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Strategies for Mitigating Abiotic Stresses in Agriculture

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Introduction:

Global agricultural output has been substantially adversely impacted by the emergence of climate change. Various consequences of climate change, including drought, salinity, waterlogging, temperature stress (heat stress, freezing, and chilling), and heavy metal accumulation, have led to significant challenges in crop production. These abiotic stresses make crops more susceptible to additional biotic stresses, such as pests and diseases, compounding the overall impact on agriculture. More than 50% of production loss is attributed to the diverse array of stresses that affect 91% of the world's cropland (Younis et al., 2020)

Management Strategies of Abiotic Stress

Breeding and Varietal Selection:

Developing and selecting stress-tolerant cultivars: This is a long-term approach that involves traditional breeding techniques or newer methods like speed breeding. The goal is to create crops with inherent resistance to specific stresses like drought or salinity. In addition to conventional breeding methods, the introduction of QTL mapping, marker-assisted breeding, genetic engineering, and speed breeding techniques has improved the ability of plants to withstand abiotic stress

Grafting:

Techniques like grafting stress-susceptible cultivars onto tolerant rootstocks can provide some level of protection.

Seed Treatments:

Seed priming: Exposing seeds to controlled stress conditions before planting can help them develop tolerance to future stress encountered during growth.

Microbial seed treatments: Applying beneficial microbes like mycorrhizae fungi to seeds can enhance root development and nutrient uptake, improving stress tolerance.

Plant Growth Regulators and Osmoprotectants:

The utilization of plant growth regulators and osmoprotectants, including polyols, glycine betaine (GB), mannitol, salicylic acid (SA), and many others, has been shown to alleviate several environmental stresses in different crops during production by enhancing the antioxidant enzymes and osmotic adjustment (Alotaibi, 2023).

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Agronomic Practices:

- **Water Management:** Employing efficient irrigation systems like drip irrigation to conserve water and deliver it directly to the roots. Practices like mulching to retain soil moisture, and deficit irrigation (providing less water than the crop typically needs) can be helpful in drought-prone areas.
- **Nutrient Management:** Ensuring proper fertilization practices to provide crops with the essential nutrients they need to cope with stress.
- **Planting Date Selection:** Planting crops at a time that avoids peak stress periods like extreme temperatures.
- **Tillage Practices:** Conservation tillage practices that minimize soil disturbance can help improve soil health and water retention.

Adopting Precision Agriculture techniques:

- Utilizing tools like remote sensing and data analysis to tailor management practices to specific field conditions and optimize resource use.

Emerging strategies:

Biochar application, sea weed extract, Higher plant extract, yeast extract, chitosan and use of nanotechnology) look promising and have been demonstrated to counteract the effects of abiotic stresses on crops, though their mechanisms still remain unclear, and more clarity is required

References:

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