Sili-Max® Limits Arsenic Uptake in Rice

Research Report

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Rice (*Oryza sativa*) is the staple food for more than half the world's population, feeding about 3.5 billion people. Compared with other crops, however, rice accumulates higher amounts of arsenic (As) due to its cultivation in flooded fields under anaerobic conditions. Arsenic is a toxic and carcinogenic element.

Decreasing As levels in the rice grain, particularly the more toxic inorganic forms (As [III] and As [V]) is, therefore, one of the main objectives of rice producers and policymakers. The European Commission has recently set a limit of As content in commercial rice to 200 µg kg^{-1} for white rice and to 100 µg kg^{-1} for baby food rice. Hence, it is essential to establish appropriate agronomic practices for reducing As accumulation in rice.

A promising practice is the application of silicon (Si) sources, since Si competes with As uptake at the root level. There are only a few efficient silicon sources in the market that limit As uptake by plants. Therefore, it is necessary to identify efficient fertilizers that are safe for the environment and food quality.

Hypothesis and Objective

Since As is taken up by rice plants through the same transporters as for the essential nutrient silicon (Si), raising the concentration of available Si in soil might decrease As uptake. This research aimed at comparing the performance of Huma Gro® Sili-Max® fertilizer, containing 10% Si, to other Si sources in limiting As uptake in rice.

Materials and Methods

Five Si-rich sources were mixed with paddy loam soil from the area of Castello d'Agogna (Pavia, Italy)—with low available Si and a pH equal to 5.9—under submerged conditions in mesocosm and macrocosm experiments for the approximate duration of the life cycle of rice plants (90 days):

- Liquid Si source Sili-Max® (SiO_2 = 21.4%)
- Solid Si source Agrosil® (SiO_2 = 39.6%)
- Rice husks ash (SiO_2 = 85.4%)
- An experimental Biochar derived from burning rice straw (SiO_2 = 23.1%)
- Silica gel beads (SiO_2 = 88.5%).

The materials were added at appropriate doses to provide similar inputs of total Si (Si_{tot}). Soil with no added fertilizer/amendment was used as a control. Rice plants were sampled at 3 different times: during mid-tillering, end-tillering, and end-flowering. The plant samples were dried, ground, and digested by microwave-assisted acid digestion using nitric acid. The acid extract was analyzed for total Si and total As.

Results

- The amount of Si released in solution by Sili-Max® was approximately three times higher with respect to all other fertilizers and the control soil (Fig. 1).

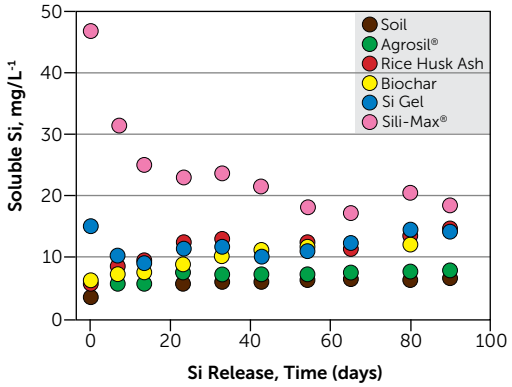

Figure 1. Kinetics of Si Release in Solution From the Tested Soil and the 5 Si-sources.

- At harvest, Sili-Max®-treated rice plants had the lowest inorganic As concentration and the highest Si concentrations (Fig. 2).

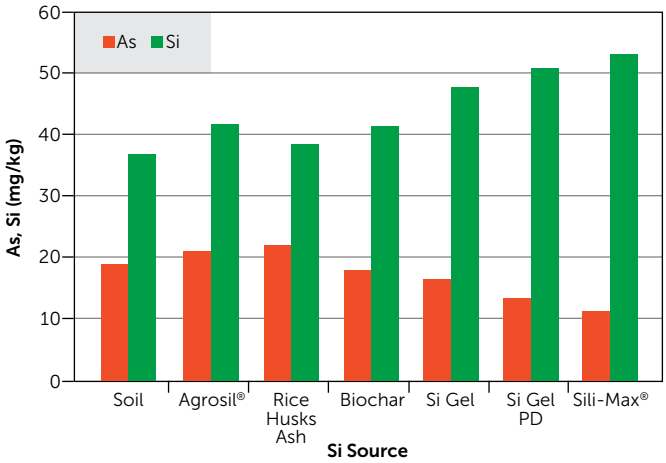

Figure 2. As and Si Content at Harvest in Rice Plants Cultivated on Non-fertilized and Fertilized Soil.

Conclusion

In this study, Huma Gro® Sili-Max® demonstrated its ability to supply rice plants with available Si while decreasing inorganic As content in the grain more significantly than the other tested Si sources. Sili-Max® proved to be a promising Si source not only for supplying Si but also for limiting plant uptake of inorganic As, one of the most toxic elements in rice products.

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