Greenhouse Environment: Air and Water Monitoring

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Abstract. Together with light and soil, air and water quality control are fundamental to the productivity and quality of greenhouse grown products. But control implies monitoring, i.e. measuring the physical, chemical and biology parameters used to access quality.

The chapter presents solutions for air and water quality monitoring that can be used in greenhouses.

Keywords: greenhouse, greenhouse environment, air quality control, water quality control.

1 Introduction

One of the most basic and thus critical and priority problems of humankind is food. Water and food shortage affect a huge percentage of the 7 billion people that inhabit Earth in 2011. According to FAO [1], over 1 billion people are undernourished (2/3 living in Asia) and about 30 000 die daily of hunger, while also about 1 billion people does not have access to drinking water. The undernourished people has been increasing at an average rate of 10 million per year, which means that the target of 420 million undernourished people by 2015 established in the 1996 World Food Summit is probably unreachable. The desertification of Earth, increasing at a rate of about 1200 hectares/hour, does not help in the reduction of food problems. In what concerns water, things look a bit better and the target set by the Millennium Development Goal (MDG) relatively to drinking-water and sanitation (MDG 7, Target 7c) of reducing in 50% by 2015 the proportion of people without sustainable access to safe drinking-water and basic sanitation seems viable.

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While some look for non-traditional forms of nourishing people (e.g. through pills), the mainstream of research is still about increasing food production using fewer resources and at a faster pace. But food and water quantity are not the only problem to overcome. The stress to increase productivity may lead to food quality problems and to a negative environmental impact of agricultural activity. Fertilizers and pesticides are fundamental in nowadays agriculture, but they contain products that are potentially dangerous to humans, animals and the environment. Tests conducted in soils used for horticulture near Lisbon, Portugal, show high concentration of chromium, nickel, lead and cadmium. Chemical tests conducted by researchers from the Instituto Superior de Engenharia de Lisboa (ISEL) on samples of Galician cabbages reveal levels of lead concentration of up to 2.1 mg/kg of dry material, i.e. 1025% over the authorized value while the same grown organically still reaches values around 0.3 mg/kg of dry material, i.e. 150% over the authorized value. This shows that organic production assures the absence of pesticides but not of atmosphere-transported pollutants or the uptake by the plants of the pollutants in the soil (e.g. heavy metals). The chemicals and heavy metals in the soil also may contaminate water resources that are used for irrigation or human consumption.

One possible way to increase the production of fruits and vegetables is by protected cultivation using greenhouses.

Greenhouses are structures covered with transparent glass or plastic films specially designed to grow plants inside. Greenhouses can modify crop micro climate according to plant needs and therefore contribute to increase crop productivity and produce quality.

The degree of environmental control provided by a greenhouse varies with its characteristics and the technological sophistication of the equipment. The basic type is the cheap mild-winter greenhouse [2] with a simple structure covered with plastic film and with no heating. These greenhouses are well fitted to regions with favorable climate where it is possible to grow out-of-season products providing incipient environmental control.

In the case of less favorable climates greenhouses have to be more weather proof and to be able to change the micro-climate according to crop requirements. A high-tech greenhouse can have full control of air temperature and humidity combining heating with cooling systems; atmospheric CO_2; and light intensity combining shading and artificial illumination. The choice of the most adequate level of greenhouse technology to be used in a certain situation is usually the result of a cost-benefit analysis. For instance the commercial production of top-quality tomatoes during the winter season in The Netherlands is the paradigm of high investments on cutting-edge greenhouse technology and fine-tuned environmental control.

Greenhouses can be used for many and diverse purposes such as: growing crops in regions with an inadequate climate; extending crop growing season or producing completely out-of-season; increasing crop yield; protecting crops from weather accidents such as rain or frost; and improving product quality relatively to open-field cultivation. Each of those situations may require specific type of equipment for environmental control but they all have in common the need of an accurate monitoring of the various parameters of greenhouse micro-climate.