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The Grape Leaf: a Bioindicator of Fluoride and Sulphur Dioxide Pollution

Nesrine Rhimi[a] Mouhiba Ben Nasri-Ayachi[b], F. Ben Abdallah*[,b]

[a] *Faculté des Sciences de Sfax, laboratoire d'écologie végétale, Département des Sciences de la vie. Sfax- Tunisie*
[b] *Laboratoire de Botanique Fondamentale et Appliquée, Faculté des Sciences de Tunis, Tunisie*

Abstract

The effects of fluorine and sulphur pollution are studied on three local vine variety trees: Asli, Jerbi and Tounsi. Each growing in the vicinity of a phosphate fertilizers producing factory in the southern suburb of the Sfax region. Our results show that, thanks to its great surface, the grape leaf could be used as a good indicator of air and plant pollution. It reflects the nature of the pollutant as well as the degree of morphological and physiological alterations. The grapevine seems to be endowed within its leaves with a fluorine external concentration mechanism in which calcium and magnesium are respectively associated, allowing it to accumulate alien elements, as fluorine, for plant metabolism in leaf tissues extremities. Therefore, a great proportion of leaf assimilatory surfaces are preserved and the plant can survive in such restrictive conditions. However, fluorine accumulation seems to be balanced by a parallel accumulation of calcium. When calcium is no more available, Mg is taken from the chlorophyll molecule, and therefore damages may appear as specific and typical symptoms of fluorine pollution. The photosynthesis of healthy leaf areas can proceed as long as disposable Mg in grape leaf central parts is at an adequate level ensuring the cell smooth running. This would not occur unless fluorine is trapped by calcium. Moreover, increasing phosphorus concentration seems to be a strategy adopted by the grapevine to reduce fluorine damage intensity as much as possible. The subdivision of leaf necrotic areas into necrotic halos could be an efficient means to estimate, within Vitis vinifera species, the sensitivity degree of varieties to pollution. Considering this criterion, Asli proved to be more tolerant to air pollution than Jerbi and Tounsi.

Keywords: *Necrotic halos, bio-indicator, translocation, fluorine external concentration mechanism, calcium, phosphorus*

1. Introduction

Sfax, second city of Tunisia, has a considerable gene pool of indigenous grapevine varieties adapted to local climatic conditions of arid regions. Despite grapevine sensitivity to air pollutants (Murray, 1984; Leece *et al.* 1986; Doley, 1986), some ecotypes of local vines such as Asli, Jerbi and Tounsi are still surviving in the area surrounding the SIAPE (factory producing phosphoric acid and phosphate fertilizers) located in the southern suburb of Sfax city. Thanks to their great leaf surfaces, local vine varieties respond differently to SIAPE pollutants, which are essentially fluoride compounds, sulphur dioxide and particles (JICA 1993; Ben Abdallah and Boukhris 1990; Azri *et al.* 2002). In addition, analyses of the air surrounding the factory showed that fluoride air contents oscillate between 0,2 and 0,6 µgF dm-3 (Mezghani 2001; Ben Abdallah *et al.*2004). According to these authors, fluoride compounds given off by SIAPE chimney are mainly HF, H2SiF6, and CaF2. The aim of this work is to show that a grape leaf may constitute not only a real plant bio-indicator of environmental pollution but also a mirror reflecting the morphological and physiological effects of fluorine pollution. Mineral analyses of necrotic and healthy area were also performed in order to understand the role of certain elements in avoiding pollutant toxicity. In addition, our study allowed us to explore some adaptation strategies adopted by these vines still surviving in such restrictive conditions (aridity, high temperatures ranging from 35 to 40°C, low rainfall etc. (Elloumi *et al.*, 2003)). On the other hand, the follow-up of peripheral leaf necrosis evolution allowed us to devise a classification method of local vine varieties according to their tolerance to fluorine pollution.

* Corresponding author.
E-mail: ferjani_fba@yahoo.fr

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