



# OFFQ

## Impact of tropospheric Ozone on Food and Feed Quality of Brassica species

### DURATION OF THE PROJECT

Phase 1: 15/12/2006 – 31/01/2009  
Phase 2: 01/02/2009 – 31/01/2011

### BUDGET

706.259 €

### KEYWORDS

Ozone, Brassicaceae, antioxidants, glucosinolates, chlorophyll fluorescence.

### CONTEXT

Various scenario's predict an increase of the air pollutant ozone by as much as 50% above today's level during this century. This will have detrimental effects on plant productivity and cause changes in yield quality of agricultural and horticultural crops. This study on the influence of ozone on changes in metabolism of vitamins and natural toxins (glucosinolates) in *Brassica* crops (cabbage vegetables, oilseed rape) will contribute to the knowledge on the indirect influence of the environment on safety and health aspects of the food chain. Increasing knowledge of the plant-environment interactions will surely provide novel strategies to stabilise agricultural yield and quality in a fluctuating environment. It is also imperative to be able to detect, monitor and understand the full impact of our changing environment, in order to identify the risks and justify the appropriate actions.

### PROJECT DESCRIPTION

#### Objectives

- Evaluation of the impact of increasing tropospheric ozone pollution on changes in antioxidant (ascorbic acid = vit C &  $\alpha$ -tocopherol = vit E) and glucosinolate composition of Brassica species, that are an important component of the food and feed chain.
- Determination of ozone induced yield losses and changes in crop quality (e.g. fatty acid and protein content of oilseed rape seeds)
- Evaluation of the influence of ozone on the human diet and animal feed intake by incorporating changes in antioxidants and glucosinolate levels in the food and feed chain
- Identification of physiological and biochemical biomarkers for ozone stress by investigating the interaction between stress induction and changes in secondary metabolites. Therefore physiological assessments of plant stress responses will be linked to biochemical analysis of antioxidants and glucosinolates as well as changes in gene expression at the leaf level.
- Elucidation of the interaction between abiotic stress induction, defence signalling pathways and changes in sec-

ondary metabolites by transcriptomic analysis

- Providing data to model the environmental dependence of ozone uptake by plants. In cooperation with ICP-Vegetation, this will be used for ozone risk assessment for vegetation.

#### Methodology

- Plant material:
  - Oilseed rape (*Brassica napus* L.)
  - Broccoli (*Brassica oleracea* L. cv. Italica)
- Preliminary comparison of the (acute) ozone sensitivity of a limited number of cultivars in environmentally controlled chambers (VAR)
- Long term exposure of both species to different levels of ozone pollution under near field conditions (Open-Top Chambers) during 3 growing seasons (VAR)
- Physiological assessments of plant health (PVE) during the entire plant growth by means of:
  - Gas exchange measurements (photosynthesis & transpiration)
  - Chlorophyll a fluorescence (kinetics, quantum yield of electron transport & imaging)
- Biochemical analysis at the leaf level and of the consumable plant parts (seeds, flowers, stems) (PPG)
  - Antioxidants: ascorbate,  $\alpha$ -tocopherol, glutathione (HPLC)
  - Total antioxidative capacity (TAC)
  - Glucosinolates (HPLC)
  - Fatty acid content (GLC)
  - Protein content (Kjeldahl)
- Transcriptomic assessments = quantification of gene expression by real-time polymerase chain reaction (RT-PCR) (PPG)

### INTERACTION BETWEEN THE DIFFERENT PARTNERS

- The Veterinary and Agrochemical Research Centre (VAR) provides the experimental facilities for controlled ozone exposure of the plants, both in environmentally controlled closed chambers and under near-field conditions in Open-Top Chambers. This partner will also perform the glucosinolate and protein analyses





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- The Plant Physiology Group (PPG), University of Antwerp, is responsible for the biochemical aspects of this research e.g. the antioxidant and PCR analyses.
- The Plant and Vegetation Ecology Group (PVE), University of Antwerp, coordinates the plant physiological assessments during crop growth.
- changes in yield and quality of oilseed rape and broccoli
- The statistically significant results are further used for extrapolation to:
  - Impacts of ozone on quality and safety of the food chain
  - Impacts of ozone on plant-pathogen/insect interaction
  - Impact of ozone on yield and food/feed quantity

### Link International Programmes

- EU funded network of Excellence funded under the 6th Framework Food Quality and Safety Programme, EuroFIR, that aims to compile a reliable and valid database of foods detailing the type and quantity of these bioactives ([www.eurofir.net](http://www.eurofir.net)).
- UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP) - International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops
- European Plant Science Organisation (EPSO)
- The integration of the physiological assessment of stress responses of the plant, in combination with the transcriptomic determination of changes in gene activity and analytical determination of changes in secondary metabolites at the leaf level will provide a better understanding on plant-environment interactions
- Identification of genes and/or metabolites that may be used as biomarker for abiotic plant stress
- Data base changes in ozone uptake by oilseed rape and broccoli as a function of environmental conditions, to be used for ozone flux modeling and ozone risk assessment for vegetation (ICP-Vegetation)

### EXPECTED RESULTS AND/OR PRODUCTS

- Results will enable an evaluation of the magnitude of ozone effects on:
  - changes in plant physiology
  - antioxidant and glucosinolate content
- Data base on range of vitamin and glucosinolate content to be used for the evaluation of "substantial equivalence"
- Results will be communicated and transferred to the community by means of reports, scientific publications, PhD thesis, website, presentations etc.

### PARTNERS - ACTIVITIES

- The section of Agro-Ecochemistry (VAR) performs policy supporting research and provides expert advice with regard to environmental contamination that may be a threat to food safety. The objective is to study the influence of external stress factors (such as air pollution, climate change, heavy metal pollution) on quality and production of agricultural and horticultural crops.
- The Plant Physiology Group (University Antwerp) focuses on the role of antioxidants, active oxygen species and antioxidative plant metabolism in response to abiotic (mainly ozone and cadmium) and biotic stress.
- Within the group of Plant and Vegetation Ecology (University Antwerp) a wide range of subdisciplines in ecology are examined, in order to provide the necessary range of tools, required to investigate newly emerging ecological problems. The research topics in the group are global changes, and their impact on plants, vegetation and landscapes.

### CONTACT INFORMATION

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#### Follow-up Committee

For the complete and most up-to-date composition of the Follow-up Committee, please consult our Federal Research Actions Database (FEDRA) by visiting <http://www.belspo.be/fedra> or <http://www.belspo.be/ssd>

