

California Agriculture. 1957. 11(3):9, 12.

Smog Reduces Seedling Growth

Zutano avocado seedling growth affected by synthetic smog of ozone and hexene vapor in fumigation chamber experiment

O. C. Taylor, E. A. Cardiff, J. D. Mersereau, and J. T. Middleton

Growth of Zutano avocado seedlings was reduced when the plants were exposed to synthetic smog—a mixture of ozone and hexene vapor—in an experiment designed to study the effect of the toxicants on seedling growth.

A general dwarfing of the treated seedlings was evident although new growth was apparently initiated normally. The average number of new leaves produced during fumigation—11.2 on the fumigated seedlings and 11.7 on the non-fumigated seedlings—was not affected. This suggests that plant food formed by photosynthesis was insufficient for proper expansion of new tissue.

Fumigations with a mixture of ozone and hexene vapor or ozone and gasoline vapor are known to produce symptoms of leaf injury on susceptible herbaceous plants that are indistinguishable from injury caused by natural smog. They have been reported also to induce growth suppression of certain herbaceous plants.

In the experiment with avocado seedlings oxidant concentration of the polluted air was maintained at about 0.17 ppm—parts per million. Daily recordings at Riverside have shown that the oxidant concentration of outside air— of unknown chemical composition— reached a peak of 0.1 ppm or more during approximately 50% of the days during the growing season.

The Zutano avocado seedlings were grown in sand in three-gallon glazed crocks in the controlled atmosphere chamber at Riverside. Hoagland's nutrient solution was supplied uniformly throughout the experiment. The large cotyledons were removed from the seedlings so that growth would be dependent upon photosynthesis during fumigation and not on stored food. The non-treated and treated seedlings were grown in air filtered through activated carbon. The treated seedlings received a constant but small amount of the reaction products from ozone and hexene vapor for seven hours a day, five days a week for eight weeks or a total of 280 hours. When the plants were not being fumigated they received carbon



Tip and marginal burn of avocado leaves exposed to ozone and hexene vapor.

filtered air. Environmental conditions during the experiment were controlled to simulate the natural atmospheric conditions at Riverside.

Effect of synthetic smog on Zutano avocado seedlings. A. Seedlings grown in air cleaned by activated carbon. B. Seedlings grown in clean air plus small additions of reaction products from mixing ozone and hexene vapors.



Some leaf injury was detected in the treated group of seedlings after approximately two weeks of fumigation. The injury appeared as faintly visible, small bronze or brown spots on the lower surface of some of the fully expanded leaves. This discoloration was intensified as fumigations continued but did not extend to the upper surface of the leaves and was not found on all leaves. Some of the leaves—on one-third of the treated seedlings—developed a tip and marginal burn which resembled injury from drought or salt excess. No leaf injury was detected on the non-treated seedlings.

Chlorosis of the treated avocado leaves increased progressively as the fumigations continued, suggesting that the chlorophyll was destroyed by the fumigants. A similar destruction of chlorophyll of duckweed—*Lemna minor*— plants exposed to synthetic smog was reported by other research workers who found that destruction of the chlorophyll was arithmetically related to length of exposure period.

In addition to the reduction in chlorophyll content, the new leaves developed in the presence of the fumigants were noticeably dwarfed. The area between the veins was wrinkled or puckered and measurements revealed that the average length and width of leaves developed in the presence of smog was 35% less than leaves developed in the clean air.

With the exception of the average number of leaves produced during the fumigation and the fresh weight and dry weight of the leaves developed before fumigation was started, the differences between the fumigated and non-fumigated seedlings were statistically significant at the 1% level. The reduction in dry weight of the original leaves was statistically significant at the 5% level. It is quite evident that expansion of all actively growing portions of the Zutano avocado seedlings was greatly reduced by exposure to the synthetic smog. Even though injury was visible on some of the seedlings, it was apparently not sufficiently general to account for the pronounced dwarfing of the seedlings.

Experiments are being continued in an effort to determine the effect of natural occurring pollutants upon the growth and development of avocado trees.

O. C. Taylor is Assistant Horticulturist, University of California, Riverside.

E. A. Cardiff is Senior Laboratory Technician, University of California, Riverside.

J. D. Mersereau is Senior Laboratory Technician, University of California, Riverside.

J. T. Middleton is Plant Pathologist, University of California, Riverside.

The arithmetical relationship between the destruction of chlorophyll and length of exposure to synthetic smog was reported by Louis C. Erickson, Associate Plant Physiologist, University of California, Riverside, and R. T. Wedding, Assistant Plant Physiologist, University of California, Riverside.