Ozone impacts on crop yield and food security

Håkan Pleijel

University of Gothenburg, Department of Biological and Environmental Sciences,

P.O. Box 461, 405 30 Göteborg, Sweden

Tropospheric ozone is generally considered to be the globally most important air pollutant with respect to effects on crops. Today, elevated levels of ozone are known to occur over large areas of the world´s important agricultural production areas in Asia, Europe and North America. In other geographical regions the degree of ozone pollution and its effects on agriculture are less well known, but are likely to be significant.

When assessing and communicating the importance of ozone for crop production and food security the evidence of effects from current ozone exposure is of particular importance. Although plant response to experimentally elevated of ozone is important for risk assessment and the derivation of response functions, effects of present ozone are highly relevant from a policy perspective, to evaluate the gains from reducing current air pollution, rather than to estimate the damage by potential future elevated ozone levels. The evidence of effects from present ozone comes mainly from bioindication, protection of plants by use of the ozone protectant chemical EDU and (meta-)analysis of the effects of reducing ozone by air filtration in chamber experiments. Examples of these three types of evidence will be given as well as of response functions based on stomatal ozone uptake including elevated ozone treatments.

There is strong evidence that the variation in ozone sensitivity varies among crops species. A corresponding variation has also been established for different cultivars or varieties of certain crop species. The magnitude, statistical evidence and potential exploration, e.g. in decisions on the choice of crop and in plant breeding, of this variation will be described and exemplified. Also the causes for variation in sensitivity, depending on stomatal ozone uptake, antioxidant defense and crop life history, will be discussed.

An important matter is the reasons why the threats of ozone to food security is often neglected in policy and agronomic contexts. Potential explanations for this will be outlined along with suggestions of ways to remedy this problem. Highlighting experimental evidence of ozone effects on crops from interaction experiments where ozone exposure was administered in combination with other environmental factors, like temperature, irrigation/water availability, fertilization and elevated CO_2, which are familiar to agronomists and/or plant physiologists, is one example. The direct comparison of ozone effects with those from other factors could facilitate the communication of the importance of ozone effects. Another benefit from this approach is that it will promote an integrated analysis of different environmental drivers on food security, including ozone, which will be necessary in any case to understand the net effect of the multitude of aspects of global change.

Finally, scenarios for the future development of ozone effects on food security will be given. Obviously, the long-term development will depend on a range of decisions related to emissions of ozone precursors including methane, climate change and adaptation of crops and agriculture. Current trends for ozone exposure of crops in different parts of the world will be described as well as projections of surface ozone development over the present century. To conclude, a reflection will be made over how international policy making can best handle the threats from ozone to food security.