Effect of Silicon Fertilization on Crop Yield Quantity and Quality : An Overview of ZumSil®

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What is soluble silicon, and why is it important to agriculture?

Silicon (Si) is classified as a beneficial element. This element limits the effects of abiotic and biotic stresses in plants. The most known effect is the effect of silicon on plants, which uptake the largest amounts of this element, i.e., in sugar cane and rice.
In recent years, more research has been performed with regards to foliar nutrition using silicon, which brings unequivocal production benefits, and at the same time is much cheaper and more convenient to use than soil fertilization. As a result, it improves the profitability of many plant species' production. The positive effect of silicon observed, in the studies, resulted in many cases in which the susceptibility of plants to drought stress is reduced. Silicon has also a beneficial effect on limiting the adverse effects of other abiotic stresses such as stress caused by salinity, heavy metals, high and low temperature, water flooding, and more.

Silicon (Si) is one of the most abundant elements in the earth's crust, and while silicon is plentiful, most sources of silicon are insoluble and not in a plant-available form. Plants can only absorb Si in the form of soluble monosilicic acid or plant available silicon (PAS). Monosilicic acid is absorbed by plants, benefiting the plant in terms of growth, resistance to disease and environmental stresses. Si also has a significant effect on soil texture, water holding capacity, adsorption capacity, and soil erosion stability. Si is taken up by plants at levels equal or greater than Nitrogen and Potassium for which it is considered essential for sustainable crop production (Savant et al, 1999).

ZUMSIL is a silica rich material composed of ionized liquid mono and poly silicic acids. In addition to providing plant-available silica, **ZUMSIL** improves soil biogeochemical characteristics and fertility.
ZumSil® has been uniquely formulated **Average content is 220,000 ppm and 240,000ppm or 24% plus/minus 2% Monosilic Acid per Liter**

This highly concentrated form of plant available silica (PAS) increases soil characteristics to enhance plant vitality and nutrient uptake, boosting plant resistance to abiotic and biotic stress while simultaneously increasing yield and crop quality.

Silicon Promotes Balanced Nutrient Availability and Transport

SILICA Benefits to Soil Characteristics
The addition of ZUMSIL to agricultural soils improves the biogeochemical characteristics of the soils that affect plant production by:

- Enhancing Soil Fertility by Improving Phosphate, Potassium, and Nitrogen Fertilizer Use Efficiency.
- Increasing the Absorption of Nutrients and Enhancement of Mineral Formation, which results in reduced nutrient leaching while maintaining nutrients in Plant Available Forms.
- Reducing Aluminum Toxicity and Transforming Heavy Metals into

Inactive Forms

SILICA Benefits to Plant Vitality and Yield

The addition of biogeochemical active ZUMSIL silica compounds to the soil has been shown to

- Increase Rice Yields by 17 to 30%
- Increase Cumulative Cane Yields 39% and Sugar Yield as much as 50% over 3 yrs.
- Increased Wheat yields 15 – 26%
- Increased Corn yields 15%

Another mechanism proposed recently is that soluble Si acts as a modulator of host resistance to pathogens (Ma and Yamaji, 2006) Plants supplied with Soluble Si can produce phenolic and phytoalexins in response to fungal infection such as those causing rice blast and powdery mildew (Fawe et al, 1998; Belanger et al, 2003; Remus-Borel et al, 2005)

- Decrease rice blast by 58% to 75%.
- Increased Resistance to Neck blast by 26% and leaf scald by 53%.
- Decrease Powdery Mildew [4]

Increase Profitability of your Crop

The increase of yield observed in many studies, after applying foliar nutrition with silicon, was caused by the improvement of all or some of the yield components. In the case of most common cereals, they were: a spike density during harvest, a number of kernels per spike, and a mass of 1000 grains [1,2]. An increase in the number of grains per cob and their mass was observed in maize [3].

A higher yield of soybean caused by foliar application of silicon resulted from the increase in the number of pods per plant, the number of seeds in the pod, and the weight of 1000 seeds. In the cultivation of winter oilseed rape, the improvement of plants' resistance to winter conditions was observed, as well as the formation of larger seeds. In the case of sugar beet, foliar nutrition with silicon contributed to the increase of fresh root mass, and increase of the root yield, which determines the yield of sugar [7]. In the potato cultivation, plants fertilized with silicon developed tubers with a larger fresh mass [6].

Nitrogen, phosphorus, potassium and other nutrients required for balanced plant nutrition, even when supplemented with soil amendments, can fail to reach the plant as they move through the soil profile. Other elements, such as toxic heavy metals can also be released and accumulate around the roots where they damage root systems and plant health. **Most secondary and tertiary root growth is controlled by the amount of PAS in the plant.**

Once Silicon – as Monosilicic acid- is absorbed by the plant, it continues to actively contribute to a balanced state of nutrient availability through uptake processes and micro-distribution of mineral ions as well as compartmentalization of metal ions.

Silicon Adds Structural Strength to Plants

Silicon is absorbed by plant roots and moves upward in the transpiration stream to sites of strong evapotranspiration in epidermal regions of stems and leaves. In these areas, the silica forms solid, hydrated gels between the cuticle and the cell walls.

Silicon is also deposited within cell walls where it improves cell wall strength, plant rigidity, root development, linear growth, and water efficiency and presents barriers to environmental stresses and limits susceptibility to pathogens and insects.

Silicon Improves Photosynthetic Activity

The accumulation of Silicon in epidermal cells and cell walls of plants produces more erect leaf blades with improved light interception characteristics and increased photosynthetic activity.

Application of Silicon as a soil amendment has been reported to result in elevated concentrations of chlorophyll per unit area of leaf tissue, resulting in improved photosynthetic efficiency.

Silicon -- The Stress Element

The body of field and physiological evidence accumulated to date, confirm that the uptake, transport and deposition of silicon (as Monosilicic acid) enhance the ability of plants to overcome environmental stress conditions as well as improve the efficiency and effectiveness of their defense response systems when under biological attack.

Monosilicic acid, has been found to be a biologically active element, participating in highly complex interactions with key components of the plant's defense response system -- resulting in plants that respond faster and more efficiently to pathogen attack.

ZUMSIL with a large amount of available Monosilicic acid is an excellent addition to your spray program.

Such evidence strongly supports the position that **many plants have an evolutionary predisposition for the use of silicon to survive under stress conditions as well as use silicon to quicken and enhance recovery**. Failure to have access to this element produces a plant that is silicon deficient, preventing it from reaching its genetic potential.

Silicon Alleviates Salt Stress

Silicon has been shown to alleviate salt stress by preventing sodium absorption and transport into shoots from roots. Silicon also increases soluble substances in the xylem that further reduce sodium absorption by plants.

Silicon Reduces Drought Stress and Heat Stress

Silicon mediated alleviation of water-deficit stress has been attributed to: (a) reduction of transpiration through the outer cells, (b) improved stomatal conductance, (c) stimulation of antioxidants that offset toxic effect of free radicals, (d) increased chlorophyll content and improved photosynthesis, and (e) healthier root systems.

The presented research results confirm, in the vast majority, the beneficial effect of ZUMSIL silicon applied to soil or as a foliar application on the quantity and quality of the yield of many plant species. The effect of silicon as foliar nutrition, which stimulates plants to grow under stress conditions, is particularly beneficial. Such application should be introduced into plant production as a standard in the cultivation of crops.

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