Introducing silicon nutrition to strawberry plants: improving growth and productivity

Introduction

Strawberries produced in substrate (e.g. coir) are grown in the presence of very low levels or no bioavailable silicon (Liu, 2017) Silicon has been shown to reduce strawberry powdery mildew epidemics, caused by P. aphidis, in consecutive field trials (2013-2016) (Liu, 2019) Reduction in disease levels may be a result of deposition of silicon within leaves and petioles, which enhances the passive defence pathway Deposition of silicon occurs in the cuticle, epidermis, palisade layers and stomata of the leaves (Figure 1); xylem and epidermis of the petioles and xylem of the roots Silicon enhances the passive defence pathway by modifying the wax and cuticle thickness of leaves (Jin 2016)

Deficiency Experiment

There were no classic deficiency symptoms observed in untreated plants, however the plants were smaller compared to silicon treated plants. The wet biomass of the untreated plants was significantly lower than the silicon treated plants (p<0.05) Results in Table 1 found that there were significantly fewer leaves and chlorophyll content (P<0.05) and significantly less fruits and higher Brix⁰ levels in the fruit (P<0.05), in untreated plants, compared to silicon treated plants. Flowering was a week later in untreated plants compared to silicon treated plants. Data was analysed using ANOVA, regression statistics and the dependant "paired" t test.

Results

Toxicity Experiment

The silicon treatments of 0.017% and 0.17% showed no detrimental effects to the plants treated, however, the silicon treatment of 1.7% gave toxicity symptoms and caused plant death. As shown in Table 2, the 1.7% silicon treatment reduced leaf number and plant biomass. The silicon treatment of 1.7% caused a reduction in the total number of fruit, average weight and size of fruit (Table 2).

Table 2: Results from hydroponic toxicity experiment (January-June 2019)

<table>
<thead>
<tr>
<th>Silicon rate</th>
<th>Average number of leaves at end of treatment</th>
<th>Average total dry biomass (g)</th>
<th>Average total number of fruits</th>
<th>Average weight of fruit (g)</th>
<th>Average size of fruit (LxW:mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Control</td>
<td>15</td>
<td>28.42</td>
<td>55</td>
<td>13.97</td>
<td>27.42 x 28.6</td>
</tr>
<tr>
<td>Silicon rate: 0.017%</td>
<td>15</td>
<td>23.90</td>
<td>75</td>
<td>13.46</td>
<td>27.37 x 29.5</td>
</tr>
<tr>
<td>Silicon rate: 0.17%</td>
<td>18</td>
<td>26.67</td>
<td>73</td>
<td>13.71</td>
<td>29.3 x 30.0</td>
</tr>
<tr>
<td>Silicon rate: 1.7%</td>
<td>7</td>
<td>9.06</td>
<td>25</td>
<td>7.98</td>
<td>22.7 x 23.2</td>
</tr>
</tbody>
</table>

The pH and EC of all hydroponic tubs was measured each week, the optimal pH for strawberry growth is 6.0-6.5 and the EC is 1.6-2.0. The pH gradually increased in the 1.7% silicon treatment through the duration of the experiment, from 6.42 to 8.59. In week 10 (14th April 2019) some of the 1.7% silicon treated plants started to show deterioration, the pH was 7.5 and the concentration of silicon in the tubs was 33.28µg/L.

Discussion

Whilst the results from the hydroponic deficiency experiment showed no classic deficiency symptoms, the number of leaves, runners, fruits and chlorophyll content of untreated plants were significantly lower than the silicon treated plants. Therefore, using a silicon treatment “Sirius” at a rate of 0.017% (normal field rate), significantly increases productivity.

However, in the toxicity experiment, the silicon treatment at the rate of 1.7% greatly reduced productivity; this may be due to the increased concentration of silicon within the growing system. The level of silicon measured in the 1.7% silicon treatment is above maximum level (22mg/L) recommended for water sources in strawberry irrigation (AHDB, 2011). The silicon content in 0.017% and 0.17% silicon treatments are both below 22mg/L. The pH measured (7.5) was also higher than the recommended pH of 6-6.5. The rate of 1.7% was not toxic to the plants, instead increased productivity, however this was not significantly different to the untreated plants.

The results suggest that though silicon is not an essential element it is probably a limiting factor in strawberry productivity, but at very high levels can be toxic. It is therefore recommended that growers use silicon at a rate of 0.017% throughout the growing season, particularly when growing in coir.

References


Acknowledgments

Many thanks to Gidon Bahati and Martyn Charik of Orton FT for providing “Sirius” for silicon experiments in both 2016 and 2019, Also, thanks to Dr Avice Hall and Dr Bo Liu for their contributions to this work. Thanks to both the chemistry and microbiological technical staff of University of Hertfordshire Science Building and technical staff based at Bayfordbury field station.