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RICE STRAW DERIVED SILICON - APPLICATIONS REVIEW OF ADVANCED TECHNOLOGIES IN AGRICULTURE AND ALLIED SECTORS

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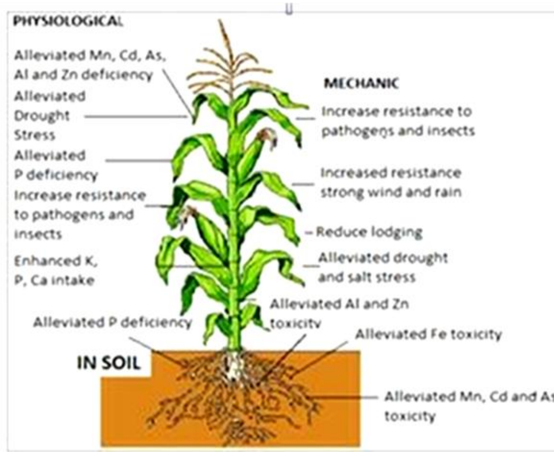
Introduction:

Silicon is not considered an essential element but is beneficial for crop growth, especially for Poaceae crops. Silica strengthens the plant, protects the plants against insect pests, increases crop production and quality, increases plant nutrition and neutralizes heavy metal toxicity in acid soils. Plants vary widely in their capacity to take up silicon. Due to continuous monocropping and/or intensive cultivation of cereal crops like rice, the soil Si concentration is depleted which can be the main reason for declined rice yields (Mali *et. al.*, 2008)

Rice straw, an abundant agricultural leftover, has emerged as a viable resource for generating renewable biomaterials. Its rich composition of cellulose, hemicellulose and lignin allows development in numerous applications, from medication delivery systems to biodegradable packaging, tackling environmental and industrial concerns. Recent advances in the valorization of rice straw, focusing on production, optimization (surface area, pore structure, surface functional groups, and modification techniques), and application of rice straw biochar (RSBC) for wastewater treatment and soil amendment applications (Savant *et al.*, 1997).



Nanotechnology facilitates the production of crops either directly by eradicating the losses due to challenging environmental conditions or indirectly by improving tolerance against salinity stress. The

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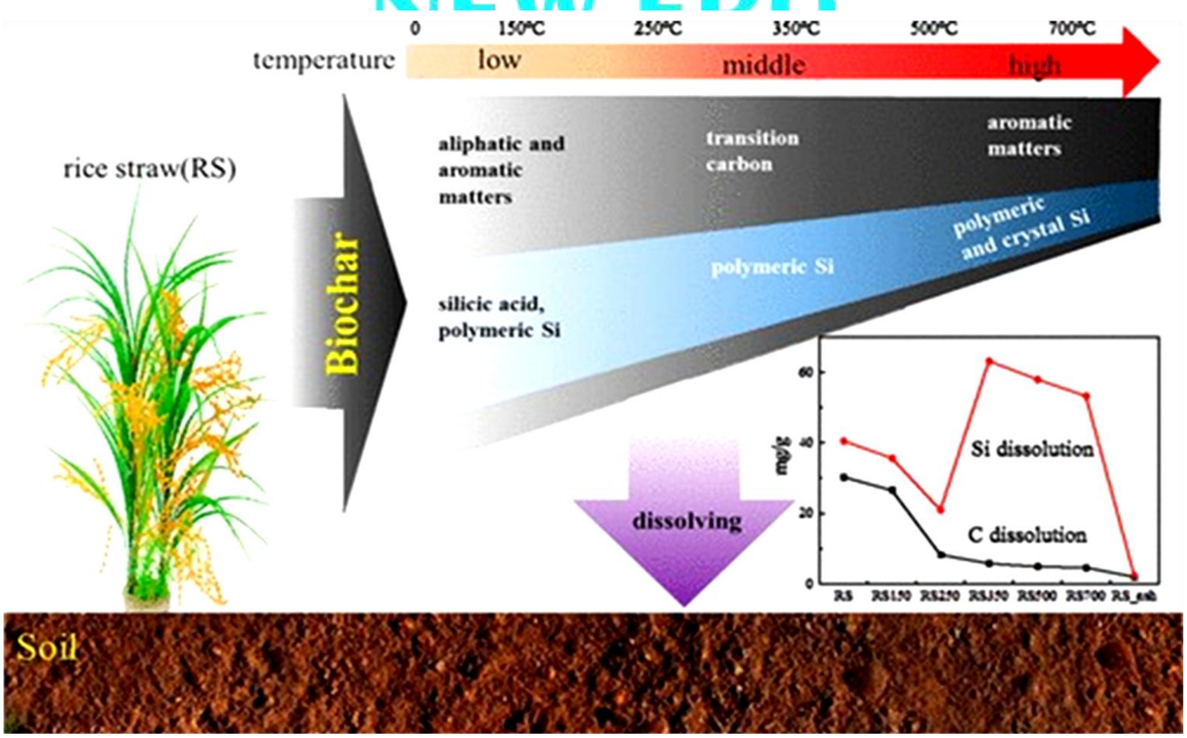
protective role of silicon nanoparticles (SiNPs) was determined in two rice genotypes, N-22 and Super-Bas, differing in salinity tolerance. The SiNPs were confirmed through standard material characterization techniques, which showed the production of spherical-shaped crystalline SiNPs with a size in the range of 14.98-23.74 nm, respectively (Ijaz*et al.*, 2023).

Biochars are increasingly recognized as environmentally friendly and cheap remediation agents for soil pollution. The roles of silicon in biochars and interactions between silicon and carbon have been neglected in the literature to date, while the transformation, morphology, and dissolution of silicon in Si-rich biochars remain largely unaddressed. In this study, Si-rich biochars derived from rice straw were prepared under 150–700 °C.

Benefits in Agriculture and allied sectors

1. **Soil fertility enhancement**: Silicon from rice straw can improve soil fertility by increasing the availability of nutrients for plants.
2. **Crop yield improvement**: Silicon has been shown to improve crop yields, particularly in rice, wheat, and maize.
3. **Disease resistance**: Silicon can help plants develop resistance to diseases, reducing the need for pesticides.
4. **Stress tolerance**: Silicon can help plants tolerate abiotic stresses such as drought, salinity, and extreme temperatures (Maghsoudi *et al.*, 2015).
5. **Animal feed**: Rice straw-derived silicon can be used as a supplement in animal feed to improve livestock health.



6. **Organic fertilizers**: Silicon-rich rice straw can be converted into organic fertilizers, reducing the need for synthetic fertilizers.
7. **Biogas production**: Rice straw can be anaerobically digested to produce biogas, which can be used as a renewable energy source.

8. **Bioactive compounds**: Rice straw-derived silicon can be used to produce bioactive compounds with potential applications in medicine and cosmetics.
9. **Alkaline extraction**: Silicon can be extracted from rice straw using alkaline solutions such as sodium hydroxide.
10. **Acidic extraction**: Silicon can also be extracted using acidic solutions such as sulfuric acid.
11. **Enzymatic extraction**: Enzymes such as
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