

Silicon: A Hidden Helper of Rice Growth

Anisha Sahoo^{1*}, Dr. Anshuman Nayak² and Dr. Bhabani Shankar Nayak³

¹Research Scholar, ²Associate Professor, Department of Agronomy,
College of Agriculture, OUAT, Bhubaneswar, Odisha, India

³Sr. Scientist (Agronomy) & OIC AICRP on cotton, RRTTS, OUAT, Bhubaneswar, Odisha, India

Corresponding Author

Anisha Sahoo

Email: anishasbp517@gmail.com



OPEN ACCESS

Keywords

Silicon, Rice, Yield, plant strength, Stress response

How to cite this article:

Sahoo, A., Nayak, A. and Nayak, B. S. 2026. Silicon: A Hidden Helper of Rice Growth. *Vigyan Varta* 7 (06): 12-14.

ABSTRACT

Silicon (Si) is a beneficial element in plant. It also known as the "hidden helper" of rice growth. It is essential for growing healthy and high-yielding rice. This article shows how silicon helps rice plants to become strong and productive. Silicon act as a protective barrier by strengthening the plant's stems so they don't fall over even when planted closely together or given less nitrogen. It also act as a biostimulant by helping the plant's metabolism to stay balanced, helping it to survive under tough conditions like drought or salt stress by keeping its water levels constant. It also enhances the photosynthesis and helps the plant to grow more heavier grains. With the reduction of indigenous silicon reserves due to intensive agricultural practices, silicon supplementation has emerged as a crucial management strategy. It helps the producers to optimize yields and minimize chemical dependency in between the challenges of a changing climate.

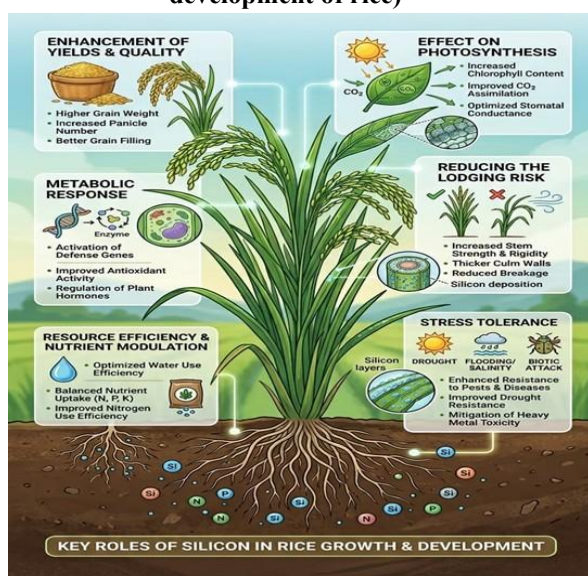
INTRODUCTION

For a long time, agriculture has focused on the three primary nutrients— Nitrogen, Phosphorus, and Potassium. However, now a day Silicon (Si) act as a "hidden helper" that is fundamentally changing how we approach rice cultivation. While

silicon is known as a semi-essential nutrient, rice plants are notable silicon accumulators, frequently taking up this element in concentrations that is more than those of primary macronutrients like nitrogen and phosphorus (Singh *et al.*, 2005). Silicon acts as

a multifunctional element for the plant. It creates a defensive barrier known as the silica-cuticle double layer, which provides the rigidity to keep leaves erect and stems strong against falling over. Besides physical strength, silicon act as a metabolic biostimulant, which helps rice to survive drought, pests, and nutrient imbalances (Ramírez-Olvera *et al.*, 2021). As modern farming reduces natural silicon from the soil, understanding this mineral's role is essential and to take a strategic decision for sustainable, high-yield rice production in a changing climate.

(Fig 1. Effect of silicon in growth and development of rice)



Enhancement of yields and quality

The addition of silicon fertilizer increases the rice yields by increasing shoot and root fresh biomass weight. It also increases the number of tillers, panicle content, spikelet fertility, and grain weight (Ramírez-Olvera *et al.*, 2021). When Si was applied during the reproductive phase, the plants showed a remarkable increase in the number of grains per panicle, higher test weight means heavier seeds. There is also improved Harvest Index, meaning the plant directed its energy more efficiently into the grain than the stem and leaves (Lavinsky *et al.*, 2016).

Effect on Photosynthesis

When silica is added to rice it accumulate in the cell walls of the epidermis and vascular tissues of plant which maintain the leaf erectness. This prevents the leaves from drooping, which reduces shading of leaves and increases plant photosynthesis (Singh *et al.*, 2005). It also increases total chlorophyll concentrations and improved the chlorophyll a/b ratio. During grain formation silica creates bigger grains which requires more sugar. So, it leads to increased photosynthetic rate higher in the leaves to meet the need (Lavinsky *et al.*, 2016). It also increased mesophyll conductance, allowing CO₂ to move more easily within the leaf to the place of photosynthesis.

Reducing the lodging risk

Application of silicon decreases the lodging risk by improving the physical and physiological strength of the plants. Here rice plant achieves short and thick stem structure which leads to bending resistance and strengthens the stems (Dong *et al.*, 2024).

Metabolic response

It increased the concentration of total sugars and proline content in the shoots, which maintains the osmotic balance and help the plant to survive in water scarcity conditions (Ramírez-Olvera *et al.*, 2021).

Resource efficiency and nutrient modulation

It reduces use of chemical nitrogen fertilizer input which reduces production costs without sacrificing yield. So reduced N, improved density, and addition of silicon help farmers to maintain stable productivity while maintaining the crop's structural integrity (Dong *et al.*, 2024). Si decreases the concentration of potassium and manganese in the roots while increasing the concentration of iron and zinc in

the shoots. Silicon increases nitrogen efficiency by allowing the plant to handle higher levels of N without the side effects of lodging or increased disease susceptibility (Singh *et al.*, 2005). Silicon enhances the availability of phosphorus by decreasing the Phosphorus fixation capacity of the soil. Silicon reduces the toxicities of aluminium, manganese, and iron by balancing their uptake and distribution within the plant tissues.

Stress tolerance

Silicon forms a silica-cuticle double layer which acts as a physical barrier against fungal hyphae and insect mouthparts like stem borers and brown plant hoppers. The accumulation of Si in the leaves decreases cuticular transpiration, which improves the plant's water-use efficiency and drought resistance. (Singh *et al.*, 2005).

CONCLUSION

In conclusion silica which once regarded as a secondary mineral, now has changed into a fundamental component of modern, sustainable rice management. So, silica may apply as calcium silicate as basal @400 kg/ha or can be apply as foliar spray as potassium silicate @1% at tillering and panicle initiation stage. More than just a building block, silicon is a metabolic regulator that prevents lodging and increases photosynthesis during grain formation (Lavinsky *et al.*, 2016; Dong *et al.*, 2024). It helps in increasing plant resilience and grain quality while decreasing the chemical effect of farming. As there are increasingly unpredictable growing seasons,

treating silicon as a fundamental nutrient is crucial for global food stability. It is the invisible support system that empowers rice to stand firm against the biological and climatic hurdles of the future.

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