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Preliminary Studies of Some Physiological Root Characteristics in Citrus and Avocado[1]

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Among the influences of rootstocks are characteristic effects on the mineral composition of foliage. This has been discussed in two recent reports from this laboratory (11, 12). It was suggested in the first report that root respiration might be a measure of hydrogen ion producing powers of roots, and, according to the theory of Mehlich and Reed (9), this power may be related to differential uptake of mono-and divalent cations by different plant species such as those that are used for rootstocks. The respiration data reported (11) were obtained from cuttings grown in sand culture. Since then additional data have been obtained with roots excised from citrus and avocado trees grown in soil in the field. The studies were expanded to include cation-exchange capacity of roots (2, 3, 4, 5, 13) and exchangeable hydrogen on roots (4). These characteristics have received much attention by recent workers because of possible relationships of cation-exchange capacity with the absorption of mono- and divalent cations according to the theory of Donnan equilibrium.

The citrus roots were obtained from field trees of three-year-old nucellar seedlings grown in the University of California at Los Angeles orchard. The soil was a Yolo loam. The five species examined were rough lemon *(Citrus Limon),* sour orange *(C. Aurantium),* Blackman sweet orange *(C. sinensis),* L.V.W. Brown grapefruit *(C. paradisi),* and Rubidoux trifoliate orange *(Poncirus trifoliata).* The -avocados used were miscellaneous young Mexican and Guatemalan seedlings. The roots were washed in tap water to remove soil, and only those roots that appeared to be functional were selected for analysis. The samples included root tips and the next several centimeters. These were thoroughly washed several times in distilled water and each sample was divided into two portions. One portion was cut into sections approximately one cm. long for Warburg respiration studies, which were carried out essentially by the procedure of Machlis (8). Exchangeable hydrogen was determined on the second portion of roots by a modification of the method of Graham and Baker (4) in which 200 ml of N KCl was added to the roots, and the roots plus KCl were titrated with standard base. After titration the same root samples were electrodialized and the exchange capacity was determined by titrating the total hydrogen according to the method of Drake, Vengris, and Colby (2). All determinations were expressed on the dry weight basis. Only parts of the data obtained will be reported at this time.

The data are in Table 1. The respiration rates were not entirely similar to those reported earlier (11). Those, however, were for rooted cuttings grown in sand

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culture. It has been demonstrated that rootstock effects on field-grown citrus may be unlike those grown in sand culture (12). It is not evident that the respiration rates for citrus roots in Table 1 are related to the pattern of cation absorption observed for citrus rootstocks (10, 11). There were some correlations; for example, sour orange and rough lemon roots were high in respiration but low in potassium accumulation. The respiration rates, however, may be more related to susceptibility to micronutrient deficiencies. Citrus species having high respiration rates were related to those which Cooper and Olson (1) found somewhat resistant to lime-induced chlorosis. Guatemalan avocado rootstocks generally are more susceptible to lime-induced chlorosis than are Mexican rootstocks (7). There was, however, little difference in the respiration rates of roots of the avocados studied.

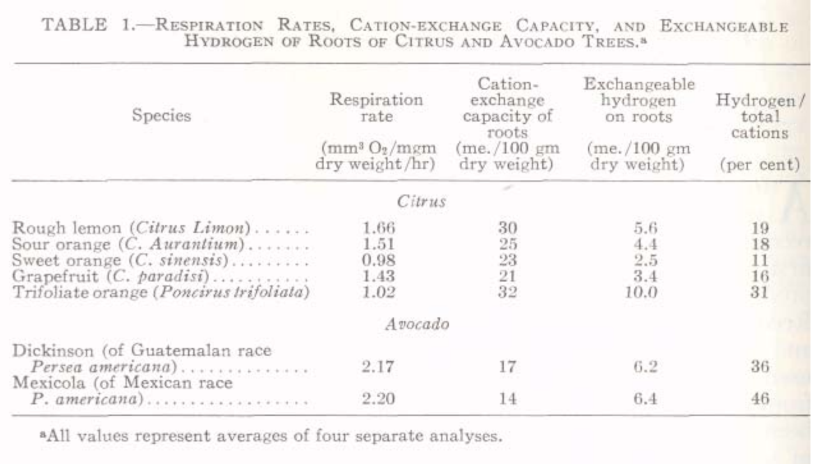

TABLE 1.—RESPIRATION RATES, CATION-EXCHANGE CAPACITY, AND EXCHANGEABLE HYDROGEN OF ROOTS OF CITRUS AND AVOCADO TREES.[a]

Species	Respiration rate (mm³ O_2/mgm dry weight/hr)	Cation-exchange capacity of roots (me./100 gm dry weight)	Exchangeable hydrogen on roots (me./100 gm dry weight)	Hydrogen/total cations (per cent)
Citrus				
Rough lemon (*Citrus Limon*)	1.66	30	5.6	19
Sour orange (*C. Aurantium*)	1.51	25	4.4	18
Sweet orange (*C. sinensis*)	0.98	23	2.5	11
Grapefruit (*C. paradisi*)	1.43	21	3.4	16
Trifoliate orange (*Poncirus trifoliata*)	1.02	32	10.0	31
Avocado				
Dickinson (of Guatemalan race *Persea americana*)	2.17	17	6.2	36
Mexicola (of Mexican race *P. americana*)	2.20	14	6.4	46

[a]All values represent averages of four separate analyses.

The cation-exchange capacity of the citrus roots appeared to be more related to cation accumulation than was respiration, but again the relationships are not simple. Grapefruit roots consistently had the lowest cation-exchange capacity. As Donnan theory would predict (2, 5), grapefruit rootstocks had a relatively high accumulation of monovalent ions (10, 11). This did not occur, however, for young lemon trees on grapefruit rootstock grown in potted soil in the glasshouse (12). The cation content of leaves of Valencia orange trees on grapefruit, rough lemon, sweet orange, and sour orange reported by Smith, Reuther, and Specht (9) correlates very well with the exchange capacity of those rootstocks. There is also a very good relationship between the exchange capacity of the rootstocks and the iron content of the leaves (9).

The cation-exchange capacities of avocado roots were much lower than those of citrus. Although the difference between the rates does not appear large, Haas (6) has reported that leaves of plants grown on Guatemalan rootstocks contain more calcium than those grown on Mexican rootstocks. Avocado roots are, on the average, much larger than are citrus roots and neither has visible root hairs. The mineral composition of avocado leaves is similar to that of citrus. If areas are considered, the exchange capacity of avocado roots may have additional meaning, since a preliminary study has shown that determinations of exchange capacity of avocado roots of different sizes agree much better when expressed on the surface area basis than on a dry weight basis. The present data are in the nature of a survey and much needs to be done to elucidate the relationships involved.

The values for exchangeable hydrogen, although subject to many environmental influences (4), varied somewhat for the species studied. Just how these data may relate to mineral nutrition or other rootstock influences on trees awaits to be known.

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