CENTRAL HARDWOOD NOTES

Diagnosing Forest Vegetation For Air Pollution Injury

The purpose of this Note is to help you become more technically informed about air pollution when serious problems need to be diagnosed by pollution specialists. (Except for ozone, most of the information discussed does not attempt to describe possible air pollution damage caused by long distance transport. This complex problem is currently under intense study.)

Air may be polluted by many components ranging in size from dust particles to invisible gases. Sulfur dioxide and nitrogen oxides may be produced when coal or oil are burned and industrial processes may release fluoride, chlorine, ammonia, hydrogen sulfide, and numerous other compounds. Farming operations may release components in fertilizer and chemical pesticides.

Of the long list of pollutants only three are important in causing leaf or needle injury. They are ozone, sulfur dioxide, and fluoride. The remaining pollutants may cause injury, but the injuries are usually limited to areas very close to the pollutant source, e.g., chlorine injury on plants near a swimming pool.

Ozone

Of these three important pollutants ozone is the most widely spread in the United States and is the most harmful. Ozone differs from most other pollutants because it is formed in the environment when sunlight causes a chemical reaction between other pollutants-nitrogen oxides and hydrocarbons. High levels of ozone may be found in both urban areas near pollution sources and in rural areas many miles from pollution sources.

High concentrations of ozone for short periods most commonly cause small flecks or stipples on the upper leaf surface of hardwood trees. Flecks may be either white, yellow, or tan and, if many are present, the entire leaf surface may appear chlorotic and bronzed. Stipples are small, dark, pigmented dots on the upper leaf surface and may be either red, reddish brown, reddish purple, or black. Low levels of ozone for long periods also injure hardwoods. With the initial exposure few symptoms may appear, but with additional exposures a few flecks or stipple-like symptoms may gradually appear and coalesce to give the leaf a bronzed or yellow appearance. This may later be followed by premature foliage drop.

The most common types of ozone injury on conifers are chlorotic mottling and tipburn Chlorotic mottles usually develop as small patches of yellow tissue surrounded by apparently healthy tissue. Tipburn is the term used to describe the condition in which the needle tip dies and becomes reddish-brown. The tip may break off.

The responses to ozone of both hardwoods and conifers are general symptoms and are often influenced by many factors including leaf age, host genetics, and environmental factors.

Sulfur Dioxide

Sulfur dioxide is produced by burning coal and oil, smelting ore, manufacturing steel, and refining petroleum. Sulfur dioxide is not as widely spread as ozone because it usually comes from "point" sources such as smoke stacks. Thus, sulfur dioxide injury to forests tends to be restricted to small areas directly downwind from its source.

High doses of sulfur dioxide will cause the death of tissue at the edge of the leaf and between the leaf veins. The injured area may become light tan to white after drying. The leaf areas near the veins are seldom injured and remain green, giving the leaf a herringbone appearance. Injury caused by low doses of sulfur dioxide have a similar injury pattern, but the injury is slightly more diffuse. Chlorotic yellowing may be observed on the leaf's edges and in the area between the veins. Again, the veins usually remain green.

Sulfur dioxide injury on conifers is very difficult to diagnose because symptoms are very similar to injury caused by other stress factors. The needle tips-and in some cases the entire needle-become reddish brown. Injured needles may also fall prematurely.

Fluoride

Fluoride pollution is usually a local problem. Hydrogen fluoride gas is released during the manufacture of aluminum phosphate fertilizer and other products. Fluoride injury in hardwoods usually appears as yellow or dead areas near the leaf margin or tip. With continued exposure, discoloration progresses toward the base of the leaf. In conifers fluoride causes tipburn and death of the needle tips.

Other pollutants also cause injury. The most common injury found after exposure to high doses of pollutants are yellowing or dead spots on broad-leaf trees and tipburn on conifers. Many of the injury patterns are similar to those caused by environmental stress factors such as drought.

Is It Really Air Pollution?

Distinguishing between injury from air pollution and injury from other causes is a very difficult process that is best approached through a series of logical steps. One approach is to answer the following questions:

1. Is there a pollution source nearby capable of causing injury? Are the symptoms consistent with nearby pollution sources?
2. What are the characteristics of the landscape? Does the terrain provide a pathway from the source? Can the terrain be the cause of injury, i.e., flooded lowland?

3. What are the injury patterns and what tissue is injured? (This is important because many stress factors produce symptoms that look like air pollution injury.)
4. What is the distribution of the affected plants? Is the pollutant from a point source or is it broadly dispersed?
5. Are any insects or diseases present? These kinds of injuries can look like pollution injury. You may have to consult a pathologist or an entomologist.
6. How many species are affected? Biological agents usually attack one species or host, whereas pollutants usually affect numerous specimens. Also, certain plants are very susceptible to certain pollutants and can be used as biological indicators for that pollutant.
7. What is the recent history of pesticide use, fertilizer applications, and similar cultural treatments in this area? injury may have been caused by chemicals used in the vicinity.

Answering the above questions will not always insure correct identification of the cause of foliar injury observed in forests. But this information will be very helpful to air pollutant specialists who should be contacted as soon as serious problems are encountered.

References

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