	<u>B</u>	<u>Zn</u>	<u>Mn</u>	<u>Na</u>
Tulare Co.											
	1991	+	+	-	+	-	+	+	+	-	-
	1992	+	-	-	+	+	-	-	-	-	-
Winters											
	1991	-	+	-	-	+	-	+	-	-	-
	1992	+	+	+	-	+	+	+	-	+	-
Guinda											
	1991	+	-	-	+	+	-	+	+	+	-
	1992	+	-	-	+	+	-	-	-	+	-

+ Significant at .05%
 - Not significant

ROOTSTOCKS

The Guinda trial has 10 cultivars grafted on both Northern California Black and Paradox walnut rootstocks. Table 2 shows the results comparing the two rootstocks. The Paradox rootstock was higher in nitrogen in 1991 but not in 1992. This might be due to young trees just coming into bearing. The Paradox trees were definitely larger trees. The same quantity of nitrogen was applied per tree. All trees show a high level of nitrogen in the leaves.

Paradox was significantly higher in phosphorus, calcium, magnesium and manganese. It was lower in potassium and zinc although only in 1991 was the zinc significantly lower.

The irrigation water at the Guinda orchard is high in sodium, chloride and boron. The leaf samples show high levels of boron with Paradox 23 and 12% higher in 1991 and 1992 respectively than N.C. Black. Chloride levels are also 64 and 52% higher in the Paradox. Sodium was analyzed in 1991 with all samples less than .01% so samples were not analyzed for sodium in 1992.

Table 2. Data evaluates leaf nutritional differences caused by rootstock. Guinda trial contains 10 cultivars replicated 3 times on each rootstock.

	<u>Year</u>	<u>N</u>	<u>P</u>	<u>K</u>	<u>Ca</u>	<u>Mg</u>	<u>Cl</u>	<u>B</u>	<u>Zn</u>	<u>Mn</u>	<u>Na</u>
N.C. Black	1991	3.29	.17	1.19	1.61	.49	.108	669	27.9	115	.01
Paradox	1991	3.42	.21	1.06	1.76	.56	.177	826	26.1	127	.01
Significant .05		+	+	+	+	+	+	+	+	+	-
N.C. Black	1992	3.26	.17	1.20	1.69	.52	.096	834	28.9	105	
Paradox	1992	3.27	.18	1.09	1.92	.62	.146	937	27.3	122	
Significant .05		-	+	+	+	+	+	+	-	+	

+ Significant at .05%
 - Not significant

NITROGEN

Table 3, 4 and 5 show the percent nitrogen in leaf samples from the Tulare Co., Winters and Guinda orchards. The first two orchards are orchards that have been bearing for several years while the Guinda orchard was grafted in 1989 and only produced a light crop in 1992. The Guinda orchard also contains several cultivars not present in the other two orchards with only Chandler, Tulare, and 67-13 as common cultivars.

In the two older orchards (Tulare Co. - 1983 planting and Winters - 1985 planting) Chandler had the highest nitrogen leaf level in 3 of the 4 analysis and was second in the fourth (3.43 compared to 3.46%). Consistently; Ashley, Payne and Tulare has had the lowest or near the lowest leaf levels of all varieties. While Tulare has had extremely high yields and in both trials Payne high yields in the Winters trial, Ashley has had lower yields. Chico has had high leaf levels in 3 of the 4 analysis while also having high yields. Yields of both the Tulare Co. and Winters orchards are reported in the chapter on high density plantings.

Table 5 shows results from the Guinda trial. The trees are not producing so data represents only growth factors and will be hard to draw conclusions.

Table 3. Shows the % nitrogen differences between varieties at the Tulare Co. variety trial.

<u>Variety</u>	<u>1991</u>		<u>1992</u>	
Chandler	3.51	A	3.45	A
Pedro	3.44	A B	3.28	A B
Amigo	3.41	A B	3.31	A B
Vina	3.40	A B C	3.40	A B
Serr	3.38	A B C	3.39	A B
Hartley	3.37	A B C	3.29	A B
68-104	3.31	A B C D	3.18	A B
Tehama	3.30	A B C D	3.23	A B
67-13	3.26	A B C D E	3.10	A B C
Chico	3.23	B C D E F	3.21	A B
Sunland	3.21	B C D E F	3.10	A B C
Howard	3.15	C D E F	3.22	A B
Tulare	3.09	D E F	3.24	A B
Ashley	3.02	E F	3.06	B C
Payne	2.99	F	2.79	C

Table 4. Shows the % nitrogen differences between varieties at the Winters variety trial.

<u>Variety</u>	<u>1991</u>	<u>1992</u>
Chandler	3.03	3.43 A
68-104	2.99	3.35 A B
67-13	2.96	3.28 A B
Chico	2.96	3.41 A
Sunland	2.92	3.31 A B
Amigo	2.91	3.46 A
Pedro	2.91	3.03 C
Howard	2.89	3.33 A B
Vina	2.77	3.17 B C
Tehama	2.74	3.13 B C
Ashley	2.72	3.05 C
Payne	2.69	2.99 C
Tulare	2.60	3.16 B C

N.S.		

Table 5. Shows the % nitrogen differences between varieties at the Guinda variety trial.

<u>Variety</u>	<u>1991</u>	<u>1992</u>
78-10	3.55 A	3.54 A
72-13	3.49 A	3.53 A
Cisco	3.46 A B	3.25 B C
Tulare	3.39 A B C	3.15 B C
78-189	3.36 A B C	3.33 B
77-12	3.35 A B C	3.12 B C
Chandler	3.32 A B C	3.29 B C
67-13	3.28 A B C	3.17 B C
77-10	3.18 B C	3.09 C
76-80	3.17 C	3.13 B C

PHOSPHORUS AND POTASSIUM

Results of phosphorus and potassium analysis are listed in Tables 6,7 and 8. While significant differences occurred in phosphorus between cultivars the differences were relatively small and as phosphorus has only been shown to be deficient in isolated cases in walnuts, I am unsure of how to interpret results.

Potassium differences only were significant in the 1992 Winters orchard where results showed borderline or deficient results following the 1991 results where many of the trees were deficient. Some potassium was applied between 1991 and 1992 plus better care and added nitrogen increased the entire health of the tree. Ashley, Payne, Tulare, Howard and Pedro were generally low in potassium although there were variations. Chandler, Sunland and Amigo were generally high in potassium.

Table 6. Shows differences between leaf samples between cultivars from the Tulare Co. orchard.

	Phosphorus		Potassium	
	1991	1992	1991	1992
Vina	.207 A	.170	2.20	2.15
Hartley	.193 A B	.183	2.12	2.12
Tehama	.193 A B	.170	1.92	2.12
67-13	.193 A B	.177	1.99	2.16
Sunland	.190 A B C	.190	2.35	2.45
Amigo	.190 A B C	.167	2.11	2.38
Chico	.190 A B C	.173	1.67	1.98
Howard	.187 B C D	.177	1.65	2.07
Tulare	.183 B C D	.173	1.73	2.12
Chandler	.183 B C D	.177	2.20	2.35
Serr	.183 B C D	.163	2.04	2.27
Ashley	.180 B C D	.170	2.21	2.33
68-104	.180 B C D	.157	2.12	2.29
Pedro	.173 C D	.177	1.99	2.20
Payne	.170 D	.180	2.15	2.28
		N.S.	N.S.	N.S.

Table 7. Shows differences between leaf samples between cultivars from the Winters orchard.

	Phosphorus				Potassium			
	1991		1992		1991		1992	
67-13	.203	A	.180	A B	.94	1.13	A B	
Sunland	.193	A B	.173	A B C D	.90	1.15	A B	
Amigo	.190	A B	.183	A	1.01	1.18	A	
Vina	.190	A B	.165	B C D	.94	1.06	A B C	
68-104	.190	A B	.175	A B C D	.98	1.07	A B C	
Howard	.188	A B	.170	A B C D	.92	.86	D	
Chandler	.188	A B	.170	A B C D	1.07	1.07	A B C	
Chico	.188	A B	.178	A B C	.96	1.05	B C	
Tehama	.185	B	.165	B C D	.87	1.06	A B C	
Tulare	.183	B	.170	A B C D	.94	1.00	C	
Pedro	.183	B	.1675	A B C D	.87	.97	C D	
Ashley	.178	B	.160	D	.91	.99	C	
Payne	.178	B	.163	C D	.91	.97	C D	

N.S.

Table 8. Shows differences between leaf samples between cultivars from the Guinda Orchard.

	Phosphorus		Potassium	
	1991	1992	1991	1992
78-10	.207	.185	1.03	1.12
Cisco	.195	.173	1.12	1.15
67-13	.195	.183	1.05	1.16
72-13	.193	.183	1.13	1.23
78-189	.190	.173	1.17	1.08
Tulare	.190	.170	1.16	1.14
Chandler	.187	.173	1.19	1.16
77-12	.182	.160	1.07	1.08
77-10	.180	.163	1.24	1.19
76-80	.177	.173	1.13	1.09

N.S. N.S. N.S. N.S.

CALCIUM AND MAGNESIUM

Tables 9, 10 and 11 show the percent calcium and magnesium for the three orchards. While both elements usually are not deficient in most of our soils these elements can influence uptake of several other essential elements.

In the two bearing orchards Tulare in the 4 analyses is the highest or very close to the highest in both calcium and magnesium. Howard on the other hand is the lowest or near the lowest in all analysis except magnesium 1992 in the Winters orchard.

Table 9. Compares the % Calcium and Magnesium in leaf samples between cultivars from the Tulare Co. orchard.

	Calcium		Magnesium	
	1991	1992	1991	1992
Tulare	2.46 A	2.63 A B C	.477	.443 A B C
Chico	2.36 A B	2.81 A B	.443	.370 C D
Tehama	2.26 A B C	2.48 A B C	.450	.443 A B C
Chandler	2.24 A B C	2.31 C	.357	.363 C D
Payne	2.22 A B C	2.50 A B C	.400	.467 A B
Pedro	2.19 A B C	2.54 A B C	.423	.423 A B C
Vina	2.18 A B C	2.67 A B C	.460	.443 A B C
Sunland	2.18 A B C	2.53 A B C	.373	.433 A B C
Ashley	2.14 A B C	2.43 A B C	.360	.413 A B C
67-13	2.11 A B C	2.90 A	.390	.473 A
Amigo	2.09 B C	2.36 B C	.410	.380 B C D
Serr	2.08 B C	2.25 C D	.413	.433 A B C
68-104	2.08 B C	2.25 A B C	.403	.460 A B
Hartley	1.95 C D	2.41 B C	.400	.397 A B C
Howard	1.74 D	1.87 D	.340	.313 D

N.S.

Table 10. Compares the % Calcium and Magnesium in leaf samples between cultivars from the Winters orchard.

	Calcium		Magnesium	
	1991	1992	1991	1992
Payne	1.45	1.52	.850 A B C	.965 A B
Ashley	1.44	1.57	.865 A B	.913 A
68-104	1.44	1.55	.905 A	.955 A B
Amigo	1.44	1.56	.830 A B C	.830 C D
Tehama	1.41	1.49	.848 A B C	.893 B C
Tulare	1.41	1.59	.885 A	.928 A B
67-13	1.39	1.47	.885 A	.905 A B
Pedro	1.38	1.55	.873 A B	.968 A
Sunland	1.37	1.42	.828 A B C	.835 C D
Chandler	1.33	1.54	.825 A B C	.903 A B
Vina	1.32	1.55	.878 A B	.955 A B
Chico	1.31	1.52	.790 B C	.815 D
Howard	1.29	1.43	.775 C	.963 A B

N.S.

N.S.

Table 11. Compares the % Calcium and Magnesium in leaf samples between cultivars from the Guinda orchard

	Calcium		Magnesium	
	1991	1992	1991	1992
78-18	1.98 A	2.14 A	.592 A	.607 A B
67-13	1.80 A B	1.85 B	.543 A B	.582 A B C
Tulare	1.80 A B	1.92 A B	.497 B C	.567 A B C D
76-80	1.69 B C	1.70 B	.495 B C	.545 B C D
77-12	1.69 B C	1.74 B	.505 B C	.498 D
Chandler	1.66 B C	1.75 B	.480 C	.532 C D
78-10	1.62 B C	1.78 B	.578 A	.575 A B C
Cisco	1.55 C	1.64 B	.542 A B	.588 A B C
77-10	1.55 C	1.78 B	.470 C	.537 B C D
72-13	1.53 C	1.77 B	.520 B C	.618 A

ZINC AND MANGANESE

Tables 12, 13 and 14 show the parts per million of zinc and manganese in leaf samples from the 3 trials. In comparing one year to the next within a single orchard there appears to be little consistency within a cultivar. It might be near the top one year and near the lowest the next. When you also look at the cultivars with higher values in one orchard and compare them to another orchard even greater variation occurs. This possibly indicates that the level of both zinc and manganese might be more dependent on other variables such as yield or amount of vegetative growth occurring during that year.

Table 12. Compares the ppm zinc and manganese in leaf samples between cultivars from the Tulare Co. orchard.

	Zinc		Manganese	
	1991	1992	1991	1992
Tehama	37.33 A	28.67	102.7	64.7
Chico	37.00 A	27.67	127.0	66.0
Sunland	36.67 A B	34.33	130.7	69.0
Serr	35.67 A B	30.00	117.3	66.0
Amigo	35.67 A B	29.67	116.3	78.0
Ashley	35.33 A B	33.00	114.0	59.3
Payne	34.33 A B C D	31.67	113.3	73.0
68-104	32.33 A B C D E	31.00	83.7	67.7
Vina	32.00 A B C D E	28.33	99.0	70.3
Howard	32.00 A B C D E	29.67	90.7	60.3
Chandler	31.33 B C D E	34.33	103.7	67.3
Tulare	31.00 C D E	31.33	89.0	70.7
67-13	30.33 C D E	36.00	110.3	91.3
Pedro	29.67 D E	32.33	82.7	58.3
Hartley	28.33 E	26.000	82.3	67.0

N.S.

N.S.

N.S.

Table 13. Compares the PPM Zinc and Manganese in leaf samples between cultivars from the Winters orchard.

	Zinc		Manganese		
	1991	1992	1991	1992	
Chandler	20.75	21.75	92.8	109.3	A
Howard	19.75	21.75	83.3	101.3	A B C D
Chico	19.25	19.75	76.3	98.5	A B C D
Vina	19.25	18.50	80.0	87.0	C D
67-13	19.25	17.50	86.3	105.3	A B
Amigo	19.00	19.75	80.5	108.3	A
Tulare	18.75	21.50	89.5	107.5	A B
Payne	18.75	19.25	91.0	94.5	A B C D
68-104	18.75	20.25	95.3	106.5	A B
Pedro	18.50	20.00	88.5	98.0	A B C D
Ashley	18.00	19.50	78.5	90.8	B C D
Sunland	18.00	17.00	92.8	102.8	A B C
Tehama	17.75	25.75	72.3	85.3	D

	N.S.	N.S.	N.S.		

Table 14. Compares the ppm zinc and manganese in leaf samples between cultivars from the Guinda orchard.

	Zinc		Manganese		
	1991	1992	1991	1992	
78-10	35.00 A	31.83	126.3 A B	115.5 A B	
Chandler	28.83 B	30.5	134.5 A B	124.2 A B	
77-10	28.50 B C	31.50	107.8 B C	110.5 B	
77-12	26.83 B C D	28.17	98.2 C	86.3 C	
Tulare	26.00 B C D	27.17	119.7 B C	112.5 A B	
67-13	25.67 B C D	25.83	147.0 A	137.5 A	
Cisco	25.50 B C D	26.33	125.1 A B C	122.5 A B	
78-189	24.83 C D	27.667	123.3 A B C	111.2 B	
72-13	24.50 D	26.83	109.2 B C	112.5 A B	
76-80	24.33 D	25.33	118.0 B C	101.2 B C	

	N.S.				

CHLORIDE, BORON AND SODIUM

Table 15, 16 and 17 shows the percent chloride and parts per million boron for leaf samples for 1991 and 1992. Also shown is the percent sodium for 1991 in the three test orchards. Sodium was not analyzed in 1992 because of the extremely low readings showing no differences in 1991 in all three orchards even though considerable sodium occurs in the Guinda irrigation water. These data suggest that sodium is excluded from walnut leaves under normal conditions growing on either N.C. Black or Paradox rootstock.

Tulare shows quite high levels of chloride in all three trials. Pedro and 68-104 also shows high levels in the two trials they are in. Most of the other cultivars vary between trials although Payne, Ashley, Tehama and Amigo are low in most but not all analysis.

Tulare, 67-13 and Chico show higher amounts of boron in most although not all cases than most other cultivars. Howard, Payne and Ashley generally were lower than many of the cultivars.

Table 15. Compare the % chloride and the ppm boron in leaf samples between cultivars from the Tulare Co. orchard.

	<u>% Chloride</u>		<u>PPM Boron</u>		<u>Na</u>
	1991	1992	1991	1992	
Tulare	.193 A	.163	70.7 A B C	116.0	.02
Chico	.190 A	.150	84.7 A	96.0	.02
Vina	.177 A B	.140	80.0 A B	98.0	.02
Pedro	.157 A B	.143	81.3 A B	104.0	.02
68-104	.150 A B C	.167	77.7 A B	102.7	.02
Chandler	.150 A B C	.153	69.0 A B C	98.3	.02
Howard	.147 A B C	.123	56.0 C	87.7	.013
Sunland	.147 A B C	.123	72.0 A B C	99.7	.023
Amigo	.147 A B C	.140	82.7 A B	95.3	.02
Tehama	.143 A B C	.133	74.3 A B	103.0	.02
Serr	.140 A B C	.143	81.3 A B	104.0	.02
Hartley	.133 A B C	.120	70.0 A B C	103.7	.02
67-13	.127 B C	.157	77.0 A B	108.3	.02
Ashley	.117 B C	.127	65.7 B C	88.0	.02
Payne	.093 C	.133	69.3 A B C	95.3	.02
		N.S.			N.S.

Table 16. Compares the % chloride and the ppm boron in leaf samples between cultivars from the Winters orchard.

	<u>% Chloride</u>			<u>PPM Boron</u>			<u>Na</u>	
	1991	1992		1991	1992		1991	
68-104	.272	.218	A	258.0	ABC	305.8	AB	.01
Payne	.213	.188	AB	233.8	C	246.8	E	.01
Tulare	.213	.228	A	269.8	A	262.5	CDE	.01
Pedro	.210	.218	A	233.0	C	248.8	E	.01
Ashley	.203	.210	AB	238.3	BC	262.0	CDE	.01
Howard	.195	.228	A	234.3	C	260.0	DE	.01
Vina	.195	.208	AB	259.3	ABC	270.3	BCDE	.01
Sunland	.195	.188	AB	232.8	C	294.3	ABCD	.01
Chico	.190	.183	AB	267.8	AB	299.8	ABC	.01
67-13	.190	.193	AB	272.3	A	302.8	AB	.01
Tehama	.180	.185	AB	238.8	BC	267.3	BCDE	.01
Amigo	.178	.163	B	266.8	AB	321.0	A	.01
Chandler	.175	.200	AB	240.3	BC	283.8	ABCDE	.01
-----							N.S.	N.S.

Table 17. Compares the % chloride and the ppm boron in leaf samples between cultivars from the Guinda Orchard.

	<u>% Chloride</u>			<u>PPM Boron</u>		<u>Na</u>		
	1991	1992		1991	1992	1991		
Tulare	.155	.135		800.5	A	888.0	.01	
77-12	.155	.117		775.7	ABC	866.0	.01	
78-189	.155	.120		787.0	ABC	922.7	.01	
72-13	.150	.132		664.2	BC	816.0	.01	
67-13	.140	.122		793.3	AB	917.5	.01	
78-10	.140	.132		761.8	ABC	896.3	.01	
Cisco	.138	.105		808.7	A	966.2	.01	
Chandler	.133	.120		660.7	C	845.7	.01	
77-10	.133	.122		691.8	ABC	832.8	.01	
76-80	.127	.105		731.5	ABC	905.0	.01	
-----							N.S.	N.S.

CONCLUSIONS

Leaf samples were collected and analyzed from three replicated walnut variety trials. The Tulare trial has 15 varieties that were grafted in 1983. The Yolo trial has 13 varieties grafted in 1985 and the Guinda trial has 10 varieties grafted in 1989. The first two trials have a production history reported under the high density management systems chapter. The last trial had limited production in 1992.

Data shows that rootstocks can have an influence on the leaf concentration of several nutrients. Leaf levels were higher for phosphorus, calcium, magnesium, chloride, boron and manganese and lower for potassium and zinc on Paradox rootstock.

Additional experiments specifically designed to grow Chandler, Tulare, Ashley and Payne and to evaluate growth, yield and nitrogen over several years would be needed to conclusively prove better uptake of Chandler.

While some differences of phosphorus and potassium were shown the relative small differences and the somewhat inconsistent results limit any conclusions.

In comparing calcium and magnesium the analyses of Tulare showed consistently high values for each of the elements. Howard on the other hand was consistently low indicating differences might exist. It might also indicate less nutrition moving into the rootstock of Howard and then early shutting down of the entire tree. We see premature yellow or pale color show on most Howard trees by mid summer in many orchards. Low levels of calcium and magnesium is also used to evaluate root health in diagnostic work. As both are low, in Howard it may indicate an entire tree slowdown early.

The analysis for sodium in 1991 where no differences were shown and where very low concentrations were found in all three trials and on both Paradox and N.C. Black rootstocks in the Guinda trial where moderately high sodium is present in the water shows that walnuts have the ability to limit or exclude sodium in the plant system. While we cannot conclude the roots exclude sodium because we only analyzed the leaves we can speculate that at least the walnut tree does not mobilize sodium and move it into leaves.

Chloride and boron were definitely higher in leaves on Paradox than on N.C. Black walnut. Tulare, Pedro and 68-104 showed high levels of chloride in the leaves while Payne, Ashley, Tehama and Amigo were generally low.

Tulare, 67-13 and Chico showed high concentrations of boron in most cases while Howard, Payne and Ashley were lower in boron. These tests suggest that some cultivars may be better able to tolerate higher rates of either chloride or boron.