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Growth and Transpiration in Avocado Seedlings as Affected by Artificial Winds of Low Intensity

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Avocado trees are frequently grown in locations subjected to considerable wind.* only when such winds become very severe or are accompanied by high temperatures is our attention likely to be focused on them. With the purpose of learning more about the role that winds play in the growth and water losses that occur in avocado trees, studies were conducted with artificial winds on avocado seedlings in soil cultures under glasshouse conditions.

The experiment was begun on June 2, 1939, and was terminated on September 5, 1939. Galvanized iron containers heavily coated with asphalt paint and water spar varnish were used for the soil cultures. The containers were 8 inches in diameter at the top, 6.5 inches in diameter at the bottom and 12 inches high. The empty containers weighed approximately 2000 grams. A screened and thoroughly mixed lot of pasture soil of the Hanford series was obtained close to the Citrus Experiment Station. Approximately the same quantity of soil was placed in each container so that upon compacting the soil about an inch of depth remained unfilled at the surface of the container. This space permitted the addition of distilled water and prevented loss of the added water during the weighing of the cultures.

Two young Puebla avocado seedlings of about 1-2 feet in height were planted in each container. The seeds had been germinated in porous clay pots filled with a mixture of peat and soil. The soil was removed from the roots prior to the transfer of the seedlings to the soil cultures. Circular concrete lids of about an inch in thickness served as covers for the cultures. The covers were heavily coated with asphalt (Gilacoat) paint and had a central opening about 1¼ inches in diameter through which the plants could protrude. The unused space in the opening was plugged with cotton. Other holes ½ to 1 inch in diameter were used for the addition of water. And when not used the holes were closed with rubber stoppers.

The wilting point of the soil used was between 4.5 and 5.5 per cent. A preliminary test was run in order to ascertain the amount of water required to bring the soil to its water-holding capacity and to saturate the soil and with these values it was possible to arrive at moisture contents conducive to good growth. The loss of water was determined by weighing the cultures every two to three days. The balance used permitted the weighings to be made within 1 gram in accuracy. Prom time to time the increased weight of the plants made it necessary to increase the weights of the cultures. When the experiment was terminated the cultures weighed approximately 16,500-17,000 grams and soil samples showed moisture contents of about 8 per cent.

Four soil cultures each bearing two Puebla avocado seedlings were placed in a row at right angles to a fan placed about 7½ feet away. A similar group of cultures was placed to one side under the same light conditions and was so situated as to avoid any of the artificial wind. A fan with four metal blades, each five inches long and two inches in width at the widest portion, was used to produce a wind. Measurements made of the wind velocity showed the wind to vary in intensity in different places: at the covers of the cultures, at 20 inches above the covers, and at 36 inches above the covers or near the tops of the plants. The wind readings ranged as follows: 8, 29, 47, and 32 feet per minute at the lids; 16, 89, 130, and 94 feet per minute 20 inches above the lids; and 2, 4, 35, and 45 feet per minute 36 inches above the lids. The cultures subjected to the wind were shifted within this wind swept area every one or two days. The movement of the air near the cultures except in the direction from the electric fan was negligible. Likewise the four cultures not in the path of the wind from the fan were surrounded by air that showed no velocity on the Taylor wind measuring instrument.

TABLE 1

EFFECT OF WIND ON TRANSPIRATION FROM AVOCADO SEEDLINGS IN SOIL CULTURES

No. of water loss readings at 2 to 3 day intervals	Culture 1, no wind	Culture 5, wind	Effect of wind on water loss*	Culture 2, no wind	Culture 6, wind	Effect of wind on water loss*	Culture 3, no wind	Culture 7, wind	Effect of wind on water loss*	Culture 4, no wind	Culture 8, wind	Effect of wind on water loss*
	Water loss, gms.			Water loss, gms.			Water loss, gms.			Water loss, gms.		
1939												
June 2 to June 30 (11 intervals)	3,457	3,248	3+, 8-	3,532	3,890	10+, 1-	2,992	3,649	10+, 1-	4,479	4,020	2+, 9-
June 30 to July 31 (13 intervals	8,877	7,847	0+, 13-	10,870	9,153	2+, 11-	7,858	7,741	4+, 9-	9,690	9,650	6+, 7-
July 31 to Aug. 30 (14 intervals)	11,311	9,602	0+, 14-	14,434	10,614	0+, 14-	10,788	9,351	2+, 12-	12,590	11,229	1+, 13-
Aug. 30 to Sept. 5 (2 intervals)	1,652	1,459	0+, 2-	2,030	1,637	0+, 2-	1,605	1,342	0+, 2-	2,020	1,800	0+, 2-
Total	25,297	22,156	3+, 37-	30,866	25,294		23,243	22,083		28,779	26,699	

* Plus sign indicates water loss greater with wind; minus sign indicates water loss decreased by wind; the numbers signify the number of periods in which wind increased or decreased the water loss.

At the time the cultures were being set up, a solution containing 2.6187 grams of chemically pure ammonium sulfate was added as a source of nitrogen to each of the eight cultures. Cultures 1, 2, 3, and 4 were not subjected to wind; cultures 5, 6, 7, and 8 were continuously in the path of the artificial wind.

At the start of the experiment a solution of chemically pure sodium chloride (NaCl) was added to six of the eight cultures. Of the cultures not subject to wind: culture 1 received 1.052 grams of NaCl, culture 2 received 2.104 grams, culture 3 received 3.156 grams, while culture 4 received no NaCl. Of the cultures subject to wind: culture 5 received

1.052 grams of NaCl, culture 6 received 2.104 grams, culture 7 received 3.156 grams, while culture 8 received no NaCl.

When the experiment was concluded the leaf areas of the eight cultures were determined by drawing the outlines of the leaves on paper and tracing these outlines with a planimeter. The burned portions were also outlined on paper. The outlines of the burned areas were cut with a razor blade and the areas were determined by weighing the paper within the outlines and comparing these weights with the weights of known areas of the same paper.

Of the wind exposed plants, culture 1 showed 0.4 sq. in. of burned area, culture 2 showed 1.8 sq. in., culture 3 showed 15.4 sq. in., while culture 4 showed 0.1 sq. in.; of the plants not exposed to wind, culture 5 showed 2.1 sq. in., culture 6 showed 5.3 sq. in., culture 7 showed 5.1 sq. in., while culture 8 showed no burned tissue. The presence of sodium chloride in the cultures was reflected in the extent of the areas of burned leaf tissue, although the proportionality of the extent of burned area with the concentration of sodium chloride added is seen to vary.

Table 1 gives the amount of water lost by each culture for given intervals of time. Soon after the experiment was begun, new growth made its appearance. The plus signs in table 1 may possibly bear some relationship to the presence of young tissue. When the data in table 1 are examined it is seen that the wind was accompanied by increased water loss primarily in the first periods of the experiment. In the latter half of the experiment the water loss was least in the wind exposed plants. The total transpiration for the experimental period was in every case somewhat less in the plants subjected to the wind.

In table 2 the total transpiration per square inch of leaf area is calculated for the experimental period as a whole. With the highest concentration of sodium chloride the rate of transpiration was slightly greater with exposure to the wind, while at the low and medium concentrations of sodium chloride as well as in the control cultures, the transpiration rate of the plants was decreased by the wind. The prevailing belief among growers is that winds, regardless of their velocity, increase the transpiration loss. The results reported in tables 1 and 2, therefore, at first glance, appear to be unreasonable. However, a study of the literature reveals that the results are in harmony with those obtained by other investigators (2) who found that the total transpiration decreased with increasing wind velocity. A reduced water loss during an exposure to wind as compared with plants similarly grown without such exposure may be the result of a partial closing of the stomata in the leaves.

TABLE 2

COMBINED SIZES OF THE TWO AVOCADO SEEDLINGS IN EACH SOIL CULTURE AT THE START AND END OF THE EXPERIMENT, AND THEIR TOTAL TRANSPIRATION

Culture No.	Sodium chloride added	Air movement	Length of trunks		Final weight of trunks and branches	Final weight of roots	Final leaves		Total leaf area	Total water loss per sq. in. of leaf area
			Initial (inches)	Final (inches)	(gms. fresh wt.)	(gms. fresh wt.)	(gms. fresh wt.)	Total No.	(sq. in.)	(gms.)
1	Low	No wind	35.8	82 19.5*	120	165	118	75	966	26.2
5	Low	Wind	41.0	84.5 26.5*	91	135	107	102	929	23.8
2	Medium	No wind	34.3	91	123	148	137	93	1155.8	26.7
6	Medium	Wind	38.0	75 33*	101	123	133	109	1072.0	23.6
3	High	No wind	44.0	84 30*	103	126	114	123	1007.3	23.1
7	High	Wind	32.3	75 18*	91	126	111	93	913.6	24.2
4	None	No wind	41.0	81	93	127	119	86	1054.1	27.3
8	None	Wind	31.5	85	110	147	133	87	1119.3	23.9

*Length of branches

The velocities of the wind used in these experiments were variable and of low intensity, ranging only up to 130 feet per minute or approximately 1.5 miles per hour. These experiments as far as it is known, represent the only ones undertaken as yet with avocado plants and form a basis for continued study. The use of high wind velocities on growth and transpiration should also prove of interest especially when used in conjunction with various soil solutions.

* Those interested in the recent literature on the effects of wind on plants can consult:
(1) Finnell, H. H. Effect of wind on plant growth. Jour. Amer. Soc. Agron. 20:1206-1210, 1928;
(2) Martin, E. V., and F. E. Clements. Studies of the effect of artificial wind on growth and transpiration in Helianthus annuus. Plant Physiol. 10:613-636, 1935; (3) Rao. V. P. Effect of artificial wind on growth and transpiration in the Italian millet. Setaria italica. Bull. Torrey Bot. Club 65, No. 4:229-232, 1938; (4) Wilson, J. D., and B. E. Livingston, Lag in water adsorption by plants in water culture with respect to changes in wind. Plant Physiol. 12, No. 1:135-150, 1937.