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Seasonal Changes in 12 Leaf Nutrients of 'Lula' Avocado with Drip and Flood Irrigation[1]

Heinz K. Wutscher and Norman P. Maxwell[2]
U.S. Department of Agriculture, Weslaco, Texas

Abstract. **Leaf samples from 7-year-old avocado trees *(Persea americana* Mill. cv. Lula) grown with drip and flood irrigation were collected every 2 months for 2 years (2 leaf cycles) and analyzed for N, P, K, Ca, Mg, Na, Fe, Mn, Zn, Cu, Cl^-, and B. Mn and Cl^- levels were significantly higher with drip irrigation; levels of the other 10 elements were not affected by irrigation method. Levels of 11 elements did not differ from year to year; only Fe was higher in leaf-cycle 1972-1973 than in leaf-cycle 1973-1974. There were seasonal changes in 10 elements; Na and Zn did not vary significantly with sampling date. Ca, Mg, Fe, Mn, and Cl^- increased with leaf age; P, K, Cu, and B declined.**

Drip irrigation modifies the root environment by keeping soil water tension low, by creating a limited area of wet soil surrounded by dry soil, and by reducing fluctuations in water supply. Earlier work in California (4) has shown that irrigations at soil moisture tensions of ½, 1, and 10 bars had little effect on the levels of Zn, Cu, Mn, and B in avocado leaves. Seasonal changes in macro- and micronutrient concentrations in the orchard (3, 5) with both sandculture and field conditions (1) in California have been described. The present report compares leaf nutrient levels of 'Lula' avocado grown in Texas with drip and flood irrigation.

Eight rows, each of 12 'Lula' on 'Waldin' rootstock, were planted on Willacy fine sandy loam soil (pH 7.3) in Oct. 1964. Spacing was 3.7 x 7.6 m. Ammonium nitrate was applied at the rate of 150 kg N/ha broadcast each spring. Trees were flood irrigated 4 to 6 times a year with river water. A drip irrigation system with 2 Eternamatic[3] emitters per tree delivering 3.8 liters of water/hr per emitter was installed on 4 rows in July 1971, when the trees were 7 years old. The other 4 rows continued under flood irrigation. Amounts of water applied and of natural rainfall (liters/tree per month) are shown in Fig. 1. Rainfall was measured at a weather station at the edge of the grove. The drip irrigation system was on for a maximum of 9 hr/day, delivering 68 liters of water/tree,

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[2] Research Horticulturist, Subtropical Texas Area, Agricultural Research Service, Weslaco, TX 78596 and Associate Professor, Texas A&M University Research and Extension Service, Weslaco, TX 78596, respectively. The authors are indebted to H. D. Petersen, Agricultural Research Service, U.S. Department of Agriculture, College Station, TX 77840, for statistical analysis of the data and advice on their presentation.
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during dry periods and for shorter periods or not at all during rainy weather. Irrigation water contained 900 to 1,200 ppm total salts. Means of 6 analyses during the test showed a content of 5.0 meq/liter Cl^-, 7.3 meq/liter Na, 9.8 meq/liter $SO_4^=$, and a sodium adsorption ratio of 4.4.

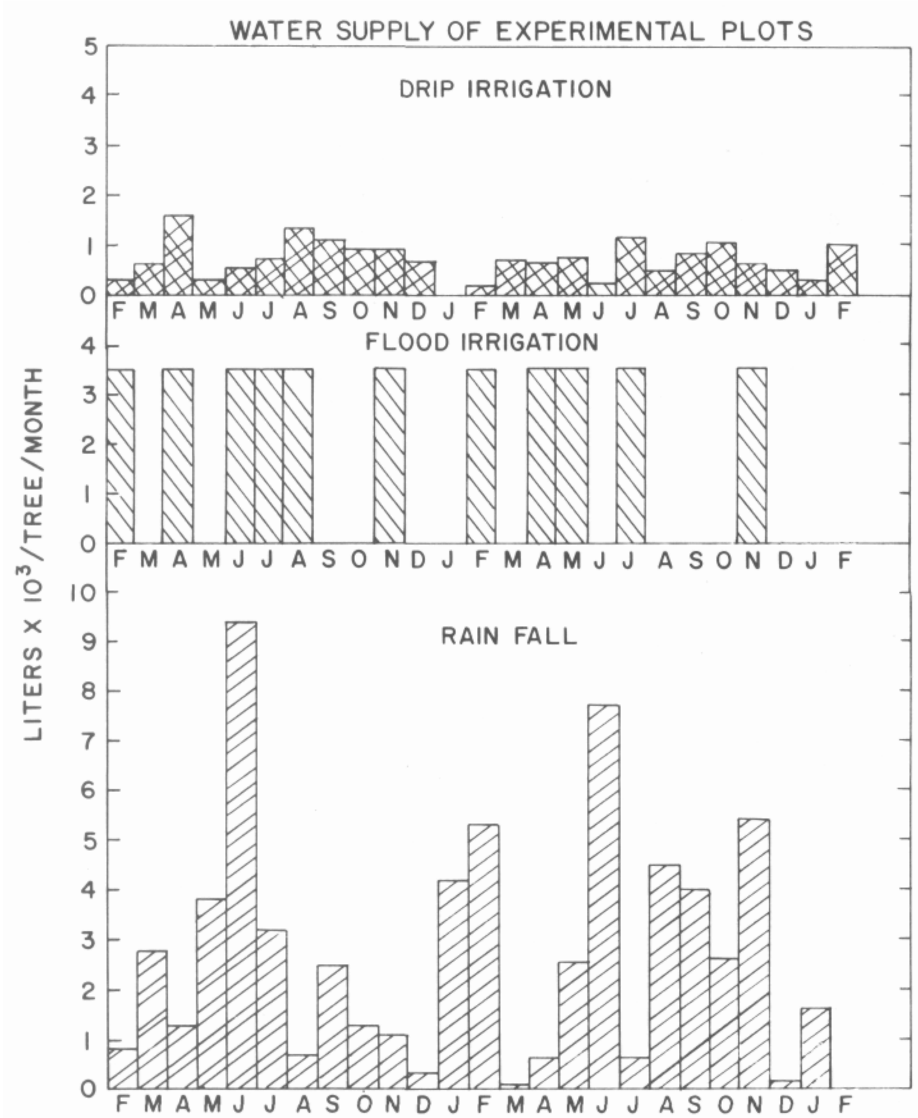

Fig. 1. Natural rainfall and water applied by drip and flood irrigation (liters/tree per month) from Feb. 1, 1972 to Feb. 28, 1974.

Eight spring flush leaves per tree from 4 two-tree plots in each irrigation treatment plot were collected between April 1972 and February 1974. Leaf samples were taken from nonfruiting terminals and contained both petioles and blades. Sampling dates at approx 60-day intervals are shown in Table 1. 'Lula' trees shed most of their leaves in Feb/March in Texas Sampling was designed to cover 2 complete leaf cycles. Leaf samples were analyzed for N, P, K, Ca, Mg, Na, Fe, Zn, Cu, B, Cl^-, and Mn by methods recently described (6).

Table 1. Seasonal changes in 10 leaf nutrient-elements of 'Lula' avocado trees with drip and flood irrigation in South Texas.

Sampling date	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	Fe (ppm)	Zn (ppm)	Cu (ppm)	B (ppm)
April	2.20^{z}a^{y}	0.221a	1.02abc	1.25b	0.32c	0.07a	39b	29a	11a	170a
June	2.02b	0.148b	0.91bc	1.18b	0.42b	0.08a	41ab	29a	9ab	146a
August	1.83c	0.147b	1.06ab	1.26b	0.46b	0.11a	39b	25a	8b	148a
Oct.	1.90bc	0.144b	1.15a	1.31b	0.42b	0.06a	44ab	29a	9ab	135a
Dec.	1.94bc	0.146b	0.82c	1.47b	0.42b	0.10a	43ab	28a	8b	86b
Feb.	2.02b	0.134b	0.81c	1.85a	0.58a	0.11a	49a	25a	4c	79b

^{z}Means of 2 years. Each value based on 16 samples collected from 8 two-tree plots.
^{y}Mean separation in columns by Duncan's multiple range test, 5% level.

A soil sample at 30 cm depth was taken at each corner of each of the 8 two-tree sampling plots at the end of the experiment. Samples around drip-irrigated trees came from the edges of the wet areas around emitters. Electrical conductivity of the saturated soil extract was determined by standard methods (2). Data were subjected to statistical analysis, with each year a replication.

Leaf analysis data for N, P, K, Ca, Mg, Na, Fe, Zn, Cu, and B are summarized in Table 1. Differences in leaf levels of Cl^- and Mn with leaf age and irrigation method are shown in Table 2. Leaf age had no significant effects on Na and Zn. Ca, Mg, Fe, Mn, and Cl^- were higher in older leaves than in younger leaves. The reverse was true for P, K, Cu, and B. N was high in very young leaves in the spring, decreased in the summer, and then rose again in the winter.

Table 2. Chloride and manganese levels in the leaves of drip- and flood-irrigated Lula avocado trees.

Sampling date	Cl^- (ppm)		Mn (ppm)	
	Drip	Flood	Drip	Flood
April	528^{z}c^{y}	233c	61c	52c
June	762c	411bc	63c	59c
August	1,155b	496b	101b	82b
Oct.	1,346b	475b	118a	90ab
Dec.	1,952a	852a	104ab	91ab
Feb.	2,291a	946a	120a	103a

^{z}Each number is the means of 2 years; each value is based on 8 samples collected from 4 two-tree plots.
^{y}Mean separation in columns by Duncan's multiple range test, 5% level.

Cl^- was consistently twice as high as or higher in the leaves of drip-irrigated trees than in flood-irrigated trees. Mn was also higher with drip Irrigation throughout the year, but the differences were much smaller (Table 2).

Soil on the edge of the wet area around emitters in drip-irrigated rows was significantly more saline, EC 1.21 mmhos/cm, than in flood-irrigated rows, EC 0.48 mmhos/cm. (Values are means of 16 samples.)

The probable reason for relatively high Cl^- levels with drip irrigation was that the trees were 7 years old and had root systems permeating all of the inter-row space when the irrigation method was changed. Rainfall in the area is sufficient to maintain good root systems in soil not covered by irrigation. Therefore, salt accumulated at the edges of the wet areas around the emitters in soil containing many feeder roots.

Higher Mn levels with drip irrigation are probably due to the greater accumulation of Mn^{++} ions in water-saturated soil than in dry soil. Wet areas around the emitters with drip irrigation were water-saturated almost continuously.

Seasonal patterns of nutrient concentrations in the leaves differed from year to year, like those reported earlier (3, 5), but not significantly, except for Fe. Increases in Ca, Mg, Fe, Mn, and Cl^- levels and decreases in P, K, Cu, and B with leaf age confirmed reports from California (1,3, 5). Na and Zn did not follow either pattern, and N was lower in the summer than at the beginning and the end of the leaf cycles.

It appears in areas like the Lower Rio Grande Valley with 60 cm of annual rainfall changing from flood to drip irrigation has little influence on nutrient uptake. The higher Cl^- accumulation with drip irrigation found in the present experiment may not be as pronounced in trees that were irrigated that way from the time of planting and whose root systems are confined to the wet zone.

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