AGRO-SOLUTIONS

TECHNICAL BRIEF

SILAMOL

TECHNICAL PRODUCT DESCRIPTION

APPLICATION, USAGE, AND PREPARATION

INGREDIENTS AND COMPOSITION

CORE TECHNOLOGY RESEARCH

FIELD CROP TRIAL REPORTS

AGRO-SOLUTIONS

SILAMOL

Importance of bioavailable silicon supplementation to agricultural crops

Fertilization with bioavailable silicon (silicic acid) decreases negative impact of stress conditions like heat, drought, salinity, pests and diseases on quality and yield. SILAMOL contains a high concentration of stabilized silicic acid. Silicic acid is the only plant available form of silicon. Once assimilated by plants, silicic acid is transported through the xylem to the cells of stems, foliage and fruits. Then it is stored in cell membranes, creating a mechanical barrier strengthening cell walls and increasing crop's natural defense mechanisms. Silicic acid also has a measurable affect on nutrient uptake and utilization so many crops see increased Brix, nutritional value, and overall improved health.

Silicon reduces stress and improves plant growth in 3 unique ways

1. Silicon acts as a physical/mechanical barrier in cell walls
2. Silicon acts as a modulator of metabolic defense reactions to stress situations
3. Silicon improves absorption of micro nutrients in plants

Silicon is a real plant strengthener by providing a natural way of protection. Crops are often exposed to stresses and silicon's benefits are most obvious during stress conditions. The impact of silicon on yield and quality of commercially grown crops is impressive. Since crops can now protect themselves against adverse stress conditions, as an added advantage less chemical crop protection products may be used. SILAMOL contributes to sustainable agricultural practic-es, including preserved production and quality levels while potentially lowering overall fertilizer inputs.

SILAMOL technology

The core of the SILAMOL formulation is 100% biologically available soluble form of silicon called 'silicic acid'. The beneficial effects of silicic acid have long been studied and documented in scientific literature. However, the unstable characteristics of silicic acid have made it practically difficult to apply in agriculture. Scientists have only very recently found a way to stabilize the highly unstable silicic acid. All SILAMOL formulations contain this stabilized bio-available silicic acid.

SILAMOL characteristics

- Consists of bio-available silicon (Si) plus key micro-elements
- Unique synergy between silicon and molybdenum (Mo), which enhances nitrogen utilization
- Applicable through the rootsystem (drip irrigation) and the leaves (foliar spray)
- Compatible with fertilizers and crop protection products
- Environmentally safe and non-toxic, approved for biological/organic growing in Europe
- Applicable on all kinds of crops and all types of growing systems

Application rates

Application rate is 5 oz of SILAMOL mixed in 50-60 gallons water per acre. If more water is used, keep the same dosage (1:000).

Application frequency

Spray 4 times pre-flowering starting when the first leaf is visible and 4 times after flowering.

Continual fruiting crops: every 10-12 days during the cycle.

Turf: every 15 days during season

Mixing instructions

Important: No premixing

1. First add clean water
2. Add SILAMOL at recommended dosage, mix well
3. Add remaining fertilizers, additives, and crop pro-tection products
4. Spray within 4-8 hrs maximum

ALSO CONTAINS NONPLANT FOOD INGREDIENT

0.08% Monosilicic Acid ($Si(OH)4$) from Potassium Silicate

SILICON AND STRESS RESISTANCE

Silicon enhances resistance to biotic stress

We have performed dozens of controlled studies with our research partners on numerous crops and pests/ diseases. SILAMOL shows significant postive effects in preventing or minimizing the affects of the below listed pests and diseases. Since SILAMOL is not a pest control product, but rather works to increase the natu-ral defense systems of the plant, it is likely to see similar effects on crops, pests, and diseases not listed here. SILAMOL is compatible and effective with any crop.

Diseases

- Rice blast
- Powdery mildew
- White mould
- Botrytis

Pests

- Psylle
- Aphids
- Stem borer

Silicon enhances resistance to abiotic stress

- Climate stress
- Heat stress
- Drought stress
- Salinity stress
- Chemical stress
- Nutrient imbalance (P deficiency, N excess, etc.)
- Heavy metal toxicity (Al, Cd, Mn, As, Fe)

Silicon acts as a physical barrier (passive)

- Silicon deposits in cell walls, strengthens cells
- Cuticle–Si double layer hypothesis

Silicon triggers defense reactions (active)

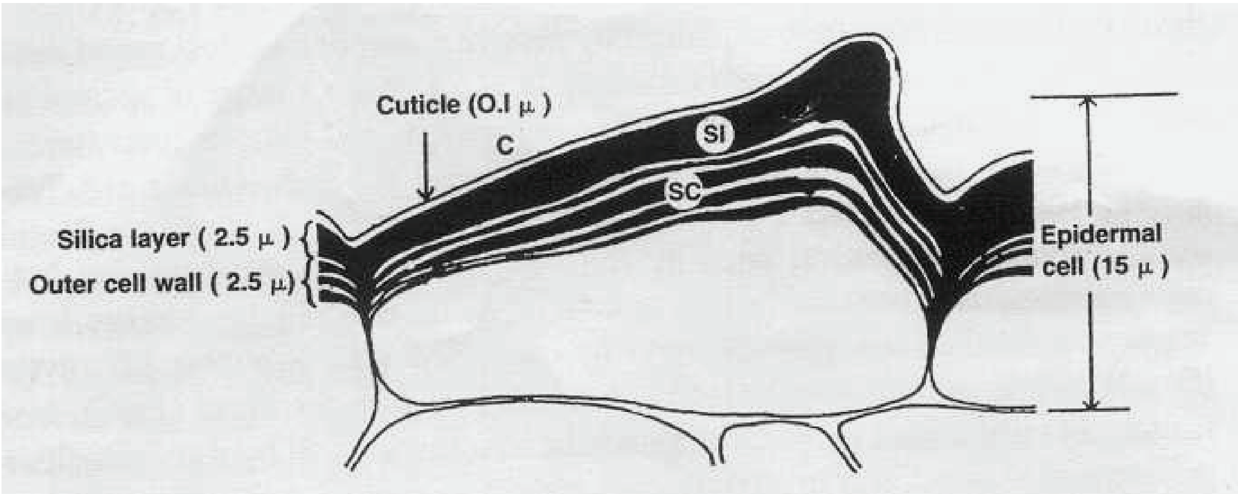
- Biochemical/metabolic responses
- Induction of defense reactions

Silicic acid increases nutritional uptake

- Higher Brix is shown to resist many pests and disease
- Increased plant sap pH resists fungal infections
- Combined with boron increases fiber development for sturdier plant tissue

SILICON MECHANICAL BARRIER

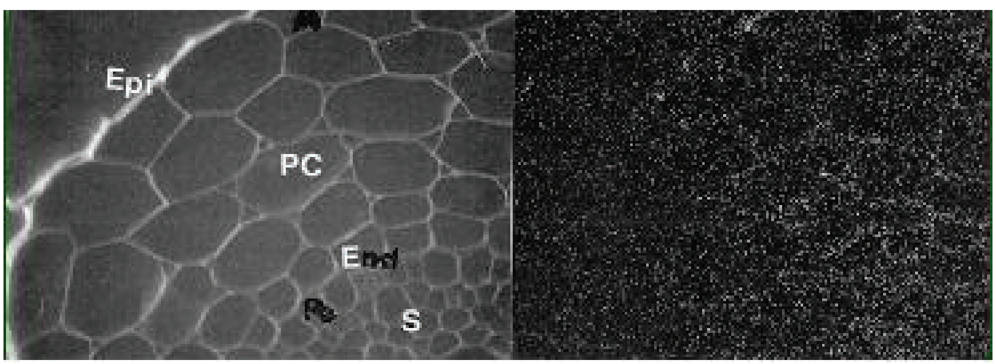
Silicon (Si) double layer hypothesis



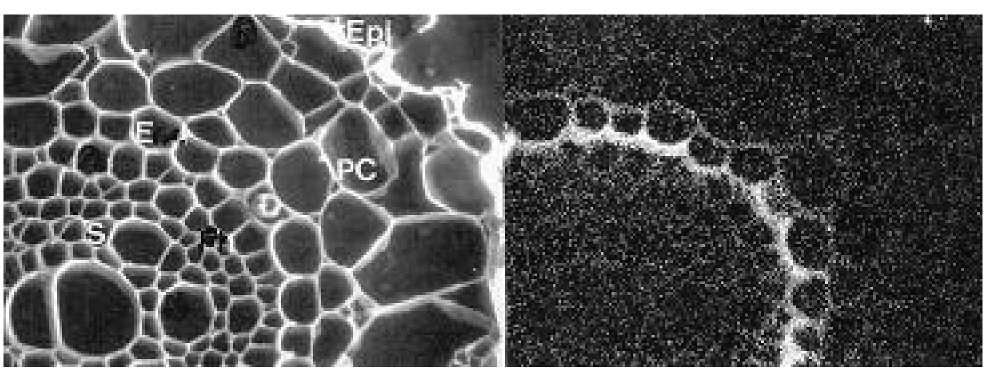
(Yoshida S., 1975. The physiology of silicon in rice. Tech. Bull. n.25., Food Fert. Tech. Centr., Taiwan)

Silicon is deposited in the out layer of the cell membrane, just beneath the waxy cuticle. This creates a solid barrier around each cell, protecting against pathogens, fungi, and insects that attempt to penetrate the cell wall.

Untreated rice cells



Rice cells treated with silicic acid



EFFECTS OF SILAMOL ON FUNGAL ATTACKS

Treated with silicic acid

Untreated

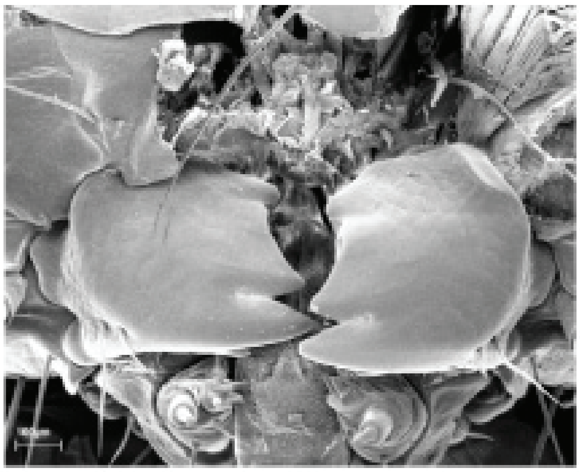
- Non-inoculated: only 2 of 28500 genes respond
- Inoculated by powdery mildew: 3970 of 28500 genes respond
- Most of the genes that respond are defense related, stress related and energy related genes

Conclusion: SILAMOL will positively affect a plant by directly stimulating defense responses against plant pathogens and by restoring the normal activity of the primary metabolism through stress alleviation

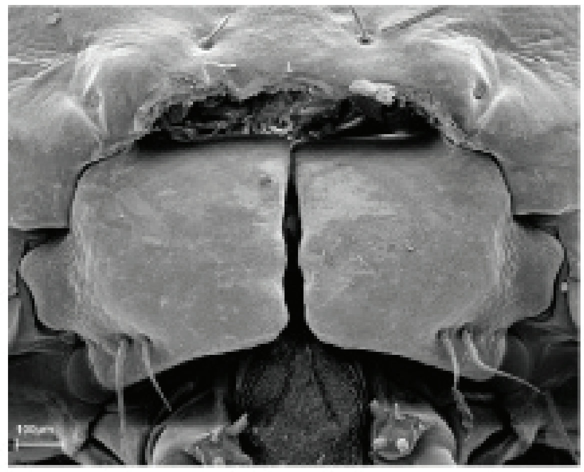
Conducted by dr. Richard Bellanger from Universite Laval, Canada

EFFECTS OF SILAMOL ON PEST ATTACKS

Effect on sugar cane stalk borer larvae (South Africa)



Untreated

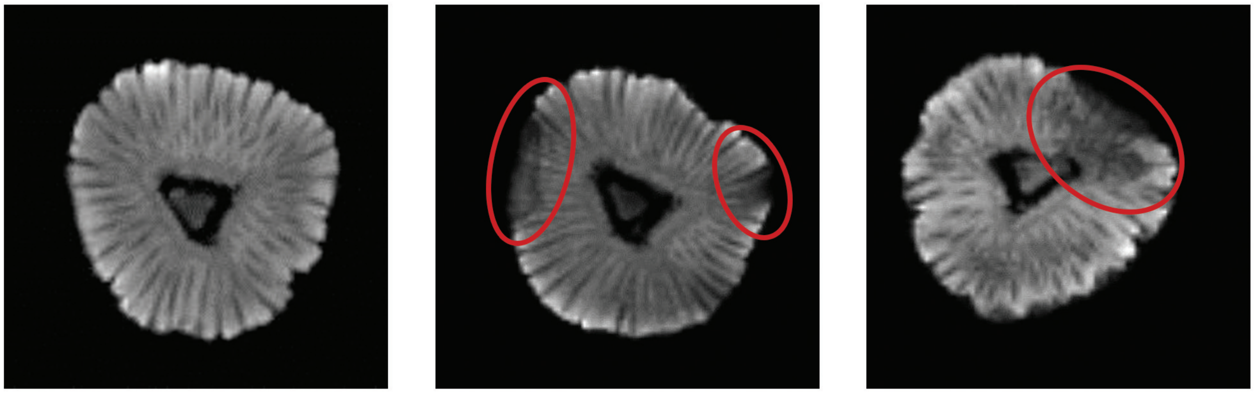


Si Treated

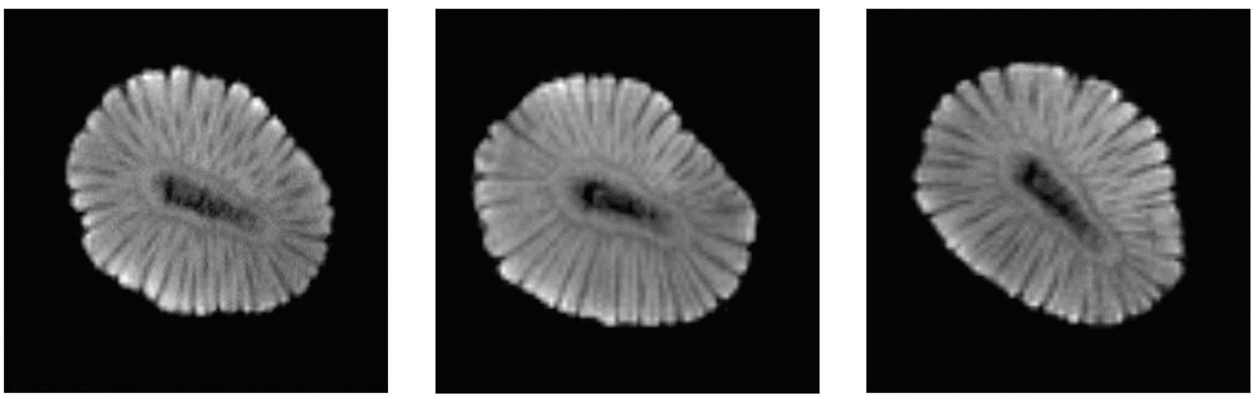
About 30% of the South African sugar cane crop is lost each year to the stalk borer larvae which burrows into the stalk of the plant. Sugar cane treated with silicic acid develops such strong cellular structure that the larvae is unable to penetrate and literally ruins its mouth parts. In performed trials, the 30% crop loss was reduced to almost zero.

EFFECTS OF SILAMOL ON SHELF LIFE

CONTROL Fungal infection showing after 5 days



SILAMOL Shelf life increased 5 days over un-treated control



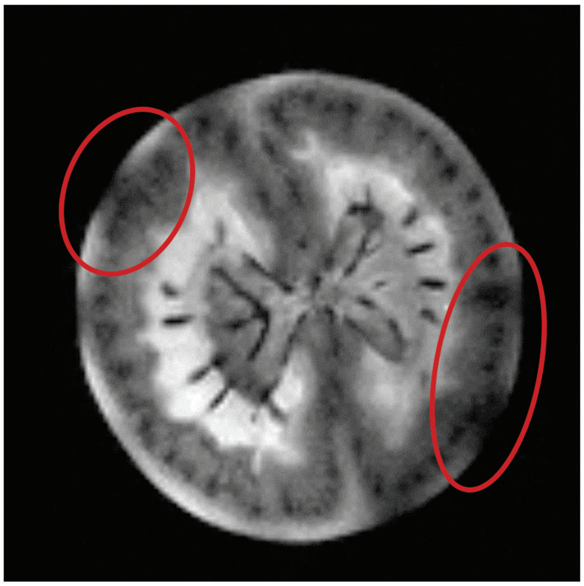
Harvest and handling create micro-abrasions on the fruit surface. Damaged cell walls leach toxins into the fruit, which attracts fungal infection and accelerates rotting and decay. Strawberries treated with silicic acid during growth have more rigid cell walls and experience less damage during harvest, thus extending shelf-life and minimizing occurance of fungal infections.

CRA CNRItaly 2009- Valentini- Metodiche RMI: caratteristiche generali e risultati applicativi sui vegetali

CRA
CONSIGLIO PER LA RICERCA
E LA SPERIMENTAZIONE
IN AGRICOLTURA

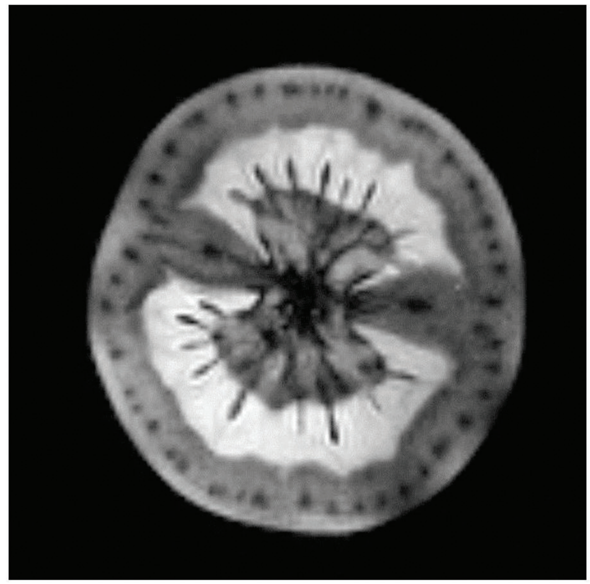
EFFECTS OF SILAMOL ON FRUIT STRUCTURE

CONTROL



- Weaker flesh
- Lower quality
- Less freshness

SILAMOL



- Better structure
- Longer shelf life
- Increased freshness

In addition to better resistance against harvest damage, SILAMOL has been shown to increase internal structure and increase freshness of a variety of crops. This is in part due to the direct effect of silicic acid on cell wall development. In addition, SILAMOL has a possitive affect on the uptake and availability of other nutrients, often raising brix levels and mineral content.

CRA CNRItaly 2009- Valentini- Metodiche RMI: caratteristiche generali e risultati applicativi sui vegetali

CRA
CONSIGLIO PER LA RICERCA
E LA SPERIMENTAZIONE
IN AGRICOLTURA

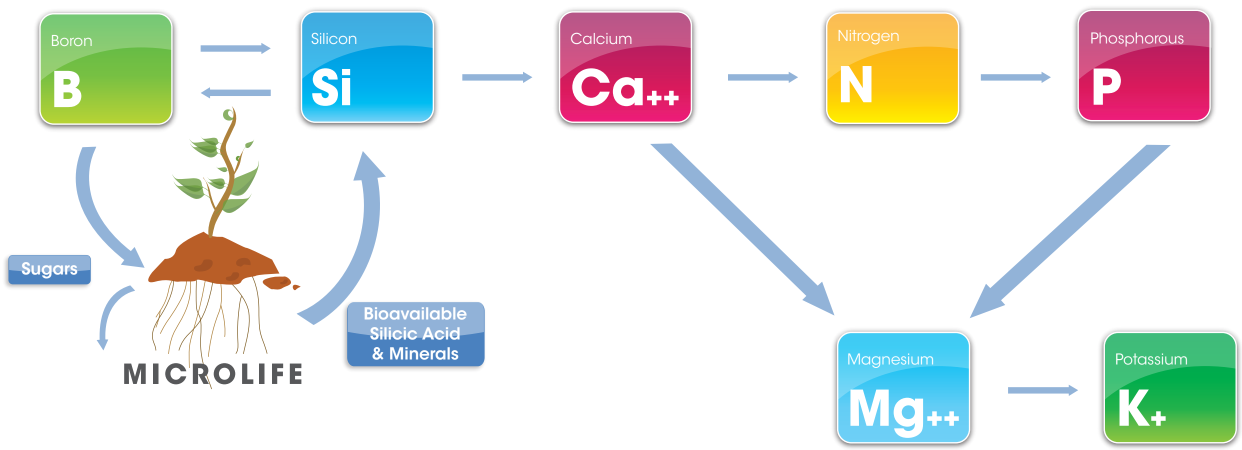
CROP	DOSAGE	APPLICATION
Cereals		
Rice	6.5 oz per acre	At raising with herbicides
Durum Wheat	6.5 oz per acre	At raising with the herbicide or fungicide. At blossoming/earing with fungicides.
Soft Wheat	6.5 oz per acre	At raising with the herbicide or fungicide. At blossoming/earing with fungicides.
Fruit		
Kiwi	5 oz per acre	Every 10 to 15 days from pre-flowering to onset of ripening
Peach	5 oz per acre	After fruit set
Strawberry	5 oz per acre	Every 10 to 12 days from pre-flowering throughout the harvest
Apple	5 oz per acre	Repeat applications every 10 to 15 days
Pear	5 oz per acre	Repeat applications every 10 to 15 days
Grape	5 oz per acre	Every 10 to 15 days from pre-flowering to onset of ripening
Melon	5 oz per acre	From initial flowering every 10 to 12 days
Legumes		
Potato	5 oz per acre	Every 8 to 10 days during most intense growth
String bean	5 oz per acre	Repeat applications every 10 to 15 days
Vegetables		
Pepper	5 oz per acre	After initial flowering every 10 to 12 days
Onion	5 oz per acre	Every 15 days during the critical phases of the productive cycle
Garlic/Scallion	5 oz per acre	Every 8 to 10 days during most intense growth period
Processing Tomato	5 oz per acre	Every 8 to 10 days during most intense growth period
Eggplant	5 oz per acre	Every 8 to 12 days from transplant to full production phase
Tomato	5 oz per acre	Every 8 to 12 days from transplant to full production phase
Leek	5 oz per acre	From the initial phases every 12 to 14 days
Cucumber	5 oz per acre	From the initial vegetative phases every 12 to 15 days
Zucchini	5 oz per acre	From the initial vegetative phases every 12 to 15 days

THE SCIENCE

BIOCHEMICAL SEQUENCING OF NUTRIENTS

It is important to understand that plants have a defined biological sequence of nutrient uptake. This starts with Boron, which stimulates the root system to leach sugars into the medium. These sugars feed the microbes, which transform silicates (Si) into silicic acid through a process called silicification. Silicic acid enhances Calcium uptake, followed by Organic Nitrogen (from L-Amino Acids), Magnesium, Phosphorus and Potassium.

These elements should be present in a bioavailable form to plants. If one nutrient in this sequence is not available (or less available), the uptake of all other elements in the sequence is more difficult or missed. It is very important to respect this sequence in order to avoid mineral deficiencies and/or nutrient uptake problems.



A common nutrient problem in agriculture is Calcium deficiency. This is because Calcium is immobile, meaning it doesn't naturally move into and throughout plant tissue. Also, Calcium is pushed away by other minerals that are often added in large quantities, such as Nitrogen (as Nitrates) and Potassium.

Looking at the chart above we can see that Calcium is near the beginning of the sequence. And if Calcium uptake is limited in any way then all other nutrients uptake and availability will be affected. There are many other problems with Calcium deficiency that will be discussed later.

One of the best ways to increase Calcium availability and uptake (other than chelating with L-amino acids) is to optimize Silicon levels in the form of Silicic Acid. This is the beginning part of the biochemical sequence. In most environments, silicic acid is rarely available because of the limited soil micro-life that naturally convert silicon into silicic acid. Even if a grower is adding a silica supplement (not in silicic acid form), virtually all of the silica remains in the soil until it is converted, which can take many weeks to months for any meaningful conversion.

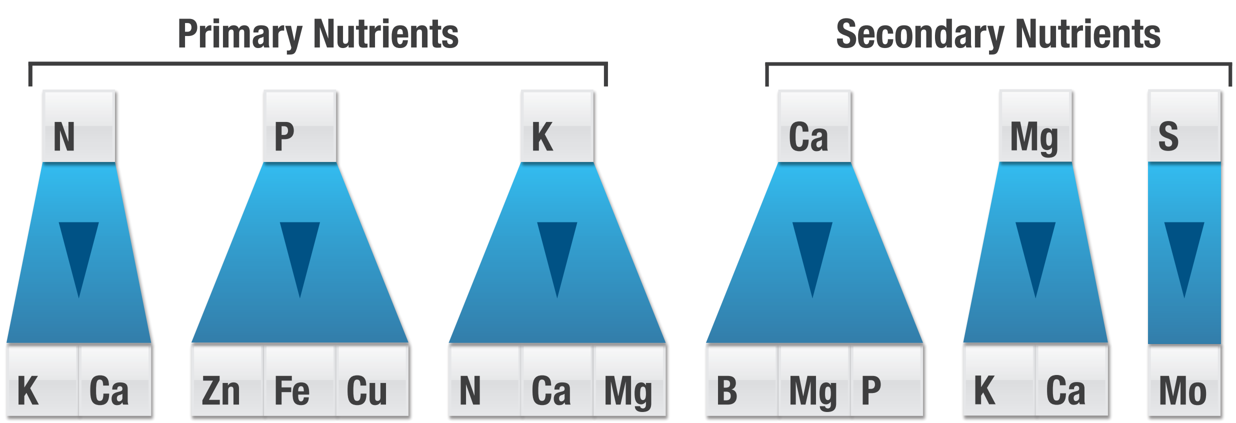
Adding bioavailable silicic acid, as in SILAMOL, helps to increase the uptake and availability of Calcium and thus, all other nutrients. This is the natural mechanism and is far more efficient than any synthetic method. Unfortunately diagnosing plant problems is usually not as simple as observing leaf discoloration or growth patterns. Re-ally these symptoms are just clues, not answers. Most of the time growers need to look deeper to assure proper diagnosis, treatment, and later prevention.

ANTAGONISTIC ACTION OF NUTRIENTS

It is very important to understand how certain nutrients react with each other. If you don't understand these interactions, you may over-supplement with a specific nutrient in attempt to correct a deficiency.

Not all deficiencies are caused by a lack of nutrients! For example, Calcium deficiency may be diagnosed due to low Calcium levels OR because there are high levels of Nitrates (NO_3). Nitrates 'push' Calcium away and can block absorption.

So you should use organic Nitrogen instead of inorganic Nitrogen, which is high in Nitrates. Many modern synthetic fertilizers contain primary Nitrates or other salt-based forms of nitrogen. The salts are the most common cause of tip burn, nutrient antagonism, and weak plant growth (more on that later).



The antagonistic action of nutrients shows how overdoses of certain elements can lock out or displace another element. This list shows which elements react with each other. Understanding nutrient antagonism makes diagnosing deficiencies and excess more difficult, but ultimately more accurate.

Most nutrients usually work together. But this is not always the case. If Phosphorus is in excess it brings in more Nitrogen to the plant, unbalancing the nutrition. At the same time it also limits Zinc, Iron and Copper. Optimum nutrition is achieved by balancing the nutrients in the medium.

ELEMENTS IN EXCESS	NUTRIENTS USUALLY AFFECTED
Nitrogen	Potassium, Calcium
Potassium	Nitrogen, Calcium, Magnesium
Phosphorus	Zinc, Iron, Copper
Calcium	Boron, Magnesium, Phosphorus
Magnesium	Calcium, Potassium
Iron	Manganese
Manganese	Iron, Molybdenum, Magnesium
Copper	Molybdenum, Iron, Manganese, Zinc
Zinc	Iron, Manganese
Molybdenum	Copper, Iron
Sodium	Potassium, Calcium, Magnesium
Aluminum	Phosphorus
Ammonium Ion	Calcium, Copper
Sulfur	Molybdenum

These problems arise often when growers attempt to create their own 'custom' nutrient recipe from multiple product lines from different companies. Unless a grower is highly scientific, this practice results in overdose and deficiency of specific nutrients.

The plants get into wild swings of deficiencies and lockout that result in decreased yield and quality. By using a balanced, high-quality, specifically formulated nutrition system, plants can maximize their genetic potential.

WHY MODERN PLANT NUTRITION CREATES ANTAGONISM

Perhaps you've noticed that each of these core concepts touches all the others. Plants are systems—intricate, delicate, and intertwined systems of biochemical reactions happening constantly within and around the plant.

Modern plant nutrition, often called 'NPK agriculture' is based on the idea that if we add the major nutrients needed, plants will grow. Nature will always find a way to survive despite mistakes we may make. But that doesn't mean that our crops are optimal.

NPK agriculture has shown us that this simplistic approach is not effective. Our crops are less nutritious, more susceptible to pests and disease, our soil is dead and infertile, and crop yields are actually decreasing around the world.

Perhaps the most important concepts that can begin to fix this issue is the principle of nutrient antagonism. In a growing medium, nutrient molecules are constantly pushing and pulling at each other based on form and electrical charge. This 'dance' is fundamentally important to how well plants are able to uptake and assimilate nutrients.

NPK agriculture doesn't do a very good job of looking at balance of soil mineral contents and fertilizer inputs. Properly structured soil and balanced fertilizer programs helps to balance the activity of nutrients and simulate natural environments.

Consider this…visit a virgin rainforest. The vastness and density of the vegetation is mind-boggling. The fruits and flowers are massive and intensely flavored. They are also the most nutritious food found anywhere. How is this possible without human interaction? It's because nature has found ways to balance nutrients through microbial activity, natural soil remediation, and biological systems.

It is impossible to fully replicate these intricate systems in isolated indoor (and many outdoor) environments. But we can learn from the biological rules and see many of the same benefits.

INSECT AND FUNGAL ATTACKS

Most growers have been raised and educated with the idea that pests and disease are simply a part of life. They plant their garden, fertilize, spider mites show up, they spray with pesticides (even organic), and hope for the best.

This is horrible thinking and extremely destructive to yields, quality, and even the planet. If we are to increase our production and quality of crop then we need to appreciate the rules nature established to deal with these invaders.

> *"Insects and disease are the symptoms of a failing crop, not the cause of it. It's not the overpowering invader we must fear but the weakened condition of the victim."* - William Albrecht

WHEN PESTS ATTACK

The first rule to understand is that nature uses insects, fungi, and other pathogens as decomposers and recyclers. The big pests cut up and break down big chunks into small bits that the small pests decompose further and convert back into base level compounds (like nutrients, sugars, etc.). This process serves an important function in nature: getting rid of what's bad and recycling it into something useful. In other words, these so called "pests" are actually our friends.

Of course, when they invade your crop, they don't quite seem like friends. Instead they are ruthless enemies bent on your destruction (or at least your plants). Because these attacks threaten to damage a grower's livelyhood, the first response is retaliation, usually in the form of chemicals.

So, the question begging to be asked is, why are these decomposers attacking your crop? The answer comes from the second important rule of crop pests: plants request the attack.

Go back to the days when you learned about natural selection. And think about the videos of lions attacking an antelope. Nature demonstrates that predators attack the weakest in the herd. This is a natural and important process to ensure that the healthy strong members (i.e. healthiest, smartest, best genetics) survive and can reproduce to carry on the species.

This is the same process in your crop; the main difference is that plants are stationary. So they have built mechanisms to signal their natural predators (insects, fungi, bacteria) to attack and destroy them when they are weak.

Plants have all sorts of different signaling mechanisms. Some are for their individual benefit (pollination, attack prevention, food sources, attracting fungus to protect roots, etc.); some are for group or species benefit (as in, "kill me so my healthy sister can survive").

These signals come in all forms, such as colors and aromas to attract pollinators, through hormones and chemical release, and some simply by emitting specific frequencies that attract specific insects. This is a broad area of plant science and varies greatly between plants so we won't get into specifics here. The important discussion is how to get the plant to send the good signals and not the bad.

HEALTHY PLANT, HEALTHY SIGNALS

Healthy plants are able to focus their energy on higher-level functions like producing chemicals, oils, resins, and aromatic compounds that are usually intended to perform a function of attraction or defense. For example, some plants produce oils that are toxic to their natural predators. If the plant is healthy, the predator may attack but be killed by the toxin (research the neem tree), thus the plant is able to survive and reproduce. If that same plant is sick and is lacking the tools to produce the oil, when the same predator attacks, it lives and is able to consume the plant.

ALL plants have these systems built into them; otherwise, their species would be destroyed within a few generations. In a healthy growing environment the occasional plant may lack the nutrition to produce it's defensive mechanism and be removed, but mostly the plants have healthy nutrition, and are able to naturally resist any attacks.

How do we raise the health of a plant then and keep it healthy in an agricultural environment? There are two indicators that have a tremendous influence on the overall health of a plant. Both can be measured relatively easily with some specialized instruments. But that's not always practical. Fortunately, even without testing there are specific techniques that will help your plants get healthier.

The Quality Factor: Brix

The most common agricultural understanding of Brix measurement is the level of sugars within the plant tissue. The guy that created the Brix scale (Adolf Brix) defined it as the sugar content of an aqueous solution. This measure has been used for long time to test fruit like grapes and apples for ripeness. The higher the Brix level, the riper, more flavorful, or more ready the crop is for specific applications like winemaking.

However, there's not just sugar (specifically sucrose) in plant tissue. There are many other compounds floating around in healthy plants like amino acids, vitamins, phytohormones, minerals, etc. These all have an effect on the Brix reading. Because of this effect, more and more researchers are expanding (or loosening) this reading to the total dissolved solids in a solution. Even though Brix was originally designed to test only sugar levels, it is quickly becoming accepted as a key measure of overall quality and health.

FRUITS	POOR	AVERAGE	GOOD	EXCELLENT	DISEASE FREE
Apples	6	10	14	18	16
Avocados	4	6	8	10	
Bananas	8	10	12	14	
Cantaloupe	8	12	14	16	16
Casaba	8	10	12	14	16
Cherries	6	8	14	16	16
Coconut	8	10	12	14	
Grapes	8	12	16	20	
Grapefruit	6	10	14	18	
Honeydew	8	10	12	14	16
Kumquat	4	6	8	10	
Lemons	4	6	8	12	
Limes	4	6	10	12	
Mangos	4	6	10	14	
Oranges	6	10	16	20	

FRUITS	POOR	AVERAGE	GOOD	EXCELLENT	DISEASE FREE
Papayas	6	10	18	22	
Peaches	6	10	14	18	
Pears	6	10	12	14	
Pineapple	12	14	20	22	
Raspberries	6	8	12	14	15
Strawberries	6	10	14	16	16
Tomatoes	4	6	8	12	18
Watermelon	8	12	14	16	

GRASSES	POOR	AVERAGE	GOOD	EXCELLENT	DISEASE FREE
Alfalfa	4	8	16	22	14
Corn, Sweet	6	10	18	24	24
Corn, Young	6	10	18	24	
Grains	6	10	14	18	
Sorghum	6	10	22	30	

VEGETABLES	POOR	AVERAGE	GOOD	EXCELLENT	DISEASE FREE
Asparagus	2	4	6	8	
Beets	6	8	10	12	
Bell Peppers	4	6	8	12	
Broccoli	6	8	10	12	
Cabbage	6	8	10	12	

VEGETABLES	POOR	AVERAGE	GOOD	EXCELLENT	DISEASE FREE
Carrots	4	6	12	18	
Cauliflower	4	6	8	10	
Celery	4	6	10	12	15
Cow Peas	4	6	10	12	
Endive	4	6	8	10	
English Peas	8	10	12	14	14
Escarole	4	6	8	10	
Field Peas	4	6	10	12	
Green Beans	4	6	8	10	14
Hot Peppers	4	6	8	12	12
Kohlrabi	6	8	10	12	
Lettuce	4	6	8	10	12
Onions	4	6	8	10	13
Parsley	4	6	8	10	
Peanuts	4	6	8	10	
Potatoes, Irish	3	5	7	8	13
Potatoes, Red	3	5	7	8	
Potatoes, Sweet	6	8	10	14	
Romaine	4	6	8	10	
Rutabagas	4	6	10	12	
Squash	6	8	12	14	15
Turnips	4	6	8	10	

These Brix level charts are generally credited to Dr. Carey A. Reams.

Most important to understand about Brix is the affect on the plant. First, if there are more sugars and other beneficial components like minerals and amino acids (building blocks), the plant is able to build more good stuff (oils, flavors, resins, etc.). This makes the plant tastier and healthier to us. At the same time, decomposing insects and pathogens don't like these compounds.

If you have a healthy plant reading a high Brix level, a spider mite for example, will not be attracted by the plant. The high mineral content makes the plant repulsive to the mite so it leaves. Natural resistance with no artificial and toxic chemicals used.

Every plant has different ideal Brix levels and many can be found online. Most important to understand is that raising the Brix is a good thing and should be a primary goal of growers. So how can you raise the Brix level in your plants?

Proper mineralization. This is the key to everything. One of the main reasons why plants get sick (low Brix) is lack of the tools to create the good stuff. Getting more minerals (in proper form) into your plants is going to raise the Brix level and provide the tools that the plant needs to produce other natural immune compounds.

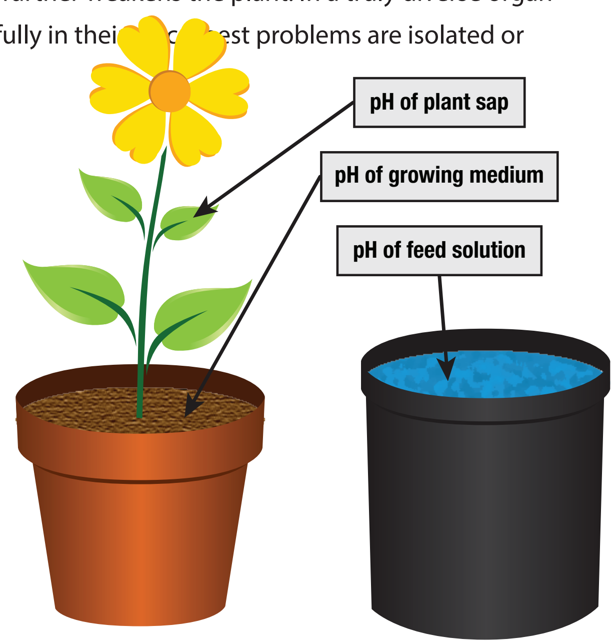
A key to this is silicic acid and L-amino acids. Both of these compounds help to increase the bioavailability (absorption and transport) of minerals into and throughout the plant. The less the plant must work to bring in food, the more it is able to bring in. More minerals equal higher Brix.

Calcium plays a key role in increasing Brix level. Since calcium is immobile AND near the beginning of the biochemical sequence of uptake, it's absorption affects most of the rest of the minerals. If calcium availability and uptake is optimized, then all other mineral uptake will be more balanced and effective.

Also, mineral salts (from cheap chemical fertilizers) can be detrimental to mineralization. Excessive salts cause imbalance and are toxic to living tissue and cause stress that further weakens the plant. In a truly diverse organic environment where soil micro-life and plants are working fully in thei[illegible]est problems are isolated or non-existent.

The Health Factor: pH

Every grower knows pH is an important measurement for any fertilizer input. And most growers have instruments to measure their feed solution. Most also know that the pH of the medium is a big factor in the availability and absorption of nutrients. What fewer growers understand is the importance of the pH of the plant itself.



Plants are living biological systems just like us. And the same rules apply. For example, if you have a plant infected with powdery mildew (a systemic fungal disease), you are guaranteed to have a low plant sap pH (under about 5.5). The good news is if the pH is raised, powdery mildew will not appear, because the plant will send a different frequency signal that will NOT attract fungus.

There are many topical application products like potassium bicarbonate and sulfur burners that treat mold problems. All they are doing is raising the pH of the leaf surface which kills and prevents the fungal spore from surviving. Unfortunately, these are topical treatments. Some pathogens like powder mildew get inside the plant and resist these treatments. The only way to combat a systemic disease is a toxic chemical treatment OR fix the plant's insides. pH is the tool for this.

One important note: it's much more difficult to raise a plant's pH if it is already infected. Most bad infections and pathogens exude acidic compounds that continually lower the pH. The best approach is to keep a plant healthy from the beginning. This creates an environment that naturally resists the attacks from the beginning.

A side benefit of increasing your plant's pH is that it becomes healthier for you as well if your goal is consumption. Since our health is a result of pH balance, by eating more alkaline foods increases our body's natural resistance to disease. In fact, there is a growing body of research and stories of destroying established cancer and other diseases simply by raising the alkalinity of the body!

Raising a plant's pH level is more difficult, especially with short term crops. Once a plant is sick or under attack with only a few weeks left till harvest, you probably won't cure the problem, only treat the symptom. At this point topical treatments may be required. But remember that chemical applications further stress the plant and invite more problems.

Calcium and magnesium have alkaline effects on a solution (raising pH). Because Calcium is immobile and tends to lock up in the soil, deficiencies are common. Magnesium is often deficient because of the antagonistic effect of potassium. If you can optimize calcium and magnesium uptake with L-amino acids and silicic acid, the pH will increase and stabilize.

SOLUTIONS TO INFECTIONS AND ATTACKS

Remember that these fungi and pests are attracted to plants with a low pH and Brix, or unhealthy in some other way. If growers can raise these two important factors most of their problems with pests and disease will be eliminated. Plus, the healthier plants will produce more at higher quality.

Proper mineralization is the key. Getting more proper form of nutrients into the plant tissue from the very early stages of growth, ensure overall health. The Agro Solutions Approach is to increase health of the plant from early stages through proper balanced nutrition and increased bioavailability.

Understand this doesn't mean feed more and more of certain 'good things'. Proper form, bioavailability, and timing are more important than quantity.

Remember that the rainforest doesn't use chemicals and treatments to fight off pests. And yet it continues to thrive without our help. That's because the occasional sick plant is removed with the help of the decomposing pests while the strong naturally resist. Apply this mindset to your growing environment and many of your pest problems will go away.

SILICIC ACID
WITH SYNERGISTIC MICRO-ELEMENTS

Silicic acid is a naturally occurring compound found in healthy soil environments. While silicon is the second most abundant mineral in the earth's crust, it is not readily absorbed into biologic tissues in common forms (potassium silicate, calcium silicate, silica, etc.). Silicon is often found in larger molecules that cannot penetrate cell walls.

The most common agriculture input forms of silicon are potassium silicate (K_2SiO_3) and calcium silicate (Ca_2SiO_4). Much of the naturally occurring silicon is in the form of silica (SiO_2). These forms when unprocessed are not bio-available to plants.

Before the silicon can be taken up into the roots and throughout the tissue it must first be converted by microbes into silicic acid by a process called silicification. This natural process is slow and can take weeks or months to occur in any meaningful amounts.

For short-term crop applications, speed and bioavailability are critical. Many times crops are grown and harvested in a matter of weeks or months. In greenhouse environments growing medium is frequently discarded or sterilized before reuse. This destroys the micro-life populations and minimizes the process of silicification.

WHY HAS THIS NOT BEEN DISCUSSED IN MODERN AGRICULTURE?

Proper scientific studies are difficult due to the fact it is nearly impossible to have a control group during research, since silicon is everywhere. In addition, silicon is not considered 'essential' for plant growth. Only recently has it even been classified as a beneficial nutrient. It seems because of its pervasiveness, silicon has simply been taken for granted.

silicon
14
Si
28.086

While silicon is not considered essential to plant development, the effects of silicon in plants are remarkable. And without bioavailable silicon, plants don't achieve their greatest potential. It's easy to see why many growers have problems in their garden when bioavailable silicon is not present. Silicon is responsible for increasing dry weight, strengthening plant tissue, balancing and increasing nutritional uptake and assimilation, immunity, and resistance to all forms of biotic and abiotic stress.

With these kinds of benefits, it is critical for growers of all types to understand the power of silicic acid and make it a regular part of their fertilizer program.

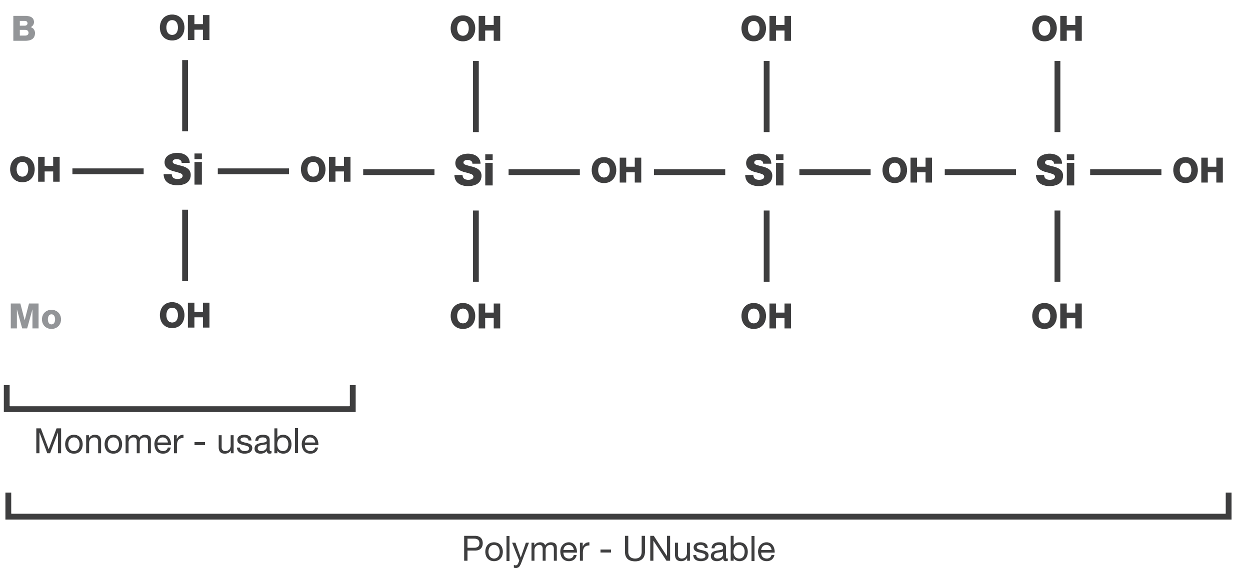
THREE PRIMARY EFFECTS OF SILICIC ACID IN PLANTS

1. **Mechanical** – Builds structure and resistance against stress
   Deposits silicon directly into the out layer of the cell creating a rigid barrier and more solid structure.

2. **<u>Nutritional</u>** - Increased and balanced uptake of nutrients
   Pressurizes the plant sap to allow better and more even flow of nutrients throughout the plant circulatory system.

3. **<u>Immunity</u>** - Stimulates plant's immune system
   Triggers the production of immunity compounds as well as pulling silicon to the point of attack to rebuild and strengthen tissue.

In nature, silica exists in polymer form because it is stable. These are long chains of molecules. In order for plants to use silicic acid it must be in monomer form (single molecule. Pure silicic acid, when stabilized as in SILAMOL, is 'packed' in polymer form. It 'unpacks' into monomer form when added to clean water, which allows it to enter the plant and carry nutrients along with it (like boron, molybdenum, zinc, and copper). Over time silicic acid will repolymerize, which is why it's important to mix fresh nutrients and feed immediately.



Study: Silicon Bio-Availability (The Netherlands)

Many growers are familiar with the benefits of including silicon in their feeding regimen. However, it must be understood that no matter how much silica product is added, if it is not in bioavailable form, then it's a waste of money and resources.

In 2008, a multi-national fertilizer company worked with Agro Solutions in Holland to perform a controlled study on the uptake of various forms of silicon. The goal was to determine the actual silicon content within plant tissue and surrounding soil after the trial period. This test would show which form of silicon amendment was most effective.

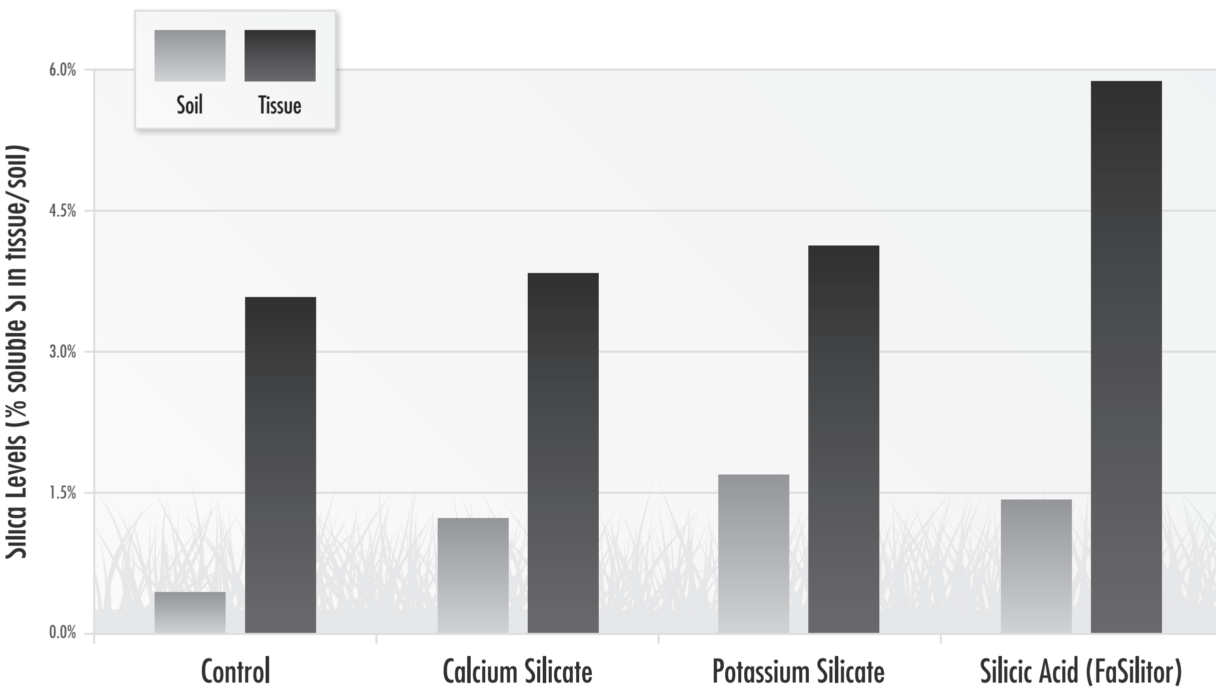
This particular study did not look at other effects such as pest resistance, plant health, plant growth and size, or soil health. The test was simple. Four one-hectare plots of land planted with turf. The trial lasted for only six weeks and all fertilizer and soils were identical.

PLOT 1	PLOT 2
Control No Silicon ammendments added	2,000 kg **Calcium Silicate** Ca_2SiO_4 Actual Silicon (Si) Content 2,000 kg x 65% Si = **1,250 kg Si**
PLOT 3	**PLOT 4**
5,000 kg **Potassium Silicate** K_2O_3Si Actual Silicon (Si) Content 5,000 kg x 25% Si = **1,250 kg Si**	1.5 kg **Silicic Acid** $Si(OH)_4$ Actual Silicon (Si) Content 1.5 kg x 1.6% Si = **24 grams Si**

Plot 1 – Control, no silicon amendment
Plot 2 – Calcium Silicate – 2,000 kg
Plot 3 – Potassium Silicate – 5,000 kg
Plot 4 – Silicic Acid (from Silamol) - 1.5 kg

At the end of the six-week trial, tissue samples were taken from multiple points in each plot and analyzed for silicon content. The results are incredible.

Most plants are roughly 80% water and 20% plant material. This means that if there is 6% silicon content in the plant tissue, when dried, silicon makes up to 30% of the dry weight of grass. Grass is particularly heavy on silicon usage but many other plants can contain silicon at around 8-15% of total dry weight if grown properly.



Notice also that the difference of uptake between the control (untreated) and the typical agricultural silicon amendments is marginal. This is because of the time required for the process of silicification. This is especially important to many annual crops where cycles are short.

WHAT SILICON DOES INSIDE PLANTS

Many growers are familiar with the benefits of including silicon in their feeding regimen. However, it must be understood that no matter how much silica product is added, if it is not in bioavailable form, then it's a waste of money and resources.

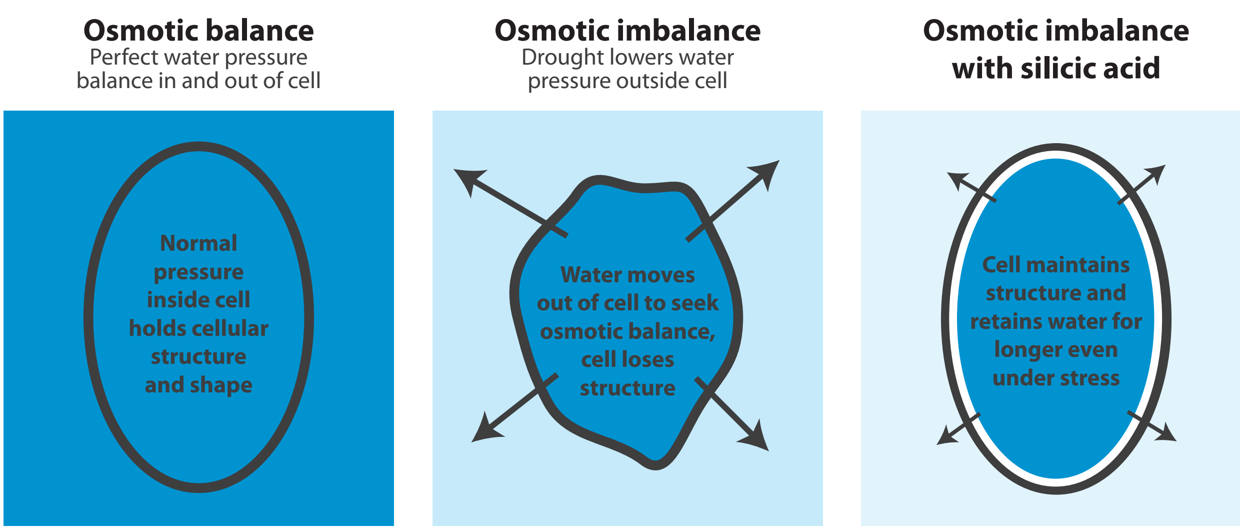
Most of the silicon in plants exists as an insoluble form of silica (SiO_2- nH_20) in leaf blades and leaf sheaths. Here it provides rigidity, and helps minimize water loss, as well as presenting a hard barrier to fungal pathogens and insect pests.

Below are brief explanations of how silicon (from silicic acid) works in plants:

Increases resistance to abiotic stress (environmental: temperature, wind, drought)

When silicon is deposited in cell walls, a rigid structure is created, much like a brick or stone wall cemented together. Cells are able to maintain their shape amid environmental attacks. When the wind blows and bends a stem in one direction, cells on the downwind side are compressed. Silicon makes firmer cells that compress less when bent.

In the case of drought, stronger cell walls are better at managing water balance inside the cells. Imagine filling a water balloon full—the balloon is firm and taught. Then as you deflate (letting water out), the skin of the balloon becomes soft and soggy. This is why dry plants droop. Stronger cells keep their structural integrity for longer.



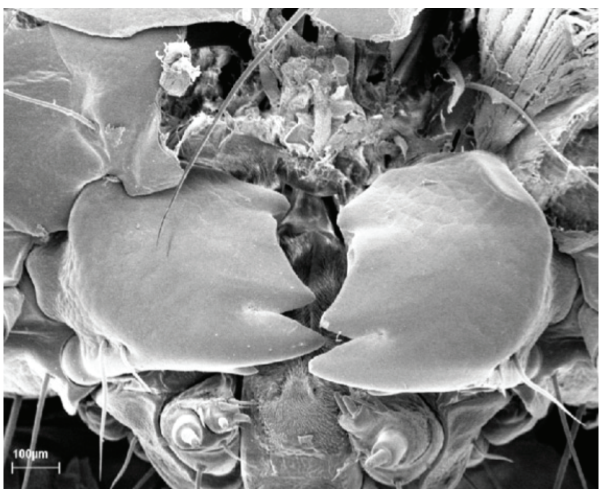
Increases resistance against biotic stress (pests and pathogens)

Many attacking insects must somehow puncture the wall of the plant 'skin' in order to suck the fluid, eat the tissue, or burrow inside. By increasing the thickness of cell walls with silicon deposits, many of these tiny insects are unable to break the surface of the cell.

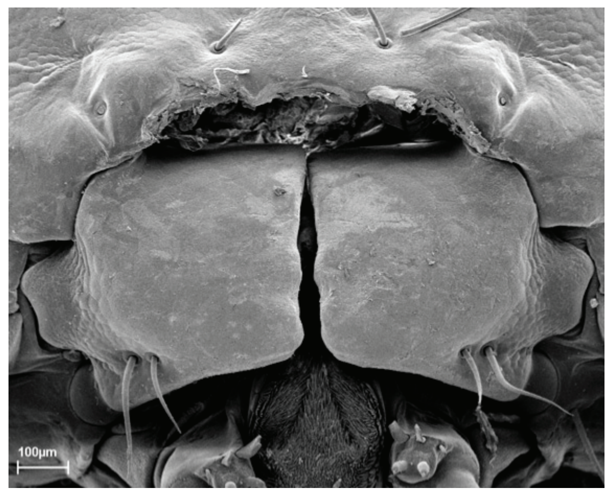
We have performed numerous studies on this effect. See the images below of the stalk borer larvae as tested on sugar cane.

Study: Sugar Cane Stalk Borer Larvae (South Africa)

It is easy to see the larvae attempting to bore into the treated sugar cane has its mouth parts dulled and rendered useless. This experiment has been performed with similar results on a variety of crops and biting, piercing, and boring pests.



Untreated



Treated with silicic acid

The above images come from a South African study on silicic acid. The findings from the study showed:

- Reduction in stalk length bored = max 63%
- Reduction in borer survival rate = max 59%
- Reduction in borer mass = max 62%
- 60% of the region's soils are deficient in silicon
- Losses of up to 30 tones a hectare
- Silicon is even more effective in case of water stress
- No Si impact on sugar quality has yet been observed

Overall the study found: "It is now estimated that applying silicon (from silicic acid) prevents the loss of 20% if not 30% of the sugar yield." Simply by increasing the plant's natural resistance.

Study: Silicon Versus Fungal Infections (Canada)

Silicon deposits in the epidermal cells of plants act as a barrier against penetration of invading fungi such as powdery mildew and Pythium. To penetrate the leaves, a pathogen must get through the wax (no problem), then penetrate this hard, rigid layer of silica mineral, before it even reaches the cell wall.

Most important to understand is that the silica doesn't kill the pathogen, but rather makes the host plant inhospitable to the pathogen. By blocking the fungal spores from attaching, the plant maintains it's health and strength. This the best preventative approach, and how nature prefers. (Figure 1)

There are also compelling studies showing plants moving extra silicic acid to points of attack and stresses, such as insects, fungi, or breakage, in effort to resist and repair. This is much like when we get a cut and platelets in our blood rush to the cut to create a clot while the wound heals. The additional silicon deposits create even stronger tissue. (Figure 2)

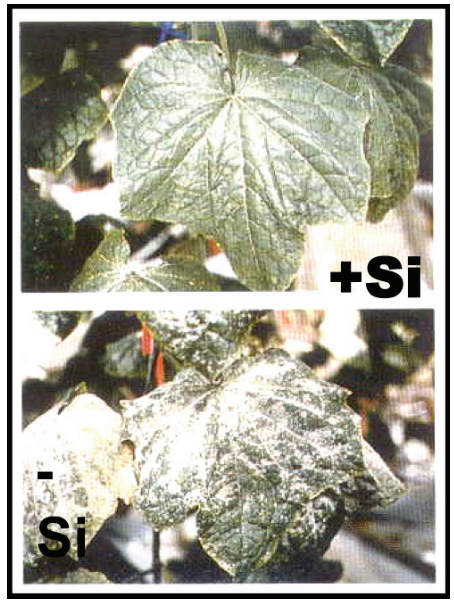


Figure 1: Cucumber leaf with and without silicon

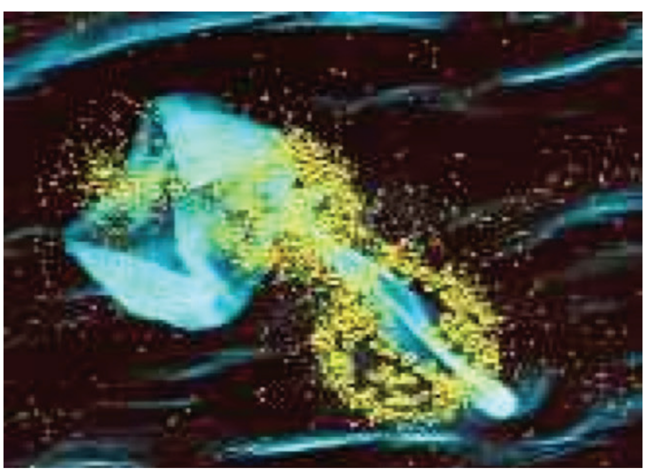


Figure 2: Increased soluble silicon (white) moved to point of fungal spores (yellow)

Silicon must be readily available in soluble form (silicic acid) at the point of infection/attack to be effective. This effect has been shown on many different plant species.

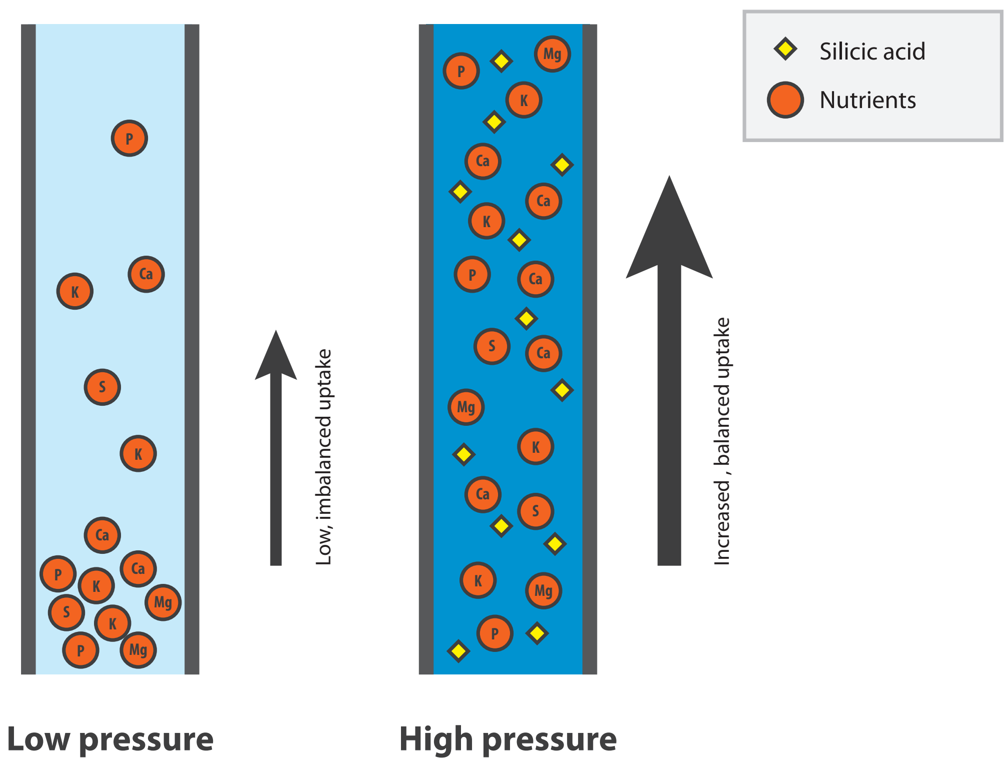
Since silicon is deposited into the cell walls within about 24 hours of uptake, it is crucial to maintain a constant supply from early stages until the end to achieve this immunity effect.

Improves uptake, absorption and utilization of nutrients

There is a remarkable effect silicic acid has on the uptake of other nutrients. Think of it as a train engine that helps pull other 'cars' throughout the plant sap. Silicic acid is particularly good at increasing the transport of heavy, immobile minerals like Calcium.

Silicic acid is a 'sticky' fluid molecule. When present, the pressure of the vascular system (like our circulatory system) increases. Imagine a hose filled with tiny particles of sand (nutrients). If a trickle of water (plant sap) moves through the hose, most of the particles stay put. If the water pressure is increased to a heavy flow, more of the sand particles are pushed through the hose.

Plants don't have muscles in the same way we do. Instead elements move around the plant by suction, pressure, and molecular interaction. Lower pressure created by synthetic fertilizers and overwatering makes heavier molecules less mobile. By increasing the pressure, minerals are more easily carried throughout the plant.



With higher pressure inside, all other minerals in various forms are more easily moved throughout the plant to where the plant needs them. This vascular pressure is especially important for larger plants with heavy branching as more energy is required to move nutrients along these complex and far-reaching pathways.

Stronger cell structures and epidermis layer creating stronger plants and thicker stems (increases dry weight)

Silicic acid is absorbed into the plant tissue and deposited into the epidermis layer of each cell within about 24 hours. This layer acts like the mortar in a brick or stone wall, holding the shape and structure of the cells.

With this added silicon, the plant is not only strong but it now contains a permanent additional layer of silicon that stays in place for the life of the cell. This is why it's important to provide silicic acid throughout the life of the plant so each new cell receives this treatment.

Study: Detection of Silicon with Electronic Micro-sensor

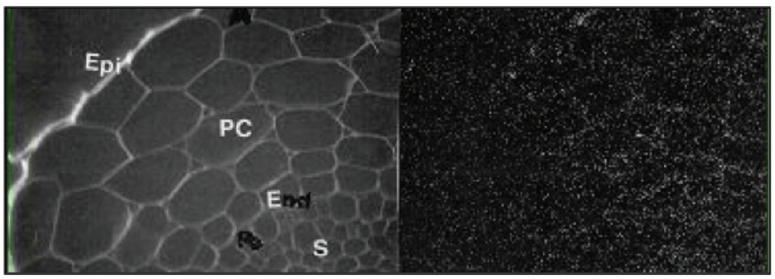


Figure 2-3 Untreated plant cells

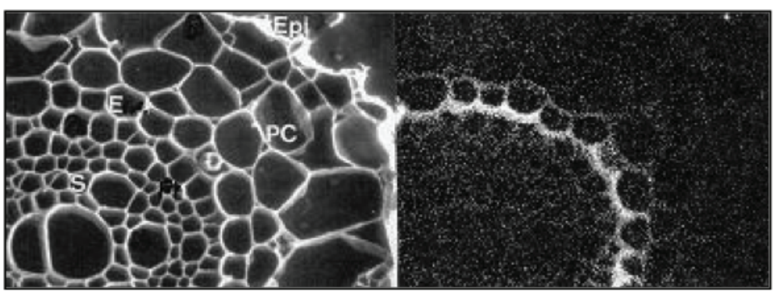


Figure 2-3 Plants treated with silicic acid have a visibly stronger cell wall

Reduces and controls the space between internodes caused by temperature stress and unbalanced nutrition

As discussed before, plants have specific goals. One of the goals is production and yield. Plants want to produce more flower sites because that means more fruit development, and thus, more chance of being fertilized and passing genetics on to the next generation. So if environmental and nutritional conditions are ideal, the plant will create more nodes and shorten node spacing to allow for more potential flower sites.

Some of the reasons plants have longer internode space (less overall flower sites):

1) Temperature differential (DIF) between day and night
2) Improperly formed cell structure from high nitrate and other salt levels
3) Overdose and deficiency of specific nutrients
4) Heat and moisture stress

The mechanical and nutritional effects of silicic acid help to buffer against these types of stress and allow the plant to grow how it wants. By providing better structure and more natural growth patterns, the plant is ultimately healthier and able to produce higher yields and improve quality factors.

Increases resistance against salinity (nutrient salt buildup)

Too many salts is one of the biggest problems indoor and outdoor gardeners face. Mostly because modern nutrients are made up of mostly salts. And we've been taught that more is better! Silicic acid helps to increase and balance nutrition so less overall inputs are needed. This generally means non-salt nutrients become more available for uptake so they can balance out over-salinized growing mediums.

Additionally, the effect silicic acid has on cell structure provides additional buffer against saline conditions. There is not a direct act on reducing levels of salt, but plants are shown to grow better with less shock in these circumstances when silicic acid is present.

Reduces transpiration (loss of moisture from the leaves)

Transpiration is one of the main ways that plants pull nutrients from lower portions to upper portions. Depending on the ambient moisture (relative humidity), moisture from the plant (and oxygen) is released from stomata on the leaf surface. This action creates a vacuum in the vascular system of the plant, which then 'pulls' water and nutrients further into the plant.

When a plant craves more nutrients, it will increase the level of transpiration in effort to bring in more nutrient-rich water from the roots and lower plant parts. If the vascular system is functioning properly, the plant has sufficient nutrients, so less transpiration is required. Silicic acid is shown to help the plant naturally manage osmoregulation through the better functioning of stomata.

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CROP SPECIFIC RESULTS

APRICOTS	
Yield (kg)	+11%
Firmness	+13%
Brix	+23%

GRAPES	
Weight	+49%
Botrytis attacks	-64%

PEARS	
Weight per fruit	+14%
Psyllids attack	-60%
Better sorting	+7%

WATERMELONS	
Firmness of pulp	+24%
Thickness of peel	+33%
Production	+10%
Brix	+6%

STRAWBERRIES	
Weight per fruit	+6%
Firmness	+9%
Brix	+14%
Shelf life	+5 days

KIWI	
Weight per fruit	+16%
Diameter	+6%
Longer shelf life	

APPLES	
Fruit size	+7%
Weight per fruit	+18%
Firmness	+33%
Color	+63%

CHERRY TOMATOES	
Weight per fruit	+12%
Brix	+9%
Dry Weight	+7%

MELONS	
Fusarium attacks	-34%
Weight	+39%
Brix	+14%
Nutrient uptake	N +15% P +8% K +8% Ca +14% Mg +29%

TOMATOES	
Increased yield	+9 to +29%
Water consumption	- 6 - 10%
Reduced salinity stress	

CEREAL GRAINS	
Growth under stress	+15%
Dry weight under stress	+12%
Fungal attacks	- 80%

FRENCH GREEN BEANS	
Increased yield	+27 to +57%
Better growth of root system	

WHEAT	
Growth under salinity stress	+3 to +94%
Growth under water stress	+9 - 111%

CHICORY	
Increased yield	+27%

ONION	
Increased yield	+12%
Better sorting (larger caliber)	

ROSES	
Powdery mildew	-58%
Downy mildew	-61%
Aphids	-61%

POTATOES	
Increased yield	+32%

BABY CARROTS	
Harvest weight	+14%
Better sorting (caliber)	+18%
More plants per sq meter	

GREEN PEPPERS	
Firmness of fruit	+9%
Weight per fruit	+11%

These are summaries of controlled studies of the various crops. This is intended to show the consistent im-proved results of supplementing with SILAMOL. More data is available upon request.