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Brief Report: Abiotic Stress: The Protective Effects of Algae on Salt and Drought Tolerance

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Abiotic Stress: The Protective Effects of Algae on Salt and Drought Tolerance

An inadequate supply of water and/or an increased salt level in irrigation water depress plant growth and yield, and both are referred to as abiotic stress. One mechanism of injury is common to both stresses: there is accumulation of reactive oxygen species (ROS) including the superoxide radical (O2 with a negative charge), the hydroxyl radical, and hydrogen peroxide, all of them cytotoxic. Plants have defensive enzyme systems that detoxify ROS, including superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX), and glutathione reductase (GR). When subjected to either increased salinity or drought, the levels of these antioxidant enzymes increase in proportion to the level of stress. **Live algae and algae extracts have been shown to bolster resistance to both salinity and drought by boosting the levels of these enzymes.**

Consider the following two studies:

1. Abd El-Baky HH, Hussein MM, El-Baroty GS. "Algae extracts improve antioxidant defense abilities and salt tolerance of wheat plant irrigated with seawater." Afr J Biochem Res (2008) 2:151-164.

In this study, wheat was grown in pots and irrigated with three levels of salinity: none (tap water), 10% seawater or 20% seawater. The control plants (those not treated with algae extract) had a progressive decline in growth and yield with increasing salinity. There was a corresponding decline in chlorophyll levels. The plants exhibited the normal defensive response to rising salinity with a progressive rise in levels of antioxidant enzymes, SOD, CAT, APX, and GR (which they measured).

The treatments tested were extracts from two green algae species, either Chlorella ellipoida or Spirulina maxima. Foliar spray with the algae extracts minimized the effects of increasing salinity on wheat growth, yield and chlorophyll content, and boosted the rise in antioxidant enzymes (SOD, etc.).

The study was quite sophisticated, and included two dose response effects. First, the increasing level (dose) of salinity caused progressive changes.

Also interesting was a varying dose of antioxidant compounds in the algae extract. In addition to extract from healthy algae, they also used extract from stressed algae. The stress was increased light intensity and exposure when growing

the algae, which led to a decline in chlorophyll, but a marked increase in antioxidant compounds. Thus, there was also a comparison of normal-algae with stressed-algae extract with a big difference in antioxidants. The higher antioxidant extract (from stressed-algae) had a larger protective effect—a dose response effect.

Note: The authors noted that brackish water is needed for irrigation in many parts of the world, and algae treatment could positively affect food production. Pertinent to our region (coastal South Carolina), algae could improve the response of turf to seawater flooding.

2. Kusvuran C, Kusvuran S. Using microbial fertilizer as biostimulant alleviates damage from drought stress in Guar seedlings. Int Letters Nat Sci (2019) 76:147-157.

This study used live *Chlorella vulgaris* applied to soil with irrigation. They subjected seedlings to four levels of drought: a reduction in water supply of 25%, 50%, 75% or 100%.

The study design was similar to Abd E-Baky's study of salinity, making similar measurements. With progressive levels of drought there was a progressive decline in multiple plant growth parameters. The defensive response was a rise, biochemical markers of stress, and antioxidant enzymes (SOD, CAT, APX, GR).

Adding Chlorella to irrigation water mitigated the effect of drought on growth, with a corresponding rise in antioxidant enzymes.

Note: Short of actual drought, algae treatment can reduce irrigation requirements. The mechanism is the induction of these antioxidant enzymes, bolstering the natural response to oxidative (abiotic) stress.