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NUTRIENT COMPOSITION AND SEASONAL LOSSES OF AVOCADO TREES

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SUMMARY

Data are reported for the dry weight and nutrient element content of a bearing, seven-year-old Mexican seedling avocado tree, for amounts of nutrients translocated from the leaves of Fuerte trees before abscission, and for the amounts of dry matter and nutrient elements lost in abscised leaves and blossoms by two thirteen-year-old Fuerte trees during a two-year period. The data indicate that half or more of the nitrogen and phosphorus and substantial amounts of potassium, magnesium and sulfur are returned to the tree from the leaves prior to leaf abscission. Losses of dry matter and nutrient elements approximately equivalent to 25 per cent of the dry weight of the tree, 40 per cent of the nitrogen, phosphorus and potassium, 60 per cent of the calcium, and 75 per cent of the magnesium may occur each year in the blossoms and leaves that are abscised by an avocado tree. The relationships between these translocations and losses and the number and nutrient composition of the blossoms and the effects on tree growth are discussed.

INTRODUCTION

This study is part of a larger project concerned with chemical composition and seasonal changes in avocado trees. The purpose of the present study was to determine the total dry matter and nutrient element content of a bearing tree and to ascertain the amount, if any, of each element returned to the tree from the leaves and blossoms prior to abscission and to assess the seasonal losses involved in the shedding of leaves and blossoms.

MATERIALS AND METHODS

Between January 18, 1936 and February 8, 1938 eighteen seven-year-old bearing Mexican avocado seedlings were completely excavated, divided into 20 fractions and subtractions, weighed, and aliquots prepared for dry weight determinations and chemical analyses. Data indicating total dry weight and nutrient element content of the tree excavated on February 29, 1936 are presented in this report.

Fuerte avocado leaves representing normal green leaves and leaves about to fall and paired according to size were collected from mature Fuerte avocado trees (set out in 1929) in the spring of 1951 and again in 1952. The sampling procedure was similar to that used earlier by Cameron and Bialoglowski (3). These samples were analyzed for nutrient elements to determine the proportions translocated from the leaves before they fall.

From April, 1942, until April, 1944 (two full years) all the abscised leaves and blossoms from two mature Fuerte avocado trees were caught on screen wire platforms erected under the trees. The trees were 13 years old in the spring of 1942, when collections were started. For convenience the trees have been designated "C" and "D." Tree "C" was a high producer for both years and Tree "D" a low producer in each of the two years. The shed parts were collected from the platforms at approximately weekly intervals, separated, counted, weighed, and an aliquot of each lot cleaned, dried at 70°C, and preserved for chemical analysis. The analytical procedures have already been described (6). Aliquots of leaves and blossoms were weighed and counted to determine the total number which fell from each of the two trees.

RESULTS AND DISCUSSION

The fresh and dry weights of each fraction, the relative proportion of each fraction to the total, nutrient content as per cent of dry weight and as grains per fraction, and as totals for the Mexican seedling tree are shown in table 1. The tree which weighed 116,038 grams (dry weight) contained 929.3 grams nitrogen, 79.6 grams phosphorus, 742.8 grams potassium, 781.0 grams calcium, and 198.5 grams magnesium. More than half of the total nutrients were concentrated in the leaves, which constitute about one-fourth of the dry weight of the tree. If, therefore, as suggested below, a relatively large proportion of the nutrients in the leaves may be withdrawn for reuse I in blossoms and new growth, it is apparent that the leaves constitute by far the most important reservoir of these elements in the avocado tree.

The additional 17 trees collected periodically during 1936-1937 will be analyzed in the future as part of a study of seasonal changes in the nutrient status of avocado trees. A more detailed account of sampling and analytical techniques will be made a part of the report of those studies. The nutrient content of green avocado leaves compared with those about to abscise is indicated by the data in table 2. Cameron and Bialoglowski (3) have previously reported that half or more of the nitrogen from avocado leaves returns to the tree before the leaf is shed. The present data indicate that about 57 per cent of the phosphorus, 25 per cent of the potassium, and33 per cent of the sulfur return to the tree before leaf abscission. This suggests that the leaves may serve as the major source of supply of these nutrients for the blossoms and the new flush growth that occurs simultaneously with or just before the leaves abscise (figure 1). Calcium, iron and manganese are apparently not translocated from the leaf prior to abscission.

Table 1
Green and dry weights and nutrient content of twenty fractions of a seven-year-old bearing Mexican avocado seedling (excavated February 29, 1936)

Fraction		Green weight	Dry weight	Distribution of dry weight	Percent of dry weight					Amount in grams				
					N	P	K	Ca	Mg	N	P	K	Ca	Mg
Blossoms		10505	2127	1.83	2.54	.308	1.93	.50	.14	54.0	6.6	41.1	10.6	3.0
Leaves		66397	28358	24.44	1.87	.110	1.16	1.78	.45	527.4	31.2	328.9	504.8	127.6
Twigs	bark	10490	4392	3.78	.81	.065	1.16	1.70	.36	35.1	2.9	51.0	74.7	15.8
	wood	16864	8233	7.10	.71	.089	.70	.45	.12	58.4	7.3	57.6	37.1	9.9
Shoots	bark	5769	2170	1.88	.74	.063	.99	1.20	.19	16.0	1.4	21.5	26.0	4.1
	wood	15456	10233	8.82	.34	.046	.43	.09	.07	34.8	4.7	44.0	9.2	7.2
Lateral branch	bark	3618	1285	1.12	.82	.076	.85	.93	.11	10.5	1.0	10.9	12.0	1.4
	wood	14202	7544	6.50	.22	.031	.26	.13	.06	16.6	2.3	19.6	9.8	4.5
Scaffold	bark	6012	2208	1.90	.82	.088	.87	.75	.10	18.1	1.9	19.2	16.6	2.2
branches	wood	36551	19913	17.16	.20	.030	.24	.15	.05	39.8	6.0	47.8	29.9	10.0
Trunk	bark	1771	607	0.52	.80	.092	.94	.88	.11	4.8	0.6	5.7	5.3	0.7
	wood	14119	7806	6.73	.20	.030	.24	.13	.04	15.6	2.3	18.7	10.2	3.1
Main root	bark	3608	1187	1.02	.90	.077	.54	.43	.12	10.9	0.9	6.4	5.1	1.4
	wood	7912	3751	3.23	.31	.038	.28	.13	.04	11.2	1.4	10.5	4.9	1.5
Primary root	bark	4077	1352	1.17	.72	.132	.85	.48	.09	9.7	1.8	11.5	6.5	1.2
	wood	20383	9170	7.90	.41	.038	.26	.08	.02	37.6	3.5	23.8	7.3	1.8
Secondary root	bark	1823	643	0.55	.66	.120	.83	.33	.09	4.2	0.8	5.3	2.1	0.6
	wood	5485	2464	2.12	.42	.043	.26	.12	.04	10.3	1.1	6.4	3.0	1.0
Tertiary root	bark	1426	573	0.49	.74	.086	.97	.58	.13	4.2	0.5	5.6	3.3	0.7
	wood	4655	2022	1.74	.50	.068	.36	.13	.04	10.1	1.4	7.3	2.6	0.8
Total		251123	116038	100.00						929.3	79.6	742.8	781.0	198.5
Weighted average					.80	.068	.64	.67	.17					
Pounds		553	258							2.0	0.18	1.64	1.72	0.44

Table 2
Nutrient content of Fuerte avocado leaves about to fall
compared with those still normally green
(Means of collection made in 1951 and in 1952)

Kind of leaves	N	P	K	Ca	Mg	Fe	Mn	S
				Per cent of dry matter				
Green	1.91	0.102	1.18	2.33	0.54	0.0175	0.0112	0.23
About to fall	0.98	0.046	0.89	2.29	0.50	0.0214	0.0125	0.18
				Mgm. per leaf				
Green	20.5	1.10	12.4	25.3	5.9	0.18	0.12	3.0
About to fall	10.2	0.47	9.3	24.2	5.3	0.23	0.12	2.0
Per cent loss	50.2	57.3	25.0	3.6	10.2	——	——	33.3

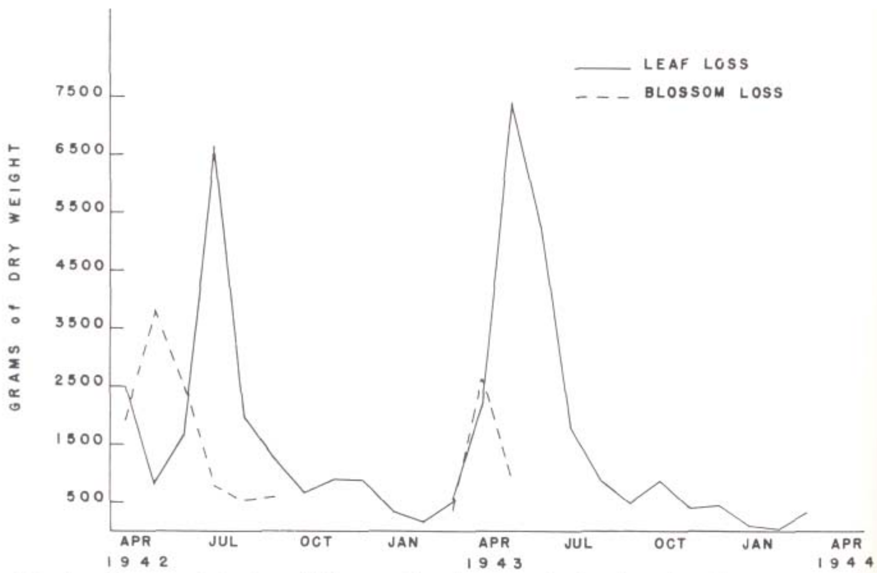

Fig. 1. *Grams of leaf and blossom loss by months for bearing Fuerte avocado trees showing that maximum leaf loss follows closely the maximum period of blossom loss. Data are means of two trees.*

Table 3

Two-year yields of Fuerte avocado trees representing high and low fruit production with the amounts of blossom and leaf loss and nitrogen and phosphorus contents of the fallen leaves and blossoms. [a]

	Tree "C" (High) 1942	1943	Tree "D" (Low) 1942	1943
Yield, no. of fruits	497	409	21	85
No. of blossoms	1,594,000	178,000	1,608,000	1,114,000
Wt. of blossoms (gm)	9,722	1,093	9,834	6,944
No. fallen leaves	22,190	25,090	23,780	33,687
Wt. of leaves (gm)	18,207	17,217	17,497	23,687
Nitrogen in blossoms (%)	2.13	2.51	1.89	2.29
Nitrogen in leaves (%)	0.94	0.95	1.01	0.90
Phosphorus in blossoms (%)	0.252	0.312	0.239	0.271
Phosphorus in leaves (%)	0.041	0.044	0.038	0.042

[a] The 1942 year was considered as the time from April 1, 1942, until March 31, 1943, and the 1943 year from April 1, 1943, until March 31, 1944. Nitrogen and phosphorus are expressed as per cent of dry weight.

Pertinent data relating to the two Fuerte trees from which shed parts were collected are presented in table 3. The production records of these two trees prior to and during the period of collection were as follows: Tree "C": 526 fruits in 1940-41, 21 in 1941-42, 497 in 1942-43, and 409 in 1943-44. Tree "D": 22, 4, 21 and 85 respectively. It will be observed that there was no apparent relationship between the number of fruits produced and the number of blossoms from which the crop was set. In 1942 each tree produced 1.6 million blossoms. One tree matured 497 fruits, the other 21. In 1943 Tree "C" matured a crop of 409 fruits from 178,000 blossoms, whereas Tree "D" produced only 85 fruits from 1,114,000 blossoms. The reasons for this difference in fruiting behavior as between trees in the same season and the same tree in different seasons are not known. The two trees in question were of the same clone and were growing adjacent to each other in the same row. The low yielding tree ("D") shed more leaves in 1943 than did Tree "C.' This probably was the result of a greater production of new growth and leaf production by this tree in 1942 than was made by Tree "C," which was carrying a large crop. The analytical data suggest a direct relationship between the average nitrogen and phosphorus content of the blossoms and the amount of bloom. This is probably largely the result of depletion of these elements (see table 5). The content of potassium, calcium and magnesium apparently was not influenced *by* the number of blossoms produced. No clear-cut relationship between the number of blossoms produced and the number or nutrient element composition of abscised leaves is evident.

Some of the data for trees "C" and "D" are combined and presented in figure 1 and tables 4 and 5 to show the seasonal pattern of leaf and blossom abscission and the differences between two consecutive years. Leaves were shed during every month of the year, but the peak losses occurred in April, May, June and July. In the first year most leaves fell in July, 36.4 per cent of the total, or almost three times as much as in any other single month. In the second year the same relative number (36.4 per cent) were abscised in May, with only 8.8 per cent in July. The period of maximum blossom loss was also later in 1942 than in 1943. This seasonal difference in behavior almost certainly may be attributed to effects of temperature. Recording thermometer records show that February and the first two weeks in March were considerably warmer in 1943 than in 1942. Substantial blossom losses occurred in April, May and June of both years.

Dry weight and nutrient content of abscised leaves by months and the yearly totals for both years are given in table 4. Similar data for blossoms are in table 5. Seasonal trends existed in the nutrient content of both abscised leaves and blossoms. Higher percentage contents of nitrogen, phosphorus, and potassium were observed for leaves that abscised in periods of relatively little leaf loss. It is possible that younger leaves were abscised during this period or that this observation is the result of larger translocation of nutrients from old leaves to blossoms and new leaves just preceding the maximum period of leaf fall. For some unknown reason leaf calcium decreased during the second year but not during the first. The average total dry weight of abscised leaves per tree was 17,852 grams in the first year and 20,452 in the second. Nutrient losses per tree from fallen leaves for each year were 174 and 188 grams nitrogen, 7 and 8 grams phosphorus, 113 and 106 grams potassium, 450 and 492 grams calcium, and 123 and 151 grams magnesium (table 4).

Blossoms produced late in the season contained much smaller quantities of nitrogen and phosphorus than those produced early. This observation is similar to those made earlier on citrus flowers (2, 4). In both citrus and avocados the late blossoms are reported to set more fruit than early season blossoms (1, 4, 5). Our collections were too gross to permit us to draw any conclusions concerning the effect of nutrient composition of the blossoms on fruit set. Average losses in shed blossoms during the two years amounted to 9796 and 4018 grams of dry weight, 196 and 93 grams of nitrogen, 24 and 11 grams of phosphorus, 198 and 74 grams of potassium, 75 and 29 grams of calcium, and 32 and 15 grams of magnesium.

Although we cannot consider the values strictly comparable, it is of some interest to indicate the magnitude of the dry weight and nutrient element losses involved in abscised leaves and blossoms by relating them to the total dry weight and nutrient element content of the tree. The values obtained by so doing are perhaps somewhat too high in this instance because the Mexican seedling tree used for reference was younger and smaller than the Fuerte trees from which the shed parts were collected. We consider it unlikely, however, that the values would have been significantly different had the trees been of the same size and variety, for the following reasons: (a) The leaf complement of the trees was roughly comparable in amount; (b) leaves of the two species are similar in nutrient element content; (c) at least half the nutrient content of the tree is concentrated in the leaves; and (d) the reported values do not include the losses in immature fruits, which in some seasons are very substantial.

Subject to the above limitations our data show that the dry weight of the abscised leaves was approximately equal to 20 per cent of the total dry weight of the tree, including the leaves. The shed leaves contained approximately 20 per cent of the total nitrogen in the tree, 10 per cent of the phosphorus, 15 per cent of the potassium, 50 per cent of the calcium, and 60 per cent of the magnesium. Comparable values of the blossoms were 8 per cent of the total dry weight, 20 per cent of the nitrogen, 30 per cent of the phosphorus, 25 per cent of the potassium, 10 per cent of the calcium, and 15 per cent of the magnesium. Taken together these values indicate that losses equivalent to more than 25 per cent of the dry matter of the tree, 40 per cent of the nitrogen, phosphorus and potassium, 60 per cent of the calcium, and 75 per cent of the magnesium may occur each year in the blossoms and leaves that are shed by an avocado tree.

The effects of dry weight and nutrient element losses on the growth and fruiting of the tree are not known at the present time. It is hoped that other studies now in progress will lead to a better understanding of the relationships involved.

LITERATURE CITED

1. *Bringhurst, R. S. Influence of glasshouse conditions on flower behavior of Hass and Anaheim avocados. Calif. Avocado Soc. Yearbook 1951: 164-168. 1952.*
2. *Cameron, S. H., and Appleman, D. Total nitrogen in developing flowers and young fruits of the Valencia orange. Amer. Soc. Hort. Sci. Proc. 32:204-207. 1934.*
3. *Cameron, S. H., and Bialogloivski, J. Effect of fertilization, ringing, blossoming and fruiting on the nitrogen content of avocado leaves. Calif. Avocado Soc. Yearbook 1937:142-148. 1938.*
4. *Haas, A. R. C. Orange fruiting in relation to the blossom opening period. Plant Physiol. 24: 481-493. 1949.*
5. *Lesley, J. W., and Bringhurst, R. S. Environmental conditions affecting pollination of avocados. Calif. Avocado Soc. Yearbook 1951: 169-173. 1952.*
6. *Wallace, A., Cameron, S. H., and Mueller, R. T. Seasonal use and loss of nutrients and dry matter in orange trees. Proc. Amer. Soc. Hort. Sci. 58:5-10. 1951*

Table 4

Leaf loss by months and nutrient composition of leaves abscised from two 13-year-old Fuerte avocado trees from April, 1942, until March, 1944 (mean of two trees) [a]

	April 1942 to March 1943						April 1943 to March 1944					
	Total gms.		Per cent of dry weight				Total gms.		Per cent of dry weight			
Month	dry weight	N	P	K	Ca	Mg	dry weight	N	P	K	Ca	Mg
April	2530.7	0.90	.038	.66	2.22	0.59	2219.3	0.86	.034	.43	2.53	.69
May	815.0	0.93	.039	.73	2.33	.59	7438.1	0.85	.034	.47	2.72	.77
June	1668.7	0.90	.039	.71	2.52	.67	5257.3	0.78	.032	.48	2.36	.69
July	6174.2	0.88	.037	.63	2.56	.70	1808.3	0.96	.051	.73	1.92	.71
Aug.	1966.0	0.83	.031	.47	2.69	.73	928.8	1.01	.078	.70	1.83	.59
Sept.	1253.9	0.86	.034	.52	2.62	.72	476.0	1.30	.089	.83	1.76	.63
Oct.	644.6	1.01	.042	.51	2.61	.70	883.6	1.17	.082	.73	1.86	.64
Nov.	911.4	0.90	.038	.44	2.88	.77	418.4	1.06	.059	.69	1.92	.65
Dec.	871.8	1.31	.057	.59	2.38	.68	425.1	1.36	.071	.65	2.03	.63
Jan.	332.8	1.61	.080	.79	1.97	.63	147.6	1.24	.067	.83	1.98	.62
Feb.	138.7	1.34	.061	.65	2.34	.68	98.9	1.44	.083	.80	1.99	.61
Mar.	543.9	0.97	.034	.45	2.51	.69	350.1	1.44	.082	.90	1.99	.57
			Total in grams						Total in grams			
Year	17851.7	173.5	7.04	113.5	449.9	122.9	20451.5	188.3	8.08	106.4	491.9	150.7

[a] Data for all collections within each month were grouped and averaged.

Table 5

Blossom loss by months and representative nutrient composition of blossoms abscised from two 13-year-old Fuerte avocado trees from April 1942 until March 1943 (mean of two trees) [a]

	April 1942 to Sept. 1942						March 1943 to May 1943					
	Total gms.	Per cent of dry weight					Total gms.	Per cent of dry weight				
Month	dry weight	N	P	K	Ca	Mg	dry weight	N	P	K	Ca	Mg
March							384.1	2.68	.290	1.68	.86	.44
April	1921.3	2.52					2665.4	2.67	.332	1.84	.90	.40
								2.59	.318	1.86	.81	.38
								2.42	.282	1.99	.84	.39
May	3775.3	2.44	.305	1.91	.68	.33	968.9	2.22	.263	2.06	.89	.37
		2.26	.271	2.34	.80	.39		1.75	.260	2.42	.86	.38
June	2593.7	1.76	.191	2.55	.73	.30						
July	802.3	1.54	.163	2.52	.62	.27						
		1.32	.195	2.27	1.45	.34						
Aug.	322.9											
Sept.	362.6	0.81	.141	1.79	1.86	.33						
		Total in grams						Total in grams				
Total	9778.1	196.4	24.0	198.1	75.2	32.1	4018.4	93.1	11.1	74.8	29.3	15.2

[a] Data for all collections within each month, except for two months in 1943, were grouped and averaged.