Plastic-covered greenhouses provided controlled atmospheres for citrus trees during air pollution tests near Upland, San Bernardino County.

Effects

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AIR POLLUTANTS, especially photochemical smog and fluorides, are known to cause major damage to agricultural crops. Commercial production of leafy vegetables has been seriously hampered in the Los Angeles Basin because of oxidant lesions which reduce their quality or render them totally unsalable. High levels of fluorides can cause visible damage to crops; where no leaf lesions can be seen, careful environmentally controlled studies are required to determine the extent of injury attributable to fluorides.

Research program

The Agricultural Air Research Program was initiated in 1960 by the Statewide Air Pollution Research Center. The program has been a unique cooperative effort supported by agriculture, industry, local and national government, various private organizations, and the University of California, with an avowed purpose of "measuring (under field conditions) the effect of various atmospheric phytotoxicants on agriculture crops growing in the upper Santa Ana Drainage Basin." The objectives were both scientific and economic; to find out if damage was being done to crops and if so, how much damage.

The program first focused on lemons near Upland because both photochemical (automobile) smog and fluoride air pollutants occur there, and because lemon trees in the selected area grow rapidly, set several flushes of leaves during the year, and bloom somewhat continuously. Later, navel orange trees were added to the experiment.

Initially 24 lemon trees were enclosed individually in plastic-covered greenhouses (see photo). The trees were divided into groups of four, and each group received one of the six treatments shown in the table. Activated carbon filters were used to remove ozone and peroxyacyl nitrates, both components of photochemical smog. Limestone removed acid fluoride gases such as hydrogen fluoride, and the addition of metered levels of nitric oxide reacted to remove ozone selectively from particular airstreams.

Levels of total oxidants, fluoride, and temperatures in the air were recorded continuously. A fluoride analyzer had to be perfected to measure the low levels of hydrogen fluoride in the air. This instrument (see photo) monitors fluorides continuously at levels from one-tenth to two parts per billion in the atmosphere.

Water use

Within a few weeks after the experimental treatments began in 1962, it was observed that water use by the trees differed. Irrigation was on a 15-day schedule, and some trees required more frequent extra irrigations than others. Extra irrigations were those required when tensiometers buried at 50-centimeter depth in soil under the skirts of the trees reached a soil suction of 45 centibars. This extra water was applied so that the suction never went above 50 centibars. The tentative conclusions of 1962 were confirmed during the succeeding years and showed that trees receiving filtered air required more extra irrigations than those with ambient air during 1963, 1964, and 1965. In 1963 and 1964 this difference was statistically greater at the 1 per cent level. In 1965, it was greater at the 5 per cent level. The orange grove showed a greater numerical frequency of

of AIR POLLUTANTS ON LEMONS AND NAVEL ORANGES

EXPERIMENTAL FIELD INSTALLATIONS ON CITRUS UPLAND AND CUCAMONGA, CALIFORNIA

Tree atmosphere	Treatment of atmospheres	Toxicant remaining
Filtered air	Activated carbon, limestone	....
Ambient air	....	Fluoride, ozone, PAN*
Low fluoride air	Limestone,	Ozone, PAN
Low ozone air	Nitric oxide	Fluoride NO, NO_2, PAN
Filtered air + fluoride	Limestone activated carbon, hydrogen fluoride	Fluoride
Low ozone, low F^- air	Limestone, nitric oxide	PAN, NO, NO_2

* Peroxyacyl nitrates

extra irrigations for trees in clean air, but this was not statistically significant.

To measure another effect of pollutants on the metabolism of the lemons, apparent photosynthesis was measured on the entire trees during 1961 and 1962. Air samples from the intake and outlet of each house were drawn through aluminum tubes to a central control room, where they were stored in plastic bags until analyzed sequentially by an infrared analyzer. Carbon dioxide changes in one set of twelve houses comprising two enclosed trees from each treatment were measured for about one week. Then the remaining twelve trees were monitored for CO_2 exchange. Before the actual air treatments were started, the rate of apparent photosynthesis of all trees was determined as a base line in 1961. Treatments were begun in January 1962.

The results showed that trees receiving filtered air and filtered air plus fluoride had a higher rate of apparent photosynthesis than those receiving ambient (smoggy) air. The addition of fluoride seemed to have no measurable effect on results. The same results were obtained when a leaf-bearing branch was enclosed in a box equipped with lights and measured for its rate of apparent photosynthesis.

Yield data

Data on leaf drop, fruit drop and fruit yield are still being collected. However, preliminary evaluation indicates that trees which get ambient air have an increased leaf drop (up to 30 per cent) and yield less fruit than trees which receive carbon-filtered air. The average yield in ambient air is often only half what it would be in clean air although fruit size is not affected. Photochemical smog, principally from auto exhaust, seems to be causing most of this damage. Atmospheric fluoride, while present, is so low that it has no measurable effect on the responses mentioned in this report. Fluoride levels in the air decreased during the course of the study. Sulfur dioxide, a pollutant emitted principally by coal and fuel-oil burning, and ore smelting, is very low in this area, and probably has little effect on crops.

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Fluorometric fluoride analyzer was used for monitoring gaseous fluoride in air pollution tests.