

## Preamble

There is an Australian invented manufacturing process which is able to grind ore-bodies down to a molecular level using a unique combination of high-speed vortices, pressure, and sound waves. Although designed initially to smash rocks, its potential applications have proved to be far wider.

One of the substances that became of interest was Victorian lignite (*'brown coal'*), initially with the objective of drying it - a job that the process does most efficiently, with the result that the now-dried lignite's thermal efficiency was shown to increase by something like 600%, thus creating a potential problem for existing power station plants which were not designed to withstand such a reduction in moisture. However, as a result of producing this dried lignite, some experiments were conducted to learn more about this now-transformed substance. The results obtained were not only remarkable, but also most exciting.

Thus the concentration on the possible future use of the process has been to explore the potential to use lignite in a manner far removed from its present application as an energy source alone. The result of this is summarised in the information to follow.

In short, there is for the first time a substance that deals with almost every known real pollutant in a totally organic way, and for which there appears to be no comparative product in the marketplace. The material has been approved at the highest level of efficacy by the U.S. Environmental Protection Agency.

The first users are likely to be some 150 power stations in the U.S. on standby to take the product immediately full-scale manufacturing commences as it will solve the present environmental regulatory problems they face under draconian new rules being imposed by the U.S. Government.

The product has been given a trade name of *'Shamantra'* and, because of its ability to deal with almost all hitherto intractable pollution problems, there is no question that the real problem will be in meeting the much larger market demand for the product once it becomes known beyond its bio-remediation and power station applications.

## Introduction

Molecular Mediation has designed and developed a range of unique and revolutionary products which have never before existed, and which provide solutions for problems which have never before been solved. The markets for these new products are immense and insatiable. They have applications in numerous industries including the Agriculture, Power, Oil & Gas, Military, Pollution Control and Health industries.

They have the ability to remove and remediate most of the pollution and contamination which exists in the world today and also to replenish depleted soils, farmland and arid areas, to such an extent that produce from these areas will be returned to their original quality and nutritional values from earlier centuries.

The products are all 100% organic, that is, completely natural, non-chemical, non-toxic and non-harmful. They are unique because they are produced by a new proprietary, patent-pending technology and they are revolutionary because they deliver exceptional results which have never before been possible on a large scale.

## Background

A massive worldwide market exists for products and solutions that can clean-up, remedy, improve, treat, sequester, remove, convert and/or eliminate air, ground and water contamination and pollution caused by industry. The most common forms of air and ground pollution are Polychlorinated Biphenyls (PCBs), Heavy Metals, Radionuclides, Hydrocarbon Oils and from burning or combusting Carbons and Hydrocarbons.

## 'The Solution to Pollution'

The Molecular Mediation range of products provides comprehensive, viable and economic solutions to address and solve these problems. By utilizing an ingenious technology known as "Aeroacoustics", Molecular Mediation has created a brand new material by subjecting organic lignite to this unique process. The new product has been branded as "Shamantra". It is hydrophobic, oleophilic and has an extraordinary propensity to absorb hydrocarbon gasses and oils, and other contaminants, at an absorption rate of up to 30:1.

Once absorbed, crude oil and contaminants like carbon dioxide/monoxide will not ever leach again, even if placed under pressure. The absorbed contaminants agglomerate and break down by natural biodegradation. Hydrocarbon oils will break down into smaller organic molecules such as fatty acids, amino acids and sugars, which becomes part of the natural food chain. Carbon and hydrocarbon gasses and will break down into pure carbon and oxygen in the lignite matrix, to form an exceptional, high quality fertilizer.

A range of *Shamantra* products will be produced in various forms, each designed for specific purposes and individually branded. What the creation of these products means in practical terms is that all the poisonous gas emissions from power stations, the energy industry in general, and all the other polluters, can be filtered through *Shamantra*, converted into beneficial matter and put safely back into the ground.

Oil spills can be completely remediated in a matter of months instead of decades. PCBs, Heavy Metals and Radionuclide contamination can be safely converted into benign matter and put back into the ground without any negative environmental impact; in fact it will have a positive impact.

For the very first time "**Ground to Ground Recycling**" will become a reality. Whatever is taken from the ground and turns into pollution can be captured and put back safely into the ground! The implementation of these products will result in the most substantial reduction in pollution and the most significant, positive impact on the environment ever achieved by any organization.

### Agriculture

An equally massive worldwide market exists for products which can replenish depleted soils and farmland and add back all the minerals and nutritional substances which have been removed over years of implementation of negligent farming methods and consequent erosion and contamination from the overuse of fertilizers and pesticides.

A recent analysis of a range of staple foods in Canada including potatoes, tomatoes, bananas, apples, onion, broccoli, etc., was commissioned by *The Globe and Mail* and CTV news. The analysis found that over the past 50 years, the potato has lost 100% of its Vitamin A, 57% of its Vitamin C, 56% of its iron, 28% of its calcium, 50% of its riboflavin, and 18% of its thiamine. All seven of broccoli's nutrients declined, notably calcium, which fell 63%, and iron, which dropped 34%.

Similar results were confirmed for the 25 fruits and vegetables that were analysed. Phil Warman, professor of agricultural sciences at Nova Scotia Agricultural College, blames the profit motive, "*The emphasis is on appearance, storability and transportability, and there has been much less emphasis on the nutritional value of fruits and vegetables. Crops are bred to produce higher yields, to be resistant to disease and to produce more visually attractive fruits and vegetables, but little or no emphasis is placed on their vitamin or mineral content.*"

Tim Lang, a professor at the *Centre for Food Policy* in London, England, agrees, "*You would have to eat eight oranges today to get the same amount of vitamin A your grandparents got from a single orange.*"

## 'The Solution to Pollution'

Molecular Mediation has discovered and developed a range of products that provide comprehensive, viable and economic solutions to address and solve these problems. By varying the processing parameters of the technology, and the organic raw material, a new product has been created which yields extraordinary amounts of humic substances. Humic substances are the primary active components of the agricultural products to be produced by Molecular Mediation and branded as "*Humanic*".

Humic Substances are found in the soil's humate layer, they are defined as Organic Matter, Humus, Humate, Humic Acid, Fulvic Acid and Humin. These are the components of humus, which are high molecular weight compounds that together form the brown to black hydrophilic, molecularly flexible, polyelectrolytes called humus. Many of the components of humus are heterogeneous, relatively large stable organic complexes. They function to give the soil structure, porosity, water holding capacity, cation and anion exchange, and are involved in the chelation of mineral elements. The elemental analysis of humic substances reveals that they are primarily composed of carbon, oxygen, hydrogen, nitrogen, and sulphur in complex carbon chains. Humic substances are recognized by most soil scientists and agronomists as the most important component of a healthy fertile soil.

### Technical Overview

For any new product to be successfully adopted and implemented, it needs not only to be effective but safe, affordable, available and sustainable. Products designed to address environmental concerns are also required to undergo more extensive scrutiny than other products. The *Shamantra* range of products exceeds these prerequisites and have recently undergone scientific validation by certified laboratories in order to receive regulatory approval from the U.S. E.P.A. for the uses described herein. All test results have confirmed the efficacy of the products and each result exceeded expectations. The U.S. E.P.A. has granted approval of *Shamantra Green* as a bioremediation product and it is now listed on the NCP list of the U.S. E.P.A. website.

[www.epa.gov/oem/docs/oil/ncp/schedule.pdf](http://www.epa.gov/oem/docs/oil/ncp/schedule.pdf)

*Shamantra* and *Humanic* products are produced by subjecting a range of organic base materials, such as, leonardite and lignite (referred to as "Substrate") to a unique process, which alters the molecular structure of the base material. These materials are prolifically available throughout the world and close to the surface of the earth, which makes them easy to access and relatively inexpensive to mine.

### Manufacturing Process

The *DevourX* process ([www.devourx.com](http://www.devourx.com)) is a recently developed, patent-pending technology which processes material by a technique known as "*Aeroacoustics*", which combines aerodynamics, pressure, vacuum and sound waves to cause the effect which alters the original molecular structure of material. The molecular alteration which occurs during the manufacturing process is a purely mechanical function, that is, there is no use of chemicals, toxic materials or any other dangerous catalysts or modification agents. Only organic substrate is used in the process, which results in a finished product that is totally organic, non-toxic, harmless and beneficial to the environment.

The change to the substrate structure primarily occurs during the removal of moisture and subsequent exposure of the organic compounds within the substrate matrix to a high oxygen and hydrogen atmosphere. The voids created in the substrate by the removal of moisture become the space to which the target contaminant is attracted and absorbed. The substrate's ability to absorb various pollutants is dramatically increased by the process

The *Humanic* range of products are produced by altering the molecular structure of the humic substances in the substrate. Although many naturally occurring materials, such as, leonardite and lignite can contain quite large amounts of humic substances, they are very difficult to extract and make readily available to vegetation because it is strongly bound to proteins or other matter in the particles of the substrate.

Humic substances have been traditionally extracted with NaOH (Sodium Hydroxide - caustic) or KOH (potassium hydroxide - also caustic). The problem with this technique is that crops grown in the United States and treated with caustic-extracted humic substances are banned from import into Europe, Japan, Australia and other large markets. The US Department of Agriculture estimates that billions of dollars of export income is lost due to these bans. The *DevourX* process breaks humic substance's strong bonds with the protein and also changes the nature of some of the functional groups which allows for easy water based extraction of the humic acid without the use of caustic substances. The process yields high quantities of available humic substances, over 90%, and its use is accordingly of exceptional value and accepted in countries where other forms of extraction are both banned and of negligible value.

## Markets, Product Applications and Technical Information

### Shamantra

The scope of the problems associated with contaminated sites, air and ground pollution is so enormous that most information regarding it is kept from the general public and information that is available has been edited into a form which requires mathematical and scientific qualifications in order to decipher the codes used by bureaucrats to deceive the public. Even though there is nothing like full disclosure, at least western democratic nations publish information which can be deciphered. Other nations either do not publish information or they suppress information regarding oil spills, air pollution, terrorist acts and industrial negligence.

The immense value of *Shamantra* is best illustrated by the following examples:

- Its ability to capture and completely convert carbon dioxide, carbon monoxide, methane (and all carbon & hydrocarbon gasses) into pure carbon and pure oxygen. It is the perfect carbon dioxide (and greenhouse emission) sequestration media.
- Its ability to completely remediate oil-contaminated land and water in just a matter of months, whereas untreated areas would otherwise remain contaminated for between 50 to 75 years or more.
- Its ability to chelate metals and toxins, such as mercury vapour, and make them harmless so they can be put into the ground where they become bioavailable to plants and vegetation.

### Hydrocarbon Mediation

Hydrocarbons and gasses emitted from their combustion include crude oil, carbon dioxide, carbon monoxide, organic chemicals such as benzene, methane, propane, butane, hexane, octane, xylenes, chlorinated hydrocarbons such as trichloroethylene, (TCE), perchloroethylene (PCE), energetic chemicals such as nitroesters and others. "*Shamantra Green*" is the name of the product designed for Hydrocarbon mediation.

*Shamantra Green* will absorb, adsorb, break down and convert hydrocarbon oils and gasses into benign organic compounds by natural biodegradation. *Shamantra Green* will capture carbon dioxide (CO<sub>2</sub>) and carbon monoxide (CO) within its matrix and convert it to pure carbon and oxygen within weeks, no CO<sub>2</sub> or CO will ever leach from the media matrix at any time. The result is a very valuable, carbon rich, oxygen rich, organic fertilizer.

### CO<sub>2</sub> Sequestration

Billions of dollars have been spent and billions more are being raised for the purpose of finding a viable and cost effective solution to capture and store (sequester) carbon dioxide. *Shamantra Green* renders this quest redundant and all funds invested into such projects wasted. Not only will it sequester carbon dioxide at a very small fraction of the cost of any other proposed or theoretical method that has been suggested or imagined to date, it will convert it into beneficial matter as described in the previous section.

### Activated Carbon

In the United States, Europe and other western nations, legislation has been passed to reduce poisonous emissions from power stations and other industrial polluters. For example, the U.S. E.P.A. has introduced compliance regulations for power stations and other major polluters which require the removal of mercury, carbon dioxide and other greenhouse gasses from flue gas streams. A number of power companies are presently being sued by state and federal governments for producing excessive poisonous emissions and greenhouse gasses.

Activated carbon is widely used to remove mercury from flue gas streams; however it is not as effective as claimed because its efficiency reduces significantly when moisture is present or when the flue gas temperature increases above 300°F. As the majority of power stations burn coal with moisture content above 30%, activated carbon is not a viable solution for these installations. Also, activated carbon will not absorb or remove carbon dioxide or other hydrocarbon/greenhouse gasses.

*Shamantra Green* is hydrophobic, so is unaffected by the presence of moisture and its ignition point is above 450°C. Not only does it retain its efficacy when activated carbon is rendered ineffective but *Shamantra Green* will also remove and sequester carbon dioxide and other hydrocarbon gasses from the flue gas stream simultaneously. Activated Carbon is also commonly used in water filtration; however, it absorbs water which makes it far less efficient than *Shamantra Green*, which is hydrophobic.

### Contaminated Sites

In addition to the massive pollution created by power stations, oil companies, sanitation, manufacturers of cement, asphalt, steel, paper and other polluters, there are innumerable sites around the world that have been contaminated over decades by the activities of industry and the military. For example, the U.S. Department of Energy (DOE) estimates the number of hazardous waste sites requiring treatment for soil and groundwater contamination under current federal and state regulations to be about 217,000 sites in the U.S. alone. The soil and groundwater at these sites has been contaminated by various toxic and hazardous substances.

The DOE estimates that more than 5,700 groundwater plumes have contaminated over 600 **billion** gallons of water and 50 million cubic meters of soil throughout the DOE complex. Mixed waste containing multiple hazardous and radioactive contaminants is a problem at a number of installations.

The above figures do not include the many sites under the stewardship of other government departments or privately owned sites which have been contaminated by mining, oil/gas-drilling, exploration, chemical manufacture and contamination caused by numerous industrial processes during manufacture and production. The figures also do not include any areas contaminated by incidents such as the recent Gulf of Mexico oil spill or the many previous spills where areas remain contaminated. A similar situation exists in most countries throughout the world.

### **Extract from the U.S. Department of Energy Website:**

[Contaminated sites include those that fall under the National Priorities List (NPL, Superfund), Resource Conservation and Recovery Act (RCIL4) Corrective Action, Department of Defence (DOD) and Department of Energy (DOE) installations.]

The soil and groundwater at these sites are contaminated with various toxic metals (about 50-70% of the sites) and with organic contaminants (40-70% of the sites). In addition, radioactive contamination is found at 90% of the DOE installations]. The (U.S.) federal government has set aside \$6 billion per year for the next 30 years and a total of \$260 billion to clean and restore these sites, however, there are presently no products or solutions with which to achieve this outcome. *Shamantra* products can provide a complete solution for the majority of this contamination. Products under development are expected to provide solutions for the more toxic and radioactive contaminants.

### **Treatment and/or Chelation of Metals, PCBs and Radionuclides**

A separate version of *Shamantra* ("*Shamantra Silver*") has been developed for the absorption, adsorption, treatment, chelation and alteration of numerous contaminants as described below. *Shamantra Silver* has been designed for the purpose of sorption and remediation of heavy metals, PCB's and radionuclides. It offers numerous advantages over existing products used for such purposes; however, the explanation is of a far more technical nature. Suffice to say that the principal advantage of these products is that they are completely organic, non-toxic, non-chemical and far more effective than any existing product. They offer benefits that no other product can equal and solutions where none presently exist. *Shamantra Silver* is exceptionally effective at sorbing and converting Polychlorinated Biphenyls (PCBs), Heavy Metals and Radionuclides, some of which are described below.

#### **Toxic Metals:**

- Aluminium, Arsenic, Boron, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Gold, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Vanadium, Zinc, Zirconium and others;

#### **Radioactive Contaminants (Radionuclides):**

- Cerium, Caesium, Plutonium, Rhenium, Strontium, Thorium, Uranium and others;

#### **Organic Contaminants:**

- Carbon Tetrachloride, Chloroform, Herbicides (Paraquat, Diquat, Triazines), PCBs (Polychlorinated biphenyls), PCE (Perchloroethylene), TCE ( Trichloroethene), Nitrogen compounds (urea and anilines).

#### **Metal Binding**

*Shamantra Silver* has strong metal binding capabilities, adsorptive capabilities on organic substances, high cation exchange capacity and chemical reducing properties which convert toxic chemicals to non-toxic forms.

#### **Ability to Chelate Metals**

Metals are bound to the carbon skeleton of *Shamantra Silver*, primarily through carboxylic and phenolic oxygen, but heteroatoms such as nitrogen and sulphur also have a positive effect on metal binding.

#### **Organic Compounds**

The mechanisms for adsorption of organic compounds by *Shamantra Silver* include Hydrophobic bonding, Hydrogen bonding, Ion exchange and Ligand exchange.

### Examples of Functionality

Regeneration refers to the necessity for further treatment such as, by heat and chemicals, washing in filter bags and other treatments, all of which require further disposal by other means.

### Advantages of Shamantra

In addition to significantly lower capital and production costs, *Shamantra* has numerous advantages and benefits over any existing product and, more importantly, they also provide solutions for which no product presently exists. The principal advantage of *Shamantra Green* for hydrocarbon mediation is that, in addition to absorbing oils and gasses, it then breaks them down by natural biodegradation and converts them into plant nutrients, no further processing or disposal is required. This product is the first ever complete solution for this purpose. No other product provides a "complete" or organic solution for these problems, existing products and services only provide partial solutions, most of which require further processing, treatment or disposal. Disposal is a contentious issue which presents another set of problems.

### Features of Shamantra

- 100% effective on hydrocarbons, it completely removes hydrocarbon contamination.
- Organic product - Produces an organic result.
- Rapidly accelerates degradation and decomposition of hydrocarbons.
- Converts hydrocarbons into plant nutrients.
- Completely remediates affected land, lakes, wetlands and ocean areas.
- Completely degrades and converts stored waste oils.
- Non-toxic - No unwanted side effects.
- Extremely efficient - Absorbs up to 30+ times its own weight.
- Rapidly accelerates natural recovery.
- Hydrophobic - Is not diluted by water.
- Can be applied directly and efficiently.
- No residue - No residual problems.
- Agglomerated material emits oxygen as it breaks down.
- Provides substantial economic benefits.
- Provides vast environmental benefits.
- New job creation.
- Indirect job creation.
- Existing job retention.
- Alternative use for mined raw materials.
- Increase longevity of jobs in mining.
- Improves existing containment/recovery measures when used to convert contained and recovered oil into a benign or beneficial material that can be safely placed in landfill.
- Recovered *Shamantra*/oil agglomerate can also be burnt as a high calorific fuel.

### Disadvantages:

- None known.

## Potential Uses of Shamantra

The *Shamantra* range of products are bioremediation agents and sorbents consisting of natural, chemical, catalytic, enzyme and microbial formulations for commercial, industrial and household applications. Applications and uses are summarized below:

- Stain removal;
- Door elimination;
- Municipal and industrial water treatment;
- Spill control, bioremediation and restoration of organic or hydrocarbon-based materials including chemical, oil or solvent liquid spills;
- Adsorbent for use in air treatment and purification;
- Adsorber filter unit containing particulates for removing soluble or insoluble organic compounds and heavy metals from water;
- Adsorbent for use in respirators and military respirator masks to purify air;
- Adsorbent for use in the removal of mercury dioxin, furans and other VOC compounds from stack gas streams;
- Adsorbent for use in the removal of Carbon Monoxide, Nitric Oxide, Nitrogen Dioxide, Sulphur Dioxide, Sulphur Trioxide & Carbon Dioxide from gas streams;
- Adsorbent for use in removing hydrogen sulphide and organic sulphur compounds from gas streams;
- Adsorber filter unit containing particulates for removing soluble or insoluble organic compounds and heavy metals from water;
- Removal of mercury from gaseous streams or environments in the natural gas processing industry, the metal refining industry, the electronics manufacturing industry, the battery production industry, the light bulb production industry and the caustic production industry;
- Chloramine removal in the home water filter and industrial water treatment sectors;
- Phosphine, hydrogen sulphide, arsine or sulphur dioxide abatement in the cigarette market;
- Ozone removal in the copier/laser printer market;
- Gold, platinum and other precious metal adsorption processes;
- Industrial processes to remove odor causing components, such as, hydrogen sulphide and methyl mercaptan;
- Adsorber filter unit containing particulates for removing soluble or insoluble organic compounds from water.

Products may be in the form of powders, granules, chips, socks, pads, rolls, booms, spill kits, filters, slurries, dispersions & micro emulsions.

## Humanic

In order for the reader to acquire a comprehension of the value of MM products, it is necessary to gain a modest understanding of the primary active product components and their functional values, a summary of which is provided in the following paragraphs. The discerning researcher may find corroborating and additional information from numerous publications (listed) and the internet.

Organic matter is defined as a grouping of carbon containing compounds which have originated from living beings and matter which has been deposited on or within the earth's structural components. Soil organic matter includes the remains of all plant and animal bodies which have fallen on the earth's surface or been purposely applied by man in the form of organically synthesized pesticides. A fertile soil should contain from 2-8 percent organic matter; most soils contain less than 2%.



Of most considerable value among humic substances is humic acid. It is a large, long-chain molecule that can be isolated in a relatively pure form. Current scientific studies show that the fertility and productivity of soil is directly related to its humic acid content. It determines the cation-exchange capacity (CEC), nutrient and oxygen content, and water holding capacity of the soil. Humic acids are unique in their ability to bind insoluble metal ions, oxides and hydroxides, and to release them slowly and continually to plants as required. Higher humic content in soil translates to higher values of these essential elements and accordingly higher productivity. Humic acids are known to produce beneficial physical, chemical and biological effects for the entire food-chain.

In the years before we depleted our growing soil, humic acid was a natural part of the food chain and present in soil in large quantities. The value of humic substances cannot be overstated, they are absolutely critical elements, without which optimum health in plants, animals and humans cannot be achieved. These are the most precious of the earth's life-giving nutrient sources. Without it, we're missing something that seems to have healthful benefits against viruses, heavy metal toxicity and dangerous free radicals.

### **Benefits of Humic Substances**

The most important feature of humic acids lies in 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.

#### **Physical Benefits:**

- Humic substances physically modify and improve the structure of the soil.
- Prevent high water and nutrient losses in light, sandy soils and simultaneously convert them into fruitful soils by way of decomposition.
- In heavy and compact soils, aeration of soil and water retention is improved; cultivation measures are facilitated.
- Prevents 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.
- Darkens the colour of the soil and thus help absorption of the sun energy.

#### **Chemical Benefits:**

- Chemically change the fixation properties of the soil.
- Neutralizes both acid and alkaline soils; regulates the pH-value of soils.
- Improves and optimizes the uptake of nutrients and water by plants.
- Increases buffering properties of soil.
- Acts as natural chelator for metal ions under alkaline conditions and promotes their uptake by the roots.
- Rich in both organic and mineral substances essential to plant growth.
- Retains water soluble inorganic fertilizers in the root zones and reduces their leaching.
- Possesses extremely high cation-exchange capacities.
- Promotes the conversion of nutrient elements (Nitrogen, Phosphorus, Potassium + Iron, Zinc and other trace elements) into forms available to plants.
- Enhances the uptake of nitrogen by plants.
- Reduces the reaction of phosphorus with Calcium, Iron, Magnesium and Aluminium and liberates it into a form that is available and beneficial to plants.
- Increases the productivity of mineral fertilizers considerably.

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- Liberates carbon dioxide from soil calcium carbonate and enables its use in photosynthesis.
- Helps to eliminate chlorosis due to iron deficiency in plants.
- Reduces the availability of toxic substances in soils.

### Biological Benefits:

- Biologically stimulate plants and the activities of micro-organisms.
- Stimulates plant enzymes and increases their production.
- Acts as an organic catalyst in many biological processes.
- Stimulates growth and proliferation of desirable micro-organisms in soil.
- Enhances plant's natural resistance against disease and pests.
- Stimulates root growth, especially vertically, and enables better uptake of nutrients.
- Increases root respiration and root formation.
- Promotes the development of chlorophyll, sugars and amino acids in plants and aids in photosynthesis.
- Increases vitamin and mineral content of plants.
- Thickens the cell walls in fruits and prolongs the storage and shelf time.
- Increases germination and viability of seeds.
- Stimulates plant growth (higher biomass production) by accelerating cell division, increasing the rate of development in root systems and increasing the yield of dry matter.
- Increases the quality of yields; improve their physical appearance and nutritional value.

### Ecological Benefits:

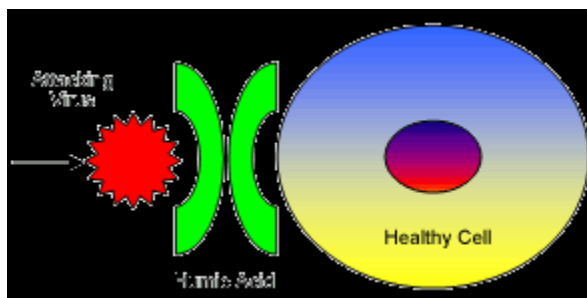
1. The ecological benefits of humic substances, particularly humic acids, are diverse and represent profitable and effective solutions for environmental problems and the preservation of the environment.
2. Soils with a high content of humic acids have low nitrate leaching and optimum nutrient efficiency, which is a prerequisite for "organic certification".
3. Promotes well-developed root systems and prevents nitrate and pesticides from mixing with ground water.
4. Humic acids reduce the salination problems created by the application of water-soluble mineral fertilizers. They have the ability to decrease high salt contents in soils and the resulting toxicities.
5. Reduce root burning from excessive salt concentrations in soils after fertilization.
6. Reduce soil erosion by increasing the ability of soil colloids to combine and by enhancing root system and plant development.
7. Humic-based products are certified for use by the organic industry authorities.

### Health Benefits of Humic Acids:

- Scientific studies have shown that humic acid impairs the attachment of the HIV-1 virus, one of the viruses responsible for the development of AIDS.
- Impedes Herpes simplex virus infections, Influenza viruses, including the swine flu.
- Inhibits exotic viruses like the West Nile Virus, hemorrhagic fever and Cocksackie viruses.
- Other studies indicate that its antiviral properties are broad spectrum, which means it would be effective against Asian and bird flu.

It is believed that humic acid blocks the virus particle from attaching to and entering a healthy cell. Viruses cannot replicate or divide without entering and taking over the cell's DNA so it can make more virus particles. This means that one virus cannot become thousands, so infection is effectively blocked as illustrated below:

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*Humic Acid blocking a virus particle from attaching and replicating in a healthy cell*

- Humic acid has been scientifically proven to be a free radical scavenger. Free radicals are "broken" molecules that are off-balanced by having too many electrons on them which makes them dangerous to healthy, living cells. Free radicals can interfere with our DNA and the effect can be cancer-causing. Humic acid can bind them so they become harmless.
- Humic acid is a potent chelator:- a molecule that binds metals, including toxic heavy metals. It is able to scavenge for heavy metals and eliminate them from the body.
- It seems to increase the permeability of cell walls, allowing for easier transfer of nutrient metals.
- It can bind to essential metals and is believed aid in their absorption in the body.
- It is very beneficial for the immune system.

### Adsorbents/Absorbents

Humic acids exhibit some novel surface and pore characteristics. They are a relatively high surface area material, organophilic and exhibit certain types of reactive sites such as phenolic hydroxyl groups, carboxylic acid groups and have the ability to adsorb, absorb and selectively extract various organic materials as well as some inorganic compounds. Due to these properties, they can be used in special filter media, selective extractants and chromatographic substances.

They can be used for removing trace amounts of non-aqueous liquids such as oils from aqueous streams. They can also be utilized in the removal of trace contaminants from aqueous streams.

### Asphalt/Bitumen

Humic acids can be used in modifying asphalt based products such as roofing compounds, mastics, sealants, coatings, etc.. Due to their dispersant characteristics, they have the potential of improving the loading of inert solids. They also have potential use as crack-resistant agents, flow control additives, sag resistant agents, spray modifiers, adhesion modifiers, enhancer or inert fillers and as agents to control penetration and evaporation of asphalt solvents. Humic acids help to stabilize certain types of asphalt based under-coatings and soundproofing compounds. They also assist in improving the aging characteristics and the thermal stability of asphalt based systems.

### Batteries

Humic acids are used as expanders in lead accumulators in the battery industry. As surface active materials, they influence the size and morphology of lead and lead-sulphate during the charging and discharging cycles and produce an increase in charge potential of the lead accumulator as well as the discharging capacity and reduces the self-discharge of the battery and thus prolongs its life.

### **Ceramics**

Humic acids have been traditionally used in ceramics as liquefier and dispersant agents. Whereas in the past humic acids were used also as liquefiers for glazes, presently the usage is limited to liquefying and diluting ceramic masses. Ceramic masses, that are prepared in fluid state, need liquefier agents, in order to optimize the rheological behaviour of the produced mud. A high hard-material concentration is required to keep the energy costs for drying low and to reach high densities. As a liquefier agent, humic acids influence the viscosity, rheology and pH-value of the ceramic masses directly, in addition to influencing ceramic streaks, crack-resistance and absorption time indirectly.

### **Concrete & Cement**

Humic Acids can be used as liquefiers in concrete. They not only reduce the consumption of concrete but also improve its physico-mechanical properties. They also have a potential as a special density control additive (light weight) in cement or concrete. Due to their properties, using humic acids results in very little water uptake. This leads to either a reduced use and an improved workability of the cement or to an increase in its stability while the amount of cement used remains the same. Humic acids help to diminish the surface tension of water, resulting in an improved utilization of solid particles in concrete. This leads to a complete fine separation (dispersion) of the cement, whereby the friction between solid particles is reduced, resulting in a better versatility and workability of concrete.

### **Controlled Release Agents**

Due to their high, porous and hydrophobic surface area, humic acids can be used in controlled release applications, where it is important to adsorb, absorb and release products at controlled rates.

### **Defoamers**

Due to their surface area and hydrophobic nature, humic acids can be used as solid or liquid defoamers where dark colour is not a concern.

### **Drilling Fluids**

Humic Acids are organic carboxylic acids of complex molecular structure (aromatic and phenolic).

The water solubility of lignite depends on its humic acid content. Decarboxylation of humic acid groups by hydrolysis in alkaline muds is a major source of carbonate and bicarbonate anions in water muds. They can be used as a fluid loss additive in oil base and water base drilling fluids.

Humic acids have three types of functions when used in drilling fluids. 1) They reduce viscosity and gel strengths; 2) They function as thinners, deflocculants, dispersants and as rheological control agents; 3) They act as fluid loss agents and emulsifiers. Potassium humates are used primarily as a kind of a shale inhibiting agent for freshwater drilling fluids and have the function of viscosity reducer and water-loss reducer.

### **Foundries & Green Sand Systems**

Humic acids can be used as foundry sand additives because of their dispersant properties and binding characteristics both in oil base and water base foundry sands. Humic acids block electrostatic interaction and thus makes the clay unwettable in sand systems. They reduce clay viscosity, improve muller efficiency and increase meld permeability, they also absorb and retain water and improve foundry environment. Use of humic acids in foundries and green sand systems as an additive improves flowability and clay efficiency and may result in the reduced use of clay in the sand system, saving considerable costs.

### **Grease & Lubricants**

Due to their organophilic nature and stability even in high temperatures, humic acids can be used as a special additive for modifying the gel structure and other properties of soap and organoclay based greases and lubricants. A higher purity and finer grind of product can be attained through the use of humic acids.

### **Immobilization of Enzymes**

Humic acids can be used for the immobilization of certain types of enzymes due to their hydrophobic and potentially reactive surfaces.

### **Paints & Industrial Coatings**

Humic acids can be used as black tinting agents, special pigments and rheological control additives in oil base paints, industrial coatings, varnishes and shellacs. They can especially be utilized in colouring wood, leather and carpets.

### **Paper & Cardboard**

Humic Acids are used for paper colouring, which improves the fastness and eliminates the penetration of toxic substances into wastewater at the same time. They can be used as special additives for certain types of dark collared papers, particularly those requiring the use of oils, waxes, resins, etc.. They can also be applied in modifying water-proofing agents and barrier coatings used in paper products. They are considered as black tinting agents, special fillers, asphalt/oil/wax/resin property modifiers and can be used where it is important to prevent penetration of nonaqueous liquids during special paper production.

### **Pharmaceuticals & Cosmetics**

Humic acids can change the activities of enzymes, for instance in the skin. Humic acids are traditionally used in the pharmaceutical industry in the preparation of bath salts and artificial mudbath. Produced in combination with different preservatives, products containing humic acids are applied in particular for the treatment of rheumatic and gynaecological diseases. They also have potential usage in cancer treatment.

### **Printing Inks**

Humic acids can be applied for modifying the rheological properties in black or dark collared printing inks. They exhibit dispersant properties (flow control) in certain types of solvent based systems. They can be used as colloidal tinting agents/pigments due to the black colour. An important property of humic acids is their ability to limit penetration of certain oils into porous substrates. This is especially applicable for certain types of ink formulations for paper and ribbon.

### **Rubber**

Humic acids can be used in the compounding and processing of rubber. Due to their organophilic and non-gelling colloidal structure, some suggested usages are as fillers/extenders, tinting compounds, property modifiers (elasticity, impact resistance, anti-cracking/crazing, aging, UV modifier, etc.), special anti-oxidants, reactive fillers or modifiers in certain systems, pigment dispersants and plasticizer modification through cross-linking reactions.

### Existing Humate Extraction Method

The existing procedure to extract Humic Acid is:

1. Soak the ground lignite for at least 24-72 hours in 0.1 M (mole) NaOH or KOH and agitate if possible several times.
2. Take off the solution, wash the lignite with some water, and collect this also.
3. Filter the solution or remove all particulate matter in some other way such as centrifuging.
4. Add concentrated hydrochloric or sulphuric acid very slowly (extremely dangerous) with agitation until the pH is ~1.
5. Filter or collect the precipitate in some other way, then wash and dry (either oven or air dry). This material is humic acid and is reasonably pure.
6. It can be further purified by dissolving in 0.1 M NaOH or KOH and precipitating again.
7. The solid humic acid can be redissolved in 10% KOH for agricultural use to give soluble potassium humate. The amounts are such that the final product has a pH of 10-11. The product can be used in solution or dried.

**Bibliography:**

1. Seffner, W. "Effects of humic acid on the availability of iodine in the food, investigated with the histometric assessment of the thyroid gland". Conference Paper Mengen- und spurenelemente-15 Arbelstagund, 1995.
2. Bernacci, F. et al. "In vivo and in vitro mutagenicity studies on natural humic acid". Conference paper 37, Riunione scientifica, October 1991.
3. Gau, R. et al. "Induction of oxidative stress by humic acid through increasing intracellular iron; a possible mechanism leading to atherothrombotic vascular disorder in blackfoot disease". *Biochem Biophys Res Commun*, 2001; Vol 283; Issue 4: 743-49.
4. Iubitskaia, NS. "Sodium humate in the treatment of osteoarthritis patients." *Vopr Kurortol Fizioter Lech Fiz Kult*, 1999; Issue 5, 22-24.
5. Schiller, F. "Results of an oriented clinical trial of ammonium humate for the local treatment of herpesvirus hominis (HVH) infections". *Dermatol Monatsschr*, 1979, Vol. 165; Issue 7; 505-09.
6. Riede, U.N. "Humate induced activation of human granulocytes. *Virchows Arch B Cell Pathol Incl Mol Pathol*, 1991; Issue 1: 27-34.
7. Herzig, I. "The effect of sodium humate on cadmium deposition in the organs of chickens". *Vet Med*, 1994, Vol 39; Issue 4; 175-85.
8. Hampi, I, et al. "Pharmacokinetics of sodium humate in chickens". *Vet Med*, 1994; Vol 39, Issue 6; 305-313.
9. Schneider, J, et al. "Inhibition of HIV-1 in cell culture by synthetic humate analogues derived from hydroquinone; mechanism of inhibition". *Virology*, 1996; Vol 218, Issue 2, 389-95.
10. Thiel, KD, et al. "In vitro studies of the antiviral activity of ammonium humate against herpes simplex virus type 1 and type 2". *Zentralbl Bakteriol*, 1977; Vol. 239, Issue 3, 304- 321.
11. Laub, R. "The chemically induced inhibition of HSV infection". Laub BioChem Corp., August 1998.
12. Laub, R. "The chemically induced inhibition of HIV-1 replication". Laub BioChem Corp., January 1995.
13. To cite this Article Lamar, Richard T. and Talbot, Karen H.'Critical Comparison of Humic Acid Test Methods', *Communications in Soil Science and Plant Analysis*, 40: 15, 2309 — 2322
14. Adani, F., Genevini, P., Zaccheo, P., Zocchi, G. 1998. The effect of commercial humic acid on tomato plant growth and mineral nutrition. *J. plant nutr.* 1998. v. 21 (3) p. 561-575.
15. Alexandrova, I.V. 1977. Soil organic matter and the nitrogen nutrition of plants. *Sov. Soil Sci. (Engl. Transl.)* 9:293-301.
16. Amalfitano, C. Quezada, R.A., Wilson, M.A. and J.V. Hanna.1995. Chemical composition of humic acids: a comparison with precursor 'light fraction' litter from different vegetations using spectroscopic techniques. *Soil science.* June 1995. v. 159 (6) Pages: p. 391-401
17. Aso, S., and I. Sakai. 1963. Studies on the physiological effects of humic acid. 1 Uptake of humic acid by crop plants and its physiological effects. *Soil Sci. Plant Nutr. (Tokyo)* 9:85-91.
18. Bar-Tal, A., B. Bar-Yosef, and Y. Chen. 1988. Effects of fulvic acid and pH on zinc sorption on montmorillonite. *Soil Sci.* 146:367-373.
19. Bkardwaj, K.K.R. and A.C. Gaur. 1972. Growth Promoting Effect of Humic Substances on *Rhizobium trifolu*. *Ind. J. of Microbiol.* (12), 19-21
20. Brannon, C.A., and L.E. Sommers. 1985a. Preparation and characterization of model humic polymers containing organic phosphorus. *Soil Biol.Biochem* 17:213-219.
21. Brannon, C.A., and L.E. Sommers. 1985b. Stability and mineralization of organic phosphorus incorporated into model humic polymers. *Soil Biol.Biochem* 17:221-227..
22. Brownell, J.R., O. Nordstrom, I. Marihart, and G. Jorgensen. 1987. Crop responses from two new Leonardite extracts. *Sci.Total Environ.* 62:492-499.

23. Cegarra, J., Garcia, D., Navarro, A. and M.P. Bernal. 1994. Effects of heat on the alkali extraction of humic substances from peat. *Communications in soil science and plant analysis*. v. 25 (15/16) p. 2685-2695.
24. Chen, Y. and T. Aviad 1990. Effects of Humic Substances on Plant Growth. In P. MacCarthy et al. Eds. *Humic Substances in Soil and Crop Sciences: Selected Readings*. Amer. Soc. of Agron., Madison WI. p. 161-186.
25. Chen, Y., and M. Schnitzer. 1978. The surface tension of aqueous solutions of soil humic substances. *Soil Sci.* 125:7-15.
26. Conte, P. and A. Piccolo. 1999. High pressure size exclusion chromatography (HPSEC) of humic substances: molecular sizes, analytical parameters, and column performance.
27. *Chemosphere* v. 38 (3) Pages: p. 517-528.
28. Crowford, J.H., Senn, T.L. and G. E. Stembridge. 1968. The Influence of Humic Acid Fractions on Sprout Production and Yield of the Carogold Sweet Potato. *S. Carolina Ag. Exp. Sta. Tech. Bull.* 1028.
29. De Almeida, R.M., F. Pospisil, K. Vackova, and M. Kutacek. 1980. Effect of humic acids on the inhibition of pea choline esterase and choline  $\alpha$ -cyltransferase with malathion. *Biol. Plant.* 22:167- 175.
30. Dekock, P.C. 1955. The influence of humic acids on plant growth. *Science (Washington, DC)* 121:473- 474.
31. Dixit, V.K., and N. Kishore. 1967. Effect of humic acid and fulvic acid fraction of soil organic matter on seed germination. *Indian J. Sci. Ind. Sec. A* 1:202-206.
32. Dormaar, J.F. 1975. Effects of humic substances from chernozemic Ah horizons on nutrient uptake by *Phaseolus vulgaris* and *Festuca scabrella*. *Can. J. Soil Sci.*55:111-118.
33. Duval, J.R. 1998. Evaluating leonardite as a crop growth enhancer for turnip and mustard greens. *HortTechnology*. Oct/Dec 1998. v. 8 (4) Pages: p. 564-567. Texas A & M.
34. Fuhr, F., and D. Sauerbeck. 1967a. The uptake of colloidal organic substances by plant roots as shown by experiments with  $^{14}$ C-labelled humus compounds. p. 73-82. In Report FAO/IAEA Meeting, Vienna, Pergamon Press, Oxford.
35. Fuhr, F., and D. Sauerbeck. 1967b. The uptake of straw decomposition products by plant roots. p. 317-327. In Report FAO/IAEA Meeting, Vienna, Pergamon Press, Oxford.
36. Gaur, A.C. 1964. influence of humic acid on growth and mineral nutrition in plants. *Bull. Assoc. Fr. Itude Sol.* 35:207-219.
37. Georgacakis, D., Tsavdaris, A., Bakouli, J., and S. Symeonidis. 1996. Composting solid swine manure and lignite mixtures with selected plant residues. *Bioresource technology*: May/June 1996. v. 56 (2/3). p. 195-200.
38. He, X.T., Stevenson, F.J., Mulvaney, R.L. and K.R. Kelly. 1988. Incorporation of newly immobilized  $^{15}$ N into stable organic forms in soil. *Soil Biol. Biochem.* 20:75-81. Iswaran, V., and P.K. Chonkar.
39. 1971. Action of sodium humate and dry matter accumulation of soybean in saline alkali soil. In B. Novak et al. (ed.) *Humus et Planta*. V:613-615. Prague.
40. Ivanova, L.V. 1965. Influence of humic substances on growth of excised maize roots. *Dokl. Abad. Nauk. BSSR* 9:255-257.
41. Jelenic, D.B., M. Hajdukovic, and Z. Aleksic. 1966. The influence of humic substances on phosphate utilization from labeled superphosphate. p. 85-88. In *The use of isotopes in soil organic matter studies*. FAO/IAEA Tech. Meet., Pergaman Press, Oxford.
42. Kelting, M. 1997. Humate-based biostimulants do not consistently increase growth of container-grown Turkish hazelnut. *Journal of environmental horticulture*. v. 15 (4) p. 197-199.
43. Kelting, M., Harris, J.R., and J. Fanelli. 1998a Humate-based biostimulants affect early post-transplant root growth and sapflow of balled and burlapped red maple. *HortScience* . v. 33 (2) Pages: p. 342- 344.



44. Kelting, M., Harris, J.R., Fanelli, J., and B. Appleton. 1998b. Biostimulants and soil amendments affect two-year post-transplant growth of red maple and Washington hawthorn. *HortScience*. v. 33 (5) Pages: p. 819-822.
45. Kohl, S.D. and J.A. Rice. 1998. The binding of contaminants to humin: a mass balance. *Chemosphere* v. 36 (2) p. 251-261.
46. Ladd, J.M., and J.H.A. Butler. 1971. Inhibition and stimulation of proteolytic enzyme activities by soil humic acids. *Austr. J. Soil Res.* 7:253-261.
47. Lee, Y.S., and R.J. Bartlett. 1976. Stimulation of plant growth by humic substances. *Soil Sci. Sec. Am. J.* 40:876-879.
48. Lobartini, J.C., Tan, K.H., and C. Pape. 1998. Dissolution of aluminium and iron phosphate by humic acids. . v. 29 (5/6) *Commun. soil sci. plant anal.* p. 535-544.
49. Linehan, D.J. 1976. Some effects of a fulvic acid component of soil organic matter on the growth of cultivated excised tomato roots. *Soil Biol. Biochem.* 8:511-517.
50. Linehan, D.J., and H. Shepherd. 1979. A comparative study of the effects of natural and synthetic
51. ligands on ion uptake by plants. *Plant Soil* 52:281-289.
52. Malcolm, R.E., and D. Vaughan. 1979a. Comparative effects of soil organic matter fractions on phosphatase activities in wheat roots. *Plant Soil* 51:117-126.
53. Malcolm, R.E., and D. Vaughan. 1979b. Effects of humic acid fractions on invertase activities in plant tissues. *Soil Biol. Biochem.* 11:65-72.
54. Malcolm, R.E., and D. Vaughan. 1979c. Humic substances and phosphatase activities in plant tissues. *Soil Biol. Biochem.* 11:253-259.
55. Martin, J.A. and T.L. Senn. 1967 The Influence of Various Rates of Nitrogen and Humic Acid Derivatives on the Growth and Yield of Greenhouse Tomatoes. *S. Carolina Ag. Exp. Sta. Research. Series No.* 95.
56. Mato, M.C., R. Fabregas, and J. Mendez. 1971. Inhibitory effect of soil humic acids on indoleacetic acid oxidase. *Soil Biol. Biochem.* 3:285-288.
57. Mato, M.C., M.G. Olmedo, and I. Mendez. 1972a. Inhibition of indoleacetic acid oxidase by soil humic acids fractionated in Sephadex. *Soil Biol. Biochem.* 4:469-473.
58. Mato, M.C., L.M. Oonralez-Alonso, and J. Mendez. 1972b. Inhibition of enzymatic indoleacetic acid oxidation by fulvic acids. *Soil Biol. Biochem.* 4:475-478.
59. Nardi, S., Pizzeghello, D., Gessa, C., Ferrarese, L. Trainotti, L., and G. Casadoro. 2000 A low molecular weight humic fraction on nitrate uptake and protein synthesis in maize seedlings. *Soil Biol. & Biochem.* 32(2000) 415- 419.
60. Piccolo, A., Celano, G. and G. Pietramellara 1993. Effects of fractions of coal-derived humic substances on seed germination and growth of seedlings (*Lactuca sativa* and *Lycopersicon esculentum*). *Biology and fertility of soils.* v. 16 (1) Pages: p. 11-15.
61. Piccolo, A. and J.S.C. Mbagwu. 1989. Effects of humic substances and surfactants on the stability of soil aggregates. *Soil science.* Jan 1989. v. 147 (1) p. 47-54.
62. Piccolo, A., Nardi, S., Concheri, G. 1992. Structural characteristics of humic substances as related to nitrate uptake and growth regulation in plant systems. *Soil Biol. and Biochem.* v. 24 (4) p. 373-380.
63. Piccolo, A., Pietramellara, G. and J.S.C. Mbagwu. 1997. Reduction in soil loss from erosion-susceptible soils amended with humic substances from oxidized coal. *Soil technology.* v. 10 (3) Pages: p. 235-245.
64. Pinton, R., Cesco, S., Iacoletti, G., Astolfi, S. and Z. Varanini. 1999. Modulation of NO<sub>3</sub>-uptake by water-extractable humic substances: involvement of root plasma membrane H<sup>+</sup>-ATPase. *Plant and soil.* v. 215 (2) p. 155-161.
65. Rauthan, B.S., and M. Schnitzer. 1981. Effects of soil fulvic acid on the growth and nutrient content of cucumber (*Cucumis sativus*) plants. *Plant Soil.* 63:491-495.

66. Reynolds, A.G., Wardle, D.A., Drought, B., and R. Cantwell 1995. Gro-Mate soil amendment improves growth of greenhouse-grown 'Chardonnay' grapevines. *HortScience*. v. 30 (3) Pages: p. 539-542.
67. Sanchez-Conde, M.P., and C.B. Ortega. 1968. Effect of humic acid on the development and the mineral nutrition of the pepper plant. p. 745-755. In *Control de la Fertilizacion de las plantas cultivadas, 2<sup>a</sup> Cologuia Evr. Medit. Cent. Edafal. Biol. Aplic. Cuarto, Sevilla, Spain.*
68. Sanchez-Conde, M.P., C.B. Ortega, and M.I. Perz Brull. 1972. Effect of humic acid on sugar beet in hydroponic culture. *Arales de edafologia y i\grobiologia* 31:319-331.
69. Santi, S., Locci, G., Pinton, R., Cesco, S. and Z Varanini. 1995. Plasma membrane H<sup>+</sup>-ATPase in maize roots induced for NO<sub>3</sub>- uptake. *Plant Physiol.* 109, 1277-1283
70. Schnitzer, M., and P.A. Poapst. 1967. Effects of a soil humic compound on root initiation. *Nature (London)* 213:598-599.
71. Sladky, Z. 1959a. The effect of extracted humus substances on growth of tomato plants. *Biol. Plant.* 1:142-150.
72. Sladky, Z. 1959b. The application of extracted humus substances to overground parts of plants. *Biol. Plant.* 1:199-204.
73. Sladky, Z. 1965. Anatomic and physiological alternations in sugar beet receiving foliar applications of humic substances. *Biol. Plant.* 7:251-260.
74. Sladky, Z. and V. Tichy. 1959. Applications of humus substances to overground organs of plants. *Biol. Plant.* 1:9-15.
75. Smidova, M. 1962. Effect of sodium humate on swelling and germination of plant roots. *Biol. Plant.* 4: 112-118.
76. Stevenson., F.J. 1994. *Humus Chemistry: Genesis, Composition, Reactions*, 2nd Ed. John Wiley & Sons. p.13, 236-256.
77. Tan, K.H. 1978. Effects of humic and fulvic acids on release of fixed potassium. *Geoderma* 21:67-74.
78. Tan, K.H., and D. Tantiwiranond. 1983. Effect of humic acids an nodulation and dry matter production of soybean, peanut and clover. *Soil Sci. Soc. Am. J.* 47:1121-1124.
79. Valdrighi, M.M. 1995. Effects of humic acids extracted from mined lignite or composted vegetable residues on plant growth and soil microbial populations. *Compost science & utilization*. Winter 1995. v. 3 (1) Pages: p. 30-38.
80. Vallini, G. Pera, A. Agnolucci, M., and M.M. Valdrighi . 1997. Humic acids stimulate growth and activity of in vitro tested axenic cultures of soil autotrophic nitrifying bacteria. *Biol. and fert, of soils*. 1997. v. 24 (3) p. 243-248.
81. Varadachari, C., Chattopadhyay, T. and K. Ghosh. 1997. Complexation of humic substances with oxides of iron and aluminium. *Soil science*. v. 162 (1) Pages: p. 28-34.
82. Vaughan, D., and D.1. Linehan. 1976. The growth of wheat plants in humic acid solutions under axenic conditions. *Plant Soil* 44:445-449.
83. Vaughan, D., and R.E. Malcolm. 1979. Effect of soil organic matter on peroxidase activity of wheat roots. *Soil Biol. Biochem.* 11:57-63.
84. Vaughan, D., and I.R. McDonald. 1971. Effects of humic acid on protein synthesis and ion uptake in beet discs. *J. Exp. Bot.* 22:400-410.
85. Vaughan, D., and I.R. McDonald. 1976. Some effects of humic acid on the cation uptake by parenchyma tissue. *Soil Biol. Biochem.* 8:415-421.
86. Vaughan, D., and B.G. Ord. 1981. Uptake and incorporation of <sup>14</sup>C--labeled soil organic matter by roots of *Pisum sativum* L. *J. Exp. Bot.* 32:679-687.
87. Wang, X.J., Wang, Z.Q., and S.G.Li. 1995. The effect of humic acids on the availability of phosphorus fertilizers in alkaline soils. *Soil Use Manage.* v. 11 (2) p. 99-102.
88. Xudan, X. 1986. The effect of foliar application of fulvic acid on water use, nutrient uptake and wheat yield. *Aust. J. Agric. Res.* 37:343-350.