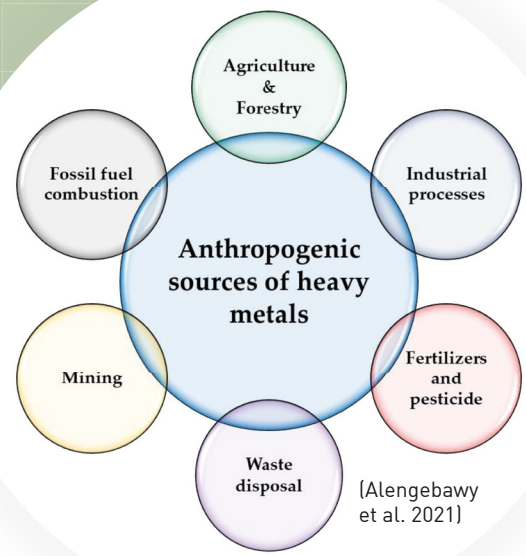
ORION
RELEASING THE BIOLOGICAL POTENTIAL OF PLANTS

Silicon: A Natural Shield Against Heavy Metal Stress in Plants

WHAT'S THE PROBLEM?

Heavy metals like Cadmium (Cd), Copper (Cu), Lead (Pb), and Arsenic (As) can accumulate in soil through pollution, leading to poor crop growth, reduced yields, and food safety risks. Conventional remediation methods such as soil excavation or chemical amendments can be costly, disruptive, or environmentally unsustainable.

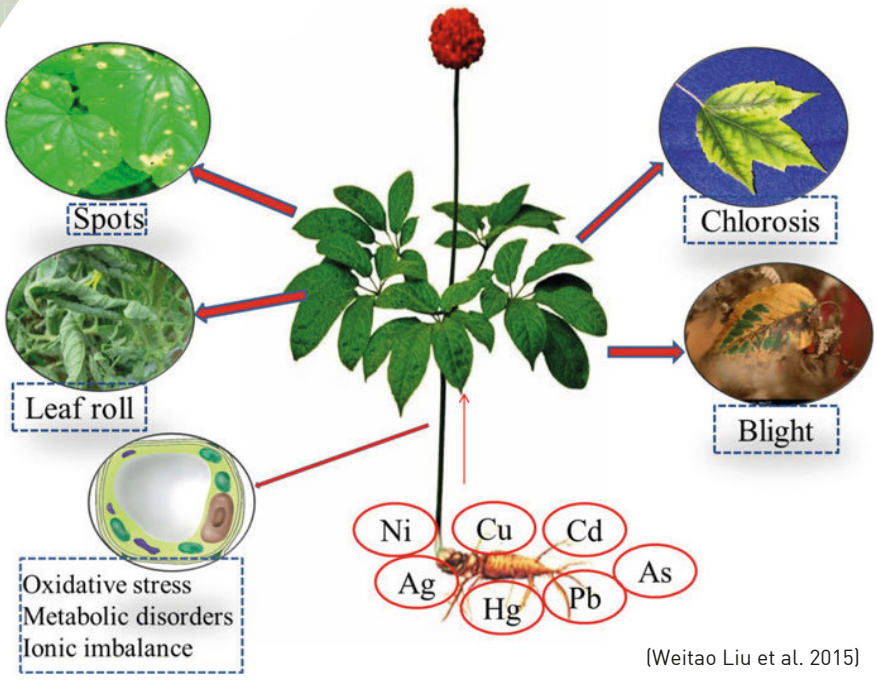


(Alengebawy et al. 2021)

WHY USE SILICON?

Silicon is a natural, sustainable solution that helps plants survive and thrive in metal-stressed soils. It reduces the uptake and translocation of toxic heavy metal, thereby limiting their harmful effects on plant metabolism.

Additionally, silicon enhances the plant's antioxidant defence system, mitigating oxidative stress caused by heavy metal exposure.



(Weitao Liu et al. 2015)

KEY BENEFITS FOR PLANTS

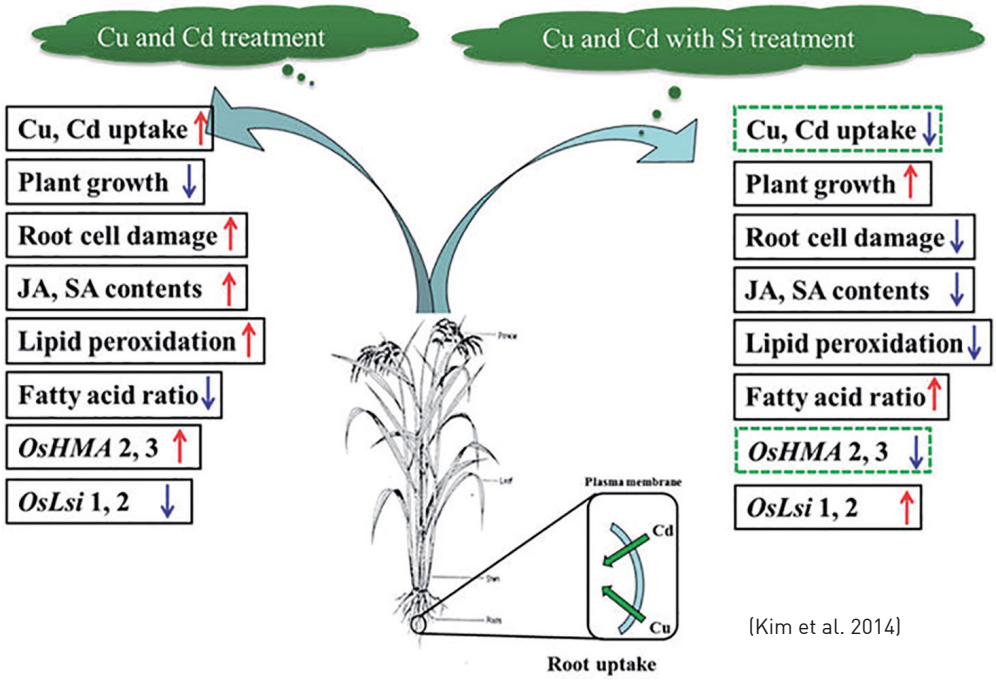
- Reduces metal uptake into shoots and edible parts
- Locks toxic metals in the roots and soil matrix
- Enhances photosynthesis and chlorophyll production
- Strengthens cell walls and limits oxidative damage
- Improves yield and food safety under stress

Silicon's Scientific Role in Mitigating Heavy Metal Stress

ORION
RELEASING THE BIOLOGICAL POTENTIAL OF PLANTS

MECHANISMS OF ACTION

- **Complexation & Co-precipitation**: Silicon forms insoluble complexes with Cd, Pb, and As, reducing mobility and uptake.
- **Root Barrier Effect**: Silicon deposits in root endodermis limit metal transport to shoots (e.g. Cd blocked by Si in rice).
- **Antioxidant Boost**: Si enhances enzymatic defenses like SOD, CAT, and APX to reduce ROS damage.
- **Photosynthesis Support**: Maintains chlorophyll levels, grana structure, and reduces membrane leakage.
- **Cell Wall Binding**: Si binds metals to pectins and hemicellulose, especially in long-term exposure.
- **Gene Expression Modulation**: Downregulates metal transporter genes and upregulates silicon transporters (e.g. OsLSi1, OsLSi2).



(Kim et al. 2014)

FIELD INSIGHT AND CONCLUSION

Si-treated plants exposed to 500 mg Pb/kg soil showed improved growth, chlorophyll levels, and reduced Pb in edible parts (Chen et al. 2019).

Silicon offers a multi-layered defense system — physical, chemical, physiological, and genetic — to help crops thrive under heavy metal stress.