# WHAT ARE HUMIC ACIDS

## AND THEIR SOURCES?

HUMIN TECH®
HUMIC SUBSTANCES BASED PRODUCTS

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# 1. HUMIC MATTER

Humic matter is formed through the chemical and biological humification of plant and animal matter *(pic.1.1)* and through the biological activities of micro-organisms.

*Picture 1.1* – Typical vegetation of the Tertiary period.

The best source of humic acids are the sedimentation layers of soft brown coal, which are referred to as Leonardite. *(pic.1.2, pic.1.3)* Humic acids are found in high concentration here.

*Picture 1.2* – Remains of a sequoia trees of the Tertiary period *(found in the coal-mine Donatus,West Germany in 1907)*.

*Picture 1.3* – Examination of a coalbed at the lignite mining strip site Garzweiler II, Germany.

INDICATION OF THE SOURCE:

*Pic. 1.1 – Fotolia.*

*Pic. 1.2 – RWE.*

*Pic. 1.3 – Fotolia.*

The biological center, the main fraction of natural humic matter, are the humic acids, which contain humic acid and fulvic acid. *(fig.1.1, pic. 1.4, 1.5,)* Humic acids are an excellent natural and organic way to provide plants and soil with a concentrated dose of essential nutrients, vitamins and trace elements. They are complex molecules that exist naturally in soils, peats, oceans and fresh waters.

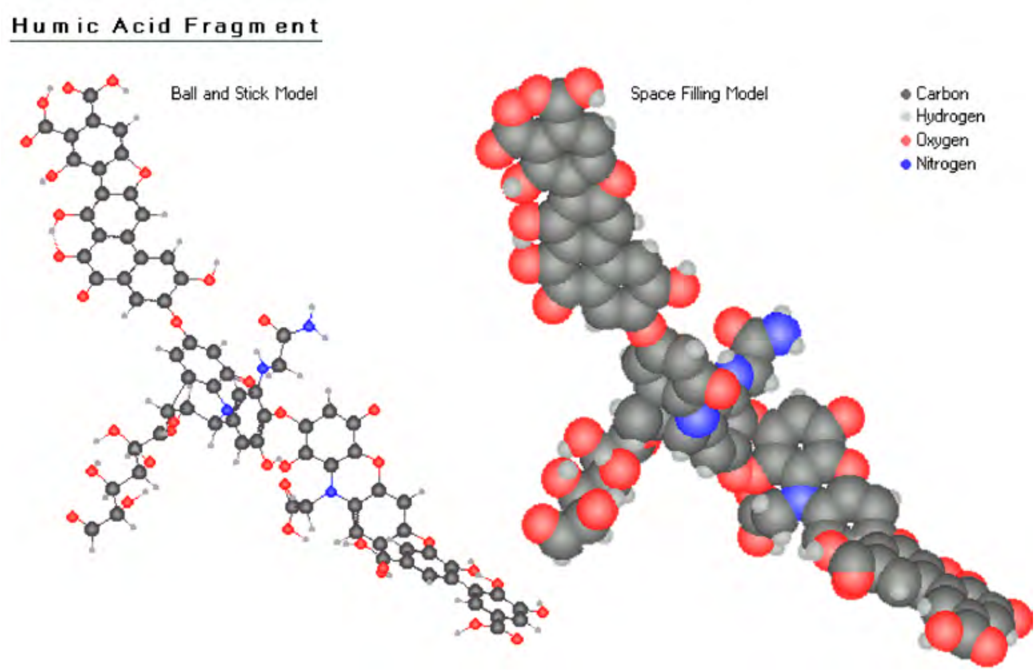
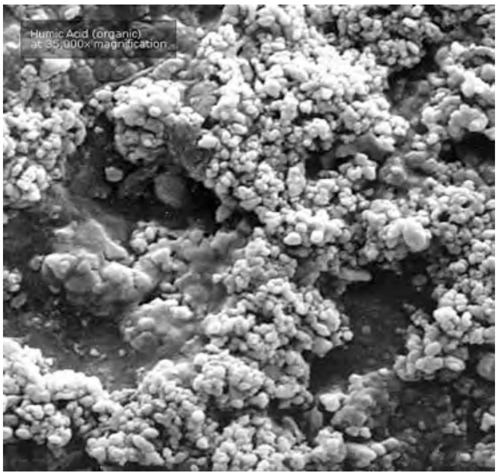
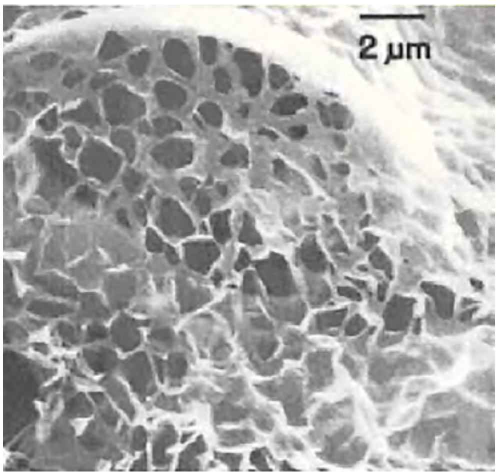



*Figure 1.1 –* Humic Acid Fragment.




*Picture 1.4 –* Humic Acid *(organic)* at 35,000x magnification.




*Picture 1.5 –* Humic / Fulvic Acid.

INDICATION OF THE SOURCE:

*Fig. 1.1 – Own representation. (Copyright © Humintech 2000)*

*Pic. 1.4 – Own representation. (Copyright © Humintech 1999)*

*Pic. 1.5 – Own representation. (Copyright © Humintech 2000)*

Leonardite is organic matter, which has not reached the state of coal and differs from soft brown coal by its high oxidation degree, a result of the process of coal formation *(bog → peat → coal)*, and high humic acid content as well as higher carboxyl groups. *(Fig. 1.2)* shows the chemical extraction of leonardite.

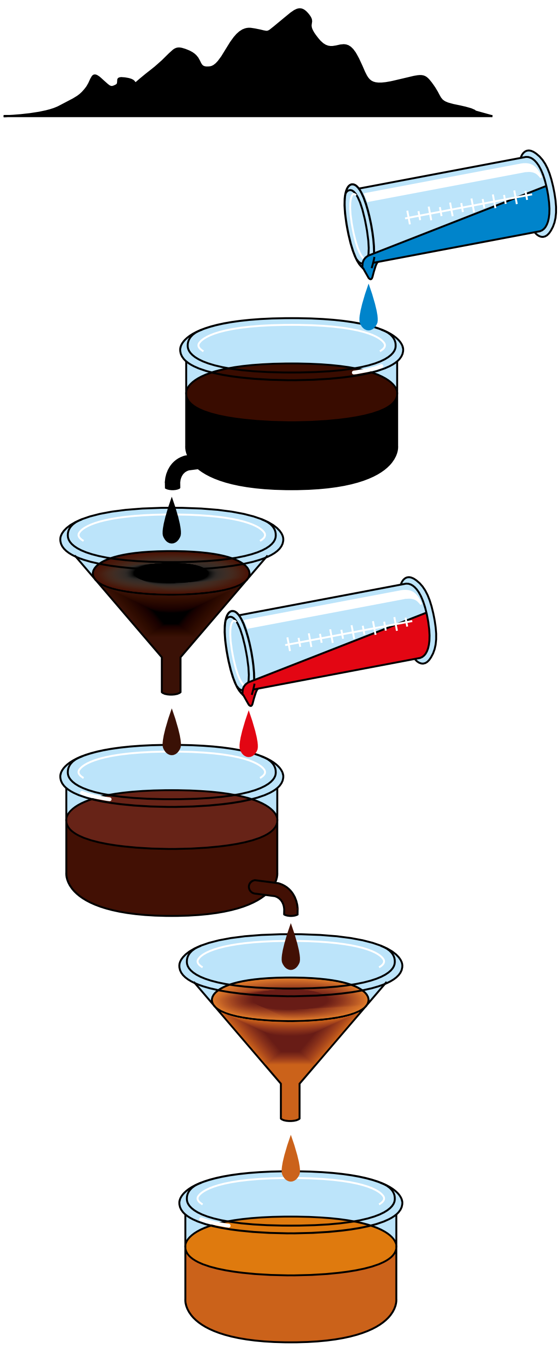


*Figure 1.2 –* Isolation of humic acid and fulvic acid by Achard *(1786)*.

**INDICATION OF THE SOURCE:**

*Fig. 1.2 – Own representation. (Copyright © Humintech 2002)*

*(Figure 1.3)* shows the formation of coal *(lignite)* to Leonardite and its basic extraction to obtain water-soluble humic acids. *(Rausa et al.)*.

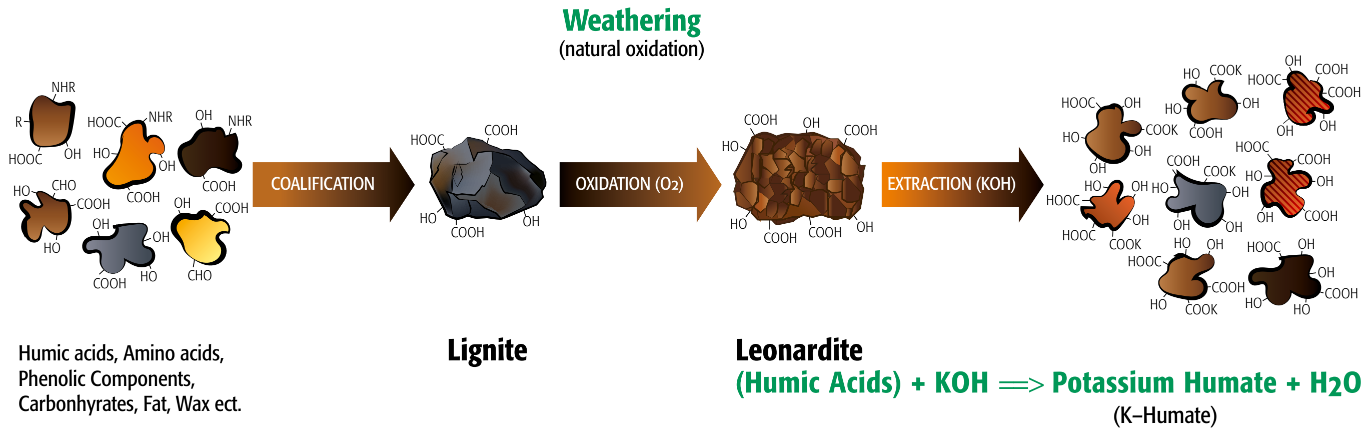



*Figure 1.3 –* Coal oxidation according to Rausa et al.

According to contemporary of view, Humus does not consist of long-chained humic substances *(Fig 1.4 A)*, but of short-chained chemical substances of different kind *(Fig 1.4 B)*, which build aggregates with cations *(yellow)* and clay particles: polysaccharides *(blue)*, polypeptides *(green)*, aliphatic groups *(e.g. fats) (bordeaux)*, aromatic lignin fragments *(brown)* *(source: Simpson et al., 2002)*.

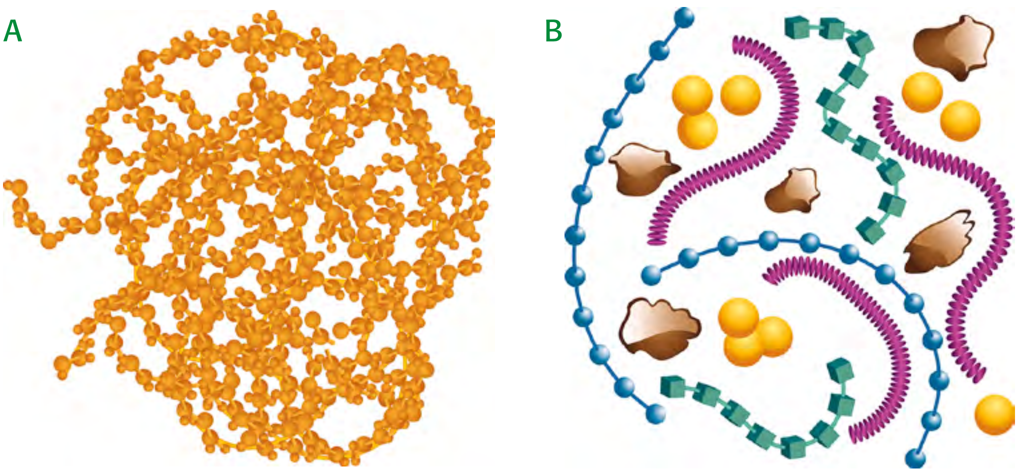



*Figure 1.4 –* Long chained *(A)* and short chained *(B)* humic substances.

**INDICATION OF THE SOURCE:**

*Fig. 1.3 – Own representation. (Copyright © Humintech 2018)*

*Fig. 1.4 – Own representation. (Copyright © Humintech 2018)*

Compared to other organic products, Leonardite is very rich in humic acids. While Leonardite is the end product of a humification process lasting 70 million years, the formation period of peat, for instance, is completed within only a few thousand years.

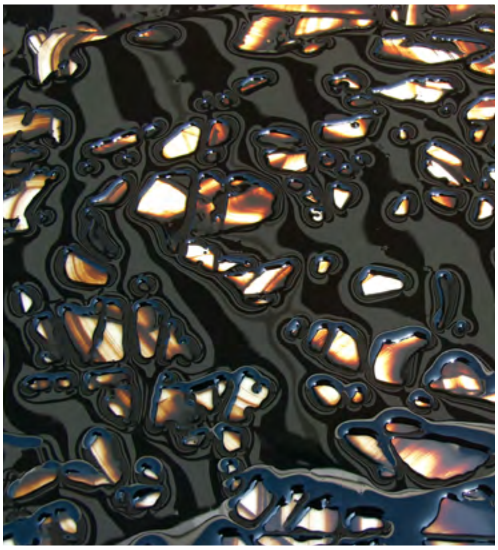
Therefore, Leonardite and other sources of humic acids differ in their molecular structure, which elucidates the extremely bioactive properties of Leonardite. This biological activity is about five times stronger than other humic matter. One kilogram of Leonardite corresponds to about five kilogram of other organic sources of humic acids.

INDICATION OF THE SOURCE:

*Fig. 1.5* – *Own representation. (Copyright © Humintech 2018)*

*Figure 1.5* – Coal formation: *(from bog via Lignite to coal)*.

In terms of humic acid content, one liter of **LIQHUMUS**® *(liquid concentrate, pic. 1.6, 1.7)* is equivalent to 7–8 metric tons of organic manure.



*Picture 1.6 –* Liquid concentrate of water-soluble humate.


*Picture 1.7 –* **LIQHUMUS18**®.

INDICATION OF THE SOURCE:

*Pic. 1.6 – Own representation. (Copyright © Humintech 1999)*

*Pic. 1.7 – Own representation. (Copyright © Humintech 1999)*

*Pic. 1.8 – Own representation. (Copyright © Humintech 1999)*

*Pic. 1.9 – Own representation. (Copyright © Humintech 1999)*

Similarly, one kilogram of **POWHUMUS**® *(concentrated powder, pic. 1.8, 1.9)* is equivalent to about 30 metric tons of manure. However, Leonardite is not a fertilizer.

*Picture 1.8 – Picture 1.8 –* Concentrated powder of potassium humate.


*Picture 1.9 –* **POWHUMUS18**®.

HUMIN TECH HUMIC SUBSTANCES BASED PRODUCTS

Leonardite acts as a conditioner for the soil and as a biocatalyst and biostimulant for the plant. *(pic. 1.10)* Compared to other organic products, Leonardite enhances particularly plant growth *(biomass production)* and fertility of the soil.

Another advantage of Leonardite is its long-term effectiveness, as it is consumed as quickly as animal manure, compost or peat. As Leonardite is a degradation product, it does not enter into nutritional competition with plants for nutrients such as nitrogen. This is not the case with incompletely decomposed compost, whereby the organic substances in soil are rapidly consumed up by micro organisms and mineralized entirely without humus formation.

*Our Leonardite-based products improve the soil structure up to five years.* ■


***Picture 1.10*** – Development of root system of Tomato plant with Liqhumus *(right)* and with water only *(left)*.

INDICATION OF THE SOURCE:

*Pic. 1.10 – Own representation. (Copyright © Humintech 2017)*

# 2. BENEFITS OF HUMIC ACIDS

Current scientific studies show that the fertility of soil is determined to a very large extent by the content of humic acids. Their high cation-exchange capacity *(CEC)*, the oxygen content as well as the above average water holding capacity are the reasons for the high value of using humic acids for improving soil fertility and plant growth.

The most important feature of humic acids is their ability to bind insoluble metal ions, oxides and hydroxides, and to release them slowly and continually to plants when required. Due to these properties, humic acids are known to produce three types of effects: physical, chemical and biological.

## 2.1 . Physical Benefits:

Humic acids physically modify the structure of the soil. They...

- Improve the structure of soil: Prevent high water and nutrient losses in light, sandy soils. Simultaneously convert them into fruitful soils by way of decomposition. In heavy and compact soils, aeration of soil and water retention are improved; cultivation measures are facilitated.
- Prevent soil cracking, surface water runoff and soil erosion by increasing the ability of colloids to combine.
- Help the soil to loosen and crumble and thus increase aeration of soil as well as soil workability.
- Increase water holding capacity of soil and thus help resist drought.
- Darken the color of the soil and thus help absorption of the sun energy.

## 2.2. Chemical Benefits:

Humic acids chemically change the fxation properties of the soil.

- Neutralize both acid and alkaline soils; regulate the pH-value of soils.
- Improve and optimize the uptake of nutrients and water by plants.
- Increase buffering properties of soil.
- Act as natural chelator for metal ions under alkaline conditions and promote their uptake by the roots.
- Rich in both organic and mineral substances essential to plant growth.
- Retain water soluble inorganic fertilizers in the root zones and reduce their leaching.
- Possess extremely high cation-exchange capacities.
- Promote the conversion of nutrient elements *(N, P, K + Fe, Zn and other trace elements)* into forms available to plants.
- Enhance the uptake of nitrogen by plants.
- Reduce the reaction of phosphorus with *(Ca, Fe, Mg and Al)* and liberate it into a form that is available and beneficial to plants. The productivity of particularly.
- Mineral fertilizers is increased considerably.
- Liberate carbon dioxide from soil calcium carbonate and enable its use in photosynthesis.
- Help to eliminate chlorosis caused by iron deficiency in plants.
- Reduce the availability of toxic substances in soils.

## 2.3. Biological Benefits:

Humic acids biologically stimulate the plant and the activities of microorganisms.

- Stimulate plant enzymes and increase their production.
- Act as an organic catalyst in many biological processes.
- Stimulate growth and proliferation of desirable micro-organisms in soil.
- Enhance plants natural resistance against disease and pest.
- Stimulate root growth, especially vertically and enable better uptake of nutrients. Increased root respiration and root formation.
- Promote the development of chlorophyll, sugars and amino acids in plants and support photosynthesis. Raise in vitamin and mineral content of plants.
- Thicken the cell walls in fruits and prolong the storing and shelf time.
- Increase in germination and viability of seeds.
- Stimulate plant growth *(higher biomass production)* by accelerating cell division, enhancing the rate of formation in root systems, which results in higher yield of dry matter.
- Improve the quality of yields, their physical appearance and nutritional value.

## Optimal Utilization of Nutrients

*Clay Humus Complex*

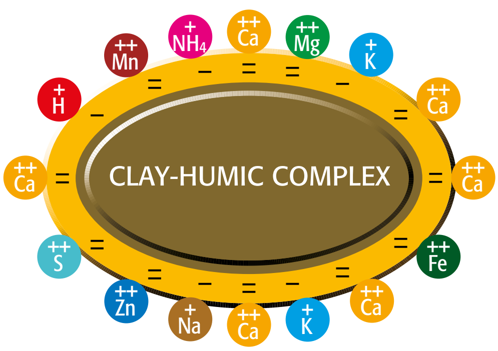



*Figure 2.1* – Increased nutrient deposit by humic acid.

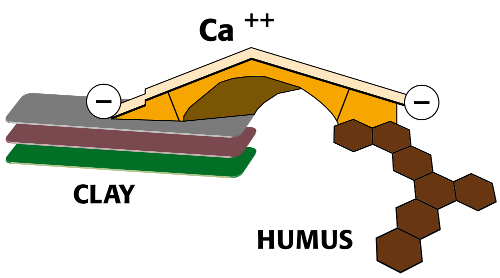



*Figure 2.2* – Ca-Bridge between clay and humus.

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*Fig. 2.1 – Own representation. (Copyright © Humintech 2001)*

*Fig. 2.2 – Own representation. (Copyright © Humintech 2001)*

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*Liebig's Law*

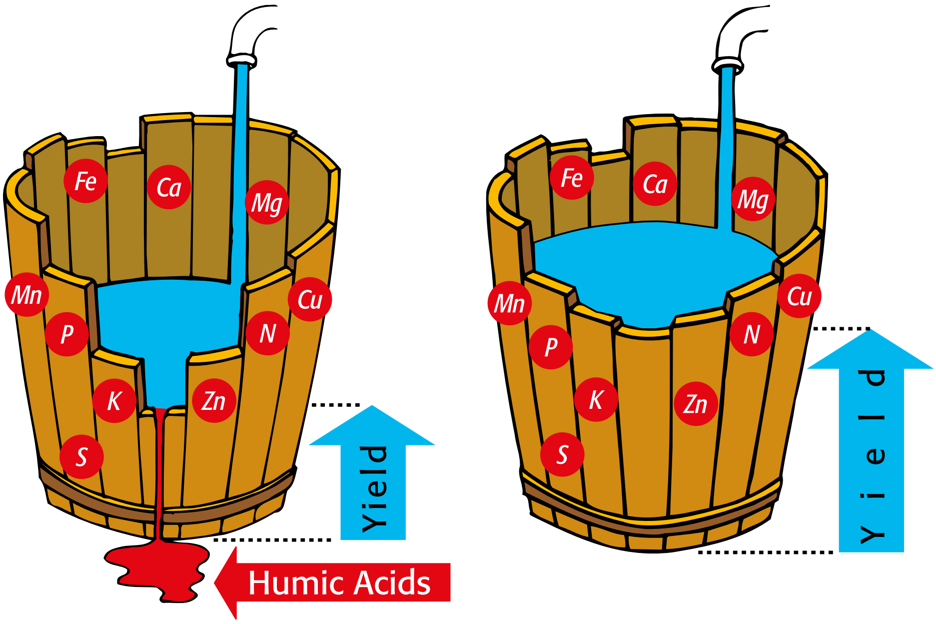


*Figure 2.3* – Growth is controlled by the scarcest resource.

## Effect in soils

*Compacted Clay Soils*

Humic acids aerate compacted soils and improve their structure. Thus water, nutrients and roots can penetrate the soil more easily *(s. fig. 2.4, 2.5, pic 2.3 Page 13)*.

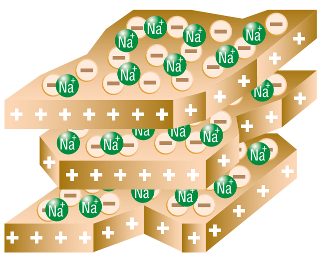

*Figure 2.4* – Compact, hardly penetrable soil structure.

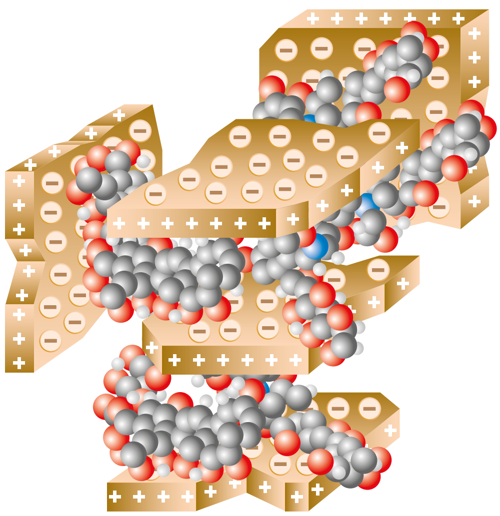

*Figure 2.5* – Humic acids aerate compact soils.

**INDICATION OF THE SOURCE:**

*Fig. 2.3 – Own representation. (Copyright © Humintech 2001)*

*Fig. 2.4 – Own representation. (Copyright © Humintech 2001)*

*Fig. 2.5 – Own representation. (Copyright © Humintech 2001)*

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*Light Sandy Soils*

In sandy soils, poor in humus, humic acid coats the sand particles, improves the cation exchange capacity *(CEC)* and increases the ability of the soil to retain nutrients and water. Therefore, nutrients *(particulary nitrate)* remain available for the plants *(s. fig. 2.6, 2.7, pic. 2.1, 2.2, 2.3)*.

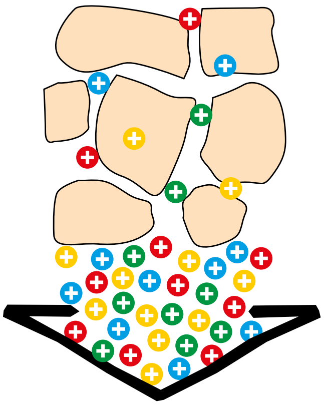


*Figure 2.6* – Sandy soils poor in humus can't retain nutrients.

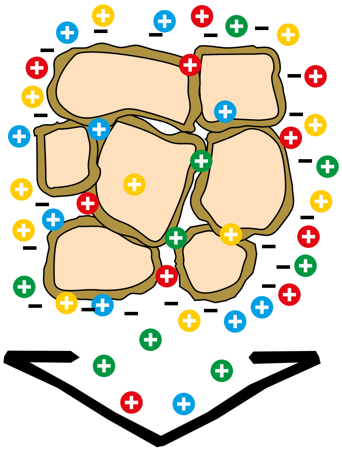
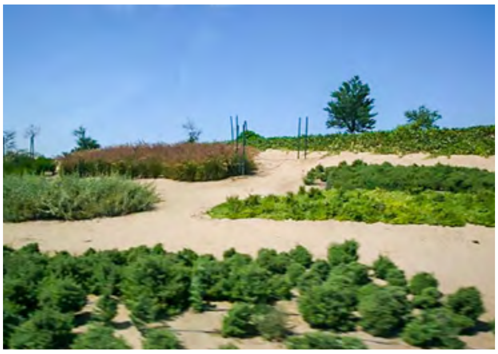


*Figure 2.7* – Effect of the cation exchange capacity to sandy soils.

*Picture 2.1* – Sandy soils without humic substance.



*Picture 2.2* – Greening with **PERLHUMUS**® **(HUMINTECH**® *GmbH)*.

*Picture 2.3* – Compacted clay soil without humic substance.

INDICATION OF THE SOURCE:

*Fig. 2.6* – *Own representation. (Copyright © Humintech 2000)*

*Fig. 2.7* – *Own representation. (Copyright © Humintech 2000)*

*Pic. 2.1* – *Own representation. (Copyright © Humintech 2002)*

*Pic.2.2* – *Own representation. (Copyright © Humintech 2002)*

*Pic. 2.3* – *Own representation. (Copyright © Humintech 2002)*

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*Salinized Soils*

Salts are split up by the high cation exchange capacity *(CEC)* of Humic acids. Cations *(e.g. Ca and Mg)* are bound and chelated. The high osmotic pressure within the root area is reduced *(s. fig. 2.8, 2.9, 2.10, pic. 2.4)*.

## Alcium concentration in the soil

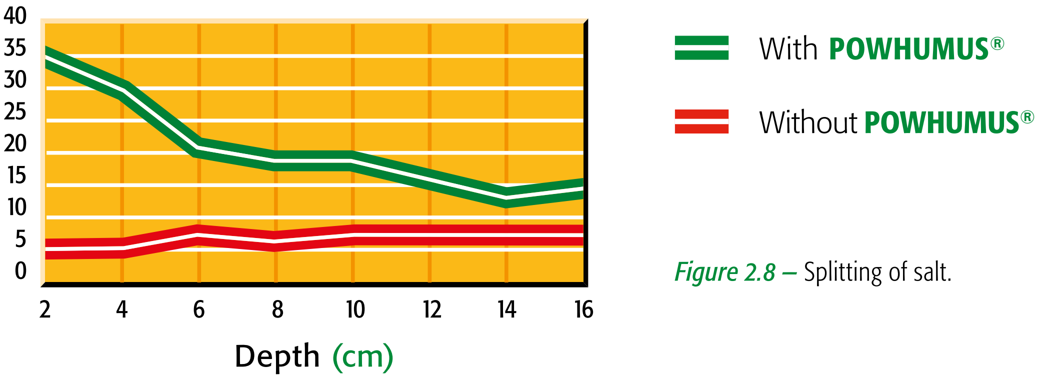


*Figure 2.8* – Splitting of salt.

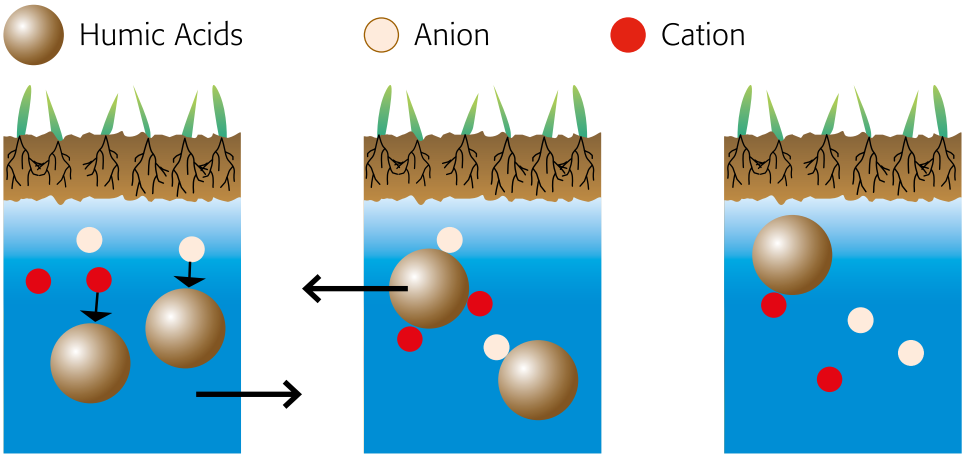


*Figure 2.9* – Humic acids reduce the effects of salinity.

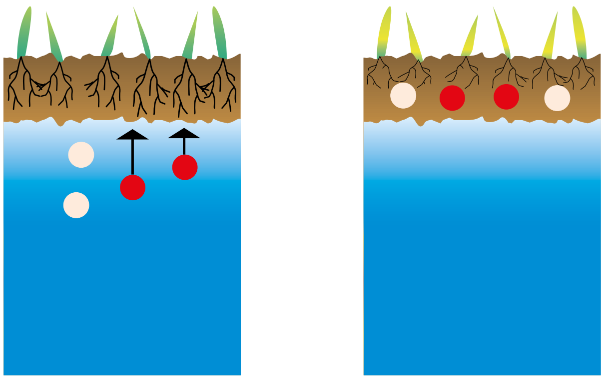

*Figure 2.10* – Salinized groundwater in a soil.

*Picture 2.4* – Highly Salinized soil.

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*Fig. 2.8 – Own representation. (Copyright © Humintech 2002)*

*Fig. 2.9 – Own representation. (Copyright © Humintech 2002)*

*Fig. 2.10 – Own representation. (Copyright © Humintech 2002)*

*Pic. 2.4 – Own representation. (Copyright © Humintech 2002)*

*Acidic Soils*

Due to their high buffer capacity humic acids neutralize acidic soils, which decimate acid caused stress in plant roots. Elements harmful for plants, especially aluminium and heavy metals, are bound firmly and immobilized by humic acids. Hence, their toxicity is reduced and phosphate bound by aluminium is released *(s. fig. 2.11,* *2.12 Page 16**)*.

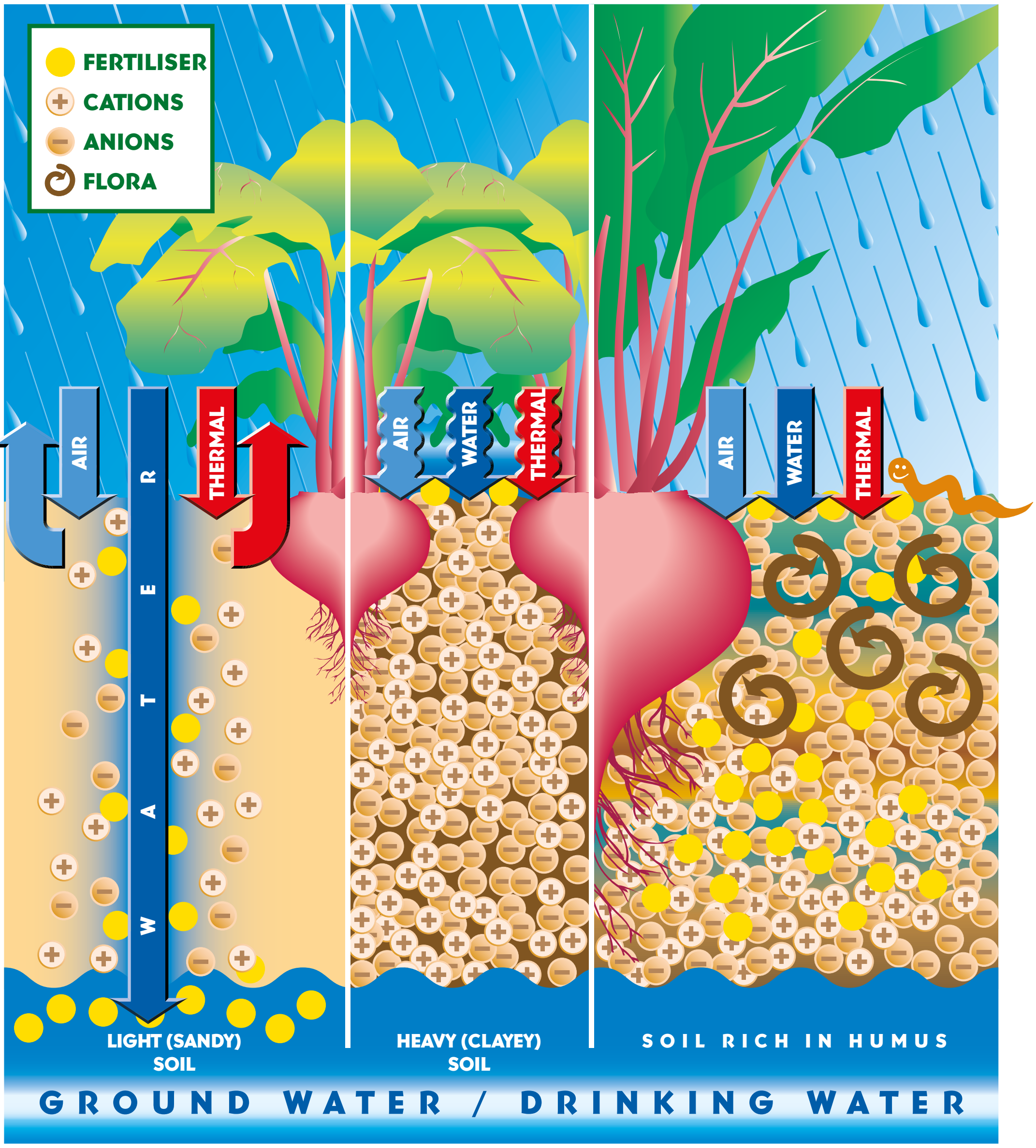


*Figure 2.11* – Comp. scheme of light sandy, heavy clayey and rich in humus soils

INDICATION OF THE SOURCE:

*Fig. 2.11 – Own representation. (Copyright © Humintech 2002)*

*Alkaline Soils*

Alkaline Soil As a result of the high pH value, many essential nutrients and trace elements are not in plant available form.

Humic acids buffer the high pH and convert nutrients and trace elements into plant receptible form by complexation. Phosphate bound by calcium is resolubilized and made available *(s. fig. 2.11 Page 15, 2.12)*.

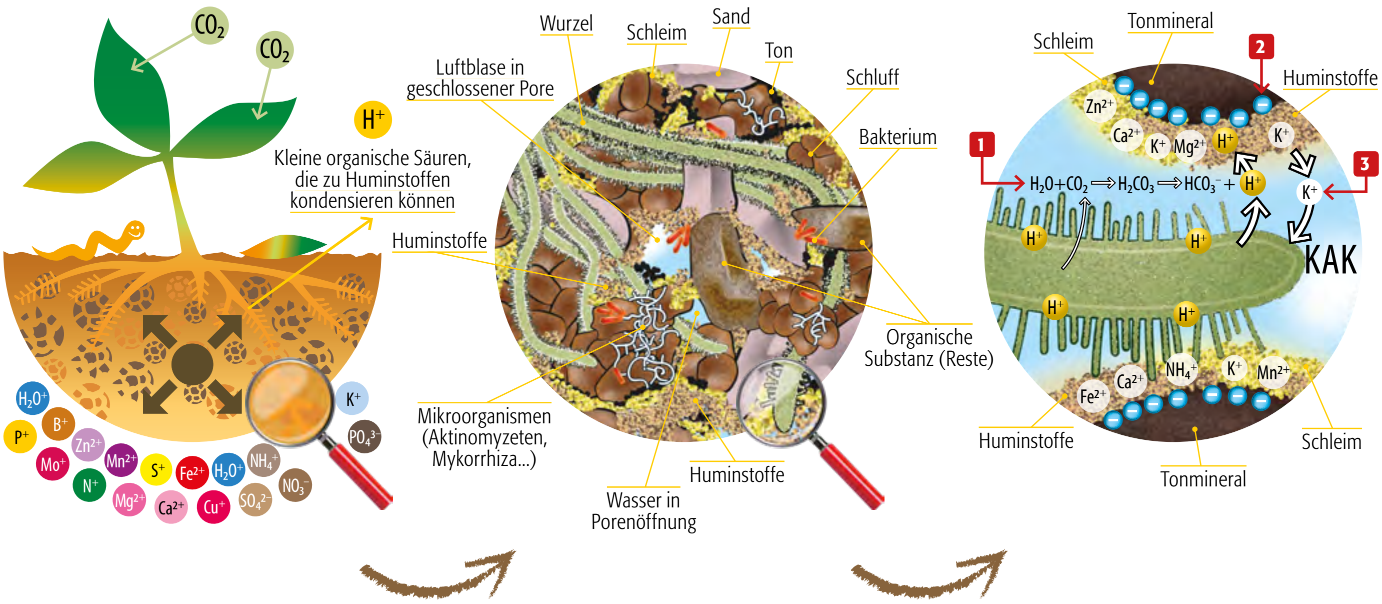


*Figure 2.12* – Humic acid opimizes the soil for the root development, e.g.nutrient uptake, soil aeration, water-holding caoacity, cation exchange capacity *(CEC)* and the formation of clay-humus-complexes.

1 Cation exchange of the various cations with protons *(H+)* from carbonic acid *$(H^2CO^3)$* or originating from the plant itself.
2 Binding of cations by negatively charged clay particles.
3 Release of mineral cations into the soil.

INDICATION OF THE SOURCE:

*Fig. 2.12 – Own representation.*

*Eroded Soils*

The addition of humic acids accumulates the organic matter in the topsoil. The erosion is effectively reduced by intensified root formation and stabilizing clay-humus complexes.

*Dry Soils*

Humic acids increase the ability of the soil to retain water. Thus, water is available for the plants in dry periods too. That way drought caused stress situations to the plants are avoided and the wastage of precious water is reduced.

*Pesticide, Herbicide, and Fungicide Charged Soils*

Humic acids raise the efficiency of pesticides, fungicides as well as herbicides and immobilize their harmful residues. ■

# 3. ECOLOGICAL BENEFITS OF HUMIC ACIDS

The ecological benefits of humic acids are diverse, present profitable and effective solutions for environmental problems along with the preservation of the environment.

***First of all,*** soils with a high content of humic acids are a guarantee for low nitrate leaching and for optimum nutrient efficiency. A well developed root system, which is achieved by a high content of humic acids, prevents that nitrate and pesticides mix in with ground water *(s.fig 3.1 Page 19)*. Futhermore, a low content of nitrate is an indicator and a prerequisite for appropriate organic agriculture.

It happens very often that growers use fertilizers more than plants can take up. This leads to nitrate concentration in soil, which is later to be found in ground water. As a result, this contaminated water can only be purified by a complex and expensive wastewater treatment process.

***Important:*** Instead of curing the symptoms *(water contamination)* only, the basic causes *(nitrate leaching)* need to be tackled.

***Secondly,*** humic acids reduce the over salination problem in the application of watersoluble mineral fertilizers. Humic acids are able to decrease high salt con-tents in soils and thus the resulting toxicities. Especially the NH4-toxicity of fertilizers containing ammonia is reduced, which is of great importance for young plants particularly.

Generally, humic acids reduce root burning which comes about through excessive salt concentrations in soils after fertilization; in case of permanent high levels of salt in soils, these are reduced. Furthermore, when humic acids are mixed with liquid fertilizers, the undesirable smell is diminished.

*Thirdly,* humic acids are an effective means to fight against soil erosion. This is achieved by increasing the ability of soil colloids to combine and by enhancing root system and plant development.

Leonardite and humate -based products are certificated for organic agriculture by renown organizations and institutions of agriculture worldwide *(s. fig 3.1)*. ■

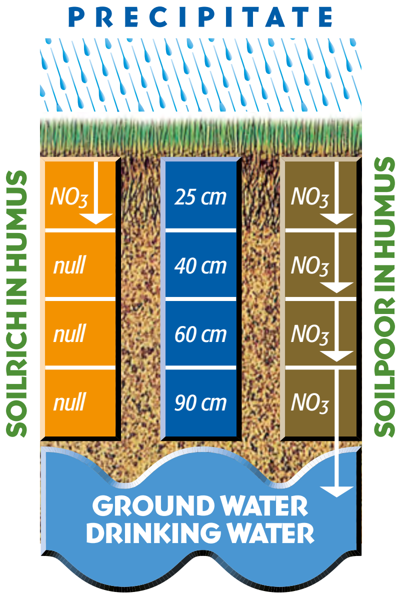


*Figure 3.1 –* Reduction of nitrate leaching

INDICATION OF THE SOURCE:

*Fig. 3.1 – Own representation. (Copyright © Humintech 2000)*

# 4. ECONOMIC BENEFITS OF HUMIC ACIDS

Humic acids chelate nutrient compounds, especially iron, to obtain a suitable formfor plant utilization in soli, so the nutrient supply of plants is optimized. High increases up to 70% in yield, accompanied by a reduction up to 30% in the use of fertilizers and pesticides, as well as better and healthier growth of green grass, ornamentals, agricultural crops and woods can be attained with the regular application of first-quality humic acids. Furthermore, water holding capacity of soils is increased considerably, which means that the use of water can be reduced substantially. Best economic results can be obtained in light and sandy soils poor in humus as well as on recultivation fields.

The diverse positive impacts of humic acids are to be observed particularly in such soils. This is true for almost all soils in dry and warm regions. As a result of the high mineralization rate of organic substances, providing these soils with stable humic acids is indispensable for the maintenance and improvement of soil fertility. ■

# 5. HUMINTECH

**HUMINTECH®** offers a variety of products which successfully fulfil the needs of different soil conditions and plants *(s. fig. 5.1)*. As a result, soils treated with **HUMINTECH®** products secure qualitative and quantitative increases in yield and reduce material and labor costs. Made of humic substances of the highest quality, **HUMINTECH®** extensive product line has been designed to suit the demands of a healthy community. ■

**INDICATION OF THE SOURCE:**

*Pic 5.1 – Own representation. (Copyright © Humintech 1974)*


*Figure 5.1 –* Some products of the **HUMINTECH®** product line

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