Biomonitoring fluoride air pollution with Gladiolus

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Abstract

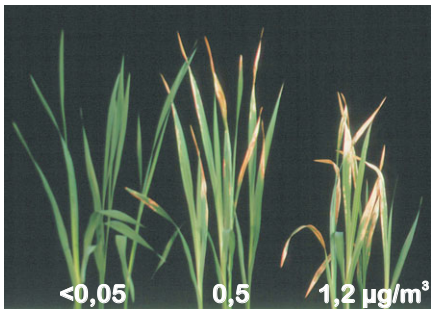
Air pollution by inorganic fluorides might be considered as a problem solved in many European countries. However, on a world-wide scale, severe damage to vegetation, crop and livestock must still be attributed to atmospheric fluorides.

A biomonitoring method has been developed which is flexible, easy to use and inexpensive, using sensitive Gladiolus cultivars and based on decades of experience.

The rate at which leaf tip injury, the characteristic symptom of fluoride pollution in Gladiolus, progresses from the leaf tip to its base is directly related to the level of atmospheric fluoride.

Using simple measurement of length of necrotic leaf injury an assessment can be made of the level of fluoride air pollution and of the risk of vegetation damage.

This method is to be established as a VDI-Guideline in Germany in 2003 and also on a multinational scale (CEN).



Introduction

In recent times, air pollution by inorganic fluoride generally is considered to be a problem of the past. This might be true for some industrialized countries e.g. in Central Europe thanks to efficient control measures.

Nevertheless, fluoride air pollution frequently causes severe damage to vegetation and, due to accumulation in forage crops, to grazing animals in many parts of the world [1-3].

Brickworks, glass, ceramic and fertilizer industries are considered the major emission sources along with coal-fired power plants.

Inorganic fluoride compounds generally are extremely phytotoxic with effect concentrations as low as 0.3 - 1.0 µg/m³. Therefore biomonitoring the effects of fluorid pollution using sensitive plants can be an effective monitoring tool to be applied flexibly and at low cost.

The deleterious effects of fluoride air pollution are well-known for far more than 100 years [4,5]. Around industrial sources of fluoride emissions severe plant injury has been observed and fluoride accumulation has been detected in crops, trees and wild plants.

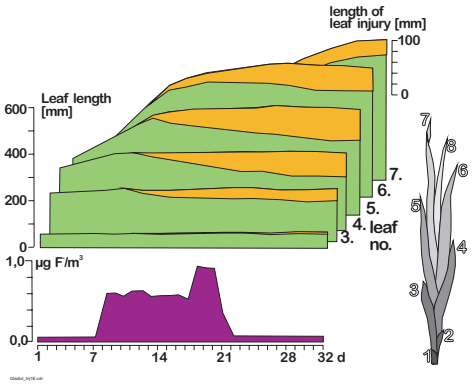
Typical injury symptoms of ambient fluoride pollution in plants are necroses at the margins and/or tips of the leaves. Generally, the necrotic tissue is separated sharply from the healthy leaf tissue, frequently by a small stripe of darkened tissue [6].

Fluoride Biomonitoring with Gladiolus

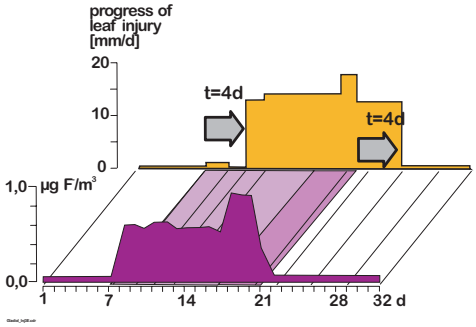
Gladiolus and other Liliaceae (Tulips, Narcissus) have been used as sensitive bioindicators for fluoride air pollution since some 50 years, after selecting the most sensitive cultivars of these species [6-9].

The leaf shape, the characteristics of the typical leaf injury symptoms and its mode of progression with increasing dose facilitates the use of Gladiolus as a quantitative bioindicator for fluoride air pollution:

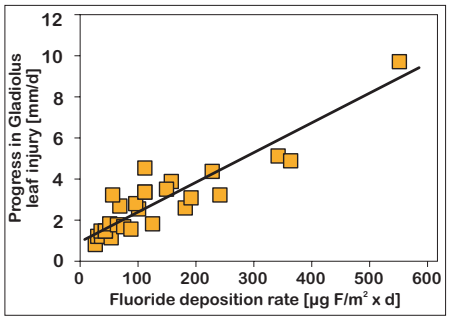
The injured leaf area extends from the tip towards the leaf base, and simple measurement of length of leaf and injury can be used instead of time-consuming area measurements.



When exposed to low fluoride concentrations (e.g. 0,5 - 1,5 µg HF/m³), leaf tip necrosis in sensitive Gladiolus plants progresses towards the leaf base as long as the exposure lasts.



When the HF-exposure is terminated, the progress of leaf tip injury also stops within a time lag of a few days [10]. From the increase in length of Gladiolus leaf injury (summed over all visible leaves) over time, the progress rate of leaf injury can be calculated in mm/d.

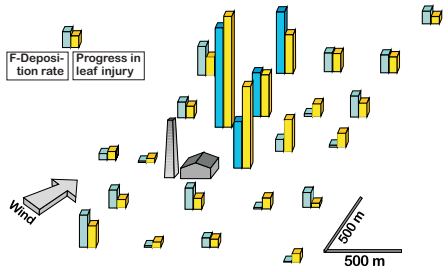


This measure of effect is closely related to fluoride exposure concentration or deposition, which has been proved under controlled conditions and in the field, respectively [11].

The Gladiolus Exposure Method can be easily used for monitoring air pollution effects by inorganic fluorides, since this technique is quick and inexpensive. Thus, monitoring networks can be established and managed at fairly low costs and at high network densities, which provide reliable information about areas of potential risks.

Moreover, the progress rate of leaf injury is an illustrative measure of effect which does not require any analytical effort.

This method is to be laid down as a guideline by the Association of Germany Engineers (VDI) as Guideline 3957 No. 14, to be published in late 2003 [12], and also to be established on a multinational scale (CEN).



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