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An Investigation into alternative slow release Si fertilisers

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Abstract

The role of Silicon (Si) in plant growth and development was overlooked until the beginning of the 20th century[1]. It is now gaining interest with clear evidence that Si plays a significant role in imparting biotic and abiotic stress resistance and enhancing growth and yield[2].

Plants absorb Si from the soil as monosilicic acid or Plant Available Si (PAS); however, many soils are deficient in PAS. While silica is an abundant element, it is largely locked up in crystalline form and cannot be absorbed by the plant. For example, sand is composed of quartz and is therefore high in SiO_2, however, this crystalline form of SiO_2 is unavailable to the plant. Failure to have access to this beneficial element results in a plant that is Si deficient, affecting its growth and ability to resist stress.

Si deficient soils can be treated with Si containing materials. Many materials have a high elemental Si content (ie percentage Si) and may be seen to be a potential Si fertiliser, however, their effectiveness as a Si fertiliser is not dependent on the total Si content, but rather on Si *availability*, or PAS.

Direct chemical extraction provides an estimate of the Plant Available Si of a Si containing material. A number of chemical extractants are mentioned in the academic literature and there is significant debate as to the best chemical extractant to use that correlates with plant Si uptake[3]. In the absence of the scientific community universally agreeing on an extractant, we have evaluated many of the extractants and find calcium chloride to be suitable due to its reliability in measuring the available Si in the soil[4]. Also, being a neutral extractant it does not preferentially

[1] Epstein, E., 1999, Silicon Annu. Rev. Plant Physiol. Plant Mol. Biol., 50:641-664
[2] Ma, J.F., Tamai, K., Yamaji, N. et al, Nature, 2006, vol 440, pp688-691
[3] Sauer, D., Saccone, L., Conley, D.J., Herman, L. and Sommer, M., 2006, Review of Methodologies for extracting plant available and amorphous Si from soils and aquatic sediments, Biogeochemistry, vol 80, No. 1, pp89-108
[4] *Berthelsen, S., Noble, A.D. and Garside, A.L., 2001, Silicon research down under: past, present and future. In: Datnoff, L.E., Snyder, G.H. and Korndorfer, G.H. (eds), Silicon in Agriculture. Elsevier Science, pp. 241-255.*

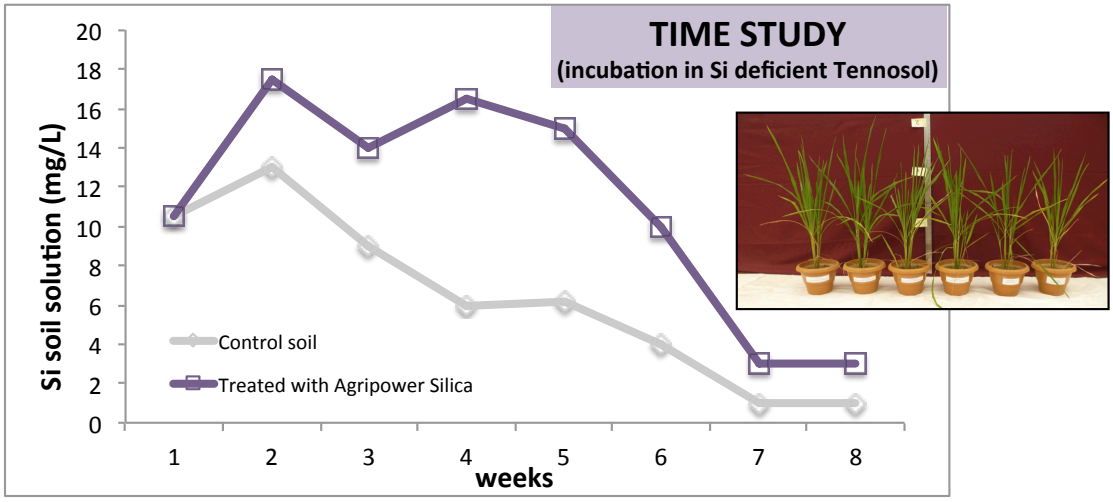
release non-plant available Si. Several materials were evaluated for their Si availability by direct chemical extraction:

Material tested	Available Si as a % of a control[5]	Available Si as a % of a lab control[6]	Available Si as a % of the material's Total Si[7]
Agripower Silica	465	15	0.5
Phosphorous furnace slag	91	3	0.1
Wollastonite	100	3	0.1
Sand	38	1	0.0

Note: Available Si is measured using the 0.01M CaCl2 extraction method at 1:100 ratio

Agripower Silica has a high Si availability compared with other commonly used materials. Agripower Silica is formed naturally from freshwater algae skeletons, called diatoms, which are composed predominantly of amorphous silica.

Soil incubation tests were conducted in various soils to understand the Si release characteristics of Agripower Silica as a function of application *rate* and *time*. Typically an optimal rate is found, which depends on the soil. The dynamics of Si as a function of time were studied in a replicated rice pot trial with a Si deficient soil:



Over the 8 weeks it is evident that the rice plant, a high Si accumulating plant, had a strong demand for Si, drawing the available Si from the soil. Agripower Silica increased the available Si of the soil resulting in a 38% increase in the plant tissue Si compared to the control. It is possible to further increase the Si availability of this soil through judicious timing and an increased application rate of Agripower Silica.

Agripower is running extensive trials in a range of crops (cotton, sugarcane, rice, tomatoes, chillies, onions etc) across Australia and India. Increased yields and quality of produce have been demonstrated. These benefits have been attributed to three distinct properties of the product: 1. An amorphous silica composition, a rich source of available Si, 2. A high quality diatom species (*Melosira Granulata*) whose unique structure enhances nutrient and water uptake, and 3. Agripower Silica is a natural product with no contaminants.

[5] *The control here is the Available Si extracted from wollastonite*
[6] *The control here is the available Si extracated from laboratory grade pure calcium silicate*
[7] *Total Si is measured for each material*