GROWERTALKS

Pest Management

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Silicon: Making the Crop Stronger to Fight Leafminers

Dr. Daniel S. Klittich

Silicon is a plant beneficial nutrient that's all but ubiquitous in the environment. The earth's crust is made up of around 27% silicon, making it a major component of most soils. However, just like other plant nutrients found in the mineral structures of soil (K, P, Ca, Mg, Mn, S, etc.), silicon (Si) can be depleted from the soil through heavy farming. To take it one step further, many crops—notably greenhouse crops—are grown in artificial media specifically designed to not break down, which leads to very low silicon availability. This can lead to plants that are deficient in silicon nutrition.

Now the next logical question after I tell you silicon is deficient in many growing conditions is: "Why don't I see deficiency symptoms in the crop like yellow leaves or necrotic tips?" The answer: Plants don't use silicon to complete a specific physiological process like iron and magnesium do in chlorophyll production. However, plants do use silicon to provide strength to plant structures and to mount a defense against abiotic and biotic stressors.

So do you see deficiency symptoms? The answer in many cases is yes, but they're attributed to another stress event, such as wind-causing lodging, temperature swings slowing growth or a pest population exploding more quickly than anticipated. So because the plant can still germinate, grow, flower and make seeds without silicon; silicon isn't classified as a Plant Essential Nutrient. However, because many plants resist stress events better with silicon present, silicon is considered a Plant Beneficial Nutrient.

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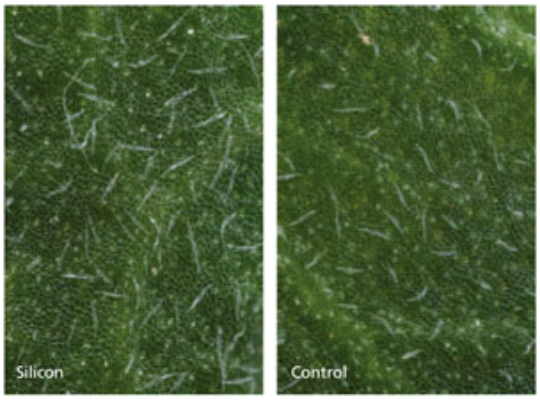


ture on the left is with silicon (longer leaf hairs); the one on the right is a control without silicon. Chry

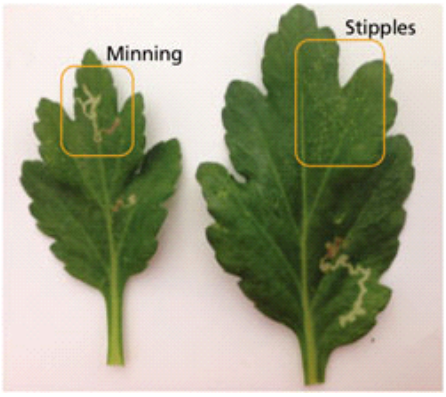
santhemums that received silicon supplementation had 17% longer trichomes and tended to also have more of them. Trichomes are known to be a plant defense mechanism against herbivores.

Using silicon against leafminers

Quantifying the impacts of silicon on crop health and quality has produced a large body of scientific research on crops ranging from rice and sugar cane to gerbera daisy, ficus and everything in between. My recent work out of the University of California—Davis Department of Entomology and Nematology found that chrysanthemums, when treated with silicon in the form of potassium silicate, had reduced damage from the leaf mining fly *Liriomyza trifolii* (Serpentine Leafminer, Diptera: Agromyzidae).

Leafminers damage plants in two ways: stippling and mining. Stipples are punctures in the leaf cuticle made by female leafminers for feeding and laying eggs. Stipples are unsightly and can allow infection of leaves by plant pathogens. Mining is caused by the larvae, which mine through the mesophyll of the leaf, causing damage. This causes a decrease in photosynthesis, and in extreme cases, can cause defoliation of the plants and plant death.

Silicon supplementation of chrysanthemums was found to decrease both stippling and number of mines by over 50%. It also was demonstrated that silicon reduced the number of second-generation offspring by 75%. This means leafminer populations would grow much slower allowing for better control by pathogens, parasitoids and pesticides.



Pictured: Leafminers damage plants in two ways: stippling and mining. Stipples are punctures in the leaf cuticle made by female leafminers for feeding and laying eggs. Mining is caused by the larvae, which mine through the mesophyll of the leaf, causing damage.

The project also looked into plant characteristics that may account for this impact on leafminer choice and found some interesting results. Silicon-treated chrysanthemums were found to accumulate silicon to over twice the level of untreated control plants. Silicon supplementation was also found to impact the physiology of the leaf trichomes or leaf hairs. Plants that received silicon had 17% longer trichomes and tended to also have more of them. Trichomes are known to be a plant defense mechanism against herbivores and this increase in length and number may account for some of the decrease in damage that were observed.

Similar changes in trichome physiology have been found in wheat, rice, verbena and cucumber, to name a few. A discussion of silicon and plant defense wouldn't be complete without mentioning that other research

has found plant chemical defenses are also influenced by silicon supplementation. This may be playing a role here, although chemical defenses weren't addressed in this study.

What does this mean for IPM?

Research has shown silicon to be a viable IPM tool in many crops; however, as a stand-alone tactic to control pests, silicon supplementation won't be sufficient. Silicon has been shown to slow down an assortment of pests—from powdery mildew in roses to stem borers in rice to the research outlined here on leafminers in chrysanthemum. However, in almost every case, the reductions in pest populations hasn't been near 100%, nor should it be. Silicon is a tactic to give the plant more resilience to stressors, whether a pest, a heat wave or a strong wind. It's important to have silicon available throughout the growth cycle of the crop to maintain the strength of the plant.

It's important to consider the silicon source that fits best into your system. Silicon can be found in the fertilizer marketplace in many different forms. We don't have the space here to discuss all of the available forms, but there are five key points to consider when looking into silicon products. (These aren't unique factors to consider for silicon products, but can be applied to other nutrient products as well.)

1. Solubility—Silicon can come as a liquid or solid. Highly soluble material can lead to quick availability, whereas a low solubility can lead to a product more on par with a slow-release fertilizer. This choice needs to be based on your specific growing conditions.

2. Silicon availability—Not all silicon sources are made equal. Studies have shown that plant use of silicon depends on the source. If the silicon-containing molecule is too large or insoluble, then uptake won't occur.

3. Stability—Silicon can be a reactive material in some forms, so maintaining availability can be difficult due to tie up with other nutrients. This is especially true for liquid products. Consult with the label and manufacturer to ensure that the product remains in solution and precipitate isn't formed.

4. Price—As with most fertilizers, different forms have different costs.

5. Efficacy—Perhaps the most important consideration is of proven success. Most products have research behind them demonstrating efficacy. Reviewing this work will give you a good idea of how well the product will integrate into your growing system. With that said, no product is tested in every growing condition, so take it as a guide of how the product may fit into your system. Weighing these factors is important, and as with any decision, there are trade-offs between each factor.

Silicon rarely makes the list of nutrients growers are concerned about in their production system. This oversight may be causing more headaches than previously thought. As more and more research is done with silicon, the ability of it to limit crop damage from both biotic and abiotic stressors is shown to be quite useful in production. **GT**

Dr. Daniel Klittich is a graduate from University of California - Davis where his research focused on the utility of silicon in IPM. He is now an Agronomist with Redox Chemicals LLC. on the California Coast.