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Historical approach to research on ozone and plants

Pierre Dizengremel
University of Lorraine, UMR SILVA, AgroParisTech, INRA, University of Lorraine
BP 70239, 54506 Vandoeuvre- lès-Nancy cedex, France
pierre.dizengremel@univ-lorraine.fr

Abstract

Seventy years ago, Haagen-Smit was commissioned to determine the nature of the smog in Los Angeles, which caused haze, eye irritation and plant damage. Earlier work related that damages to crops were different from those observed in smog episodes in the eastern USA and Europe. Consequently, Haagen-Smit realized that the odor of smog resembled that of oxidized hydrocarbons. He tested the action of ozone and gasoline on crops and got symptoms of damage similar to those caused by smog. Getting similar results with hydrocarbons and nitrogen dioxide under sunlight, he concluded that the smog resulted from the photochemical reaction of hydrocarbons and nitrogen dioxide from car exhausts and fuel combustion, ozone being a secondary pollutant. Visible symptoms of ozone damage on pines were also identified in the mountains surrounding Los Angeles. This breakthrough in knowledge further led to the development of research programs in the USA. Concurrently, in the eighties in Europe, German scientists claimed that the conifers in Germany and France were declining. A fruitful cooperation started between the two countries, followed by European programs, allowing large improvement in knowledge about the physiology of crops and trees and their behavior when exposed to ozone. At the leaf level, the decreased photosynthesis and the increased respiration were the physiological symptoms of a lower growth of plants. The negative impact of ozone counteracting the possible positive effect of an increasing atmospheric CO2 cannot be denied. To improve the indices of risk assessment, the SUM0 and AOT40 metrics were abandoned in favor of integrating the real quantity of ozone entering the leaf, leading to POD's. The challenge remains to better include the detoxification capacity of cells even though recent work has discussed this aspect. An important point concerns the differences between C3 (including trees) and C4 plants. At similar POD's, C4 plants show a faster decline in metabolic activities under ozone. However, they resist better to ozone in the fields, thanks to their lower stomatal conductance. The study of the behavior of these two groups of plants exposed to ozone and associated stresses (drought, elevated CO2), and the upscaling to ecosystems, need to be improved.

Keywords: history, smog, ozone, physiology, C3 and C4 plants