Air Pollution Injury to Crops

injurious components of smog identified as derivatives of petroleum products while annual crop damage increases

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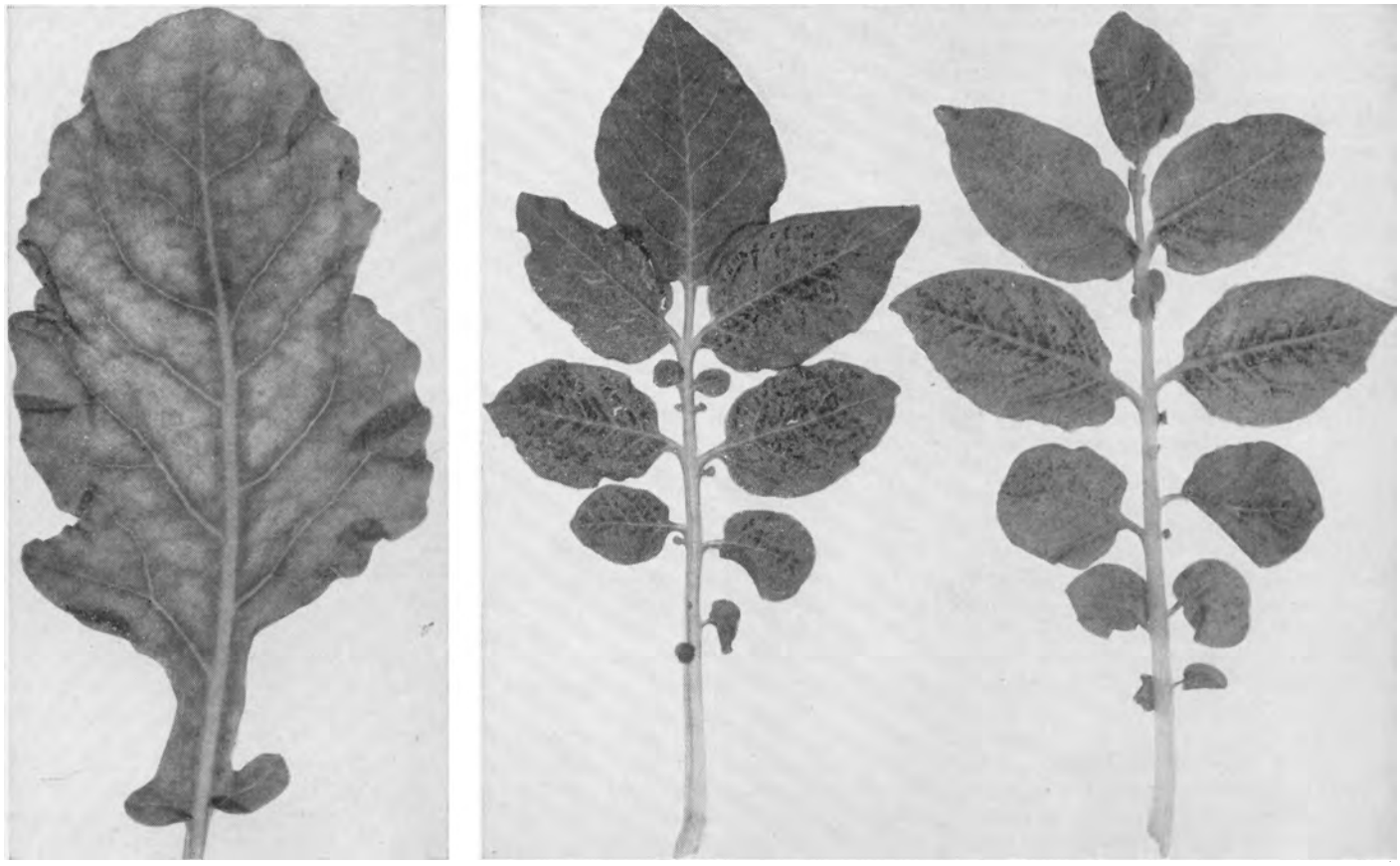

Smog damage to a broccoli leaf, *left*, and to the upper surface, *center*, and lower surface, *right*, of potato leaves.

Air pollutants that cause typical smog damage—the silvering, bronzing, and spotting on many agricultural crops—are certain olefinic peroxides, formed when ozone reacts with the vapors of unsaturated hydrocarbons derived from gasoline and other petroleum products.

In Los Angeles County alone, annual crop losses have exceeded $500,000 since 1949 when they were estimated to be $479,495.

Field, horticultural, ornamental, and vegetable crops in the south coastal basin—from the Mexican border to Ventura and inland as far as Banning—are being injured by air pollution. Crop damage identical to that observed in the southern part of the state now occurs in the San Francisco Bay area and in other metropolitan centers where both ozone and the olefin vapors are known to be present in the air.

The identification of plant-damaging constituents resulted from a co-operative research project of the University of California, the Los Angeles Air Pollution Control District, and the California Institute of Technology. Susceptible plants were fumigated under controlled conditions with the vapors of more than 70 chemicals known—or believed to be—present in the polluted air about Los Angeles.

Injury identical to that observed in the field was obtained only when plants were exposed to the reaction products of ozone and unsaturated hydrocarbons. These reaction products include olefinic peroxides, organic acids, and aldehydes. Only the peroxides cause typical plant damage.

Mixtures of oxides of nitrogen and olefins in sunlight cause the same injury to plants since ozone is formed from the oxides of nitrogen in the presence of sunlight.

Controlled fumigation experiments have shown that the severity of plant damage varies with the conditions under which the crop is grown prior to fumigation. Spinach grown at air temperatures of about 75° F was damaged four times more severely than when grown at approximately 55° F. Romaine lettuce grown under the same conditions showed 30% more damage at the higher temperature than it did at the lower. Endive responded similarly.

The application of about 45 pounds of nitrogen per acre increased the injury to spinach 40% and to Romaine lettuce 80% compared to plants not receiving nitrogen additions. Damage to barley and oat was slightly increased by nitrogen applications.

The extent of injury also depends upon the length of fumigation, age of plant, and the soil moisture level. Gen-

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erally speaking, the longer the exposure to olefinic peroxides the greater the damage. Damage to Pinto bean leaves is greatest on the oldest and least on the youngest. Plants grown with high soil moisture levels are more severely damaged than those grown with low soil moisture.

Varieties of a given crop respond differently to the air-borne peroxides. The common beans, Golden Cluster and Pink, and the lima bean, Fordhook 242, are among the most susceptible, but the common bean, Bountiful, and the lima bean, Concentrated Fordhook, are among the most resistant.

The greatest economic losses are experienced in crops in which the foliage is marketed, either as a perishable commodity for human consumption or as fresh or dried hay for poultry and livestock.

The floricultural and ornamental industries of both Los Angeles and San Francisco must contend with increasing economic losses from air pollution injury. A variety of flower and nursery crops are damaged when grown outdoors, under shade, and in glasshouses. Injury to susceptible crops is likely to be most severe when the plants are grown under glass.

The fruits of lemon, orange, and grapefruit—though resistant—were damaged during the protracted pollution period in the Los Angeles area during the fall of 1952.

A variety of weeds are known to be affected by the same constituents in smog that damage cultivated crops. These weeds are useful indicators of the presence of the peroxides in areas where there are no susceptible cultivated crops. The extent of the area affected by these air-borne pollutants also can be assessed by observing the response of susceptible weeds. Weeds which may be used for this purpose include: annual bluegrass, cheeseweed, chickweed, dwarf nettle, lambs quarter, London rocket, quickweed, and wild oats.

Alfalfa plant damaged by smog.

The discovery that the growth of plants may be materially retarded without visible symptoms of injury is of great importance. It is impossible to recognize this effect in the field since all of the plants in a given area may be subjected to sublethal doses of olefinic peroxides, leaving no healthy plants for comparison. Growth suppression has been experimentally induced in alfalfa, endive, lettuce, sugar beet, and tomato. The failure of a variety of agricultural crops to produce normal yields may in part be associated with this growth retardation phenomenon.

It is very difficult to assign plants to susceptibility groups on the basis of field observations since extent and severity of damage depend not only on the variety of plant, but on the environment in which it has grown and the time and length of exposure to the olefinic peroxides. Since the fumigation and testing of plants under controlled conditions is slow and exacting, a detailed listing of relative plant susceptibility can not yet be presented.

The accompanying list has been compiled from field and laboratory observations and is offered as a guide to the relative susceptibility of a variety of crops to olefinic peroxide injury occurring in the air pollution basins of Los Angeles and San Francisco.

Research is now in progress to develop methods for the economic production of agricultural crops in areas affected by air pollution. Protection of glasshouse-grown plants can be afforded by passing all the incoming air through activated carbon filters.

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Plants Known to Be Damaged by Olefinic Peroxides in Smog

Crops	Susceptible	Resistant
Tree		Grapefruit Lemon Orange
Field	Alfalfa Oat Sudan Sugar beet	Barley Blackeyed bean Mustard Black White Sweet clover Vetch Wheat
Vegetable	Bean—common Golden Cluster Pink Pinto Small white Bean—lima Fordhook 242 Beet Celery Endive Lettuce—Romaine Onion Parsley Parsnip Spinach Swiss chard Lucullus Turnip	Bean—common Bountiful Kentucky Wonder Bean—lima Concentrated Fordhook Westan Broccoli Cabbage Cauliflower Chinese cabbage Corn Eggplant Leek Lettuce—head Muskmelon Mustard Pea Pepper Potato Radish Rhubarb Swiss chard Large ribbed Tomato
Ornamental	Chrysanthemum (Some varieties) Grass Annual rye Perennial rye Larkspur Petunia Snapdragon	Calendula China aster Chrysanthemum (Most varieties) Dahlia Forget-me-not Gaillardia Grass Bermuda Kentucky blue Lobelia Pansy Stock Sweetpea Viola White clover

Controlled fumigation experiments in the smog chambers at Riverside.