Active carbon

-why you should add every time you fertilise

RESEARCH BULLETIN:

- **Humates provide charged surface (carbon) for nutrients to hook onto to**
- **Rapid rise in humate use - research shows they work**
- **Humates are the main active component of soil organic matter**
- **Humates cost effectively provide the benefits of soil organic matter**

THERE IS NO LIFE WITHOUT CARBON

The basics:

- Soil contains living organisms and along with plants need organic matter (carbon) to thrive.
- Humic substances are the most chemically active compounds in soils & are the major component of soil organic matter—Celik 2011; Asik 2003 - adding humates is a cheap and practical way to control N loss & get carbon into soil—Kasim 2011
- Good soils contain on average 1-5% HFA's - (OFS) humates contain 85 - 90%% HA's—Dong 2009
- Humic and fulvic acid (HFA) combined provide the best result for nutrient retention due to increased number of functional groups embedded in them.—Taufik 2011
- Humates enter into a complex reaction with a variety of organic and inorganic components of soils and influence plant growth and plant production.—Celik 2011

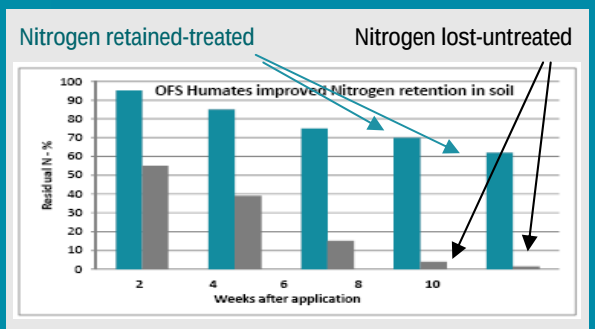
REDUCE N LOSS - CHARGED SURFACE TO HOLD ONTO NUTRIENTS

The problem

- All top dressed ammonia and ammonium based N fertilisers can volatilize, the potential is greatest with urea and fluids containing urea with as much as 20-50% of N applied to soil lost through volatilization alone – most lost when surface applied. – Reeza et al 2009; Kasim 2009.
- Acidic soils most susceptible to N loss—Reeza 2009
- Urea reduces total bacteria population & changes composition —Dong 2009

Solution - Research

- Humic and fulvic combination (HFA's) reduced ammonia loss by 30% compared to urea alone. The combination of humic and fulvic better than humus alone because of increased number of functional groups —Reeza 2009; Rosliza 2009
- Humic compounds significantly reduced N loss and increased exchangeable N. Humates could be the cheapest and easiest way to control N loss.—Kasim 2009
- Amending ureas with humates and acid sulphate significantly improved soil pH and retention of exchangeable ammonium. —Taufik 2011
- Total bacterial quantities higher when humic acids added with Urea—Dong 2009



The graph shows extra nitrogen fertiliser retained in the soil when coated with humate compared to uncoated fertiliser.

Mechanism

1. HFA's lower soil microsite pH immediately around the fertiliser, reducing hydrolysis of urea and thus reducing ammonia loss.—Rosliza 2009
2. Humates indirectly affect the availability of ammonium through stabilization of extracellular enzymes such as urease. Since urease is the key enzyme which decomposes urea to ammonia, application of urea along with HFA's slows down the transformation of urea to ammonium. (Activity of urease in HA treatments much lower than urea treatment during first 5 days and then the activity was maintained at 50 - 60% for the following 16 days) - Dong 2009

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HUMATES IMPROVE NUTRIENT UPTAKE/AVAILABILITY

Problem

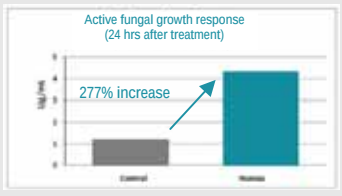
Maximising nutrient uptake and availability - nutrient loss is a significant business and environmental cost

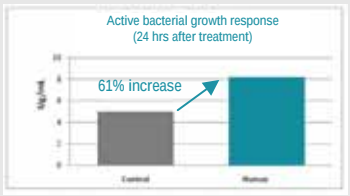
Solution - Research

- Foliar applications of humic acids positively affected plant growth - increased root length, increased uptake of macro and micro-nutrients and stimulated respiration, photosynthesis and protein nucleic acid synthesis, increased chlorophyll - Celik 2011
- Spraying fulvic acid on leaves resulted in greater level of chlorophyll and greater uptake of P by roots.—Celik 2011
- Humic acid increased chlorophyll density by 63% and fulvic acid increased chlorophyll by 69%. Wheat sprayed with fulvic acid in pot and field trials resulted in higher level of chlorophyll in leaves.—Nardi 2002; Karr 2001
- Humates improved uptake of nutrients, and trace elements in a wide variety of crops: following references show nutrient uptake increases for beans, corn, cucumber, grapes, ryegrass, pepper, tomatoes, wheat—Nardi 2002: Karr 2001
- Humates increased the nutrient uptake of green peppers and led to an increase in the content of proteins and other substances in the plants. It helped reduce the content of nitrates in plant tissues and made the green peppers more resistant to unfavourable environmental conditions.—Varga 2003
- Increased uptake of P in corn and wheat in field trials by 25% - multiples studies as in Karr 2001
- Humic acid treatments improve the yield of grapes by increasing the contents of antioxidant compounds and the specific activities of antioxidant enzymes.—Hosny 2012.
- Humates shown to be absorbed into epidermis of sunflower, radish and carrot roots; taken up by wheat roots and transported to shoots, fulvic transported to shoots to a greater extent than humic; in beets up taken by cell walls and to a smaller level mitochondria and ribosomes.—Nardi 2002

Mechanisms

- In degraded soil, humates improve availability of micro elements (eg Fe, Zn, Mn) and some macro elements (eg K, Ca, P) which in turn improves productivity.—Tahir 2010: Nardi 2002 : Humates have been widely regarded as playing a beneficial role in Fe acquisition by plants. This effect has been mainly attributed to the complexing properties of humates, which increase the availability of micronutrients from sparingly soluble hydroxides.—Nardi 2002.
- Nutrient uptake - humates with low molecular mass are taken up by plants and actively modify the plant metabolism. Their effects appear to be mainly exerted on cell membrane functions, promoting nutrient uptake or plant growth and development, by hormone-like substances. In addition humates chelating capacity improves nutrient uptake. Humates have a complex and differentiated nature which contributes to their numerous benefits.– Nardi 2002
- Humic acids appear to affect membrane permeability, increasing permeability to some ions and decreasing it to others. This could be due to the surface activity of humic substances on cell membranes. Oxygen consumption increased by 23% in humic acid treated plants and by 34% in fulvic acid treated plants. Foliar applications increase oxygen uptake by plants.—Nardi 2002; Karr 2001





Humates improve soil biological activity which

- Holds more nutrients in soil
- Holds more water in soil
- Helps buffer sodium
- Provides competition for pathogens

SOIL SALINITY

The problem

- Soil salinity is a major agricultural problem - loss from salt affected farms is approximately $130m and rising.—DPI 2013

Solution - Research

- Under salt stress the first doses of both soil and foliar application of humic substances at 0.1% increased uptake of nutrients in wheat.—Asik 2003
- Humates reduced effect of salt by improving germination and growth of certain species of plants.—Masciandara 2002

Mechanism

- Humic acid increases the CEC of soil which means sodium and soluble salts are held by the soil rather than used by the plants
- Humus acid increases soil biological activity further buffering the effects of sodium.—Masciandaro 2002
- Humus acid improves soil structure which allows for drainage, keeping the salt below the prevailing root zone.—Tisdell and Oades 1982

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DEGRADED SOIL—HUMATES ADD SOIL ORGANIC MATTER

The problem

- Degraded soils - Most arable soils in the world suffer from serious problems of degradation due to high rates of runoff erosion. This high erosion has been attributed to (among other factors) depletion in soil organic matter from intensive mechanised tillage and over-exploitation.—Piccolo 1997
- Reduced aggregate stability in soils with continuous wetting and drying cycles result in increased slaking, reduced water infiltration rates, accelerated run-off erosion and reduced crop productivity.—Imbufe 2005
- Microbial populations depleted with degraded soil—Tahir 2010

Solution - Research

- Foliar applications of humic acids positively affects plant growth in degraded soil - increased root length, increases uptake of macro – and micro-nutrients and stimulates respiration, photosynthesis and protein nucleic acid synthesis, increased chlorophyll.—Celik 2011
- Humic acid treatment delayed the onset of runoff and favoured water entry through the stable inter- aggregate pore spaces within the soil bed. Soil loss reduced.—Piccolo 1997
- Research has shown it is the humic fractions (humic acid, fulvic acid & humin) of the soil organic matter that are responsible for the improvement of soil aggregate stability.—Imbufe 2005; Tahir 2010; Piccolo 1996
- In degraded soil microbial populations are compromised. Humates improve microbial growth which in turn improves productivity.—Tahir 2010; Karr 2001

Mechanisms

- Widely accepted increasing soil organic matter helps redress degraded soil. Lignite humates are cost effective way to improve soil organic matter as humates are highly reactive towards soil components (because of their content of functional acidic groups) and recalcitrant to microbial attack (due to presence of polycondensed aromatic structures).—Piccolo 1997
- Lignite carbon ie OFS humates remain in soil due to low decomposition rate and have an impact on the quantity and composition of the soil organic matter.—Tahir 2010

Improved soil structure in sandy soils in only 3 weeks by improving fungal growth

- Left - 2 treatments
- Centre - 1 treatment
- Right - no treatment

CALCAREOUS SOILS

The problem

- Calcareous soils - one of key factors that limit nutrient availability and agricultural production - common in Australia - unavailability of plant nutrients due to high pH and poor physical soil properties—Celik 2011; Tahir 2010
- Reduced aggregate stability in soils with continuous wetting and drying cycles result in increased slaking, reduced water infiltration rates, accelerated run-off erosion and reduced crop productivity.—Imbufe 2005

Solution - Research

- Under calcareous soil conditions foliar humic acid applications increased the uptake of elements against control and stimulated dry matter production of shoots.—Celik 2011
- Humic acid application enhanced wheat growth and nutrient uptake in both calcareous and non-calcareous soils. Best results with low rates.—Tahir 2010
- Potassium humates are effective as a soil conditioner in improving aggregate stability of acidic and sodic soils against adverse effects of cyclic seasonal wetting and drying conditions.—Imbufe 2005

Mechanisms

- Calcareous soils - multiple effects as soil organic matter / humus improves soil properties such as aggregation, aeration, permeability, water-holding capacity, solubilisation and availability for micro and macro elements. Humus also goes directly into plant tissue, resulting in various biochemical effects such as protein synthesis, photosynthesis and enzyme activity. As a foliar spray, it is thought humates improve growth by improving nutrient uptake.—Celik 2011

DROUGHT TOLERANCE - MOISTURE MANAGEMENT

The problem

- Moisture management is a major issue in agriculture

Solution - Research

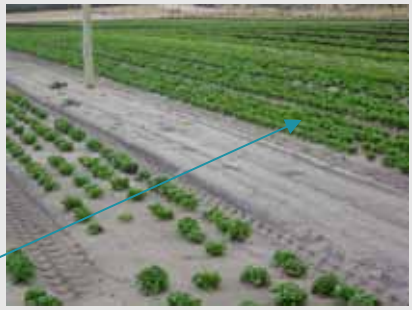
- Spraying fulvic acid increased yield of wheat in dry conditions to 97% of the irrigated control. In semi-arid conditions, foliar application with humic acid stimulated shoot and root growth, improved resistance to environmental stress, increased leaf water retention and photosynthetic and antioxidant metabolism.—Celik 2011
- Humic acid treatment delayed the onset of runoff and favoured water entry through the stable inter-aggregate pore spaces within the soil bed. Soil loss reduced.—Piccolo 1997
- Potassium humates are effective as a soil conditioner in improving aggregate stability of acidic and sodic soils against adverse effects of cyclic seasonal wetting and drying conditions.—Imbufe 2005
- Humates increased the nutrient uptake of green peppers and led to an increase in the content of proteins and other substances in the plants. It helped reduce the content of nitrates in plant tissues and made the green peppers more resistant to unfavourable environmental conditions.—Varga 2003
- Drought tolerance—multiple studies show drought stressed crops suffer less with humates compared to irrigated control eg wheat 3% yield loss with fulvic acid compared to 30% loss with control plants for wheat.—Karr 2001

Mechanisms

- Improves moisture holding capacity of most soils. Sandy soils have low ability to hold nutrients as open structure. Humates provide a charged surface to hold moisture. In clay, humates penetrate clay particles and prevent them sticking together. This keeps clay particles apart so that water can easily penetrate.

Tomatoes growing strongly & flowering
7 days after severe heat stress.
13% yield increase
(Program included Humus 26,
Super Kelp & Fish Emulsion)

Improved germination with lettuce with
Humus 26 at 10L/ha



SOIL ACIDIFICATION

The problem

- Soil acidification is a major concern in Australia - when soil pH drops, aluminium becomes soluble limiting plants access to soil water and nutrients.—Noble 1995
- Broadcast applications of lime to the surface have proved to be ineffective in ameliorating subsurface acidity in the short term. .– Noble 1995.
- Acidification accelerated by ammonium based fertilisers leaching away from root zone

Solution - Research

- Soil acidification - humates improved Ca uptake with gypsum.— CSIRO - Yamaguchi 2004
- Acidic soils - humates improved Calcium uptake with liming and significantly improved the downward movement of Ca. Humates also decreased levels of toxic Al and Mn. Al toxicity in acidic soils - humic substances can form stable complexes with Al, thereby lowering the activity of Al.—Noble 1995

Mechanism

- Soil Acidity - humic substances can form stable complexes with Al, thereby lowering the activity of Al. Noble 1995 showed the decrease in exchangeable Al was achieved by exchanging adsorbed Al for Ca and then removing it from the soil solution. This occurred in part through precipitation as a solid phase within the column due to increased soil solution pH. In addition Al was removed from the soil column in the leachate and it is speculated this was due to complexation by inorganic sulphate and to a lesser degree organic ligands.—Noble 1995

Contact us for copies of all references

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