FOREST SPECIES SHOW A DELAYED RESPONSE TO CEMENT DUST IN THE SOIL

by Ann F. Rhoads [1]

ABSTRACT

Severe foliar chlorosis, leaf scorch and accompanying branch dieback, and mortality of native oak species presently occurring on a 300-acre site in northwestern New Jersey have been associated with deposition of cement dust which occurred from 1903 to 1940. Because soil pH values in the affected area are abnormally high, I conclude that acid-loving species such as *Quercus prinus* are declining due to the unavailability of certain essential nutrients.

In 1974 native oak trees on over 300 acres of the Pohatcong Ridge in northwestern New Jersey exhibited severe foliar damage. Although the symptom has been observed only during the last three years, the condition may well be related to an air pollution problem that occurred over 30 years ago.

Recognition of the problem. The problem was first detected in June 1972 by Kegg, New Jersey Department of Agriculture entomologist, while making a yearly aerial survey to determine the extent of gypsy moth damage in the state's forested areas. Kegg noticed discoloration of the foliage of trees along a ridge west of Washington, New Jersey. The appearance of the affected crowns was not that associated with gypsy moth activity or any other recognizable condition. The following year he again observed the same condition over a more extensive area, and further expansion was apparent in 1974. Concerned that the discoloration might be an indication of some new threat to forest trees in the state, he made a ground inspection of the area in June 1974.

Figure 1. Severe chlorosis and leaf scorch typical of *Quercus* spp. at the Pohatcong Mt. site.

Kegg found damage ranging from foliar chlorosis to severe leaf scorch and branch dieback on the native oaks (Figures 1 & 2). Chestnut oak (*Quercus prinus*), black oak (*Q. velutina*), red oak (*Q. rubra*), and scarlet oak (*Q. coccinea*) were the most severely affected, white oak (*Q. alba*) less so. Some other tree species present showed slight to moderate chlorosis. These included red

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maple (*Acer rubrum*), flowering dogwood (*Cornus florida*), and hickory (*Carya* spp.). Green ash (*Fraxinus pennsylvanica*), yellow poplar (*Liriodendron tulipifera*), and sugar maple (*A. saccharum*) showed no visible damage.

Figure 2. Branch dieback of severely affected *Quercus* spp. associated with high soil pH values.

Kegg estimated the area involved at that time to be about 300 acres along the north slopes and ridge tops of Pohatcong Mt. in Warren County west of Washington, N.J. He could find no obvious cause for the poor condition of the trees. There was no history of insect defoliation in this area.

An explanation is found. In July 1974 a plant pathologist and an entomologist examined the site but were unable to find evidence to implicate either insects or disease pathogens. Drought was considered, but the yellowing and leaf scorch had first been observed in late May and early June, long before the summer dry spell could have had an effect. In addition, chestnut oak, the most severely affected of the species, is noted for its ability to grow on dry ridgetop sites. The experts were baffled.

Because I had been documenting the effects of air pollution on trees in New Jersey for the past 18 months, I examined samples of chlorotic oak leaves that had been brought back to the plant pathology laboratory. When the location of the affected trees was described, I associated it with a site at which a study had been conducted on the effects of airborne cement dust.

With this lead a specialist in soils collected samples at the soil surface and at 6-inch depth. They had pH values of 8.0, very low amounts of available manganese, and practically no available phosphorus.

Relevant local history. A search of the literature has provided information relevant to the current situation at Pohatcong Mt. From 1903 until just before WW II the Edison Portland Cement Company operated a plant in Warren County, N.J., west of the town of Washington, N.J. During the years that the plant was in operation, farmers and residents in the area were aware of a continual fallout of cement dust. Farmers were also aware that they did not have to add lime to their fields; crops thrived because the airborne cement dust raised the pH of the naturally acidic soils. Clucas and Tedrow (1957, N.J. Agriculture 39(5):13-15) studied the extent of the cement-dust effect. They measured soil pH values throughout southern Warren County and concluded that the effect, reflected by higher than normal pH values of undisturbed soils, covered an area of over 100 square miles. Soil pH values above 7.0 were not uncommon, despite the fact that normal unaffected values were 4.5-5.0. Five cement factories were located in the general area, but by the 1950's only one or two of them were still in operation.

In 1971, Cole (M.Sc. Thesis, Rutgers) studied the effect of the fallout from the Edison Portland Cement Company on the native vegetation of Pohatcong Mt. She recorded soil pH values of 7.2 at the surface dropping to 6.1 at a 24-inch depth. Normal pH in this region is 4.5 at the sur-

face increasing to 5.5 at 24 inches down. The most prominent effect that she noted on the vegetation was a drastic change in the composition of the shrub layer on the wooded slopes facing the cement plant. Ericaceous species, normally a major component of the shrub layer, were no longer present. In their place were species favored by more alkaline and more mesic conditions.

At that time Cole did not record any apparent alterations in the tree component of the forest, although she did note that there were no pines or other conifers present. Pitch pine is normally found on this type of site.

Literature review. My interpretation that we are observing a delayed plant response to cement dust is reinforced by reports of recent studies of the effects of limestone dust accumulation on a forested site in southwestern Virginia. Researchers Brandt and Rhoades (1972 and 1973, Environ. Pollut. 3:217-225; Environ. Pollut. 4:207-213) report 18-29% reductions in lateral growth of *Acer rubrum, Quercus rubra,* and *Q. prinus* and increased growth of *Liriodendron tulipifera,* in the dust-affected area as compared to a similar but nondusty control site. They also note a decrease in the basal area and seedling density of *A. rubrum, Q. rubra,* and *Q. prinus* at the affected site. *L. tulipifera,* on the other hand, showed increased seedling density in the dusty area and had increased in importance at that site to the extent that it was considered a codominant. Although there is clearly a differential effect of the limestone dust on the species studies by Brandt and Rhoades which parallels the species sensitivity which we have observed at Pohatcong Mt., Brandt and Rhoades made no mention of foliar symptoms on the trees they studied. *Quercus prinus,* which they found to have the greatest reduction in lateral growth after dust accumulation, was also the most severely damaged species at the New Jersey location; however, severe foliar chlorosis and leaf scorch accompanied the general decline in growth and vigor which we observed.

There is one report of foliar symptoms associated with deposition of limestone dust on native woodland. Manning (1971, Environ. Pollut. 2:69-76) mentions chlorosis, stunting, and distortion of leaves of wild grape with heavy dust encrustations. Hemlock at the same site, which had received limestone dustfall for 5 years, showed chlorosis of the second-year needles and a 48% reduction in the growth of new terminals.

Neither of these studies is strictly analogous to the New Jersey problem since they involved cases of ongoing dust deposition. I am reporting on a situation where dustfall ceased 30 years ago but damage to the native vegetation is apparently still intensifying.

Conclusions. It seems clear that the increased soil pH values resulting from past deposition of cement dust are responsible for the poor condition of the oak trees on Pohatcong Mt. The oaks are acid-loving species and at high pH they cannot obtain needed nutrients.

However, there are some questions still remaining. There are numerous dead and dying trees visible in portions of the area involved. It would appear that the oaks have been declining over a period of many years. If so, why hasn't it been noticed before this by either the state aerial survey, by Cole or others concerned with the specific effect of the cement dust? If it is only in the past few years that the oaks have developed this foliar-yellowing, leaf-scorch, and dieback syndrome, how can this delayed response be explained? It may be a matter of the altered pH values only recently reaching the root zone of the trees involved or perhaps the addition of one or more additional stress factors bringing out the symptom at this time.

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