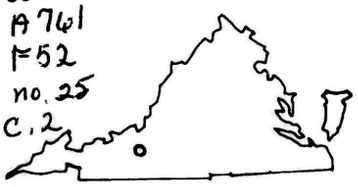
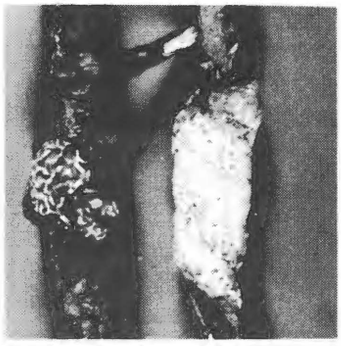


Forest Tree Diseases of Virginia



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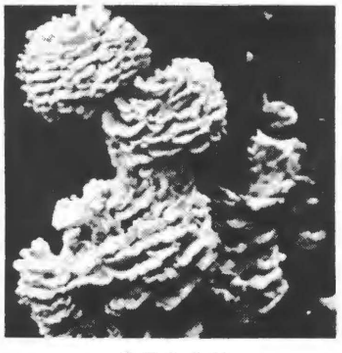

DECAY

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Ozone and Its Effect on Forest Trees

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Oxidant air pollution has increased significantly over the past several years throughout most of the urban and many of the rural areas of Virginia. The most important oxidant air pollutant in the eastern United States is considered to be ozone (O_3) and its widespread occurrence in Virginia at levels in excess of the National Ambient Air Quality Standard (NAAQS) has resulted in significantly increased damage to many sensitive tree species. The major urban centers as well as the rural agricultural and remote forested areas have more than occasionally experienced oxidant levels considered to be above those that cause damage to vegetation.

Eastern white pine throughout the mountains of western Virginia appears to be the most sensitive species to ozone. Decline of a small percentage of the population has been noted and a serious increase in symptom expression has been observed on another large percent of trees formerly not symptomatic.

Figure 1. Tulip poplar leaf exhibiting typical oxidant (ozone) injury. Black dots are pigmented lesions that are usually purple in color. Such lesions may coalesce to form larger areas of purple coloration.

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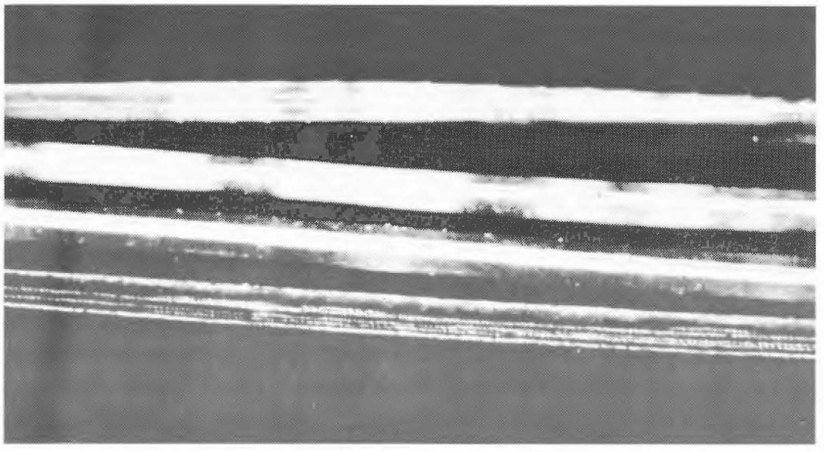

Figure 2. Chlorotic mottle of pine needles. Light colored areas appear as non-delineated yellow to yellow-green spots. Entire trees may appear to be light green in color.

Ozone defined and sources: Ozone is triatomic oxygen (O_3) and is considered to be a very powerful oxidizing agent. Ozone occurs naturally in the upper atmosphere as a result of instantaneous dissociation of O_2 to O + O and the recombination of O + O_2 under ultraviolet radiation. Without this reaction, that absorbs UV light energy, life would not exist on earth. However, this natural source of O_3 can be transported to ground level by means of subsidence of the O_3 layer from aloft; such "stratospheric inclusions" are not considered to be important in causing plant damage. Another "natural source" of ozone is a lightning strike and the arid odor detectable near such a strike is ozone.

Ozone levels that are sufficiently high to cause plant damage over widespread areas are of man made origins. The interaction of hydrocarbons and oxides of nitrogen produces excesses of ozone in a rather complicated cycle that is set in motion during periods of bright sunlight. The precursors are released from the combustion of the hydrocarbons and nitrogen oxides by way of the exhaust system. The entire transportation industry (automobile, trucks, aircraft, etc.) contributes 60% of all national air pollution. Increased ozone levels result during air stagnations that coincide with stationary high pressure systems that are further characterized by bright sunlight.

Although numerous expansive urban areas exist in Virginia of sufficient size to generate high oxidant levels, few such areas exist in the mountainous portion of the state and long distance transport of oxidant from the Megapolis of the east coast (Boston, Massachusetts to Charleston, South Carolina) to the rural areas of Virginia has been documented.

Symptoms:

Broadleaf trees: Under chronic exposure (long term - low levels of ozone) broadleaf trees develop watersoaked areas of leaf tissue immediately following exposure. These areas are usually small in size and may eventually develop into a pigmented stipple of either a red, brown, or purple color. This stippling is usually confined to the upper leaf surface only. The pigmented lesions are most commonly pinhead sized and may have an angular shape (Figure 1). Under continued chronic exposure, entire leaves or large portions of leaves may turn purple or red prematurely. Growth loss and loss of tree vigor will result following extended periods of exposure.

Acute exposure to ozone (high level of ozone for short or long periods of time) will result in death of large areas of leaf surface with both upper and lower surfaces

being affected. Severe defoliation will result. However, concentrations would need to be excessively high to cause widespread observable damage. Acute fumigation can result in tree death.

Conifers: Ozone is considered to be particularly damaging to conifers with most concern for eastern white pine. Chronically exposed trees develop a general chlorotic mottle of one and two year old needles with increased damage to the two year old needles due to the extended period of exposure (Figure 2). Injured white pines drop their 2 year old needles prematurely (they should remain for a third year). Under chronic levels, but just below sub-acute levels, even the one year old needles will drop at the end of the current years growing season i.e. only the current year's needles remain for the winter months. The entire tree appears thin and spindly i.e. tufts of needles remain at the ends of branches (Figure 3).

Acute damage is predominantly expressed as a uniform tip burn of the needles. Usually all needles within a given fasicle are burned uniformly since they emerge from the fasicle sheath together. Acute damage occurs most often early in the growing season as the needles are emerging. Pine needles grow from the base and exposed needle tips from the fasicle sheath are actually the oldest portion of the needles. When exposed to high levels of ozone the needle tissue that has emerged may be severely injured; those portions protected by the fasicle sheath remain healthy during later development unless a second or third exposure occurs. Severe stunting of needles, short internodal distance and severe reduction in height growth will occur (Figure 4).

Sensitive tree species:

Hardwood species considered to be sensitive include ash, birch, box elder, honey locust, black locust, white oak, sycamore, sweet gum, yellow poplar, and walnut.

Conifer species considered to be sensitive include eastern white, jack, Virginia and loblolly pine, hemlock and larch.

Diagnostic methods: Due to the widespread occurrence of ozone levels that are high enough to cause plant damage, a specific diagnosis in a given area is extremely difficult. However, by examining several sensitive tree species for the described symptom expression within the area of concern and/or other sensitive vegetation as outlined in Publication No. 568 "Diagnosis of Air Pollution Injury to Plants" Extension Division, VPI and SU, Blacksburg, June 1974, an individual can establish a pattern of suspected damage. Additional information concerning weather patterns and associated air stagnations will assist the diagnosis.

Caution must be advised in making a diagnosis to carefully eliminate other pathogenic agents that may directly cause a similar symptom pattern. The use of

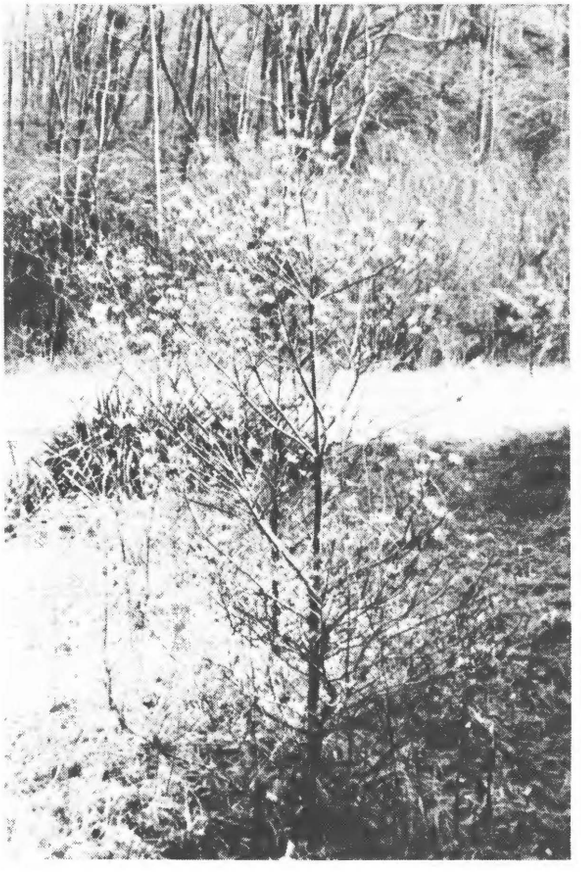

Figure 3. A sensitive eastern white pine. Note tufts of needles and loss of 2 and 3 year old needles. Such trees are very weak and die over an extended period of time.

several different types of vegetation in making diagnosis will enhance the accuracy.

Control or reduction of losses. Obviously the control of ozone damage would best occur through the reduction of the precursors leading to ozone formation. Research information and field collected data will continue to assist the U. S. Environmental Protection Agency in setting standards.

The reduction of losses in forested areas is based upon recognition of a decline situation and removal and utilization of the dying trees. Eastern white pine, found as individuals or in groups of symptomatic trees, would be the only trees at this time considered to be so affected to warrant cutting. Other conifers and hardwoods are affected by way of growth reduction over wide areas.

Losses in Christmas tree plantations or in high value plantings can be alleviated with the use of high nitrogen fertilizers as outlined in publication on MR-FTD-21 "The Use of Fertilizer to Alleviate Air Pollution Damage to White Pine Christmas Trees." Extension Division, VPI & SU, Blacksburg, June 1974.

Figure 4. Dramatic differences in growth of sensitive white pine (foreground) can be noted when compared to tolerant white pine (background). Both tree groups were planted the same day; therefore, both are the same age. Height and diameter growth can be greatly suppressed due to oxidant air pollution.