PHOTO CHEMICAL AIR POLLUTION INJURY TO POTATOES IN THE ATLANTIC COASTAL STATES

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ABSTRACT

Photochemical oxidants, primarily ozone, can cause severe injury to potatoes, including premature senescence of leaves, death of plants, and reduced yield of tubers. Under some controlled conditions, ozone produced leaf injuries similar to those observed in fields. Studies were initiated in 1969 comparing growth of eight varieties in greenhouses with carbon-filtered and unfiltered air. The yields of sensitive varieties were reduced as much as 50% in unfiltered air. Tolerant varieties produced about the same yields in both environments, but their yields in filtered air tended to ozone, and to pollutants in unfiltered air, were assessed in 1972. A summary of 4 years of oxidant data at Beltsville is provided. The severe leaf injury and yield loss (about 50%) with some potato varieties on the Eastern Shore of Virginia in 1971 are attributed primarily to oxidant air pollutants. In 1971 and 1972, oxidants reached about the same maximum levels as at Beltsville.

INTRODUCTION

Photochemical air pollution injury on a crop in the Atlantic Coastal States was first established in 1958. Ozone, one of the oxidants in photochemical smog, was determined to be the primary cause of weather fleck, a leaf spot on cigar-wraper tobacco (Heggestad and Middleton, 4). In a single weekend, July 1959, growers lost an estimated one-fourth of the $25 million crop in the Connecticut Valley (Heggestad, 5). Ozone is formed by action of sunlight on products of fuel combustion. Photochemical air pollution injury to vegetation has been present in the Atlantic Coastal States at least since 1952. An injury to potato known as speckle leaf, and believed caused by ozone and other oxidants, was serious in Michigan in 1968 (Hooker et al., 7). Similar injury has been observed in the Atlantic coastal States (Brennan et al., 1; Manning et al., 3; Rich and Hawkins, 8). These investigators also studied leaf injury produced by ozone in chambers and observed varietal differences.

Our studies of photochemical air pollution injury to potatoes were initiated in 1969. We compared growth of potatoes in greenhouses supplied with carbon-filtered clean air with growth in unfiltered air containing oxidants (Heggestad, 6; U.S. Dept. Agr., 9).

This report provides information (i) on growth of potato varieties in greenhouses with and without oxidant air pollution; (ii) on studies with ozone designed to determine its role in causing symptoms observed in greenhouses and the field; and (iii) on the potato speckle-leaf problem on the Eastern Shore of Virginia in 1971 and 1972.

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Materials and Methods

Filtered and unfiltered air studies

Eight varieties of potatoes (Solanum tuberosum L.) were studied each year from 1969 to 1971. Fifty-six varieties were planted in more limited tests in 1972. The potatoes were grown in a (2:1) mixture of soil and perlite in clay pots varying in size from 6 to 12 inches in diameter, depending upon the experiment. They were seeded in April in 1969 and 1970, in mid-June in 1971, and in early May in 1972. Plants were fertilized weekly with Peters 2-20-20 liquid nutrient solution. The number of vines per pot was reduced to three or less. All plants were staked. Plants for most of the experiments were grown in large greenhouse sections, 25 x 36 feet. They were cultured under normal photoperiod with day and night temperatures of about 28 and 18 C, respectively. Humidities averaged about 70% during the day and about 90% at night. Shading and a wet-pad and fan cooling system helped reduce temperature and increase humidity. The temperature and relative humidity were about the same in the greenhouse sections with carbon-filtered and unfiltered air. The light intensity was somewhat higher in the unfiltered-air section located at the end of a greenhouse with a southern exposure.

In 1971 and 1972, four small greenhouses, 10 x 13 feet, also were used. Two houses had carbon-filtered and two unfiltered air. Light conditions in the small greenhouses were very similar.

Ozone exposure studies

Most of the tests involving ozone were conducted in Controlled Environment growth chambers (PGW36). Exposure conditions were 26 C, 85 ± 5% relative humidity, and 21.5 Klx of light — about 10% incandescent and the remainder fluorescent. Some experiments involved eight plastic-covered chambers (30 x 30 x 30 inches) where plants were grown as well as exposed to ozone. A bank of fluorescent lights above these chambers provide about 16.0 Klx to the plants. A continuous flow of air through these chambers was regulated to provide one change per minute. When lights were on, the temperature was 26 C and the relative humidity 84%; with lights off, the temperature was 23 C and relative humidity 95%.

Young potted plants of the same varieties as grown in filtered and unfiltered air were exposed to doses of ozone which produced varying amounts of acute injury. After exposure the plants were grown in filtered air for symptom development. Within 48 to 96 hours the injury was indexed using ratings from 0, no injury, to 10, total loss of leaves or plants.

Eastern Shore, Virginia

Observations were made on field plantings of potatoes at the Ornamental and Truck Crop Research Station, Painter, Virginia, and on nearby farms. Painter is about 50 miles north of Norfolk on the southern portion of the Del-Mar-Va Peninsula and near the center of a 30,000-acre potato-production area. From mid-June to mid-September 1971, and from May to mid-September 1972, oxidants were measured with a Mast 3 meter.

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