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SOME INORGANIC CHANGES IN THE PULP OF MATURE FUERTE AVOCADO FRUIT

A. R. C. Haas
Plant Physiologist, University of California, Citrus Experiment Station, Riverside
J. N. Brusca
Senior laboratory technician in the same department.

SUMMARY

Percentage changes occur in the calcium, magnesium, and potassium content in the dry matter of the stem and tip portions of the pulp of Fuerte avocado fruit during the season in which the fruit are mature.

The fresh weights or sizes of the mature fruit in the samples picked at various times increased during the season of fruit maturity as the sampling (thinning) progressed.

The percentages of calcium in the dry matter of the pulp decrease as the season of fruit maturity advances and in every case, even though the percentages of calcium are low, the percentages are highest in the stem portions.

In the dry matter of the pulp, the percentages of magnesium in the stem portions are higher than in the tip portions only in the first half or more of the season of fruit maturity and these high percentages in the stem portion decrease very markedly. The percentages of magnesium, in both portions of the pulp, greatly exceed the percentages of calcium.

The dry matter of avocado pulp contains large percentages of potassium. Whereas the calcium and magnesium percentages are usually higher in the dry matter of the stem than in the tip portion of the pulp, the percentages of potassium are highest in the tip portion. The percentages of potassium in the dry matter of the pulp decrease as the season of fruit maturity progresses.

Possibly the total content of Ca, Mg, and K is attained in the early phases of fruit development and the decreased percentages may largely or entirely be the result of a dilution brought about by the increase in organic matter content.

Chlorides may accumulate in the fruit stalk or pedicel after the fruit reaches maturity. In orchards in which the soils contain high concentrations of chlorides, the picking of the mature fruit may be necessary at the earliest possible date.

The changing composition of an avocado seed was followed by means of graphs in a previous article[1] in which it was shown that certain constituents of the seed may be moved or translocated to other portions of the fruit. Approximately half of the maximum content of potassium (K) in the seed is removed during the period of fruit maturity. It is desirable that we follow some of the changes occurring in pulp of Fuerte avocado fruit

during the season in which the fruits are mature.

For this purpose a Carr Fuerte avocado tree on Ganter rootstock (C.E.S. R 20, T 2) was selected because of its large crop of available fruit, its excellent tree and orchard conditions and its convenience to the laboratory.

The first lot of fruit was picked on November 10, 1952, and out of about twelve fruits (taken by means of a pole picker with a cloth bag attached at the top) a sample of eight uniform fruits was selected for chemical analysis. In picking the fruit, care was taken to obtain the fruit stalk or pedicel. The sample was permitted to lie on a table until the fruit, upon slight pressure, was considered sufficiently soft as to be edible and in good condition for removing the skin, the seed and the seed coats. The fresh weights of the fruit sample were obtained immediately after being picked and also at the time when the fruits were sufficiently soft. From these weights the loss, during softening, could be determined as a per cent of the original fresh weight of the sample.

The fruits were then lightly scrubbed under running distilled water and wiped dry before removal of the button, skin, seed and seed coats in obtaining the pulp. During the season of fruit maturity a series of seven fruit samples was obtained.

The chemical data are for the most part shown in table 1. In order for the samples of fruit to become soft, the sample nos. 1 to 7 inclusive required: 10, 10, 8, 7, 8, 7, and 7 days, respectively, the first two samples requiring the longest period. These two samples of fruit (table 1) lost the largest percentages of their original weight during the period required for the softening of the pulp.

Figure 1 shows the weights of the fruit samples both at the time of collection and when soft, the two graphs being quite similar. After the data were assembled, it was found that the fresh weights of the fruit samples showed a steady increase during most of the mature Fuerte avocado season at Riverside. Figure 1 show's the extent of the increase in fruit size or weight as the season of fruit maturity and fruit thinning (sampling) progressed.

When the pulp was obtained from each fruit of a fruit sample, thin sections of pulp from the stem and tip portions were placed in weighed porcelain dishes. With a sample of eight fruits, eight sections were cut from the stem and the tip portions and were distributed among the dishes in such a manner that each dish contained comparable portions of the pulp end that was sampled. The dishes containing the pulp samples were dried to constant weight at 65°C in a ventilated oven.

Dilute sulfuric acid and hot distilled water were added to the dry matter samples used for the determination of potassium and sodium; magnesium nitrate solution and hot water were added to the samples used for the total sulfur content (expressed as sulfate) and sodium carbonate solution and hot water were used for the total chloride content. All these samples were then dried on a hot plate at low heat. Ignition of the samples for the Ca, Mg, K, and Na determinations were carried on at low heat, followed when cool by the leaching-out of soluble salts with hot water and by the re-ignition of the residues. After the addition of dilute HC1 to the dishes, the combined filtrates were used for the duplicated or triplicated chemical determinations.

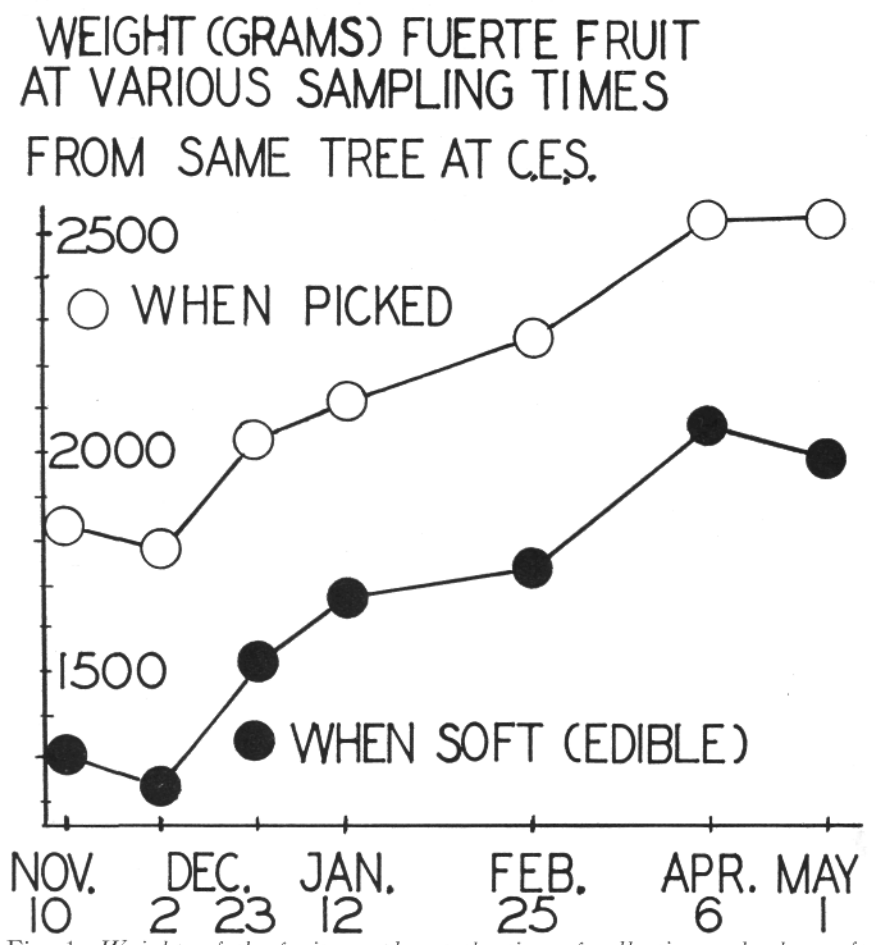

Fig. 1. *Weights of the fruit samples at the time of collection and when soft. Note the steady increase in the fruit weights or sizes as the maturity season and the fruit thinning (sampling) progressed.*

In the case of sulfur, small additions of magnesium nitrate were repeatedly made after the repeated ignitions, until the ash was practically free of carbon, when dilute HC1 was added and the sulfate was determined in the filtrate. The Vycor 250 ml. beakers aided by cover glasses were used to advantage in the place of porcelain dishes in the ignitions for the total sulfur determinations.

In table 1, the data show for a given sampling that the calcium (Ca) percentages in the dry matter of the stem portion always exceed those of the tip portion of the pulp. In figure 2, the percentages of Ca in the dry matter of both portions of the pulp decrease as the season of Fuerte fruit maturity progresses.

The data in table 1, for the magnesium (Mg) content in the dry matter of the pulp, show that the percentages during the first half or more of the mature Fuerte fruit season are greater for the stem than for the tip portions. When the season was well advanced, the percentages of Mg (fig. 3) in the dry matter of the stem portions were less than those of the tip portions. The dry matter of Fuerte avocado pulp contains in both portions of the

fruit considerably more Mg than Ca. Avocado leaves also contain large amounts of Mg, the dry matter containing approximately double the percentage of Mg as does that of citrus leaves. Note the steepness of the decrease in the percentages of Mg in the stem portion of the pulp in the first few samples of mature fruit. Without experimental proof, however, it cannot be concluded that inorganic elements such as Mg can be withdrawn by the leaves from the fruit.

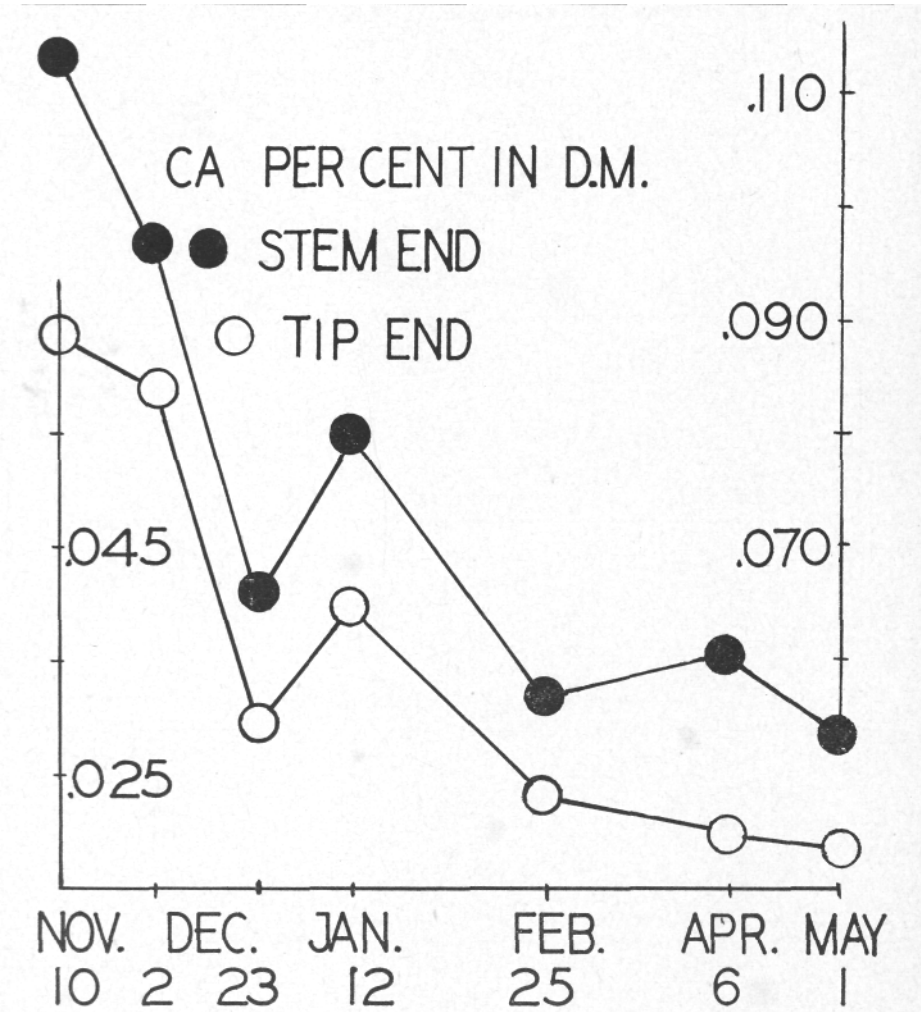

Fig. 2. *The graph shows the decrease in calcium percentages in the dry matter in both the stem and tip portions of the pulp as the season of the fruit maturity advances. The values for the stem portions always exceeded those for the tip portions for a given sampling.*

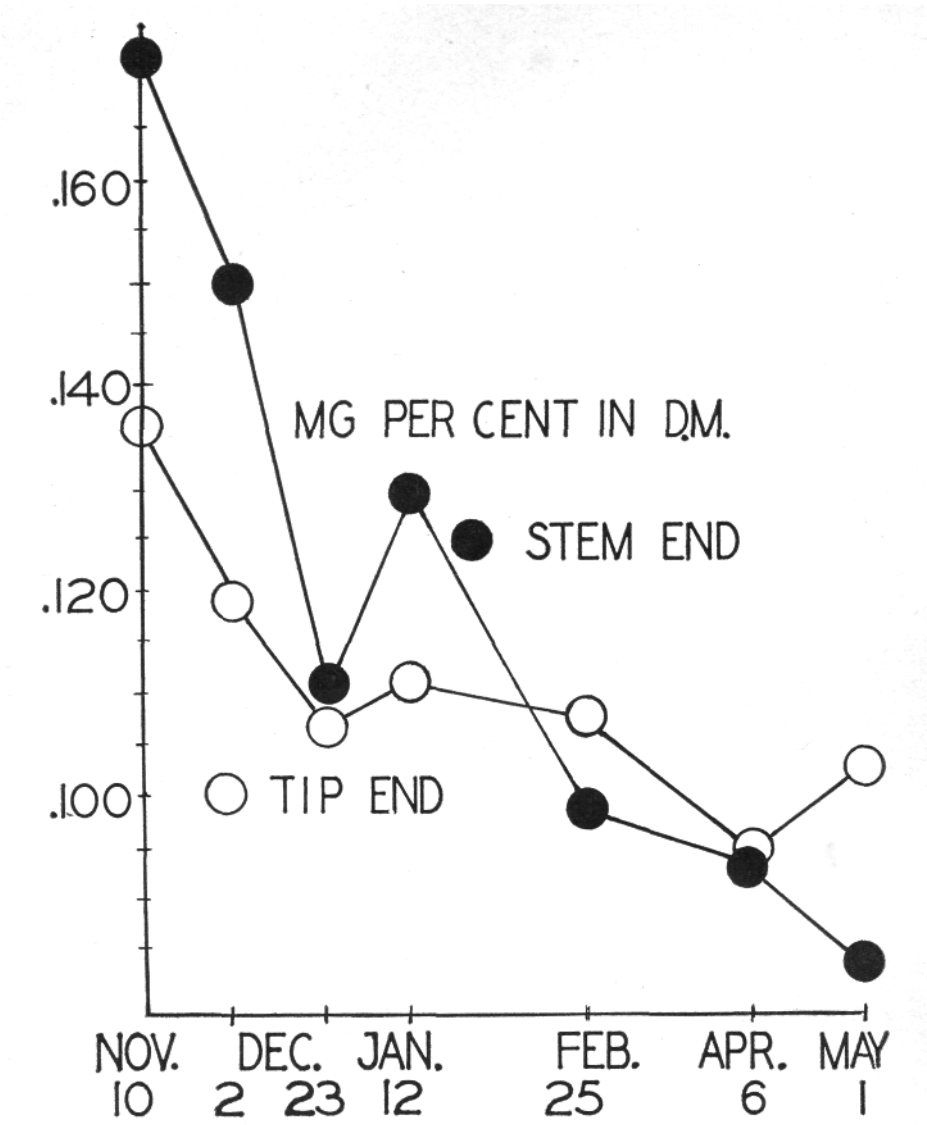

Fig. 3. *The percentages of magnesium in the dry matter of the pulp of the stem portion exceed those for the tip portion only for the first part of the period of fruit maturity. During this time the percentages for the stem portion decrease very markedly.*

Table 1 and figure 4 show that the percentages of potassium (K) are greater in the dry matter of the tip than in that of the stem portion of the pulp, quite the reverse of the Ca and Mg percentages. The percentage of K in both portions of the pulp decreases as the state of fruit maturity is increased.

In the stem portion of the pulp, the percentages of total sulfur (determined as sulfate) in the dry matter increased in the fruit during the early stages of full maturity and then decreased: .359, .429, .408, .386, .349 and .289 per cent, respectively. The trend in the dry matter of the tip portion (table 1) only in part was of this same pattern.

When the fruit samples were collected, care was taken to obtain the fruit stalk or pedicel which for this study was taken to be the portion between (not including) the button and

the first joint. Since in the orchard in which this tree was grown the soil contains a minimum of chloride, it was considered worthwhile to test whether chlorine could be detected as accumulating in the fruit stalk or pedicel as fruit maturity increased.

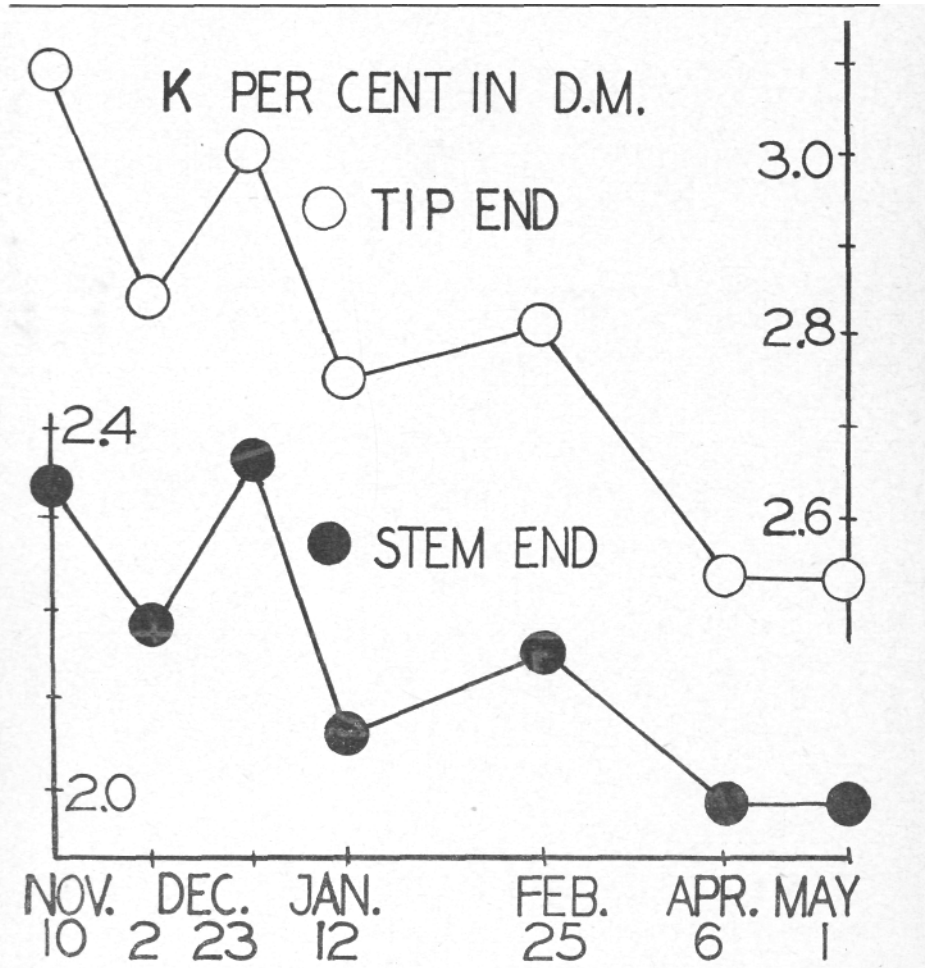

Fig. 4. *Unlike the percentages of calcium and magnesium which were usually highest in the dry matter of the stem portion of the pulp, the percentages of potassium are highest in the dry matter of the tip portion of the pulp.*

Large samples of dry matter were used for the chloride determinations. After a low temperature ignition of the dry matter containing sodium carbonate, the cooled material was leached with hot water to remove salts and the residue was re-ignited and leached with dilute nitric acid and hot water, the combined filtrates being used for chloride precipitation. The data obtained are shown as a graph in figure 5 and reveal that even when the chloride concentration is very low, the chloride may be accumulated in the fruit stalk or pedicel during the season in which the fruit is mature. In orchards in which the soil contains much chloride, the chloride accumulation in the leaves and fruit stalk or pedicel may become excessive as to require the earliest possible harvesting of the fruit.

The percentages of sodium (Na) in the dry matter of the pulp were very small, the

values for the stem portions of sample nos. 1 to 7 inclusive being 0, 0, .030, 0, .095, 0, 0, per cent, respectively, and for the tip portions, .158,0, 0, 0, .061, .027, and .038 per cent, respectively.

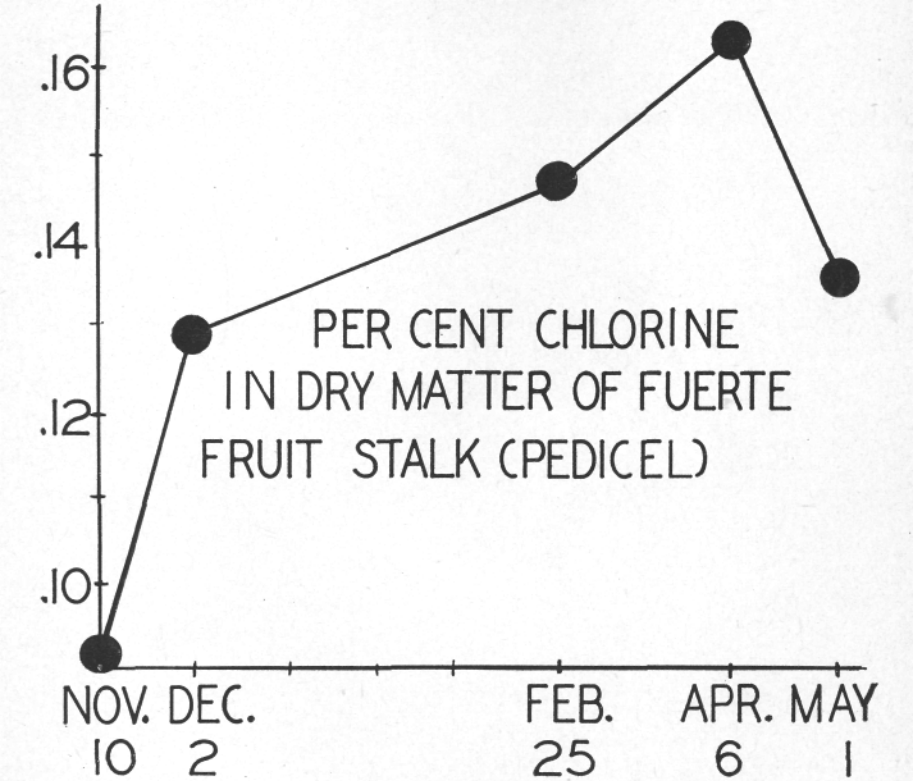

Fig. 5. *After the fruit is mature, the chloride continues to accumulate in the fruit stalk or pedicel. In orchards in which the soil contains high chlorine concentrations the accumulation in the leaves and fruit stalks or pedicels may make necessary the earliest possible fruit picking.*

Table 1

Changes in the inorganic composition of the pulp of fruit collected at various times from a Carr Fuerte avocado tree grown on a Ganter avocado rootstock at Riverside (C.E.S. R20 T2).

Sample No.	No. of fruit in sample	Fresh wt. of fruit when collected		Fresh wt. of fruit when edible	at (soft) stage	Wt. loss (per cent)	Per cent in dry matter of pulp							
							Stem portion				Tip portion			
										Total S				Total S
		1952	gms	1952	gms		Ca	Mg	K	as SO_4	Ca	Mg	K	as SO_4
1	8	Nov. 10	1834	Nov. 20	1302	29.01	.112	.167	2.332	.359	.064	.131	3.085	.338
2	8	Dec. 2	1767	Dec. 12	1242	29.71	.096	.145	2.182	.429	.059	.114	2.837	.426
3	8	Dec. 23	2038	Dec. 31	1517	25.56	.065	.106	2.374	.408	.030	.102	3.003	
		1953		1953										
4	8	Jan. 12	2102	Jan. 19	1652	21.41	.080	.125	2.064	.386	.040	.106	2.759	.344
5	8	Feb. 25	2270	Mar. 5	1740	23.35	.056	.092	2.151	.349	.023	.103	2.813	.401
6	8	Apr. 6	2538	Apr. 13	2060	18.83	.060	.088	1.816		.020	.090	2.525	.224
7	8	May 1	2537	May 8	1985	21.76	.053	.081	1.811	.289	.019	.098	2.533	.338

The chlorine contents in the dry matter of the pulp were: stem portion, .012, .018, .015, .015, .016, .013, and .013 per cent respectively, and in the tip portion, .014, .018, .016, .014, .018, 014, and .015 per cent, respectively, for sample nos. 1 to 7 inclusive. The skins of the fruit sample no. 6 were found to contain: Ca, .360; Mg, .325; K, 4.091, and Na, 0 per cent, respectively, in their dry matter. The dry matter of the skins of sample No. 5 contained .073 and of no. 7, .045 per cent of chlorine, respectively. The skins of sample no. 7 contained .288 per cent of total sulfur (as sulfate) in their dry matter.

The dry matter of the seeds (without seed coats) of sample no. 7 contained: Ca, .067; Mg, .095; K, 1.554; and Na, .023 per cent, respectively. In sample nos. 1 and 2, the fresh weights of the eight seeds were 336 and 285.9 grams, respectively, whereas those of sample nos. 5, 6, and 7 -were 371, 378.4, and 263 (for 8 seeds) grams, respectively. Without the seed coats, the dry matters of the seeds were: sample no. 1, 132.2; and for sample nos. 5, 6, and 7, 154.9, 163.1, and 104.7 grams, respectively. For these data, it appears that the seed were larger in the larger fruits of the late samplings whereas in the very last sampling, the seeds were the smallest of all. If in samples nos. 1 and 2 the fresh weights of the seeds are subtracted from the fresh weights of the soft fruit, then the fresh weights of the skin and pulp would he 966 and 956.1 grams, respectively, whereas for sample nos. 5 and 6, the values would be 1369 and 1681.6 grams, respectively.

The dry matter of the buttons of sample no. 5 contained .118 and of sample no. 6, .105 per cent, respectively, of chlorine. The dry matter of the seed coats of sample nos. 5 and 6 each contained .006 per cent of chlorine, whereas the dry matter of the seed of both contained .010 per cent of chlorine.

In the several figures the percentages of Ca, Mg, and K decrease while the fruit were in the various stages of full maturity. In the fruit pulp, possibly the total content of these elements is reached during the very early phases of fruit development and the decreased percentages of these elements may be largely or entirely the result of dilution brought about by the increase in organic matter content.

[1]Haas, A. R. C. Variations in the composition of avocado seed. Yearbook Calif. Avoc. Soc. 1951, 139-152.