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CHLORIDE AND AVOCADO ROOTSTOCKS

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Tipburn of avocado leaves resulting from excess chloride is a problem in avocado production in California. Tipburn of avocado leaves may appear if the chloride in the leaf exceeds 0.25 percent (1, 5, 7). To evaluate rootstock effects on chloride accumulation in the leaves, samples were obtained from five avocado rootstock experiments that were established in San Diego County by Halma (10).

In four of these experiments Hass or Fuerte scions were budded onto a number of Mexican and Guatemalan rootstocks. In each of the four orchards selections were made for this study so that there were six trees of each rootstock-scion combination in a given orchard, arranged in a completely randomized block. The mean percentages of chloride in the youngest, fully matured leaves from terminals that were not fruiting nor flushing appear in Table 1. Only the healthiest leaves were sampled, that is, leaves with the least amount of chlorosis and tipburn. This type of sampling technique tends to minimize the treatment differences observed in this study.

Table 1. Chloride concentration in avocado leaves as influenced by rootstock variety and race.

Race rootstock and statistical indices	Variety of Rootstock	Mean % Cl in dry leaves[1] Rootstock Variety[2]	Rootstock Race
Orchard No. 1—Hass scion—planted 1954 near Fallbrook			
Guatemalan	Itzamna	0.12v	
	Sharpless	0.15vw	
	Taft	0.16vw	
	Dickinson	0.18vwx	
	Mayapan	0.19vwx	
	Challenge	0.20vwx	
	Queen	0.24wxy	
	MacArthur	0.25wxy	
	Anaheim	0.25wxy	0.19
Mexican	Duke	0.23wxy	
	Blake	0.24wxy	
	Mexicola	0.28xy	
	Topa Topa	0.28xy	
	Northrop	0.29xy	
	Ganter	0.30y	0.27
Significance[3]		**	***
C.V. in %[4]		28	
Orchard No. 2—Hass scion—planted 1952 and 1953. Pauma Valley			
Guatemalan	Anaheim	0.14v	
	Challenge	0.15v	
	Nabal	0.15v	
	Hass	0.15v	
	Taft	0.19vw	
	Dickinson	0.22vw	
	MacArthur	0.24vw	0.18
Mexican	Mexicola	0.22vw	
	Duke	0.23vw	
	Blake	0.30vw	
	Ganter	0.31vw	
	Topa Topa	0.32vw	
	Northrop	0.38w	0.29
Significance[3]		**	***
C.V. in %[4]		47	

Orchard No. 2—Fuerte scion—planted 1952 and 1953, Pauma Valley

Guatemalan	Dickinson	0.19	
	Nabal	0.19	
	Taft	0.22	
	Hass	0.22	
	MacArthur	0.24	
	Anaheim	0.25	
	Challenge	0.27	
	Itzamna	0.27	0.23
Mexican	Topa Topa	0.27	0.27
Significance[3]		N.S.	—
C.V. in %[4]			

Orchard No. 3—Fuerte scion—planted 1954 near Fallbrook

Guatemalan	Nabal	0.08v	
	Itzamna	0.11v	
	MacArthur	0.16vw	
	Hass	0.18vwx	
	Dickinson	0.18vwx	
	Anaheim	0.25wxy	
	Edranol	0.33yz	0.18
Mexican	Duke	0.28xyz	
	Zutano	0.28xyz	
	Ganter	0.34yz	
	Mexicola	0.35yz	
	Topa Topa	0.37z	0.32
Significance[3]		***	***
C.V. in %[4]		26	

Orchard No. 4—Hass scion—planted 1952 near Fallbrook

Guatemalan	Hass	0.28v	
	Nabal	0.31vw	
	Dickinson	0.35vwx	
	Anaheim	0.36vwx	0.33
Mexican	Duke	0.32vwx	
	Ganter	0.42wx	
	Blake	0.43wx	
	Mexicola	0.44wx	
	Northrop	0.45wx	
	Topa Topa	0.46x	0.42
Significance[3]		*	***
C.V. in %[4]		27	

[1] Leaves were sampled in orchard No. 2 in February 1960, and in orchards No. 1, 3, and 4 in March i960.

[2] Subscript letters v. w. x, y, and z after mean values indicates populations within each orchard at the level of probability indicated by the asterisks. Mean values are statistically different if they do not have a common subscript letter after the values.

[3] N.S. indicates that difference between means are not statistically significant.

* *indicates significance of F at the 5% level.*

** *indicates significance of F at the 1% level.*

*** *indicates significance of F at the 0.1% level.*

[4] *C.V. in % is the coefficient of variability obtained by dividing the square root of the error variance by the grand mean and multiplying by 100.*

Hass and Fuerte scions on Guatemalan rootstocks had .substantially lower percentages of chloride in the leaves than these same scion varieties on Mexican rootstocks. However, certain individual rootstock varieties within the Guatemalan race did result in higher percentages of chloride in the leaves than did some of the Mexican root-stock varieties. Within the Guatemalan rootstocks, use of Hass, Itzamna, and Nabal generally resulted in a relatively low percentage of chloride in the scion leaves and, in three out of the four orchards, Anaheim rootstock resulted in a relatively high percentage of chloride in the scion leaves. Comparisons among effects of four root-stock varieties of the Mexican race that were common to the four orchards resulted in the following mean percentages of chloride in the leaves: Duke—0.27; Mexicola—0.32; Ganter—0.34; and Topa Topa—0.36. The mean percentage of chloride associated with Duke was statistically significantly lower than the means associated with Canter or Topa Topa rootstocks.

In another experiment cuttings of Hass and Fuerte were compared with Hass and Fuerte varieties budded into Mexicola seedlings. The Hass and Fuerte cuttings were rooted by E. F. Frolich of the University of California at Los Angeles using a method developed and described by him (6). The Hass and Fuerte trees budded on Mexicola seedlings were obtained from a commercial nursery. In the Hass block there were 28 replications comparing the Hass cuttings with Hass trees on Mexicola seedling root and in the Fuerte block there were 29 replications comparing the Fuerte cuttings with Fuerte trees on Mexicola seedling root. The leaves on the Hass trees propagated from cuttings had distinctly less tipburn than leaves on the Hass trees on Mexicola root-stock. Fuerte leaves on the trees propagated from cuttings generally had less tipburn than leaves on Fuerte trees on Mexicola rootstock, but the differences were not as distinct as in the Hass comparison. Leaf analysis confirmed that the tipburn was from excess chloride. The mean percentages of chloride in the youngest, fully matured leaves from terminals that were not fruiting nor flushing appear in Table 2. Again, only the healthiest leaves were sampled.

Table 2. Comparison of the concentrations of chloride in Hass and Fuerte avocado leaves from trees propagated on their own roots by cuttings, with the concentrations in Hass and Fuerte leaves from trees budded on Mexicola seedlings, orchard No. 5, planted 1954 near Fallbrook.

Type of root and statistical indices	Top variety	
	Hass	Fuerte
	% Cl in dry leaves, 3/60	
Hass Cutting	0.33	—
Fuerte cutting	—	0.41
Mexicola seedling	0.54	0.53
Significance[1]	***	***
C.V. in %[1]	15	16

[1] *See Table 1 footnotes [3] and [4] for meaning of statistical symbols.*

The percentage of chloride in Hass leaves propagated on their own roots (Guatemalan) by cuttings was substantially lower than in Hass leaves from trees budded onto Mexicola (Mexican) rootstock. The same was true in comparing the percentages of chloride in the Fuerte leaves from trees on their own roots (Guatemalan-Mexican hybrid) with leaves from trees budded onto Mexicola (Mexican) seedlings but the magnitude of the difference was smaller than the Hass comparison.

Discussion

These studies show that trees on Guatemalan rootstock varieties are generally more tolerant to high chloride conditions than trees on Mexican rootstock varieties. These findings are in general agreement with observations in the field in the Lower Rio Grande Valley of Texas by Cooper (2, 3), Cooper and Gorton (5), and Cooper, Cowley, and Shull (4); with observations in sand-culture experiments in California by Haas (8), and Haas and Brusca (9); and with field observations in Israel by Oppenheimer (II).

This suggests that Guatemalan rootstock should be used in preference to Mexican rootstock where excess chloride is a problem. However, Halma (10), in summarizing avocado rootstock experiments in California, points out that Guatemalan rootstocks are generally more susceptible to Verticillium wilt, Dothiorella canker, and chlorosis presumably associated with high calcium in the soil. Thus, Mexican rootstocks will probably continue in use in California even though they are more susceptible to chloride excess than Guatemalan rootstocks.

In the present studies there were differences in chloride nutrition attributable to rootstock varieties within the Mexican race. Use of Topa Topa rootstock variety, a common commercial rootstock used in California, resulted in a higher percentage of chloride in the leaves of the scion variety than did use of other Mexican varieties. Among rootstock varieties of the Mexican race, use of Duke resulted in the lowest percentage of chloride in the leaves.

Zentmyer and Mircetich (12) and Zentmyer and Thorn (13) have found that Duke seedlings and cuttings have appreciable resistance to Phytophthora cinnamomi, a very serious disease of avocados in California, while Topa Topa seedlings have practically no resistance to this disease. Since Duke as a rootstock appears to be more tolerant to conditions of excess chloride and shows considerably more resistance to Phytophthora root rot than Topa Topa rootstock which is commonly used in California, Duke should he considered seriously as a commercial rootstock in California.

SUMMARY

The influence of the race and variety of avocado rootstock on the concentrations of chloride in scion leaves was studied in five commercial orchards in San Diego County where chloride excess is a problem. In the study were Anaheim, Challenge, Dickinson, Edranol, Hass, Itzamna, MacArthur, Mayapan, Nabal, Queen, Sharpless, and Taft varieties of the Guatemalan race, and Blake, Duke, Canter, Mexicola, Northrop, Topa Topa, and Zutano varieties of the Mexican race. Hass and Fuerte trees propagated on their own roots were also included.

The use of the Guatemalan race of rootstocks resulted in significantly lower

percentages of chloride in scion leaves than did use of Mexican race of rootstocks, but there was some overlap of effects of varieties between races.

Within the Guatemalan rootstocks use of Hass, Itzamna, and Nabal generally resulted in relatively low percentages of chloride in scion leaves.

Within the Mexican race use of Duke generally resulted in low and Topa Topa in high percentages of chloride in scion leaves.

Hass and Fuerte varieties propagated on their own roots by cuttings had significantly less chloride in their leaves than the same scion varieties propagated on Mexicola rootstocks.

Practical aspects on the selection of rootstocks are discussed.

LITERATURE CITED

1. Ayers, A. D., D. G. Aldrich, and J. J. Coony. 1951. Sodium and chloride injury of Fuerte avocado leaves. California Avocado Society Yearbook 36: 174-178.
2. Cooper, W. C. 1948. Tipburn problems on avocados. Texas Avocado Society Yearbook 1948:52-53.
3. 1951. Salt tolerance of avocados on various rootstocks. Texas Avocado Society Yearbook 1951:24-28.
4. ……. W. R. Cowley, and A. V. Shull. 1952. Selection for salt tolerance of some subtropical fruit plants. Texas Avocado Society Yearbook 1952:25-36.
5. ……,and B. S. Gorton. 1950. Relation of leaf composition to leaf burn of avocados and other subtropical fruits. Texas Avocado Society Yearbook 1950:32-38.
6. Frolich, E. F. 1951. Rooting Guatemalan avocado cuttings. California Avocado Society Yearbook 36:136-138.
7. Haas, A. R. C. 1929. Composition of avocado trees in relation to chlorosis and tipburn. Bot. Gaz. 87:422-430.
8. ……. 1950. Rootstock influence on the composition of scion avocado leaves. California Avocado Society Yearbook 35:149-152.
9. ....., and J. N. Brusca. 1935. Chloride toxicity in avocados. California Agr. 9(2):I2-14.
10. Halma, F. F. 1954. Avocado rootstock experiments—a 10-year report, California Avocado Society Yearbook 38:79-86.
11. Oppenheimer, Channan. 1947. The acclimatization of new tropical and subtropical fruit trees in Palestine. Agr. Res. Sta., Rehovot, Bui. 44.
12. Zentmyer, G. A., and S. M. Mircetich. 1960, Results with new method of testing for resistance to Phytophthora root rot of avocado. California Avocado Society Yearbook 44:107-109.
13. ……, and D. A. Thorn. 1956. Resistance of the Duke variety of avocado to Phytophthora root rot. California Avocado Society Yearbook 40:169-173.