Chapter 3

Interaction between atmospheric sulfur dioxide deposition and pedospheric sulfate nutrition in Chinese cabbage

Abstract

Chinese cabbage was able to utilize foliarly absorbed SO2 as sulfur source for growth and at atmospheric levels of ≥ 0.06 µl l⁻¹ SO2 it appeared to be beneficial when roots were sulfate deprived. Sulfate deprivation resulted in a decrease in the shoot to root ratio, which remained unaltered low upon SO2 exposure.

Introduction

At present, sulfur deficiency appears to be one of the most frequent nutrient deficiencies occurring in high yielding arable crops. Sulfur is usually available to plants as sulfate from the pedosphere. Despite improved air pollution control legislation, SO2 pollution is still rather serious in the vicinity of populated areas in China. Atmospheric sulfur gases, viz. SO2, H2S, may be phytotoxic (Okpodu et al., 1996; De Kok, 1990), they can also be utilized as a sulfur source for plant growth and may even be beneficial when the pedospheric sulfate supply is limited (De Kok, 1990; De Kok and Stulen, 1998; De Kok et al., 2000; Westerman et al., 2000). The present study was conducted to evaluate the possible significance of SO2 as nutrient for Chinese cabbage, an important vegetable crop in Northern China.

Materials and methods

Seedlings of Chinese cabbage (*Brassica pekinensis*, cv. Kasumi F1, Nickerson-Zwaan, The Netherlands) were grown on a 25% Hoagland nutrient solution in a climate-controlled room for one week and subsequently transferred to a 25% Hoagland nutrient solution with or without 0.5 mM sulfate and acclimated for one day in the cabinets, then exposed to various levels of SO2 (0.06-0.18 µl l⁻¹; see for experimental setup De Kok et al., 1997). The relative growth rate (RGR) of the plants, sulfate and total S were determined after 5 days of exposure (see for methods De Kok et al., 1997; Westerman et al., 2000).

Results and discussion

Chinese cabbage was not very susceptible to SO2 since growth was not affected upon exposure to 0.06 - 0.18 µl l⁻¹ SO2 for 5 days (Table 1). When Chinese cabbage was grown
Table 1. Impact of sulfate nutrition and SO$_2$ exposure on growth of Chinese cabbage. Plants were exposed for five days. Relative growth rate (RGR in % day$^{-1}$; determined over a five-day-time interval) and shoot/root ration (S/R) are expressed on a fresh weight basis and represent the mean of 3 measurements with 9 plants in each (± SD).

<table>
<thead>
<tr>
<th>SO$_2$ (µl l$^{-1}$)</th>
<th>- Sulfate</th>
<th>+ Sulfate</th>
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<tbody>
<tr>
<td>RGR</td>
<td>24 ± 2</td>
<td>30 ± 1</td>
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<tr>
<td>S/R</td>
<td>4.9 ± 0.3</td>
<td>4.7 ± 0.3</td>
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Fig. 1. Impact of sulfate nutrition and SO$_2$ exposure on total sulfur and sulfate content of shoots. Plants were exposed for five days and data are expressed in µmol g$^{-1}$ fresh weight and represent the mean of three measurements (± SD).

without sulfate in the nutrient solution, it resulted in a significant reduction in growth, a decrease in shoot/root ratio and in rapid development of sulfur deficiency symptoms. The young developing leaves already started to yellow after two or three days of sulfate deprivation. Sulfate-deprived plants were characterized by a very low content of sulfate and total sulfur in both shoots and roots (Fig. 1). When sulfate-deprived plants were simultaneously exposed to levels of 0.06-0.18 µl l$^{-1}$ SO$_2$, the development of sulfur
deficiency symptoms was alleviated, growth was retained but shoot/root ratio remained lower (Table 1). The content of sulfate and total sulfur in plant tissue slightly increased upon exposure to the various levels of atmospheric SO$_2$ both in presence and in absence of sulfate in the pedosphere (Fig. 1).

The present results demonstrate that in the absence of sulfate in the pedosphere, Chinese cabbage was able to utilize foliarly absorbed atmospheric SO$_2$ as the sulfur source for growth. The interaction between atmospheric SO$_2$ deposition and pedospheric sulfur nutrition will further be studied under both laboratory and field conditions at polluted sites in China in the vicinity of Beijing.

References


