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Research Update: Does Silicon Have a Role in Ornamental Crop Production?

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Silicon (Si) is not considered an essential plant nutrient because most plant species can complete their life cycle without it. Still, some plants can accumulate Si at concentrations greater than nitrogen and potassium, and all flower species evaluated so far have concentrations of Si in tissue greater than the micronutrients boron, copper, and zinc.

A clear benefit of Si for some ornamental crops has been reported. These include decreased bract edge burn in poinsettia; decreased powdery mildew in zinnia, sunflower, and phlox; enhanced flower size of gerbera; resistance to metal toxicity in zinnia; decreased population growth of aphids on zinnia; improved salt-tolerance in New Guinea impatiens; and improved shelf-life of poinsettia. As a result of these positive responses, interest in using Si in ornamental crop production has increased.

Silicon is not, however, a cure-all. There was no benefit from supplemental Si in the control of mealy bugs on ficus, for example, and the extent of control of some pests that Si provides may not justify its commercial application. This report reviews some of the information on the role of Si in plant growth and how it can be applied in a commercial setting.

Powdery Mildew on Zinnia, Phlox & Sunflower

Supplemental Si helped control powdery mildew on zinnia (Figure 1), phlox, and sunflower. The control of powdery mildew was not complete, but initial symptoms of powdery mildew were delayed by about a week, while expansion of colony size and further spread was delayed up to two weeks. Practically speaking, this delay in spread and suppression in severity would be beneficial to commercial producers by providing more time to manage disease and potentially eliminate one or more pesticide applications in a period of time.

Figure 1a & b. *Powdery mildew on zinnia leaves without or with supplemental Si mixed in the peat-based substrate.*

Copper Toxicity in Zinnia

Copper (Cu) is found in high concentrations in some pesticides and in low, but still potentially damaging concentrations, in some irrigation water disinfection systems. Zinnia were grown with and without supplemental Si in hydroponics and exposed to toxic concentrations of Cu toxicity. Visible stress symptoms indicated severe stress of roots, stems, and leaves as well as long-term stunting of plants, while those receiving supplemental Si had less or no signs of stress. In fact, plants receiving supplemental Si had the same mass of leaves, roots, and stems as control (unstressed) plants. Similar studies with plants with a lower capacity to accumulate Si indicate that it consistently reduces Cu toxicity, though the underlying mechanism may differ.

Post Harvest of Poinsettia

Poinsettias were grown with and without supplemental Si in a standard peat-containing mix and evaluated in a post-harvest/retail-like environment. Plants grown without Si began to wilt earlier than those grown with it (Figure 2). Upon complete wilt and subsequent rewatering, plants grown with supplemental Si recovered more completely and lost fewer leaves than those without supplemental Si. This study suggests that supplemental Si could mitigate some post-harvest or retail display losses and provide a higher-quality product for the consumer.

Figure 2. *Poinsettias grown with supplemental Si showed delayed wilting in a post-production environment compared to those grown without supplemental Si.*

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These three examples illustrate a common theme for the potential benefits of Si in crop production: the benefits from utilizing Si are not evident until a stress is present. That is, if plants are grown in a low-stress environment, there may be no benefit of Si supplementation. But not all stresses will be mitigated in all plants.

Delivery

An appropriate and predictable supply of Si to crops is an important aspect of utilizing this element in crop production, and there is debate regarding the most effective mechanism of delivery (as a spray, "fertilizer," or media supplement). Even in typical plant production, we inadvertently add Si in small amounts through substrate selections, pesticides, and as an impurity in fertilizers and water. It is not known whether these trace amounts are enough to cause a beneficial silicon response in some crops.

The floriculture industry has begun moving toward "sustainable" production, which means, among many things, decreasing utilization of synthetic "agricultural chemicals." Many horticultural materials contain naturally high levels of Si, most notably rice hulls. Rice hulls have been used as a perlite replacement, but have not been investigated extensively as a Si source. In some cases, it may be possible to incorporate a Si-containing material into a container substrate to provide supplemental Si. Calcium silicate slag, a by-product of smelting ore, has also been used in field applications for Si supply.

We compared zinnia growth and Si uptake in peat-based substrates amended with various materials at 10 percent of total volume, irrigated with Si-containing fertilizers, or with Si-containing slag at 18 kg m^{-3} (Table 1). Generally, the total amount of Si in zinnia tissue increased when the material contained at least 10,000 ppm (1 percent) total Si, but there was no further enhancement of Si concentration when the source material had greater amounts. The Si accumulated in zinnia from switchgrass, bamboo, and coconut coir was not sufficient to elicit any beneficial response when challenged with pathogen stress like powdery mildew.

So should Si be incorporated into your system? There are clear benefits for several crops when they receive supplemental Si, and Si appears to have broader benefits in cases where water quality due to high EC is a problem or when high Cu due to injectors or Cu-containing pesticide application is present. Before using silicon supplementation with your crops, conduct small test runs. Several commercial products are available on the market; however, rates and application methods can vary among species and cultivars, so testing is important.

Table 1. Average total Si concentrations in various biological materials potentially useful for substrate amendments and average total Si concentrations (+/- one standard deviation) in leaf tissue of zinnia grown with unamended or amended sphagnum peat mix.

Material	Total Si (mg Si kg-1 dry wt)	Total Si in Zinnia leaves* (mg Si kg-1 dry wt)
Unamended sphagnum peat mix	498	842 +/- 230
Sphagnum + 50 ppm Si (as potassium silicate)	50 ppm	15,680 +/- 650
Bamboo (*Phyllostachys aureosulcata*)	2,900	3,711 +/- 500
Par-boiled rice hulls	75,500	15,727 +/-1991
Miscanthus (*Miscanthus x giganteus*)	13,000	14,456 +/- 2281
Switchgrass (*Panicum virgatum*)	3,550	4,394 +/- 685
Willow (*Salix* spp.)	60	680 +/- 91
Pine bark (*Pinus taeda*)	3,500	917 +/- 143
Coconut Coir	3,100	2,168 +/- 284
Slag from iron processing (field rate, 2.6 kg m^{-3})	40% total Si in slag	821 +/- 123
Slag from iron processing (7x field rate, 18 kg m^{-3})	40% total Si in slag	18,700 +/- 3,400

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