SUSTAINABLE VALORIZATION OF RICE HUSK FOR DEVELOPING A SILICON SUPPLEMENT TO ENHANCE GROWTH AND YIELD OF PADDY (*Oryza sativa* L.)

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Rice husk is a silica rich agricultural byproduct with considerable potential for the development of sustainable silicon (Si) based agricultural inputs. This study aimed to develop a stable rice husk derived orthosilicic acid ($Si(OH)_4$) solution and evaluate its effects on the growth and yield performance of rice (*Oryza sativa L*). Silica (SiO_2) was extracted from rice husk ash through alkali fusion using potassium hydroxide (KOH), followed by acidification with phosphoric acid (H_3PO_4) to produce a stabilized orthosilicic acid formulation. The synthesized materials were characterized using gravimetric analysis, UV-vis spectroscopy, Fourier transform infrared spectroscopy, and X-ray diffraction analysis. The final bulk formulation contained 4750 ppm silicon with a pH of 4 and was subsequently evaluated in a pot experiment using the rice variety Ld 253 under a completely randomized design comprising five treatments (0, 200, 300, 400, and 4750 ppm Si) with five replicates. Growth and yield parameters, including plant height, tiller number, productive panicle number, and grain weight, were assessed and statistically analyzed. Characterization results confirmed the successful synthesis of a plant available silicon product, with UV-vis spectroscopy showing a maximum absorbance at 804 nm and X-ray diffraction analysis indicating the presence of semi-crystalline SiO_2. Silicon supplementation significantly enhanced rice growth and yield compared with the control treatment. The observed improvement may be attributed to the role of silicon in strengthening plant tissues, improving stress tolerance, enhancing photosynthetic efficiency, and promoting more efficient nutrient utilization, resulting in increased plant height, tiller production, productive panicle number, and grain weight. Among the tested concentrations, 300 ppm Si produced the highest overall performance, resulting in a mean improvement of approximately 35% across measured parameters. The greatest relative response was observed for grain weight, which increased by approximately 51wt% compared with the control experiment. In contrast, application of the undiluted bulk 4750 ppm stock solution caused phytotoxic effects and reduced plant performance. The developed rice husk derived formulation represents a low cost Si–K–P nutrient source with potential application as a sustainable silicon supplement for rice cultivation.

Keywords: orthosilicic acid, rice growth, silicon nutrition, sustainable agriculture, yield enhancement.