Maxstim™

Creating New Standards in Biostimulants

Product Insight

Cynosa™

Reducing boron toxicity in desalinated and low quality water supplies.

The increased use of desalinated water in agriculture in different regions is reducing the quality of available water for agriculture. Desalination through reverse osmosis or distillation is not 100% efficient. While these processes remove a significant amount of salt, some residual salts may remain in the water (Panagopoulos et al. 2019). Desalinated water may still contain accumulated trace elements such as boron (Grattan & Grieve, 1998). Boron, while necessary in small amounts for plants, can be toxic at higher concentrations, leading to reduced crop yields. Long-term use of desalinated water can result in the gradual accumulation of these elements in the soil, contributing to toxicity problems. A potential remedy is the application of silicon in the form of ortho silicic acid (OSA).

Silicon is the second most prevalent element in the soil. Although abundant, silicon is never found in a plant available form and is always combined with other elements, usually forming oxides or silicates. Silicon is absorbed by plants in the form of uncharged ortho silicic acid, $Si(OH)_4$, and is ultimately irreversibly precipitated throughout the plant as amorphous silica (Gunes et al. 2007).

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The application of silicon (Si), particularly in its bioavailable form of ortho-silicic acid (OSA) can help plants manage increased boron (B) concentrations in the water supply. Several studies have shown that silicon supplementation can mitigate the toxic effects of excess boron in plants. This protective role is primarily linked to silicon's ability to reduce boron uptake, improve antioxidant activity, and strengthen plant tissues.

Introducing Cynosa

Cynosa incorporates **Amphenox** and generates OSA for plants to easily assimilate silicon. Amphenox contains specific highly bioactive bioflavonoids This synergistic combination improves resistance to oxidative stress and improves photosynthetic activity and binds with excess boron restricting its uptake by plants allowing them to resist the toxicity of excess boron.

Mechanisms by which Cynosa helps with boron toxicity:

1. **Reduced boron uptake:** Silicon can reduce the uptake and accumulation of toxic levels of boron in plant tissues, limiting the damage caused by boron toxicity. Silicon appears to compete with boron for uptake or modify root permeability to boron, thus minimising excessive accumulation in sensitive plant parts.
2. **Improved antioxidant defence:** Excess boron often leads to oxidative stress, damaging cellular structures. Silicon, in its bioavailable form as OSA, enhances the plant's antioxidant systems by boosting the production of key antioxidant enzymes. This helps plants to better handle oxidative stress induced by high boron levels.
3. **Cell wall strengthening:** Silicon is known to accumulate in plant cell walls, particularly in areas of high stress. This strengthens the plant's structural integrity, helping it resist the mechanical damage associated with boron toxicity. By reinforcing cell walls, silicon can reduce symptoms like leaf necrosis and chlorosis that are common in boron-stressed plants.

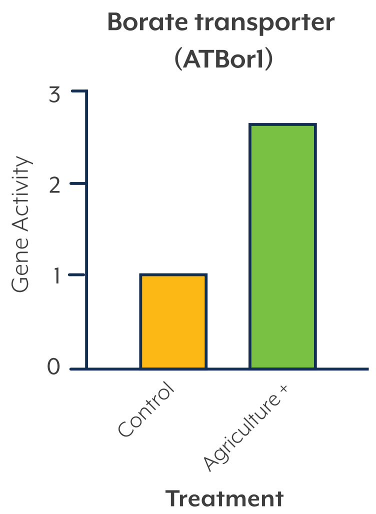
Karabal et al. (2003) reported the application of silicon to barley led to a decrease in boron-induced oxidative damage by enhancing the activity of antioxidant enzymes such as superoxide dismutase (SOD) and catalase (CAT). Silicon supplementation decreased ROS levels and improved the activities of key antioxidant enzymes, helping the plants manage excessive boron more effectively.

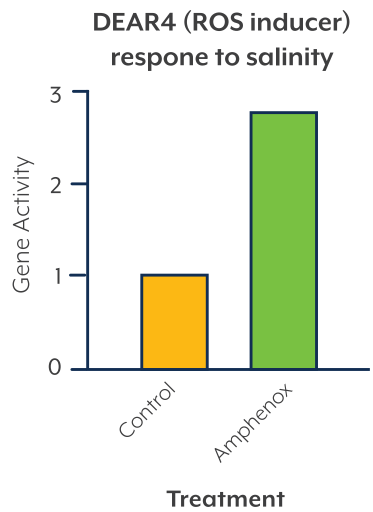
The study by **Behtash et al. (2024)** investigates the role of silicon (Si) in alleviating boron (B) toxicity in maize grown hydroponically. The findings indicate that silicon supplementation significantly reduces the harmful effects of excess boron, which can impair growth, reduce chlorophyll levels, and destabilise membranes. Silicon enhances plant antioxidant defences, supports cell wall stability, and helps maintain chlorophyll content under boron stress. This effect is particularly beneficial at lower to moderate concentrations of silicon, improving overall plant health and mitigating boron toxicity.

Riaz et al. (2022) published "Alleviation of Boron Toxicity in Plants by Silicon: Mechanisms and Approaches" and outlined how silicon (Si) mitigates boron (B) toxicity in plants. Silicon enhances growth and photosynthetic efficiency while decreasing the translocation of boron from roots to shoots. It also reduces oxidative stress by boosting antioxidant defences and forms boron-silicate complexes, lowering boron availability for uptake. These mechanisms protect plants from boron-induced damage, improving overall resilience to high boron concentrations in soil or water.

Silicon uptake

The means of silicon uptake is complex. Si enters the plant from the external environment in the form of $Si(OH)_4$ through specific influx channels (termed Lsi1), and efflux trans-porters (termed Lsi2) mediate the loading of Si into the xylem and thus facilitate root-to-shoot translocation, which, in turn, moves Si to the aerial parts of the plant, where it deposits as amorphous SiO2. Lsi1, providing primary entry of $Si(OH)_4$ and boric acid into plant root cells (Coskun et al. 2019). Boron and OSA use the same point of entry into the plant therefore increasing the opportunity for OSA to bond with boron to form Boron-silicate complexes, potentially inhibiting the uptake of boron. The effect of impeding the uptake of excess boron can also be enhanced with the further application of Maxstim Agriculture + which increases the activity of the borate transporter gene, actively removing borate anions form the plant when boron is at toxic levels.





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Both Cynosa, containing Amphenox, and Maxstim Agriculture + stimulate the plant genes involved in borate transportation and response to salinity.

Summary

The regular application of Maxstim's Cynosa will help prevent the uptake of excess boron from desalinated water and boost photosynthesis, plant development and stress management. Cynosa creates a synergistic action between ortho silicic acid and highly bioactive bioflavonoids increasing crop yield and is highly effective when used with Maxstim Agriculture+.

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