

Drought Tolerance

Humic Acid- moisture management Kelp - resilience by better root growth Decades of research!

Drought - Humic Acid - moisture management from \$1/ha

Humic Acid improves drought resistance by:

- Improving moisture holding capacity of most soils. Humic acid is concentrated humus which holds seven times its own weight/volume in water, compared to humus in soil and compost which hold their own weight.
- Improving soil structure like no other input can. Humic acid modifies the permeability, porosity, water retaining capacity, absorption characteristics, surface area and cation exchange reactions. In sandy soils, humic acid provides a charged surface to hold onto moisture. In clay, humates penetrate clay particles and prevent them sticking together. This keeps clay particles apart so the water can easily penetrate. - Karr 2001
- Working at the cellular level. Plants subjected to drought stress showed the capacity to osmotic adjust by maintaining water absorption and cell turgor in response to humic acid. Humic acids also stimulate enzymatic and non-enzymatic antioxidant defence systems during drought stress. - Canellas 2015
- Increasing the water content of leaves. For example common beans had significantly higher water content with humic acids and bacteria during water stress and after recovery - Canellas 2015. Multiple studies show drought stressed crops suffer less with humates. - Karr 2001, Celik 2011, Piccolo 1997, Imbufe 2005

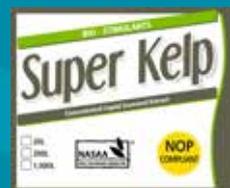
Humic Acid is a highly concentrated form of the most active part of humus (carbon). It is an extremely cost-effective from only \$1/ha.



Drought - Kelp - root growth improves resilience

Kelp improves drought tolerance by:

- Enhanced water uptake by the plant as a direct result of increased root growth - Khan 2009.
- Stimulating changes in the plant's metabolic pathways, allowing roots access to moisture not normally available to plants. Even under moisture stress conditions, the use of kelp has been shown to stimulate root growth.- Khan 2009.
- Cytokinins in kelp slowing the rate of the plant's degradation processes and stimulating photosynthetic activity. - Ervin 2004
- Cytokinins & Betaines in kelp increasing turgidity of cell walls ie water less likely to flow out of cells. - Khan, 2009
- Increasing chlorophyll ie improving photosynthesis (Betaines thought to be responsible). - Blunden 1997
- Improving the moisture-holding capacity and promoting the growth of beneficial soil microbes (alginates in Kelp involved) - Khan 2009
- Enhancing Potassium uptake which also induces heat tolerance - Ervin 2004



Contact us to talk through options to help your crop through heat stress.



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