Introduction to

HUMIC ACID IN AGRICULTURE
The importance of soil

Soil is the most important resource a farmer has.

“A nation that destroys its soils destroys itself.”
Franklin D. Roosevelt

Healthy soil is the foundation of the food system. It produces healthy crops that in turn nourish people.

Maintaining a healthy soil demands care and effort from farmers because farming is not benign.

By definition, farming disturbs the natural soil processes including that of nutrient cycling - the release and uptake of nutrients.
The importance of soil

Plants obtain nutrients from two natural sources:

1. organic matter
2. minerals

Organic matter includes any plant or animal material that returns to the soil and goes through the decomposition process. In addition to providing nutrients and habitat to organisms living in the soil, organic matter also binds soil particles into aggregates and improves the water holding capacity of soil. Most soils contain 2-10% organic matter, however even in small amounts, organic matter is very important.
The importance of soil

Soil is a living, dynamic ecosystem. Healthy soil is teeming with microscopic and larger organisms that perform many vital functions including converting dead and decaying matter as well as the minerals to plant nutrients.

Different soil organisms feed on different organic substrates. Their biological activity depends on the organic matter supply.
The importance of soil

Nutrient exchanges between organic matter, water and soil are essential to soil fertility and need to be maintained for sustainable production purposes. Where the soil is exploited for crop production without restoring the organic matter and nutrient contents whilst maintaining a good structure, the nutrient cycles are broken, soil fertility declines and the balance in the agro-ecosystem is destroyed.
The importance of soil

Soil organic matter content is a function of organic matter inputs (residues and roots) and litter decomposition. It is related to moisture, temperature and aeration, physical and chemical properties of the soils as well as the bioturbation (mixing by soil macrofauna), leaching by water and humus stabilisation (organomineral complexes and aggregates). Land use and management practices also affect soil organic matter.
The importance of soil

Farming systems have tended to mine the soil for nutrients and to reduce soil organic matter levels through repetitive harvesting of crops and inadequate efforts to replenish nutrients and restore soil quality.

This decline continues until management practices are improved or until a fallow period allows a gradual recovery through natural ecological processes. Only carefully selected diversified cropping systems or well-managed mixed crop-livestock systems are able to maintain a balance in nutrient and organic matter supply and removal.
Soil Facts

• Damage to UK soil is estimated to cost £1.2 billion a year - Farm Business 23.08.16

• 75% of UK topsoil has disappeared in the last 150 years - UK Committee on Climate Change (CCC)

• "Failure to prevent soil degradation could lead to increased flooding, lower food security and greater carbon emissions" - House of Commons report June 2016

• It takes 500 years to make 2.5 cm of topsoil - DEFRA

• About 300,000 ha of soil are contaminated as a result of the UK’s Industrial past - EAC
The UK Soil Association has suggested a 7 point plan to improve the UK’s soils:

1. Increase the amount of plant and animal matter going back into fields.
2. Improve soil health monitoring across the UK.
3. Encourage soil organisms - both those that build up soil and those that release nutrients.
4. Cover up bare soil with continuous plant cover
5. Grow more trees on farmland
6. Reduce soil compaction from machinery and livestock
7. Design crop rotations to improve soil health
EU Common Agricultural Policy

The UK Government has linked soil protection to farm subsidy payments due under the CAP.

As part of the “Cross Compliance” process there are now published Soil Protection Standards.

It seems clear that soil conservation will be an important part of farming policy for the foreseeable future.
Organic Matter is critical to:

1. **Structure** - helps reduce compaction & waterlogging
2. **Nutrient availability**
3. **Crop root development**
4. **General health of the Rhizosphere**
Soil Organic Matter

LIVING ORGANISMS
Soil engine

PARTIALLY DECOMPOSED
PLANT AND ANIMAL RESIDUES

UNALTERED MATERIAL
Potential food of organisms

TRANSFORMED PRODUCTS

NON-HUMIC SUBSTANCES
Food and energy
‘Glue of the soil’

HUMIC SUBSTANCES
Nutrient bank
Buffer

Source: FAO
The importance of soil flora and fauna

A cup of soil contains...

- **Microflora or ‘microbes’**
  - Bacteria = 200 billion
  - Fungi = 100,000 metres

- **Microfauna**
  - Protozoa = 20 million
  - Nematodes = 100,000

- **Macro and mesofauna**
  - Arthropods = 50,000
  - Earthworms = <1

Source: Colorado State University Extension Service
The importance of soil flora and fauna

Macro-organisms

Earthworms, centipedes, insects, collembola, etc.
Break up the coarse organic matter and improve soil structure

Microflora or ‘microbes’

Bacteria, fungi, protozoa, nematodes etc.
Use N and C from the organic matter and decompose it to restore it into humus and mineral elements.

Microfauna

Algae, mycorrhizae, lichens
Contribute to the recycling of nutrients.
What is Humus?

Humus or humidified organic matter is the remaining part of organic matter that has been used and transformed by any different soil organisms. It is a relatively stable component formed by humic substances, including humic acids, fulvic acids, hymatomelanic acids and humins (Tan, 1994).

The term acid is used to describe humic materials because humus behaves like weak acids. Fulvic and humic acids are complex mixtures of large molecules. Humic acids are larger than Fulvic acids. Research suggests that the different substances are differentiated from each other on the basis of their water solubility.
What is Humus?

Humus is the stable organic fraction of the soil that absorbs and holds nutrients in a plant-available form.

Humus in the soil consists of different humic substances:

- **Fulvic Acids:** the fraction of humus that is soluble in water under all pH conditions. Their colour is commonly light yellow to yellow-brown.

- **Humic Acids:** the fraction of humus that is soluble in water, except for conditions more acidic than pH 2. Common colours are dark brown to black.

- **Humins:** the fraction of humus that is not soluble in water at any pH and that cannot be extracted with a strong base, such as sodium hydroxide (NaOH). Commonly black in colour.
What are Humates?

The common term ‘humic acid’ is often used to describe commercial products that contain humic acids, fulvic acids, humins (in some cases), and minor minerals.

Such a product is more correctly known as a HUMATE.

We use the term ‘humate’ in this sense throughout this presentation.
Where does Humic Acid come from?

- Humic Acid comes from Leonardite which is a type of soft brown coal.
- It is usually found associated with lignite coal deposits.
- Leonardite has been produced over millions of years in the same way as coal, and contains all the natural products from prehistoric plant life.
- Humic and Fulvic acids can be extracted chemically from Leonardite by chemical extraction - known as alkaline hydrolysis.
- It can also be micronized directly to form pure extracted product – Viskofof Black.
Humates in agriculture

Humates are recognised by many in the sustainable agriculture movement as one of the most productive inputs available to growers.

- Humates are rich in both organic and mineral substances essential to plant growth.
- They have the ability to chemically bond with nutrients in the soil for increased absorption by the plant.
- They increase the permeability of plant cells which has been shown to both increase nutrient uptake and decrease stress on plants throughout the growing season.
Humates in agriculture

- Humates can be soil applied.
- Soil application improves nutrient uptake and plant development.
- Repeated long-term applications increase the soil health of the field.
- Humates can also be foliar applied to boost crop growth.
- Foliar application increases stress resistance.
How do Humates benefit the soil?

- Improve the physical soil structure.
- Increase the “nutrient bank” in the soil.
- Increase water retention during periods of drought:
  - Prevents water and nutrient losses in light, sandy soils.
  - Increases aeration and water infiltration in clay soils.
- Bind insoluble metal ions, oxides and hydroxides, making them available and slowly releasing them to the roots.
- Stabilise and assist in degradation of toxic substances such as nicotine, aflatoxins, antibiotics and most organic pesticides.
Humic Acid in Soil

PHYSICAL ACTION
a) Improves the soil structure
b) Facilitates the flocculation of clays
c) Increases the porosity (aeration, water circulation, better root growth)
Humic Acid in Soil

**CHEMICAL ACTION**

a) Increases the cation-exchange capacity (C.E.C.) - therefore, increase in the potential to create mineral reserves.

b) Improves absorption of nutritional elements by the formation of stable and soluble complexes, providing:
   - Good solubility in the circulating soil solution (better absorption by crops)
   - Stability at a wide range of pH values of the irrigation water and soil.
   - Complexation of the elements (trace elements and phosphorus)
How do soil applied Humates benefit crops?

- Improved fertilizer efficiency; long life N e.g. urea performs 60-80 days longer.
- Improved nutrient uptake particularly of P and Ca.
- Stimulation of beneficial soil life.
- Organic humates are a catalyst for increasing soil C levels.
Root Development

The early development of the crop roots is essential to good establishment, stress resistance and ultimate yield.

Root development depends mainly on:

- Humic acids
- Fulvic acids
- Cytokinins
- Certain amino acids
- Organic matter of vegetable origin

A healthy soil rhizosphere is essential for healthy root development.
Cation exchange capacity

- The quality of organic matter in the soil affects the Cation Exchange Capacity.
- Humates complex metal ions and make them more available to the plant roots.
- Adding Humates to soil can increase the Cation Exchange Capacity.
- This can significantly increase nutrient uptake.
How does FOLIAR applied Viscofol Black benefit crops?

- Stimulates general nutrient uptake by the plant resulting in bigger, healthier and higher yielding crops.
- Helps the crop resist stress factors including pesticide induced stress.
- Acts as a natural chelator by enhancing the availability of iron, thus increased photosynthesis and sugar production translating into increased storage for plant defence.
- Acts as a carrier for many pesticides - helping them enter the leaf quickly and efficiently.
- The low pH also improves the efficacy of many pesticides.
Key Benefits of applying Humic Acid

30 YEARS OF RESEARCH DOCUMENTS THE INFLUENCE OF HUMIC SUBSTANCES ON SOIL HEALTH, FERTILIZER AND WATER-USE EFFICIENCY

Mir M Seyedbagheri

ABSTRACT
“In continuation of my 30 years of on-farm studies on soil organic matter from different humates and compost, I have documented quantitative improvements in soil health and water-use efficiency. Research trials were established to evaluate the efficacy of different commercial humates products derived from Leonardite (highly oxidized lignite) in crop production. Data from humic acid (HA) trials showed that different cropping systems responded differently to different products in relation to yield and quality. The consistent use of good quality products in our replicated plots resulted in a yield increase from 6% to 30% over several decades”.

Published by the University of Idaho 2015 (www.uidaho.edu)
Early research on soybean found a significant increase in root dry matter after the roots and shoots were exposed to humic acid and fulvic acid. Nodule weight was also increased but the number of nodules was inversely related to increasing amounts of humic acid.

Stimulation of root and shoot growth by humic acid was also reported in corn (maize). They reported an increase in branching and root hair development of corn roots when plants were grown in a nutrient solution containing humic acids.

Similar results were reported on tobacco roots.

“Root proliferation is a benefit from applications of humic and fulvic acids at low concentrations. These stimulatory effects also have been directly correlated with enhanced uptake of nitrogen, phosphorus, sulfur, zinc, and iron”.

David Wright and Andy Lenssen, Department of Agronomy, Iowa State University
Trials Evidence

USING HUMIC COMPOUNDS TO IMPROVE EFFICIENCY OF FERTILISER NITROGEN

Phillip Schofield (1), Nicky Watt (2) and Max Schofield (3)

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We have been evaluating the use of humic compounds applied with nitrogen fertiliser at Cloverdale Holdings a 730 Ha, 2900 cow dairy unit near Ashburton since December 2009. The trial work has consisted of half paddock (6 ha) plots where treatments have been applied in conjunction with regular fertiliser applications on the farm. Pasture dry matter production was assessed by cutting 4 x 0.5 square metre sample areas at each harvest date for each treatment.

Granular urea was applied on its own at a rate of 30kgN/Ha or with 3 kg/ha of soluble humic acid granules. We recorded between 3% and 12% greater dry matter production where soluble humic acid was included with granular urea applications.

We compared applications of granular urea with liquid fertiliser consisting of dissolved urea, bio-stimulants and humic compounds. The comparison of dry matter production per unit of nitrogen fertiliser applied showed that dissolved urea with humic compounds and bio-stimulants produced approximately three times more dry matter per unit of applied nitrogen than solid urea applications.

When dissolved urea was applied either on its own, or with the addition of humic compounds and bio-stimulants, we found 12.5% greater dry matter was achieved by adding humic compounds and bio-stimulants to dissolved urea applications.
Trials Evidence

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These results have significant implications for farmers using nitrogen fertiliser and trying to minimise leaching of nitrates. Liquid or foliar applications of nitrogen fertiliser with the inclusion of humic compounds have been shown to be a more efficient method of applying nitrogen to pastures than the use of granular urea applications. Based on these trials it can be seen that pasture dry matter production can be maintained using only one third of the nitrogen fertiliser inputs using foliar application to pasture covers of 1800 to 2000 kg/ha DM.

“With the current, increasing need to reduce N leaching from farms the use of humic compounds with solid nitrogen fertilisers will allow pasture production to be maintained when fertiliser applications are reduced by 10% or more. When a foliar nitrogen fertiliser programme that includes humic compounds is employed, pasture production can be maintained using one third of the solid fertiliser quantity”.

G C i C
Summary

Key Benefits of applying Humic Acid

- Better crop establishment
- Healthier plants
- Increased stress resistance
- Better quality
- Healthier soil
- Improved fertilizer efficacy
- Higher yields
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