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

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

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 nontreated 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 nonfumigated 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 ex-

Concluded on page 12

Soil Sterilized by Irradiation

sterilization of soil by exposure to an electron beam offers new tool for research on chemistry and microbiology of soil

A. D. McLaren and Lola Reshetko

Soil may be sterilized easily by an electron beam—of sufficient intensity and energy—without destroying the urease-enzyme activity.

Sterile soil is often desired for studies of the chemistry and microbiology of soil but—unfortunately—the use of heat or chemicals for sterilization tends to change the chemical and nutritional properties of soils rather markedly.

Experience with the irradiation of foods suggested that heatless sterilization of soils—by electron beam radiation—would leave the soil and its enzymes essentially unchanged.

Bacteria, as well as spores, are more sensitive to electron beam radiation than are viruses and enzymes. For example, to kill bacteria and bacterial spores in broth only about one-tenth as much radiation is required as for the inactivation of urease. Urease action converts urea into plant-usable ammonium carbonate.

Results of experiments with soil of the Dublin series show that doses comparable to those required to sterilize broth are required for killing microorganisms in soil.

Samples of Dublin clay-loam—100 grams, air-dried and sieved—were irradiated in sealed polyethylene bags placed around the rim of a turntable of 45 centimeters diameter, which turned under a 12 million volt electron beam at 20 revolutions per minute. The swept beam was wide enough to cover completely the width of each bag as it passed through the radiation field. By this technique heating was imperceptible to the touch. The bags were turned over after 50% of the dose had been received.

Analyses of the irradiated soil samples showed that doses of about two million rep—roentgen equivalent physical, a unit of energy in radiation dosimetry—will kill all bacteria and actinomycetes and one million rep will kill all fungi in soil. At a dose of one-fourth million rep the number of viable organisms is reduced to less than 1%.

With urea added, the rates of production of ammonia in slightly alkaline soil and in irradiation sterilized soil were nearly constant during the first ten hours of incubation. By contrast, autoclaved—steam sterilized—soil was devoid of urease activity.

The production of ammonia from benzoylarginineamide—BAA—by nonsterile soil proceeded to the extent of 45%–55% of the maximum possible release of nitrogen as ammonia in 80 hours. Thus more ammonia was released than was expected by tryptic activity alone, indicating the presence of some arginine decarboxylase or arginine dihydrolase activity. No ammonia was liberated from BAA in irradiated soil.

Electron penetration is limited by the energy, and for practical reasons this method of sterilization is only useful for laboratory and for greenhouse work—as with flats—or where the soil penetration need be only a few inches. Evidently soil so sterilized is virtually free from chemical change and should lend itself readily to studies with pure cultures of plant pathogens, nitrogen fixers, and soil-borne viruses.

A. D. McLaren is Associate Professor of Soil Chemistry, University of California, Berkeley.

Lola Reshetko was Laboratory Technician, University of California, Berkeley, when the above reported study was conducted.

The staff of the Applied Radiation Corporation of Walnut Creek assisted in the experiment in soil sterilization by the electron beam.

SOIL SURVEYS

Continued from preceding page

A soil profile often can be seen in road cuts, stream banks, drainage ditches, excavations for pipe lines and other places where a bank of soil is exposed. When such open soil surfaces can not be found it is necessary to bore holes with a soil auger to locate a typical profile and then dig a hole about 3′ square and 5′ deep. The composition and characteristics of the soil determine its classification by series. For purposes of study, monoliths—as shown in the photograph on the preceding page—are taken from soil profiles.

Another, and a more involved rating system—known as the Storie Index—is based on soil characteristics that govern the soils' potential utilization and productive capacity. It is wholly independent of physical and economic factors such as climate and accessibility. Soils are rated on four factors: *A*, the soil profile; *B*, the texture of the surface soil; *C*, the slope; and *X*, consisting of the following six additional factors: drainage, alkali, nutrient—fertility—level, acidity, erosion, and microrelief.

In addition to establishing the various characteristics of soils and their best agricultural use, the basic information represented by soil surveys and ratings is used by many public agencies in their work with soils. The United States Bureau of Reclamation uses the information in setting up irrigability classifications of soils; the state engineer uses it in planning irrigation developments; the United States Soil Conservation Service uses it in developing their land-use capability system; and state and county assessors use soil surveys and ratings in setting up classifications for assessment purposes.

Lloyd N. Brown is Extension Soils Specialist, University of California, Berkeley.

The soil series profile group system of classification was developed by R. Earl Storie, Professor of Soils and Plant Nutrition, University of California, Berkeley.

SMOG

Continued from page 9

posure 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.