BIO CHARGE

RESEARCH SERIES / NOVEMBER 2026

SILARA N30 research

Nutrient access.
Water-stress resilience.

The science behind monosilicic acid, aluminium interactions, phosphorus availability, potassium nutrition and drought tolerance.

FROM PUBLISHED SCIENCE TO PRODUCT TESTING

01 **Silica & monosilicic acid**
Dissolution and the plant-available silicon pathway

02 **Nutrients & root function**
Aluminium interactions, phosphorus and potassium

03 **Drought tolerance & recovery**
Water status, growth and recovery after rewatering

Published findings provide the scientific basis for outcomes Bio Charge aims to match with SILARA N30. Product performance requires its own testing.

12 RESEARCH PAPERS

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Silica, roots and nutrient access

Monosilicic acid and aluminium interactions

The research outcomes Bio Charge aims to match

Bio Charge aims to establish whether SILARA N30 can deliver the silicon effects reported in published research: release of monosilicic acid, reduced aluminium stress, improved phosphorus availability, improved potassium uptake or movement, and greater tolerance of water stress. Each objective requires its own measurement. [2] [3] [4] [5] [8] [9] [12] [13]

Bio Charge describes SILARA N30 as an amorphous colloidal silica concentrate with a dissolved silicon fraction and a reservoir intended to release soluble silicon over time. Its published typical pasture rate is 300 mL/ha. [1] The studies below used other materials and experimental conditions; they provide a rationale and comparison points for product testing.

How colloidal silica releases monosilicic acid

Colloidal silica contains silica particles dispersed in water. As particles dissolve, they can form monosilicic acid, also called orthosilicic acid, H_4SiO_4 or $Si(OH)_4$. [2] This dissolved form is available for plant silicon uptake. [8]

$$SiO_2 + 2H_2O \rightleftharpoons H_4SiO_4$$

Spitzmüller and colleagues (2023) measured dissolution of approximately 45 nm silica particles in water. Dissolution depended on pH, temperature, salinity, existing dissolved silica and particle properties. The reaction approaches equilibrium; dispersion in water does not imply immediate or complete dissolution. The study supports measuring SILARA N30's dissolved silicon release over time. [2]

Direct crop evidence for colloidal silica. Jarosz (2014) supplied modified colloidal silica at 100 mg SiO_2/L in greenhouse tomato nutrient solution. Total fruit yield and leaf silicon increased, but P and K concentrations in leaves and fruit did not change significantly. This is a relevant formulation comparison, while also showing why crop growth and nutrient responses need separate tests. [11]

What reducing aluminium activity means

Silicic acid can participate in the formation of hydroxyaluminosilicates, compounds containing aluminium and silicon. Exley and Birchall (1993) demonstrated a formation mechanism involving aluminium hydroxide growth sites; the reaction depended on pH and silicic acid concentration. [3]

In an aluminium-sensitive maize cultivar, Wang, Stass and Horst (2004) found that silicon reduced root injury. Their treatment used 1.4 mmol/L Si with 25 micromol/L Al at pH 4.3. Aluminium in the surrounding solution did not decline; the findings supported detoxification within the root cell-wall region. Therefore, reduced aluminium toxicity need not mean less total aluminium in soil or roots. [4]

Research target: demonstrate reduced harmful aluminium activity or root injury under defined conditions. The phrase "locks up aluminium" is best explained as a possible reduction in its biological reactivity, with the location and mechanism tested.

Phosphorus and potassium

Phosphorus availability involves more than aluminium binding

Phosphate can be retained on iron and aluminium mineral surfaces. Silicon may alter these interactions and increase the amount of phosphorus in soil solution. The proposed benefit is improved access to existing phosphorus. Aluminium detoxification and phosphate mobilisation are separate mechanisms, so demonstrating one does not establish the other. [4] [5] [6] [7]

Soil evidence. Uhuegbue and colleagues (2024) added amorphous silica to two agricultural soils. At the 3% treatment, water-extractable phosphorus after six hours was 10 versus 4 mg P/kg in one soil, and 21 versus 10 mg P/kg in the other. Other extraction methods gave different responses. These are laboratory extraction results at a substantial silica addition, not demonstrated crop uptake or a prediction for a low-volume spray. [5]

A recent crop test. Petrin and colleagues (2026) grew maize for 60 days in a greenhouse using fumed silica at 480 mg Si/kg soil and phosphorus at 100 mg P/kg. Applying Si before P, or together with P, increased Mehlich-3 extractable P by about 60% and 55%, respectively, compared with P at sowing alone. However, combining Si with P did not increase maize P concentration or uptake. Soil availability and plant uptake therefore need separate evaluation. [6]

Where the mechanism has limits. Sabur and colleagues (2022) found little competition between silicate and phosphate on goethite under acidic conditions. Competition increased at alkaline pH, but silicate did not increase release of previously adsorbed phosphate in their desorption experiment. A universal claim that silicon frees fixed phosphorus would exceed this evidence. [7]

Potassium uptake and transport have direct experimental support

Uptake in salt-stressed rice. Yan and colleagues (2021) compared normal rice with mutants deficient in silicon uptake or transport. After five days, silicon increased net potassium influx, K accumulation and movement to shoots in normal plants, but not in the mutants. Expression of genes involved in K uptake and xylem loading also increased. This is direct evidence for a silicon-related potassium response under the tested salt stress. [8]

Redistribution in potassium-deficient barley. Beier and colleagues (2022) found that silicon promoted movement of potassium from root stores to shoots and altered potassium transporter regulation. The study supports more effective internal K redistribution, which is distinct from proving that more K was extracted from soil. [9]

A useful qualification. In sorghum, Chen and colleagues (2016) reported improved growth and water status under K deficiency, with xylem-sap K concentration about 80% higher after silicon treatment. Root and shoot K concentrations did not increase. This result should not be described as an 80% increase in whole-plant potassium uptake. [10]

Research target: establish whether SILARA N30 improves total plant P and K accumulation, their distribution and productive growth under relevant nutrient or stress conditions. These effects do not imply that silicon supplies phosphorus or potassium.

Drought tolerance and recovery

Water-stress resilience is a further outcome Bio Charge aims to evaluate with SILARA N30. The practical question is whether treated plants can maintain useful growth during a dry period and recover after rain or irrigation. Published silicon experiments provide a rationale for testing this response. [12] [13]

Ryegrass: a relevant starting point for pasture

Mastalerczuk and colleagues (2025) tested two perennial ryegrass turf cultivars in pots through 21 days without watering and 14 days of recovery. Foliar Optysil, containing sodium metasilicate and iron, improved some physiological responses and root-to-shoot allocation. Most growth measurements within the drought treatments did not differ significantly with silicon. The study supports testing water status and recovery, but does not establish SILARA N30 performance in grazed New Zealand pasture. [12]

Tomato: evidence for improved root water uptake

Shi and colleagues (2016) used 2.5 mmol/L silicate in tomato seedlings exposed to water stress induced by polyethylene glycol. Silicon improved root hydraulic conductance, water status and photosynthesis, and reduced oxidative damage. This supports a possible root-water-uptake mechanism. The controlled osmotic-stress system differs from a drying field soil and from a colloidal silica spray. [13]

What Bio Charge aims to match

The objective is to demonstrate useful drought tolerance, not immunity to water shortage. Potential comparison points are maintenance of leaf water status, productive dry matter during a defined water deficit, and regrowth after rewatering. A physiological response alone does not establish additional seasonal yield or a profitable return.

A suitable first trial would compare SILARA N30 and an untreated control under both adequate water and a measured water deficit. Include replicated treatments, matched nutrient supply, an appropriate silicon reference and consistent application timing. A treatment-by-water interaction helps establish whether a benefit is specifically associated with water stress.

Measure the full water-stress response

Before stress: record starting biomass, soil moisture, plant nutrient status, product dose and application route. Confirm that treatment groups begin under comparable conditions.

During stress: monitor soil water, leaf water status, photosynthetic performance and dry-matter growth. Measure water use alongside biomass before describing improved water-use efficiency.

After rewatering: measure recovery of growth, survival and harvestable dry matter. Follow through into seasonal production under relevant pasture or crop management.

Interpretation: potassium nutrition, root function and water relations can interact, but improved K transport is not itself proof of drought tolerance. Silicon should be evaluated within a complete soil, nutrition and water-management programme. [10] [12] [13]

Targets for SILARA N30

The following is a proposed validation approach for Bio Charge. Success means a repeatable, useful response under intended conditions of use; published percentage gains should be treated as study-specific findings rather than product forecasts.

Target	Evidence to seek with SILARA N30
Monosilicic acid release	Measure dissolved monomeric Si over time after dilution, separately from total and particulate Si.
Reduced aluminium stress	Measure reactive Al and root growth under Al stress, with pH-matched controls.
Improved phosphorus access	Measure soil-solution or labile P alongside total plant P accumulation and growth.
Improved potassium nutrition	Measure total plant K accumulation, root-to-shoot distribution and dry matter at equal K supply.
Drought tolerance and recovery	Measure water status, dry matter during water deficit, and regrowth after rewatering.

Make the comparisons meaningful

Confirm exposure. Measure total and dissolved monomeric Si, particle size, pH and accompanying ions. Test release in the intended dilution water, using a validated method to separate particles from dissolved Si.

Compare like with like. Include untreated and soluble-silicon controls. Match pH and nutrient supply, including accompanying K or Na. Express dose as product volume and elemental Si mass; do not infer concentration from N30.

Test the intended route. Evaluate practical label rates in relevant New Zealand soils and plants. Keep foliar and soil exposure separate: root-solution results do not establish that a foliar spray changes soil aluminium or phosphate binding.

Measure the agricultural result. Use replicated, randomised trials. Calculate nutrient accumulation as concentration multiplied by dry biomass. Assess roots, crop safety, yield and persistence before setting fertiliser-saving claims.

Suggested research positioning

“Published research shows that silica can release monosilicic acid, and that silicon can influence aluminium stress, phosphorus availability, potassium nutrition and water-stress tolerance under particular conditions. Bio Charge aims to reproduce relevant benefits with SILARA N30 at practical application rates in New Zealand soils and crops.” [2] [4] [5] [8] [9] [12] [13]

References

Primary experimental research is listed below, together with Bio Charge's product description. Numbered citations link to these entries; article titles link to their sources.

[1] Bio Charge. SILARA N30 product information.
Product description and typical pasture rate. Accessed 12 November 2026.

[2] Spitzmüller L et al. (2023). Dissolution control and stability improvement of silica nanoparticles in aqueous media.
Journal of Nanoparticle Research 25, 40. Full text.

[3] Exley C, Birchall JD (1993). A mechanism of hydroxyaluminosilicate formation.
Polyhedron 12(9), 1007-1017. Publisher abstract.

[4] Wang Y, Stass A, Horst WJ (2004). Apoplastic Binding of Aluminum Is Involved in Silicon-Induced Amelioration of Aluminum Toxicity in Maize.
Plant Physiology 136(3), 3762-3770. Open-access article text.

[5] Uhuegbue PO, Stein M, Kalbitz K, Schaller J (2024). Silicon effects on soil phosphorus availability: results obtained depend on the method used.
Frontiers in Environmental Science 12, 1461477. Full text.

[6] Petrin JE et al. (2026). Silicon application timing on phosphorus availability and fractionation in tropical soil and its effects on maize growth.
Plant and Soil. Published 1 October 2026. Full text.

[7] Sabur MA, Parsons CT, Maavara T, Van Cappellen P (2022). Effects of pH and Dissolved Silicate on Phosphate Mineral-Water Partitioning with Goethite.
ACS Earth and Space Chemistry 6, 34-43. Full text; first published online in December 2021.

[8] Yan G et al. (2021). Silicon alleviates salt stress-induced potassium deficiency by promoting potassium uptake and translocation in rice (Oryza sativa L.).
Journal of Plant Physiology 258-259, 153379. Abstract and accessible publisher excerpts.

[9] Beier S, Marella NC, Yvin JC, Hosseini SA, von Wirén N (2022). Silicon mitigates potassium deficiency by enhanced remobilization and modulated potassium transporter regulation.
Environmental and Experimental Botany 198, 104849. Publisher abstract and highlights.

[10] Chen D et al. (2016). Silicon moderated the K deficiency by improving the plant-water status in sorghum.
Scientific Reports 6, 22882. Open-access article text.

[11] Jarosz Z (2014). The effect of silicon application and type of medium on yielding and chemical composition of tomato.
Acta Scientiarum Polonorum Hortorum Cultus 13(4), 171-183. Full text.

[12] Mastalerczuk G et al. (2025). Silicon mitigates the adverse effects of drought on Lolium perenne physiological, morphometric and anatomical characters.
PeerJ 13:e18944. Full text. Turf ryegrass; Optysil treatment.

[13] Shi Y et al. (2016). Silicon Enhances Water Stress Tolerance by Improving Root Hydraulic Conductance in Solanum lycopersicum L.
Frontiers in Plant Science 7:196. Full text. Controlled osmotic stress.

Interpretation: the evidence is strongest for the underlying dissolution chemistry and for specific silicon responses under controlled conditions. Transfer to SILARA N30 depends on formulation, delivered dose, application route, soil chemistry and plant response.