TECH
BULLETIN

Understanding Silicon in Cropping Systems

Plant Available Silicon (PAS)

Introduction

Silicon is a major component of sand, silt and clay materials, therefore not normally considered to be a limiting factor in soil fertility.

Numerous field studies have shown that treating crops with plant available silicon can suppress plant disease, reduce insect attack, improve environmental stress tolerance and improve productivity.

Chemical Names

Silicon refers to the chemical element (Si).

Silicone is a rubber like synthetic compound used as a sealant.

Silicate refers to Silicon containing crystalline or amorphous compounds (Calcium silicate $CaSio_3$, Magnesium silicate $MgSio_3$, Sodium silicate ($NaSio_3$), or Potassium silicate ($K2Sio_3$).

Silicic acid or mono silicic acid ($H4SiO_4$) is the plant available form of Silicon.

Mono-silicic Acid (MSA)

Is stable at pH 2.

Polymerisation occurs at higher pH levels where the MSA becomes unstable and unavailable over time.

Function of Silicon

Silicon is classified as a 'beneficial nutrient' in plant biology.

It reinforces the cell wall by deposition of solid silica, translocated from the roots as silicic acid ($Si(OH)_4$) through the xylem until it deposits as SiO2 under the cuticle and in intercellular spaces. These silica bodies are called phytoliths.

Grasses can take up large amounts of Si where it contributes to mechanical strength. Si has a role in triggering a range of natural defences (systemic acquired resistance (SAR)). Silicon has shown to stimulate compounds such as chitinase, peroxidase, polyphenol oxidase and flavonoid phytoalexins – all of which can protect against fungal pathogens.

Benefits of Si Nutrition

- Stimulation of plant growth and yield through more upright growth and plant rigidity.
- Suppression of plant disease caused by bacteria and fungi (Powdery mildew, grey leaf spot, phytopthera), by supressing fungal spore germination.
- Improved insect resistance – the deposition of solid silicon (phytoliths) into cell walls damage the mouthparts of insect pests.
- Mitigation of environmental stresses (temperature heat/chill, drought) resultant of strengthened cell walls and reduced transpiration.
- Mitigation of chemical stresses (nutrition in-balances, saline soils, sodic soils and heavy metals).
- Prolonged shelf life – slowing of chlorophyll degradation and delaying leaf senescence.
- Reduced nitrate uptake and nitrate content in plants – increases resistance to insect and disease attack.
- Increase fruit sugar %'s.
- Reduced bi-ennial bearing in apples (Netherlands).
- Lower levels of minimal nutrient levels in plants (better availability of nutrition from Silicon).

Symptoms of Low Si in Plants

- Increase disease and pest damage.
- Grain crops more susceptible to lodging.
- Higher nitrate levels.

Plant Tissue Analysis

Grasses and monocots generally accumulate higher concentrations of Si than dicots (approx. 0.1% Si).

Soil Analysis

Soils commonly contain about 30% Si by weight but most of it is bound in insoluble materials. Soils that are highly weathered and have been subject to extensive leaching in a humid environment tend to be depleted of Si. Information and knowledge are very limited in correlating Si soil test levels with plant uptake.

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AgriSiL™
Plant available silicon formulation

Soil Factors Effecting Silicon Availability

- Sandy soils – plants growing in sandy soils tend to have low Si concentrations. Sand is largely composed of Silicon dioxide and this material provides very little plant available silicon. They have good drainage that prevents Si accumulation
- Organic matter – Silicon is not a major component of soil organic matter.
- Soiless medium – The use of soiless growing medium in glasshouses and hydroponics results in very little Si being supplied to the plant.
- pH – Silicon availability does not tend to change markedly across the soil pH range where most crops are grown.
- Mono-silicic acid – once available if not taken up by the plant may be bound to clay particles or leached down the soil profile.
- Sodic soils are very responsive to supplemented silicon applications (especially rice).

Silicon Requirement Timing

Silicon is required early in the crop growth cycle for vegetables.

Tree crop application should begin at pre-flower for 6 weeks.

It is not known how long silicon residual activity on plants may last following an application, therefore it is recommended that frequent applications may be necessary to maintain crop health.

Crops Likely to Benefit from Silicon Application

- High accumulators >1.5% Si
- Rice, Sugarcane
- Moderate accumulators 0.5-1.5% Si Cucurbits, Wheat, Oats, Turf, Ornamentals
- Low accumulators <0.5% Si - Sunflower, Tomatoes

Silicon Sources

- Crop residues, animal manures and composts are all potential sources of Silicon.
- Straw from wheat can hold concentrations of 0.15-1.2% Si, depending on the soluble Silicon concentrations of the soil on which it was grown.
- Silicon in crop residues can take many years to dissolve and become available for plant uptake.
- Calcium Silicate – helps to neutralise soil acidity and Ca, used as an alternate liming agent in low pH soils. Application no more than 200ppm Si / week, otherwise likely phytotoxicity.
- Wollastonite – naturally occurring mined CaSiO3, needs to be finely ground to become plant available.
- Diatomaceous Earth – (80-90% Si) can be used.
- Potassium Silicate / Sodium Silicate – very alkaline product also delivers K, soluble form of Si. Application no more than 200ppm Si / week, otherwise likely phytotoxicity.
- Mono-silicic acid – must be stabilised to be plant available, concentrate pH <2, provides only Silicon to the plant, can be applied either foliar or fertigated.

NB: Some sources of Si amendments are manufacturing bi-products and need to be checked for contaminants.

Uptake of Silicon

Plants tend to respond better to Silicon acquired via the roots system than from foliar applications for non mono-silicic acid applied products. Foliar applications require only low levels of Silicon, and can influence the plant to produce larger root system.

Improved Nutrient Availability

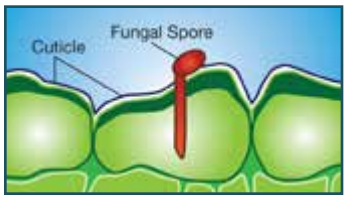
Silicon can influence the uptake of Nitrogen, phosphorus and and potassium, due to its high Cation Exchange Capacity (CEC), adsorbing nutrients and making them more plant available.

Silicon plays a role in regulating excessive toxic elements such as aluminium, iron, zinc and manganese.

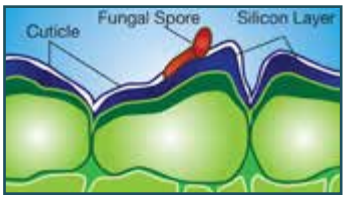
Some research has shown that it can increase phosphorus availability by decreasing the availability of iron and manganese in the soil.

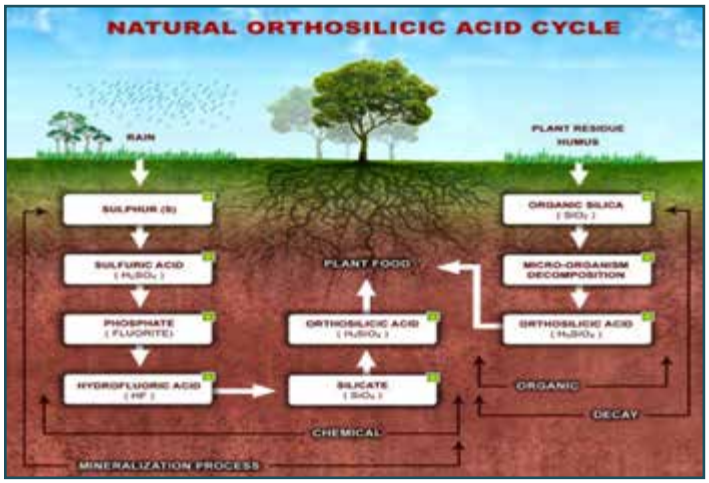
Silicon has been seen to have an evening effect on other micro nutrients allowing them to become more plant available after application of Silicon.

Without Silicon



With Silicon





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