BTI Studies Offer New Insight Into Ozone Crop Damage

ITHACA, N.Y.— While national studies have established that ozone can damage crop plants, scientists at the Boyce Thompson Institute for Plant Research have discovered that this damage could be even worse with higher ozone levels and more sensitive crops.

A previous national study conducted in part at the institute had shown that crop reductions of up to 12 percent could be produced by high ozone levels. However, in tests of a spring wheat crop last year, the BTI scientists found a 30 percent yield reduction due to the highest ozone concentrations in 10 years in the Ithaca area. These ozone levels were the result of a prolonged heat wave and stagnant air masses over the Northeast.

The institute is a private, independent research organization based at Cornell University.

"What's new in our study was that the magnitude of yield reductions due to ozone was never so high," said BTI plant pathologist John Laurence. "We seemed to have had a combination of sensitive varieties and exceptionally high concentrations of ozone in an unusually warm year which led to dramatic yield reductions.

"Farmers need to realize that air quality as affected by high ozone concentrations represents a significant production cost factor, because they have to plant more acres to grow the same amount of crop," he said. "Until we begin to control ozone-producing pollutants, we can expect to see yield reductions in the years to come."

Ozone is formed in the lower atmosphere when sunlight "cooks" chemical pollutants -- nitrogen oxides and hydrocarbons -- that come from the burning of fossil fuels. Ozone concentrations generally peak in the mid-afternoon and drop to low levels during the night.

Ozone reduces the photosynthetic ability of crop plants to make carbohydrates, the compounds necessary for growth and development, Laurence said.

The BTI scientist said that pollutants from East Coast cities such as metropolitan New York and from industrial complexes in the Midwest, along with hot and sunny weather, led to unusually high concentrations of ozone in the area.

Laurence reported that daylight ozone concentrations averaged 45 parts per billion (ppb) throughout the growing season in 1988, up 25 percent from the previous high of 36 ppb recorded in 1985. The average concentration in normal years is about 30 ppb.

"It was probably the worst year in terms of ozone concentrations we have ever had here," he said.

Based on ozone levels monitored during the past decade, Laurence said that the level in normal years hits a peak during May and early June, with a few days of high concentrations occurring in July and August, but the level last year consistently remained high well into July and August.

He also reported that the maximum ozone concentration was 115 ppb, slightly below the federal standard of allowable ozone concentration of 120 ppb for one hour per year but far above the 80 ppb that many plant scientists consider injurious to agricultural crops, forests and other types of vegetation. There were 180 hours of ozone concentrations above 80 ppb last year, compared with the previous record of 81 hours in 1983.

The effect of high ozone concentrations was dramatic. Compared to control wheat exposed to charcoal-filtered air that still contains some ozone, test crops grown in non-filtered, open-top chambers suffered a 30 percent reduction in yield, or about 14 bushels per acre. The variety tested was a spring wheat called Stoa.

"Sensitivity of crop plants to ozone damage varies depending on varieties," Laurence said. In previous studies, a winter wheat called Vona was as sensitive as Stoa to ozone, but another winter wheat called Hawk was much more resistant.

Ironically, by damaging the wheat, ozone decreased the development of wheat diseases, said Laurence. In the same experiment, he found that the ozone levels reduced the severity of a fungal disease known as powdery mildew, one of the most pervasive wheat diseases.

The fungus thrives in healthy plant tissue, but ozone causes plant leaves to die prematurely, leaving less healthy tissue in which the microorganism can flourish. Ozone injury also often results in smaller leaves, leading to less disease buildup, Laurence said.

"This particular disease turned out to be less severe, but that was far overshadowed by drastic yield reductions," he pointed out.

Laurence has been monitoring ozone levels in this area for the past 10 years in efforts to develop computer models that can predict the effect of ozone on agricultural crops under different conditions. He said that such a computer model would be able to answer these key questions:

- What if ozone occurs early or late in the growing season?
- What if average ozone concentrations are normal but there are a lot more days of very high levels and very low levels?
- What happens if ozone levels remain generally above average but there are fewer high peaks throughout the season?

The ultimate solution to the ozone problem as it affects food crops and other plants, including forests, is to stop polluting the atmosphere, Laurence said.

"Unless man's activity in polluting the environment is curtailed drastically, the problem will not go away," he warned. "We need to be better stewards of our environment."

Laurence's work is part of a larger effort now under way at the Boyce Thompson Institute, a major center for study of the effects of ozone and acid rain on plants. BTI scientists are now studying what effects ozone, acid rain, or both, have on eastern U.S. forests, where untold numbers of red spruces and sugar maple have died or are dying mysteriously, a phenomenon called forest decline. BTI scientists suspect that ozone and acid rain may play a part in causing the death of these trees.

The original national study, completed in 1987, was known as the National Crop Loss Assessment Network. Sponsored by the U.S. Environmental Protection Agency (EPA), it revealed that ozone was an important air pollutant affecting a wide range of agricultural crops. Annual yield reductions in corn, wheat, soybeans and alfalfa grown in the Midwest alone were estimated at more than $2.5 billion, according to Robert J. Kohut, a plant pathologist at the institute, who participated in the study. Other BTI scientists who took part in the study, conducted in 1980 through 1987, were Laurence and Robert G. Amundson, a plant pathologist.

Crops tested in this study included corn, wheat, soybeans, sorghum, cotton, dry beans, peanuts, forages, tomatoes and lettuce. The crops were grown at Ithaca, Raleigh, N.C., Riverside, Calif., Argonne, Ill., and Corvallis, Ore. Other participating institutions were EPA, the U.S. Department of Agriculture, the Argonne National Laboratory and the University of California at Riverside.

All regional tests utilized the same experimental setup using an array of open-top field chambers. Some test plants were grown in ambient air, without the chambers. Others were grown as controls in charcoal-filtered air chambers to represent "clean" air.

Kohut said that yield reductions due to ozone exposure in the crops tested in open air ranged from about 2 percent to 12 percent.

Baltimore's Farm Credit Promotes Amoss

BALTIMORE, MD. — The Farm Credit Bank of Baltimore announced recently the promoton of Benjamin H. Amoss, II to senior vice president and chief financial officer. His new responsibilities include directing the activities in the finance division, which covers treasury, accounting and audit functions. He also will serve on the Bank's Executive Committee.

Amoss, a certified public accountant, joined Farm Credit in 1985 as vice president of the audit and review division. Previously, he supervised financial reporting and internal auditing for the Baltimore Gas and Electric Company, and worked as an audit manager for Price Waterhouse.

A native of Baltimore, Amoss earned a B.S. degree in accounting from St. Mary's College in Emmitsburg, MD and an M.B.A. in finance from Loyola College in Baltimore, MD.