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Effects of Irrigation Treatments and Rates of Nitrogen Fertilization on Young Hass Avocado Trees. II. Relation to Leaf Tipburn, Tree Sunburn, Shoot Dieback, Leaf Scorch, Leaf Color, Leaf Size, Tree Vigor, and Leaf Moisture Deficits

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Periodic observations were made during the years 1955 and 1956. The presence and extent of leaf tipburn, tree sunburn, shoot dieback, leaf scorch, leaf color, leaf size, and tree vigor were noted. Leal: moisture deficits were determined during part of the 1956 irrigation season.

LEAF TIPBURN

Leaf tipburn, due to the accumulation of Cl and SO_4 in mature leaves, is a common and serious disorder in certain commercial avocado districts of California. It is associated with irrigation waters containing moderate to high amounts of these ions. Where severe, it eventually results in defoliation, reduced tree vigor, and reduced yields.

Very little or no leaf tipburn was noted during the 1955 surveys. However, by the end of 1956 it was present in all treatments, varying in severity from very slight to severe. A six-point scale was used to rate the severity of leaf tipburn on individual trees: 0, no tipburn, to 5, severe tipburn, with 50 per cent or more of the leaves affected and with 30 per cent or more of the tip ends of the affected leaves burned. Each tree in all plots was rated according to the number of mature leaves showing tipburn and the extent of burn on the affected leaves. The results of these ratings are shown in Table 1.

In all irrigation treatments, the amount of tipburn decreased as nitrogen, applications increased. Tipburn was 43 per cent greater in the Zero-N treated plots and 37 per cent greater in the Low-N plots than in the High-N plots, Irrigating at low soil moisture suction values tended to decrease leaf tipburn, which was 12.5 per cent greater in the 1-bar plots and 41.5 per cent greater in the 10-bar plots than in the ½-bar plots.

These data suggest that leaf tipburn, due to Cl and/or SO_4, can be alleviated by the use of relatively large amounts of nitrogenous fertilizers and by irrigating at low soil moisture suction values.

TREE SUNBURN, SHOOT DIEBACK, AND LEAF SCORCH

From August 26 to September 14, 1955, a 20-day heat wave occurred, with daily

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maximum temperatures ranging from 101 to 118 degrees F, and relative humidities at midday ranging from 15 to 21 per cent. In 1956, maximum temperatures for a 3-day period, September 8 to 10, ranged from 105 to 107 degrees F, and relative humidities at midday ranged from 17 to 21 per cent. An appraisal of heat damage followed both hot spells. A six-point scale (0, no damage, to 5, greatest damage observed) was used to rate the severity of sunburn, dieback of tender shoot terminals, and leaf scorch.

Table 1.—Effects of differential rates of irrigation and fertilization on young Hass avocado trees.

Nitrogen treatment	Irrigation treatments (maximum soil suction)							
	1/2 bar	1 bar	10 bars	Average	1/2 bar	1 bar	10 bars	Average
	Leaf tipburn, Feb. 25, 1957[a]				Tree sunburn, Dec. 15, 1955[a]			
Zero-N	2.3	2.3	3.7	2.8	0.5	0.8	0.4	0.8
Low-N	2.5	2.8	2.6	2.6	0.6	1.1	1.1	0.9
High-N	1.4	1.9	2.5	1.9	0.7	0.9	0.9	0.8
Average	2.1	2.3	2.9		0.6	0.9	0.8	
	Shoot dieback, Sept. 7, 1955[a]				Leaf size, Dec. 15, 1955[b]			
Zero-N	1.6	3.0	2.7	2.4	2.4	2.1	2.0	2.2
Low-N	2.1	3.2	2.6	2.7	2.7	2.0	2.0	2.2
High-N	3.2	2.9	2.0	2.7	2.7	2.1	1.8	2.2
Average	2.3	3.0	2.4		2.6	2.1	1.9	
	Leaf scorch, Sept. 7, 1955[a]				Leaf scorch, Sept. 26, 1956[a]			
Zero-N	1.8	2.2	2.8	2.4	0.3	0.7	3.0	1.3
Low-N	2.3	2.6	2.8	2.6	0.6	1.0	2.1	1.2
High-N	1.8	2.8	3.0	2.5	0.9	1.3	2.5	1.6
Average	2.0	2.5	2.9		0.6	1.0	2.5	
	Leaf color, Dec. 15, 1955[c]				Leaf color, Mar. 1, 1957[d]			
Zero-N	1.3	1.3	1.0	1.2	1.4	1.9	1.7	1.7
Low-N	1.6	1.3	1.3	1.4	2.5	2.3	2.3	2.4
High-N	1.8	1.6	1.3	1.6	2.8	2.7	2.3	2.6
Average	1.6	1.4	1.2		2.2	2.3	2.1	

[a]Injury rated according to a six-point scale; 0, no injury—5, severe injury.
[b]Leaf size rated according to a three-point scale: 1, small; 2, medium; 3, large.
[c]Leaf color rated according to a two-point scale: 1, pale green; 2, dark green.
[d]Leaf color rated according to a three-point scale: 1, pale green; 2, intermediate; 3, dark green.

Tree Sunburn:—Many trees were injured by sunburn in 1955. Results are tabulated in Table 1. Sunburned limbs were most common on trees of the 1-bar irrigation treatments and least common in the ½-bar treatments. There was 13 per cent less sunburn in the 10-bar plots and 33 per cent less in the ½-bar plots than in the 1-bar plots. Trees receiving Zero-N suffered slightly less sunburn than those receiving either Low-N or High-N. Damage was about equal on trees receiving either Low-N or High-N fertilization.

Little or no sunburn occurred in 1956 because the trees were larger and had more foliage to protect tender limbs.

Shoot Dieback:—Dieback of young succulent terminals for a length of 1 to 3 inches was observed following the 1955 hot spell. Table 1 summarizes the amount of damage sustained by the different plots. The least damage occurred on trees irrigated at ½-bar. The greatest amount of dieback was found on trees irrigated at 1 bar. Trees in the 10-bar plots had intermediate damage.

In the ½ bar treatments, increasing amounts of N increased the amount, of shoot terminal dieback due to excessive heat. Damage increased 31 per cent in the Low-N and 100 per cent in the High-N plots over the Zero-N level. Nitrogen level in the 1-bar plots had no consistent influence on dieback. The highest level of N in the 10-bar irrigation schedule decreased the amount of damage.

Leaf Scorch:—This term describes the damage done to mature leaves by high temperatures. Leaf tissue was actually cooked, later dying and leaving dead areas in the affected leaves. Both soil moisture conditions and soil nitrogen appeared to influence this type of damage, as shown in Table 1.

Following the 1955 heat wave, injury to leaves was rated. Damage increased as soil moisture suction values increased. Trees in the 1-bar treatment developed 30 per cent more scorched leaves than did those in the ½-bar treatments, and trees in the 10-bar plots 47 per cent more. In the 1-bar treatments, Low-N increased scorch 20 per cent arid High-N 29 per cent. No definite influence of N can be shown for the ½-bar or 10-bar irrigation treatments for this year. Leaf scorch which developed from the 1956 heat wave showed a greater range of damage between treatments than occurred in 1955. This was probably due to the shorter duration of the 1956 hot spell. As in 1955, injury increased with increasing soil suction. It also increased with increasing amounts of nitrogen in. the plots irrigated at ½-bar and 1 bar. However, nitrogen tended to decrease injury in the 10-bar treatments.

Trees in the 1-bar plots had 50 per cent more scorched leaves, and those in the 10-bar plots had 323 per cent more than those in the ½-bar treatments.

Both Low and High-N in the ½-bar treatments increased injury over Zero-N treatments by 70 per cent and 176 per cent respectively. In the 1-bar treatments, Low and High-N increased the amount of injury by 42 and 93 per cent. Low-N decreased injury in the 1.0-bar plots by 30 per cent and High-N by 15 per cent.

LEAF COLOR

Leaf color is frequently used by growers as a rule of thumb to determine if an adequate nitrogen fertilization program is being followed. In 1955, all trees were given a numerical rating for leaf-color. The value "1" was given to trees having leaves that were pale green, and the value "2" was given to those having dark-green leaves.

Both soil suction and nitrogen influenced leaf color. Leaves became darker green as nitrogen increased from zero to high. Leaves were paler green as soil moisture tension increased.

In 1956, leaves were rated on a 3-point scale. The value "1" was given to trees with the palest green foliage and the value "3" to those which had the darkest green foliage. Trends were similar to those shown in 1955. Tabulations of results for both, years appear in Table 1.

LEAF SIZE

Leaf size has also been used as a criterion of good commercial fertilization and irrigation practices. Leaf size was rated numerically on the basis of the overall average size of leaves on individual trees. Trees with predominately small leaves were rated 1, those with medium-sized leaves, 2; and those with large leaves, 3.

Soil moisture suction had a greater effect upon leaf size than nitrogen. The most frequently irrigated trees developed the largest leaves. The trees in the driest treatments developed the smallest leaves. The addition of nitrogen to the ½-*bar* irrigation treatments increased leaf size slightly. High-N combined with the 10-bar irrigation regime reduced leaf size. These data are shown in Table 1.

TREE VIGOR

Tree vigor ratings were based upon the general appearance related to leaf size, density of foliage, and amount of new growth developed in successive growth cycles. The least-vigorous trees were rated "1" and the most-vigorous "3". Intermediate trees were rated "2". The summary of ratings is shown in Table 2.

Table 2.—Effects of differential rates of irrigation and fertilization on tree vigor of young Hass avocado trees, December 15, 1955.[a]

Nitrogen treatment	Irrigation treatments (maximum soil suction)			
	1/2 bar	1 bar	10 bars	Average
Zero-N	2.6	2.2	2.2	2.3
Low-N	2.9	2.3	2.1	2.4
High-N	2.9	2.2	1.6	2.2
Average	2.8	2.2	2.0	

[a]Tree vigor rated according to a three-point scale: 1, low vigor; 2, medium vigor; 3 most vigorous.

Irrigation had a greater influence on tree vigor than nitrogen. The most-vigorous trees were those receiving irrigations when soil moisture suction values reached ½-bar. The least-vigorous trees were those irrigated at 10 bars. Those in the 1-bar treatment were intermediate. Both low and high levels of nitrogen increased vigor slightly in the ½-bar treatments. High nitrogen depressed vigor within the 10-bar treatments.

LEAF MOISTURE DEFICITS

Leaf moisture deficits were determined twice weekly during a portion of the 1956 irrigation season, from September 25 to November 27. Leaf samples were taken at 2:00 p.m. from the southwest portions-bf the tree, where moisture stresses were thought to be most severe. The percentage of moisture deficit was determined by the relative saturation deficit method of Halma (1).

Throughout the period, trees in the ½-bar treatments developed the lowest relative saturation deficits. Those in the 10-bar treatments maintained the highest saturation deficits, as shown in Fig. 1. These higher deficits in the 10-bar treatments were maintained even following irrigation. This would seem to indicate that certain physiological changes may take place within trees under moisture stresses which retard their recovery to normal following the rewetting of the soil. Further study is needed to develop an understanding of the effects of moisture stresses in the field on rates of photosynthesis and crop production.

SUMMARY

Hass avocado trees on Mexican rootstocks were set out in June, 1952. Differential irrigation treatments, based on soil moisture suction measurements, were started in 1954. Irrigations by sprinklers were applied when soil moisture suction values reached ½, 1, and 10 bars. Three levels of nitrogen fertilization were also started in 1954.

Periodic observations were made on the presence and extent of leaf tipburn, tree sunburn, shoot dieback, leaf scorch, leaf color, leaf size, and tree vigor. Leaf moisture deficits were determined during a portion of the 1956 irrigation season.

1. Leaf tipburn decreased with increasing amounts of N, and increased under high soil moisture suction.

2. Sunburn of shoots and branches was least in the ½-bar irrigation treatment.

3. Shoot terminal dieback following a late summer heat wave was greatest in the High-N treatments and in the 1-bar irrigation treatments.

4. Leaf scorch, due to high temperature, was not influenced by nitrogen but was increased by high soil moisture tension.

5. Leaves became darker green as N and soil moisture increased.

6. Leaf size was unaffected by N and increased under low moisture tension.

7. Tree vigor was best in the ½-bar irrigation treatments. Nitrogen had no effect on increasing vigor.

8. Leaf moisture deficits were highest in the 10-bar plots, lowest in the ½-bar plots and intermediate in the 1-bar plots.

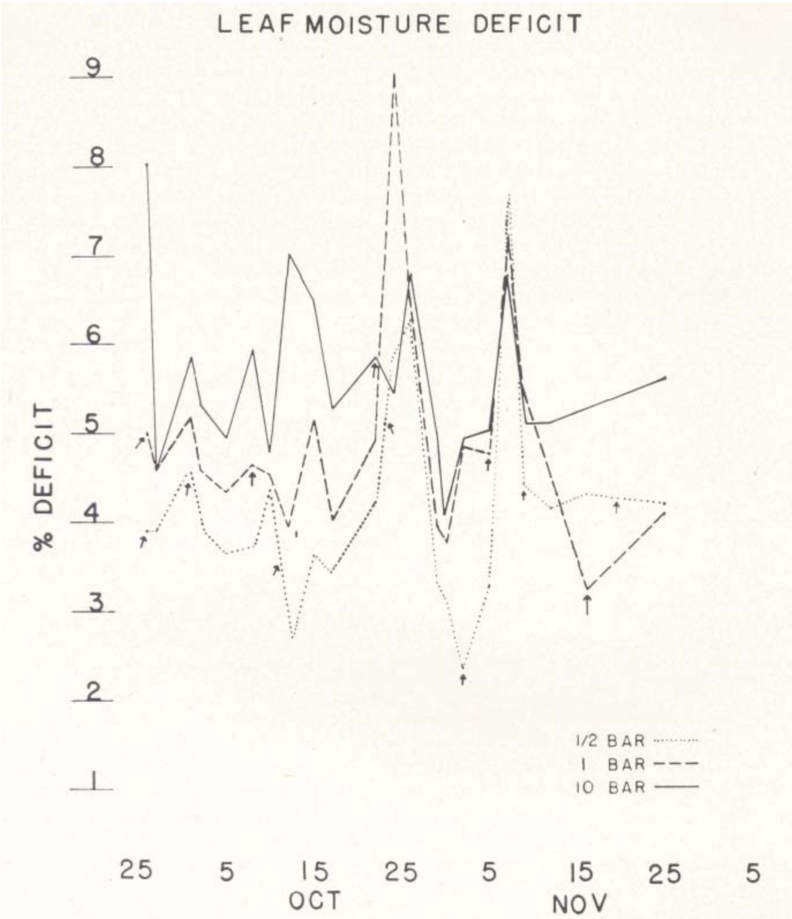

Fig. 1. Effects of differential irrigation on leaf moisture deficits during part of the 1956 irrigation season, September 25 to November 25. Arrows indicate irrigation dates.

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