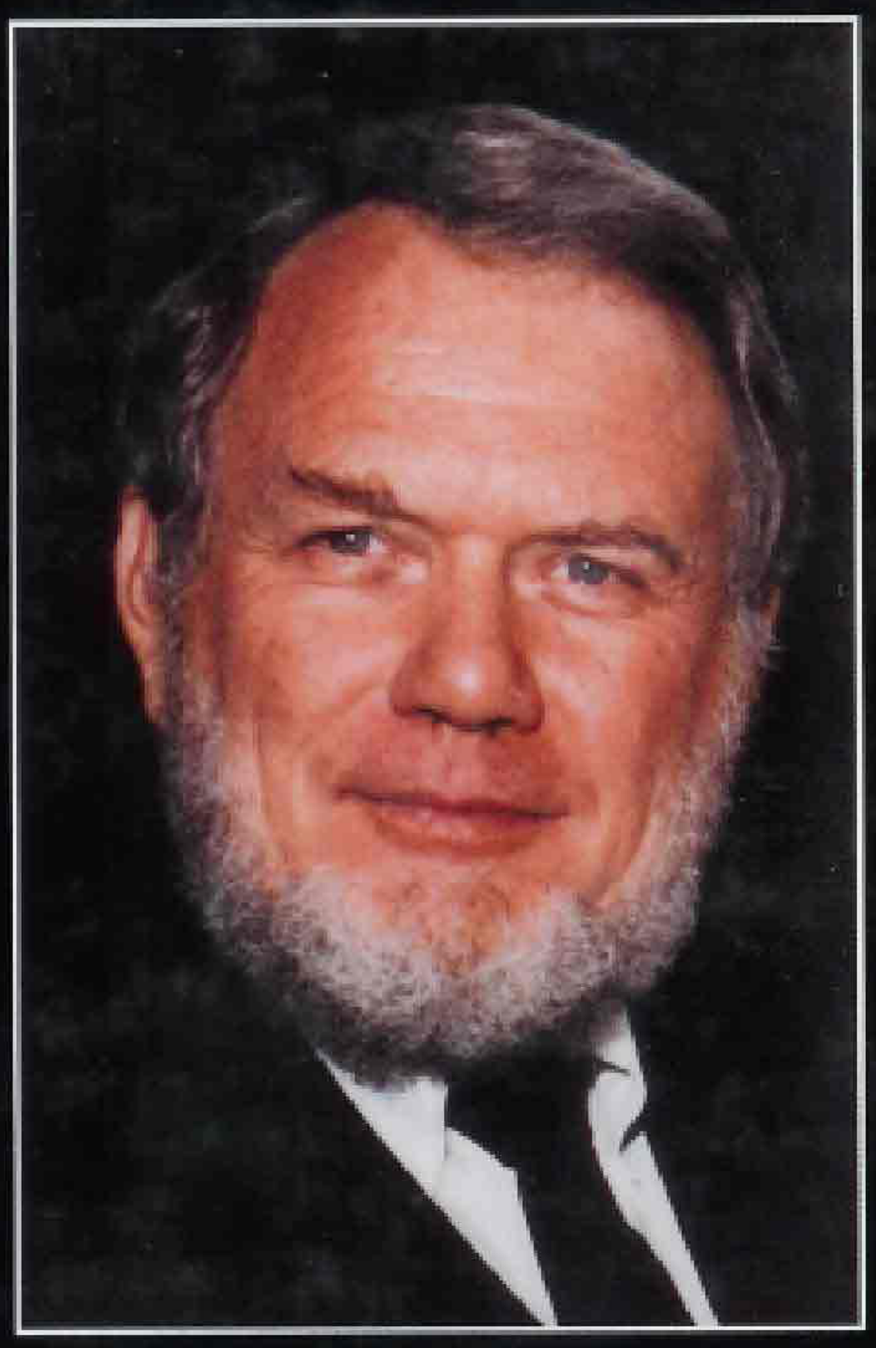
HUMIC, FULVIC and MICROBIAL BALANCE:

ORGANIC SOIL CONDITIONING

From the Amish of Ohio
To the crops of California,
Through the documented research
From universities around the world,
Explore nature's natural balance



William R. Jackson, PhD.

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by
William R. Jackson, Ph.D.

(A complete book overview)

HISTORICAL INTRODUCTION

The modern chemical fertilizer (N-P-K) theory originated in the now famous lectures that Justis von Liebig delivered before the British Association for the Advancement of Science. He argued that "the primary source whence man and animals derive the means of their growth and support is the vegetable kingdom. Plants, on the other hand, find new nutritive materials only in inorganic substances." Simple logic then would hold that one could analyze the produce of an acre and "return the nutrients" removed for a maintenance fertility program, or add a little more and have a "build up program."

In some observations he made later, in 1843, Justis von Liebig, the father of NPK agriculture, made this statement:

> "I had sinned against the wisdom of our creator, and received just punishment for it. I wanted to improve his handiwork, and in my blindness, I believed that in this wonderful chain of laws, which ties life to the surface of the earth and always keeps it rejuvenated, there might be a link missing that had to be replaced by me--this weak powerless nothing.
>
> "The law, to which my research on the topsoil led me, states, 'On the outer crust of the earth, under the influence of the sun, organic life shall develop'. And so, the great master and builder gave the fragments of the earth the ability to attract and hold all these elements necessary to feed plants and further serve animals, like a magnet attracts and holds iron particles, so as no piece be lost. Our master enclosed a second law unto this one, through which the plant bearing earth becomes an enormous cleansing apparatus for the water. Through this particular ability, the earth removes from the water all substances harmful to humans and animals--all products of decay and putrefaction, of perished plant and animal generations.
>
> "What might justify my actions is the circumstance, that a man is the product of his time, and he is only able to escape the commonly accepted views if a violent pressure urges him to muster all of his strength to struggle free of these chains of error. The opinion, that plants draw their food from a solution that is formed in the soil through rainwater, was everyone's belief. It was engraved into my mind. This opinion was wrong and the source of my foolish behavior.
>
> "When a chemist makes mistakes in rating agricultural fertilizers, don't be too critical of his errors, because he has had to base his conclusions upon facts which he can't know from his own experience, but rather, has to take from agricultural texts as true and reliable. After I learned the reason why my fertilizers weren't effective in the proper way, I was like a person that received a new life. For along with that, all processes of tillage were now explained as to their natural laws. Now that this principle is known and clear to all eyes, the only thing that remains is the astonishment of why it hadn't been discovered a long time ago. The human spirit, however, is a strange thing; 'Whatever doesn't fit into the given circle of thinking, doesn't exist'."

This information is an historical introduction to the subject matter of this reference book.

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PREFACE

HUMIC, FULVIC AND MICROBIAL BALANCE: ORGANIC SOIL CONDITIONING is designed for a wide range of individuals who are interested in learning more about alternative methods of safe and productive soil conditioning. Home and indoor gardeners, farmers, agricultural and toxic waste consultants, researchers, and any one who wants to understand our environment better will find interesting and helpful information here. The book includes an overview of scientific studies and reports contributed to our body of knowledge by over 1,500 authors and researchers. In preparing this volume, I examined over 70,000 pages of documentation from universities, researchers, and authors all over the world. I have explained why organic balance is essential to a healthy world and how it can be achieved.

The agricultural industry has experienced major changes during the past 50 years. The acceleration of mechanical technology has precipitated ingenuity and economic change. New methods, procedures, and stimulants (including man-made chemicals) have been employed in the struggle for financial survival. Many new ideas have been abused. In some cases, the long term effects of these developments have not been researched adequately. Problems of environmental toxicity are becoming apparent around the globe. Food lacks the nutrients we expect, fields are becoming sterile, and ground waters are polluted.

What is the problem? Is anyone honest and brave enough to answer? Do pride, propaganda, and profit blind both farmers and consumers? Land owners are losing the fertility of their soil; many family farms are gone forever, or in many cases, they are only days from bankruptcy; and consumers are complaining of serious health problems. The dramatic battle for survival is being lost.

Who is the winner in this scenario? Is it possible that anyone can profit in the long run if we don't survive? Is it possible that the few who might profit most in the short run influence government, research, and the dissemination of information in negative ways, and that the lives and well being of the masses are unimportant to them?

But if I am one among the masses and you are one, why don't we come up with some answers for ourselves? Maybe our responsibility is not to change the world. Perhaps we must only make our little part of the world safer and more productive for ourselves, our family, and our neighbors. We must start where we are and make a difference in the lives of those around us.

HOW TO READ THIS BOOK

(text not included in this document)

OVERVIEW OF BOOK

The chapters of this book will lead you from an historical point of beginning through the processes involved in the accumulation and the abundance of organic matter, the function of humic and fulvic acids, and the involvement of microorganisms in nature's life cycle. I have attempted to explain electrochemistry and how organic materials assist us in relatively uncomplicated language. Topics such as water, nitrogen, clays, silicates, metabolic stimulants, and natural insect control are discussed. Chapter 12, "Bless Our Fields," gives documented percentages of increases in crop yields associated with the use of organic soil conditioners. This chapter also provides general guidelines for using organic soil conditioners. Chapter 13, "Heal Our Lands," discusses methods and materials that can be used to remediate toxic environmental conditions. The last chapter, "What Can I Do to Help?," describes practical application plans each of us can implement.

It is my hope that this reference book will meet your needs and foster a better understanding of nature's processes. You have my best wishes as you endeavor to make our world a better and healthier place to live.

William R. Jackson, Ph.D.

Chapter Highlights:

The inhabitants of spaceship earth must understand and protect their soils from the destructive forces of erosion and the depletion of land nutrients. Good soil management includes careful tillage practices, sound soil conservation, and the proper utilization of crop residues.

"Fire is the Sun unwinding from the tree's log. The Earth revolves and the trees revolve as the radiation from the Sun flame reaches the revolving planet Earth. By photosynthesis the green buds and leaves of the tree convert that Sun radiation into hydrocarbon molecules, which form into the bio-cells of the great, outer, cambium layer of the tree. The tree is a tetrahedron that makes a cone as it revolves. The tree's three tetrahedral roots spread out into the ground to anchor the tree and get water. Each year the new, outer-layer, green-tree cone revolves 365 turns, and every year the tree grows its new tender-green, bio-cell cone layer just under the bark and over the accumulating cones of previous years. Each ring of the many rings of the saw-cut log is one year's Sun energy impoundment. So the fire is the many-years-of-Sun-flame-winding now unwinding from the tree. When the log fire pop-sparks, it is letting go a very sunny day long ago, and doing so in a hurry."

Chapter Figures:

Chapter Highlights:

Imagine abundant stored energy available at your fingertips! Developed power for daily disposal! Some people manage it; other people market it. More research is needed to further develop it, but everyone must learn to conserve it while blessed by it.

Carbon dioxide enters the atmosphere through:

1. Exhaling animals and plants;
2. Bacterial action on decaying and decomposing organic matter; and
3. The burning of carboniferous fuels.

Carbon dioxide vacates the air predominantly through absorption by plants and the sea.

Approximately 1 to 10% of organic matter becomes resistant to decomposition and degradation and escapes recycling. Water was designed to carry much of this resistant material, which is refractory or highly transformed and is known as water humus. Humic compounds present in bodies of water react with metals and clay minerals to form organometallic and organo-clay complexes.

A portion of this sunlight energy is utilized by plant life on land and part is used in the oceans to convert between 32 and 146 billion tons of carbon into living material each year. This conversion of carbon takes place through the engineered design of photosynthesis.

These organic compounds sustain all life directly, in the photosynthetic organism itself or any organism that consumes it, or indirectly, in larger animals that occupy the higher levels in various food chains.

The manufacturing process, or synthesis of organic combinations by living plant cells from inorganic substances using water and carbon dioxide, is part of the design that includes all living things--plants, animals, and humankind.

The principal course in which carbon moves from the nonliving world to the organic, living world is through the process of photosynthesis in green plants. Through a series of reactions, green plants remove carbon dioxide from the air or water and link it, molecule for molecule, with a special compound called a carbon-dioxide acceptor. Additional reactions merge energy from sunlight and hydrogen (from the splitting of water molecules) into the new molecules, eventually creating more of the carbon dioxide acceptors along with carbon-rich organic compounds required by plants.

In fact, all life processes require a continuous supply of usable energy. Light energy, which is converted by photosynthesis to the potential chemical energy of organic matter, and oxygen are the only significant primary sources of energy for life. Living cells then respire, combust, or "burn" these organic compounds with oxygen. This design is the "unwinding of the sun" (see Chapter 1). It includes harnessing part of the energy released by reuniting oxygen with the elements carbon, hydrogen, nitrogen, and sulphur for use in various life processes such as movement, growth, and duplication. As oxygen consolidates with these elements, oxides are formed such as carbon dioxide, water, nitrate, and sulphur, and their cycle is consummated.

Organic matter in soil consists of a whole series of products that can range from undecayed plant and animal tissue, through products of decomposition, to fairly stable but indeterminate brown to black material demonstrating no trace of the anatomical structure of the formerly living organisms from which it originated. In our study here, these materials in the soil, regardless of their stage of decomposition, are referred to as organic mater. The dark colored, homogeneous substance that behaves with a degree of resistance to further decomposition is referred to as **humus**.

Chapter Figures:

Chapter Tables:

Chapter Appendices:

Chapter Highlights:

During the life cycle, all living organisms experience a certain period of growth and then all of them eventually die. The physical remains of the dead organisms then experience intense transformations brought about by a multitude of microorganisms. This is the genesis of humification, the breakdown of organic matter into humic material. While the microorganisms are involved in decay and disintegration, many compounds containing carbon are completely mineralized, releasing carbon dioxide to the atmosphere. This completes the carbon dioxide cycle.

The microorganisms in our environment act by initiating humification through biochemical transformation of complex carbonaceous substances. They are involved in a series of reactions caused by their enzymes that decompose dead plant and animal tissues, thus disintegrating parts from complex polymers into simple segments. All biochemically produced organic compounds can be digested by microorganisms.

Soil microorganisms perform many activities that make powerful contributions to our ecosystem. The fertility level of the soil depends so heavily upon microorganism activity that if they were to fail, life for higher plants and animals would cease.

Humification by microorganisms involves complex carbon compounds being digested and disintegrated into simple forms. These simple forms are then remanufactured, transformed, resynthesized, and recombined into altogether new and different combinations and sequences of now new complex polymers. As the original material is broken down and new combinations are assembled, these new multiple combinations are forming humic molecules.

Numerous soil bacteria are capable of producing an abundance of extracellular polysaccharides that perform many functions such as adhesion, protection against dehydration, ion exchange and selection, tolerance to metals, and recognition and immunization protection against predators.

In addition to functioning as a reserve of energy, soil humic substances can form stable complexes with some metals and thus influence the availability of these complexes to plants and microorganisms.

Except for a plant's invagination of nutrients by absorption, plants seldom can take up substances of high or low molecular weight. Because the majority of soil organic matter consists of high-molecular-weight materials, the value of soil microorganisms becomes apparent. Soil microorganisms break down high-molecular-weight material, and thereby these biodegradable substances can better serve as a major food source for plants.

With the accelerated use of commercial farm chemicals thought to be necessary to modern agriculture, the study and use of soil microbes becomes increasingly important in revitalizing the soil rapidly, safely, and economically.

Microbial transformations of cellular makeup result in many chemical and biochemical reactions leading to the vast number of products of decay and disintegration. This activity eventually results in the beginning of a group of compounds commonly known as humic substances. This material makes up 50 to 80% of the organic matter in natural waters, sediments, soils, peat bogs, and other natural ecological systems.

Chapter Summary:

Humification is the most universal biogeochemical phenomenon in the biosphere, and humic compounds are among the most plentiful organic compounds on and around our spaceship earth. These organic materials exist in our soils, sediments, peats, shales, lignites, coals, and all marine environments.

In general, humified energy represents a major part of the organic matter in our waters and sedimentary deposits. It has been estimated that humic compounds make up to 80 or 90% of the total organic matter in certain soils, recent sediments, and water bodies. **Imagine, light energy converted to mass energy, and then humified to "bite size" food energy made usable for spaceship earth's plants and animals as personal energy!**

Chapter Tables:

Chapter Appendices:

Chapter Highlights

In general, organic matter in the soil protects growing plants from sudden alterations in their chemical environment and preserves moisture in times of drought. Organic substances help keep soil crumbly, easily tilled, well-aerated, and relatively free of drainage problems. These conditions permit young seedlings and growing plants an excellent opportunity for growth.

The use of humic substances has enhanced the fertility of various soils by improving their physical characteristics, such as crumb structure, drainage, and aeration, that affect the movement of water and nutrients. This facilitates the transport and availability of inorganic nutrient elements, especially trace minerals. In this manner, a more favorable environment is created for plant growth.

We generally understand that organic matter is the residue of previously living plant and animal life, particularly plant substances, including both roots and top growths in various stages of decomposition and transition. If these materials are left on the land, they rot and decompose. Thus, under favorable climatic and weathering conditions and in conjunction with the necessary presence of numerous types of microorganisms, the materials naturally go through chemical changes over time and become part of the soil.

Organic materials are decomposed in the soil by living microorganisms, primarily bacteria, fungi, and actinomycetes. These and larger organisms such as earthworms and insects ingest organic residue and soil, thereby binding these substances together as stable aggregates in soil particles. Almost all properties of soil are affected by its organic matter.

Humic substances, the major organic components of soils and organic marine sediments, are widely distributed over the earth's surface and occur in almost all terrestrial and aquatic environments. Because approximately 70% of the total soil carbon is found in humic materials, the role of carbon in the carbon cycle as a major source of carbon dioxide and as a carbon reservoir is often underestimated.

Generally speaking, the productivity or crop yield of soil enriched with humic materials increases. The high-molecular-weight humic materials, humic acids, alter the physical characteristics of the soil, while the low-molecular-weight humic substances, fulvic acids, are involved in chemical reactions in the soil that in turn influence plants' metabolic processes.

These effects are the economic value in that they contribute to increased yields and to improved crop quality, including the storage life of perishable crops.

The role of humic substances in increasing productivity includes more complete utilization by plants of nutrients such as nitrogen, phosphorus, and potassium. In addition, the solubility, mobility, migration, recycling, and accumulation of trace metals through chelation processes of humic compounds play a very meaningful role in the mineral nutrition of soil grown plants. The participation of humic substances in plant respiration occurs either through their acting as respiratory catalysts or through other mechanisms that increase oxygen absorption by plant tissue. This is ecologically significant because it enables plants to withstand better the adverse effects of higher and lower temperature exposures.

Chapter Summary:

In the unwinding of the sun, we experience light energy available to spaceship earth. The radiation of the sun is involved in the action and design of photosynthesis through green buds and leaves. Also involved are various heats, the passage of time, and earth pressures. Through digestion, disintegration, and transformation processes, humic substance molecules are manufactured, representing sun-energy impoundment. This is light energy converted to mass chemical energy, thus humified and made available and usable to spaceship earth plants and animals as biological energy. Truly this is the unwinding of the sun reflected as the carbon power pack, in the form of humic hope. Humic substances may or may not be beautiful, but they do such beautiful things!

As trustees, this humic hope is available from our savings reservoir--stored energy available for daily withdrawal to supplement our personal needs. Humic substances do make better crops possible! Worn soil can be improved and crops can be cultivated to their full potential. "Correction burns" can be practiced in agriculture to improve our agronomy and thus re-establish a safe and economically productive course. Remember: The high-molecular-weight humic substance, humic acid, alters the physical characteristics of the soil, while the low-molecular-weight humic substance, fulvic acid, is involved in chemical reactions in the soil that influence plants' metabolic processes.

1. Humic substance is the end product of decayed matter and usually contains large quantities of trace minerals. It contains up to 5,000 calories per gram, providing energy, that can be used for plant growth.
2. Humates (metal complexes of humic acid) supply growing plants with food. They also act in other important ways to make soil more productive and fertile.
3. Humic substance increases the water holding capacity of soil; therefore, it helps plants resist droughts and produces better crops in reduced water conditions.
4. Humic substance breaks up unproductive clay soils, turning them into profitable soils.
5. Humic substance helps retain water soluble inorganic fertilizers, releases them, as needed, to the growing plants, and helps prevent soil leaching.
6. Humic acid stimulates seed germination and viability, and root respiration, formation, and growth.
7. Humic acid reduces other fertilizer requirements and increases yield in crops such as cotton, potatoes, wheat, rice, tomatoes, corn, beets, etc. .....
8. Humic substance fosters improved drainage.
9. Humic substance increases aeration of the soil.
10. Humic acids increase the protein and mineral contents of most crops.
11. Humates establish a desirable environment for microorganism development.
12. Humic substances produce thicker, greener, and healthier corps.

Chapter 6 further considers the merits of humic substances. This chapter, "Fulvic Phenomenon," describes the marvel of low-molecular-weight humic substances, fulvic acids, which provide many chemical reactions in the soil that influence plant metabolic processes.

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Chapter Appendices:

Chapter Highlights:

Brief summary list of the unique functions of fulvic acids:

1. Assistance in seed germination and growth.
2. Improved development of roots and shoots.
3. Resistance of plants to fungal attack.
4. Metal complexing and nutritional physiology.
5. Enhanced uptake of nutrients.
6. Stimulation of plant metabolism.
7. Chelation and effects on the plant growth cycle.
8. Positive effect on plant RNA and DNA.
9. Catalysts in plant respiration.
10. Increased metabolism of proteins.
11. Increased activity of multiple enzymes.
12. Enhanced permeability of cell membranes.
13. Enhanced cell division and cell elongation.
14. Aid to chlorophyll synthesis.
15. Increased drought tolerance.
16. Increased growth and yield of crops.
17. Assist denitrification of microbes.
18. pH buffering capacity.
19. Special chemical affinity for balance.
20. Participation in synthesis of new minerals.
21. Chemical weathering of inorganic substances.
22. Silicate decomposition by hydrogen ions of fulvic acids.
23. Aid in the creation of fertile new soil.
24. Ability to scavenge heavy metals.
25. Detoxification of various pollutants.

For our survival and economic purposes today, we as trustees of spaceship earth will concentrate in this chapter on the early diagenetic product, fulvic acids. What are they? How do they function? Is the magic definable?

The concentration of acidic functional groups in fulvic acids is substantially higher than in any other naturally occurring organic polyelectrolyte.

Among the humic materials, water-soluble fulvic acids are especially important because of their abundance, mobility, and ability to complex or chelate metal ions and interact with silica. It has been demonstrated that these interactions may increase the concentrations of metal ions and silica found in water solutions to levels that are far in excess of their assumed dissolution ability. Thus, fulvic acids in water solutions may not only bring about the dissolution or degradation of existing minerals, but may also lead to the synthesis or manufacturing of new minerals by permitting the complexed and dissolved metals and silica to form new combinations

It is important from the point of soil science that fulvic acid can bring into a water solution substantial amounts of potassium, aluminum, iron, magnesium, and silicon from micas.

The literature review confirms that from the biological standpoint, the metal chelating ability of fulvic acids is perhaps the most important factor in the growth cycle because it plays a vital role in the nutritional physiology of not only single cell algae but also of higher plants. Sufficient experimental evidence has accumulated in the past few years to show that humic substances of apparent lower-molecular-weights (fulvic acids) are biologically more active than those of higher-molecular-weights (humic acids).

Iron, for example, is needed by basically all plant life, but its transport through the plant is very difficult. As fulvic acid chelates or complexes the iron and because of the fulvic acids' ease of transport throughout the plant, the iron, now reduced in size and a part of the fulvic acid complex, can "piggyback" with the fulvic acid in a way that is acceptable to the plant.

Schnitzer concluded that fulvic acid is a highly oxidized, biologically stable, water soluble, naturally occurring complexing agent that can complex divalent and trivalent metal ions and hydroxylated metal compounds that assist interaction with clay minerals. Because fulvic acid is found to some extent in all soils, it is possible that it will profoundly affect the supply and availability of nutrients to plants and their total biological system.

Aquatic humic substances, often referred to as stream humic substance, usually consist of approximately 90% fulvic acids and 10% humic acids. Phosphorus and nitrogen are present in stream humic substance as structural components as well as functional groups. Nitrogen and phosphorus are much more prevalent in the fulvic acids and humic acids of the stream **sediment** than in the fulvic acids and humic acids found in the stream itself.

The summary of these studies indicates that aquatic fulvic acids and humic acids definitely affect not only the concentration, fate, distribution, and reactivity of many organic and inorganic aquatic materials, but also the microbiology of these humic materials as well.

By the reactions of polymerization and condensation, fulvic acids are transformed into acid-insoluble, base-soluble, high-molecular-weight humic acids. Following this sequence, as polymerization, polycondensation, and aromatization occur over time and with the depth of burial, the high-molecular-weight, base-soluble humic compounds become more condensed and gradually form insoluble humins and/or protokerogens. Eventually, they are transformed into kerogens.

To understand the immense importance of fulvic acids in altering the chemical characteristics of trace metals in the soil environment requires an understanding of the mechanisms by which the metal ions are combined with the humic substances.

In addition to the nutritional benefits of humic substances, fulvic acids affect the growth of plant life by stimulating various physiological and biochemical processes related to cellular metabolism.

Humic substances, specifically fulvic acids, are involved in the relief of oxygen deficiency, thus increasing the heat resistance of plants and enabling plants to withstand drought better.

Fulvic acid is physiologically active in enhancing plant growth, in influencing enzyme activities, and in providing selective effects on many biochemical processes. This low-molecular-weight substance was found to have a positive effect on root initiation that appeared to be related to its metal complexing ability.

There is evidence that all humic compounds, especially those of the fulvic acid fraction, are excellent natural chelators and cation exchangers. These functional properties of fulvic acid are vitally important in the nutrition of all higher and lower plants.

An impressive number of field observations and substantial experimental evidence indicate that the fulvic acid fraction of organic compounds directly and/or indirectly influence the chemistry, physics, and biology of spaceship earth's plant life. At the same time, the scavenging of heavy metals and the detoxification of pollutants also are related to the fulvic phenomenon. This subject is covered in more detail in Chapter 13, "Heal Our Lands."

In general, multiple biochemical and geochemical processes develop as a result of physical and chemical modifications to the environment. The fulvic phenomenon is responsible for a surprising number of these modifications. Spaceship earth is empowered by the fulvic phenomenon. With the magic and the miracle of a dynamic electrolyte, humic substance creates a natural balance for many life processes.

Chapter Highlights:

At the death of electric potential, life is reduced to zero and the biological and histological components of plants and animals are resolved back into the simple elements of the earth and air.

If we start with a plant sample, we understand that all living things are composed of small units of matter called atoms. The union of atoms forms molecules, and molecules are organized into cells. Cells of the same sort form tissues, and various types of tissues make up this plant sample. All living things are made up of chemical combinations, organized to provide an orderly structure and to perform specific functions necessary for life.

Knowledge of the "atom family" principles will be helpful later in this chapter as we discuss applications for multiple crop and soil needs and the potential of balancing the atoms with the assistance of humic and fulvic acids.

Plant life dominates our environment and performs a variety of services for all living things. The sun beams energy to our spaceship earth. This energy source is available to all plants and living things, which use approximately 2% of the energy that reaches our spaceship earth. This 2% of the sun's energy is sufficient to sustain not only plants but almost all other living things. The ultimate source of physical energy for life on earth is derived from the sun.

Many benefits are brought about by the action, reaction, and results of polyelectric chemistry as it relates to humic substances. The components of humic substances interact with a diversity of organic and inorganic materials in soil as well as water. This association of humic compounds with other matter involves a wide range of chemical bonding. An important aspect of humic substances is related to their sorptive interaction with environmental chemicals, either before or after they reach concentrations toxic to living organisms.

A better understanding of the chemical makeup of various complexes would benefit the development of more efficient methods of extraction and purification of humic acids and fulvic acids. It would provide useful information regarding the role of humic substances in soil forming processes, soil structure formation, nutrient availability, and the mobilization, transport, and immobilization of microelements and toxic elements in aquatic environments or liquid application.

Aside from the variation in molecular size, humic acids and fulvic acids share a number of similarities. The major components of humic acid and fulvic acid are carbon and oxygen. The percentage of carbon in humic acid is from 50 to 60%, while fulvic acid generally contains 40 to 50% carbon. The amount of oxygen found in humic acid will range from 30 to 35%, but the oxygen range for fulvic acid is from 45 to 50%. Because of the additional amount of oxygen in fulvic acid, it tends to have more oxygen containing functional groups **capable of metal chelation.**

Under most circumstances, carbon bonds to hydrogen, oxygen, nitrogen, or another carbon atom. This ability of carbon to bond to itself makes carbon chains of various lengths and shapes possible.

Humic substances are characterized by a polydynamic electric potential and a variety of binding sites leading to chemical heterogeneity. Binding of ions to these substances is influenced by both this electric potential and the variety of sites. The interaction between metal ions and organic materials, including humic substances, determines to a great extent the bio-availability and mobility of heavy metal ions.

Fulvic acids of any nature and origin contain indigenous (native) organics of indefinite structure. The unpaired electrons of these acids, known as free radicals, are unstable compounds with an extra electron or proton. They are extremely reactive with other molecules and have a very short half life. These free radicals are responsible for the numerous functions and balancing processes of fulvic acids in the environment.

Chapter Conclusion:

In summary, let us return to our soup and cornbread. The plus and minus ingredients of life, the elements in our "kettle," consist of combinations, complexes, and compounds that are mathematically unbelievable and experientially astounding! With humic hope, the "magic" phenomena of fulvic acids for seasoning and balance, and the industrious labors of microorganisms, we can experience a wonderful aroma from our environmental "kitchen." **Nature's combined elements can be so positive, pleasing and productive!**

Chapter Outline:

Chapter Figures:

Chapter Tables:

Chapter Highlights:

Soil is a **renewable resource** that can be **used** and **improved** if it is better **understood.**

The *Western Fertilizer Handbook,* published by the California Fertilizer Association, stated that an **ounce** of soil may have surfaces totalling **250,000 square feet.**

Microorganism activity in one acre of soil expends about the same amount of **energy** in soil preparation as 10,000 people would burn for the same work for the same period of time.

A very moist soil has a thick film of water around its particles and, therefore, requires low suction for removal. A drier soil has a thin film of water and, thus, requires stronger suction for removal.

Humic and fulvic acids have a very positive effect on the **water holding capacity** of the soil. These organic substances also allow the reduced supply of water in its very thin film to be **more easily released** during drought conditions, thus **made available** to the roots of plants. Fulvic acids also assist in the **development of better, stronger, and larger root structures** to assist with the uptake of water and nutrients.

Under **drought** conditions, humic and fulvic acids help balance water and assist plant **transpiration** (water and nutrient transport).

The balancing phenomenon of **fulvic acids reduces plants' water requirements.**

Humic and fulvic acids assist the balance of water under drought conditions, increasing plant **respiration** (breathing of oxygen under stress).

Fulvic acid helps water **penetrate and permeate** plant cells, assisting **nutrient uptake** and **water storage** during drought conditions. Fulvic acid may balance water during drought and assist in the accumulation of soluble sugars, helping to **prevent wilting.**

Electrolytes in solution, especially in water or aqueous solution, **conduct electrical current.**

The powerful organic electrolyte, **fulvic acid,** is **dissolved** by water, **transported and amplified by the water,** combining to make a transport material of **high electrolytic action.**

Water is the only common molecule that can be a solid, liquid, or gas depending on the environmental temperatures. This makes it **very available** for everyday use!

Acids lower the pH of a solution. Any pH below 7 indicates that there are **more** hydrogen ions than hydroxyl ions.

Bases increase the pH of a solution. Any pH above 7 indicates that there are **fewer** hydrogen ions than hydroxyl ions.

Consult the pH scale (Figure 8.5) to see logically why pH **balance** is so important.

One of the valuable characteristics of humic substances is the **ability to absorb and retain** quite large amounts of **water.**

Water vapor or humidity tends to cluster around and bond to fulvic acids and humic acids. This is referred to as water sorption.

1. Fulvic acid adsorbs much more water than humic acid due to the additional oxygen in fulvic acid.
2. In fulvic acid, hydrogen bonded water molecules appear to cluster.

Microorganisms produce thick, sticky polysaccharides that conserve moisture in the soil.

Humic and fulvic substances **reduce soil erosion** through the increased cohesive force of the very fine soil particles to electrolytic water.

Humic and fulvic acids solubilize in water and make available to plants certain nutrients and trace minerals that would be unavailable otherwise.

Chapter Summary:

Water, water (every)where, with more of nature's help than we could ask or think; water, water (every)where, nor any reason for crop production rates to sink! As we consider the information we have studied in this chapter, we can now aggressively pursue some additional soil and crop conservation and management techniques for spaceship earth.

(Summary of highlights not included in this document)

Humic and fulvic acids combined with water provide a highly productive material with many very unique properties. The value of this unique combination of nature is in its productivity and its natural safety.

Our next chapter deals with a very popular and important subject. Everyone knows the value of nitrogen to plant life. On the other hand, are there some things we may not know? How do we determine a balanced application? What happens if too little is applied? And, if too much is applied? Can nature help balance nitrogen in natural systems?

Chapter Outline:

Chapter Figures:

Chapter Highlights:

Nitrogen compounds furnish **amino acids** and thus **proteins** for the protoplasm in **all living cells.** In addition, they are important in **nucleic acids, enzymes,** and **chlorophyll** activity.

Bacteria are the agents by which **90%** of needed nitrogen of the air is converted to useful compounds.

Because nitrogen-fixing microorganisms do not require fossil fuel energy and do not cause pollution, soil science is now directing its research toward developing a way to make all plants capable of forming nodules, along with genetic work in the field of DNA techniques so plants can contain the biochemical ability to fix nitrogen on their own.

REMEMBER: **Microorganism activity** in **1 acre** of soil uses about the same amount of **energy** in soil preparation as **10,000 people** would burn for the same work, for the same period of time. Microorganisms must be **protected** and **nourished,** and **replaced** in the event of death.

There is a **nitrogen reservoir** in soil humus. This humus serves as a conditioner and stabilizer to the soil ecosystem. Humus serves as a nitrogen buffer, protecting plants against abrupt changes in the nitrogen supply.

Chapter Summary:

Nitrogen, the most plentiful element in spaceship earth's atmosphere, furnishes nitrogen compounds to all living cells that convert it to amino acids and proteins. Nitrogen compounds also contribute to nucleic acids, enzymes, and chlorophyll needed for life activities.

Microorganisms, specifically bacteria, are the principal agents in the nitrogen cycle, helping convert approximately 90% of all nitrogen used by living cells to useful compounds. More research is needed to develop natural ways for plants to become capable of creating their own required nitrogen. Until then, caution must be used to prevent the interruption of nature's balanced nitrogen system. Microorganism life must be guarded and nurtured. Jansson argued that **understanding the nitrogen reservoir contained in the soil humus will assist us in better using humus as a conditioner and stabilizer in the soil ecosystem. Humic material in soil can provide a slow-acting source of essential nitrogen to the plants while it continues to function as a buffer, protecting plants against abrupt changes in the nitrogen supply.** These dynamic functions are of great significance for a balanced and dependable level of crop production and crop efficiency.

Our next chapter is of equal importance to us as we learn more about how humic and fulvic substances can help us return to a more balanced organic soil condition. The specific subject matter involves the role clay and silica can play when exposed to humic and fulvic treatment.

Chapter Outline:

Chapter Tables:

Chapter Appendices:

Chapter Highlights:

The most plentiful single minerals are silicates or clay. This abundant component of sedimentary rocks makes up approximately 40 to 50% of all the minerals in these rocks.

Amino acids constitute the most abundant form of soil nitrogen, and they form stable complexes with clay minerals. Nitrogen remains available in the soil due to its secure bonding and tenacious linkage with clay minerals.

Fulvic acids are enriched in a variety of reactive abilities and are the most reactive compounds with metals and minerals. Fulvic acids react particularly well with clay minerals.

Humic acids do react with clay minerals, but at a much less rapid rate than fulvic acids, while being absorbed onto clay surfaces.

Chemical ionic bonding uses the affinity of humic acids and fulvic acids for clay surfaces. It assists the ionic potential or polarizing power of cation exchanges, in electron acceptor interactions with electron donors from humic and fulvic acids.

The positive and negative dipole charges from the fulvic acid activity on the clay minerals allow the electrolyte to penetrate the tight clay layers and reduce the compaction of the clay, thus lessening soil crust, clods, hardpan, and general tillage problems. Water management, tilth, and aeration benefit.

ORGANO-CLAY COMPLEXES MODIFY the collection of soil particles in several ways:

- Permeability
- Porosity
- Water-retaining capacity
- Adsorption characteristics
- Surface area
- Cation exchange reactions

Because of chelation reactions, humic and fulvic substances have a dissolving effect on clay minerals.

Chelation reactions occur as humic and fulvic acids weaken the structure of the clay minerals by extracting divalent and polyvalent cations (positive ions). These reactions are involved in the weathering of rocks.

The lower the molecular weight (fulvic acids), the greater will be the concentration of reactive functions to resist coagulation and flocculation. Thus there is the possibility and probability for positive action with beneficial results to break down and aerate tightly locked clay soils, as well as compacted hardpan.

Humic and fulvic acids play a definite role in liberating fixed potassium due to their chelating power.

Fulvic acids, the lower-molecular-weight fractions of humic compounds, are capable of penetrating the inner spaces of expanding clay.

Zinc fulvic salts improve the movement of chelated zinc ions to plant roots and thus improve the yield of crops.

Phosphorus is bonded to humic and fulvic acids in the presence of complexed zinc. Thus, phosphorus and zinc fulvic salts and associated complexes improve the movement of nutrient ions to plant roots and improve crop yield.

Fulvic acids are the low-molecular-weight, **water soluble** humic fractions that are abundantly present in soils and water and create reactions with clay.

Chapter Summary:

Humic and fulvic acids and clay minerals play a very important role in the balanced development of plant life because this combination provides bonding, weathering, etching, dissolving, and desorbing. These processes transform rock-forming minerals into functional plant food. The most plentiful single minerals are silicates or clay, and this abundant component of sedimentary material makes up approximately 40 to 50% of all the minerals available to us. Included in this combination are electrical charges arising from various sources, most specifically aided by fulvic acids and their activities. The cations provided function as bridges between the anionic groups of organic polymers and the mineral surfaces of the clay.

Amino acids are the most abundant form of soil nitrogen, and increases in nitrogen result when amino acids form stable complexes with clay minerals. The secure bonding and tenacious linkage with clay minerals allows the nitrogen to remain available to the soil and thus to the plants. This bonding occurs due to fulvic acids and their variety of reactive abilities and functions. Although humic acid does react with clay minerals while being adsorbed on clay surfaces, the reaction is at a much less rapid rate than that of the fulvic acids. Because of the function of chelation, humic and fulvic acids have a dissolving effect on clay minerals. This reaction occurs as the organic substances weaken the structures of the clay minerals and involves the weathering of rocks.

The positive and negative dipole charges provided by the fulvic acid activity on the clay minerals allow the electrolyte to penetrate the tight clay layers and reduce the compaction of the clay. Thus fulvic acid improves the growth potential within the collection of soil particles: the soils' permeability is increased; while crust and clods are broken down; crumbling, general porosity, and tillage are improved; water retaining capacity is increased; adsorption characteristics are improved; hard pan is degraded; and cation exchange reactions are increased. Humic and fulvic substances are phenomenal in their positive impact on clay minerals and in their contribution to good soil management.

The following chapter is an exciting chapter because it discusses the possibility of plants developing to their natural potential, which is much greater than that to which we often are accustomed. Are there such things as bio-regulators? What are RNA and DNA, and how do they affect plant metabolism? Can DNA be programmed to help plants reach their natural, healthy, and nutritional potential?

Chapter Outline:

Chapter Figures:

Chapter Appendices:

Chapter Highlights:

Growth promoting effects of humic and fulvic acids are a result of chelation and cation exchange activity. The ability of **fulvic acids to enter the plant cell membrane may also sensitize various physiological functions.**

REMEMBER: **Raise** all you can, and **save** as much of it as you can, so you will **go to market** with the most that you can. Jack will be proud of **your** bean stalk!

Amino acids and proteins are enzymes that increase the speed of the "cold" chemical reactions within cells.

No reaction can occur in a growing plant cell unless its own personalized enzymes are present and active.

Heat or "warm chemistry" causes an increased number of effective collisions between molecules, thus chemical reactions occur more frequently when the energy of activation is available. Enzymes lower the amount of energy necessary for activation. Enzymes are most effective at optimum temperature and acceptable pH.

Coenzymes, nonprotein organic molecules, attach to enzymes and function as carriers for both chemical groups and electrons.

PLANTS RESPOND TO FACTORS THAT REGULATE GROWTH

External examples: light, length of day, temperature, gravity.

Internal examples: natural plant hormones. These naturally occurring hormones have a particular chemical structure and regulate plant growth.

Auxins are natural plant hormones that promote the growth of plant cells in roots, shoots, leaves, flowers, and fruits by controlling light reception and making sugars available to the plant. Humic and fulvic substances include auxins, or function as auxins, and thus have a positive effect on plant metabolism.

Gibberellins are natural plant hormones, that help regulate **balance** in plant development, affect cell division and stem elongation, and **trigger DNA gene codes** for enzymes that break down starch and awaken seeds and buds.

Natural Plant Growth Regulating Hormones

Type	Function
Auxins	Cell elongation
Gibberellins	Stem elongation
Cytokinins	Cell Division

Organic growth regulators involve certain functions of DNA, including specific enzymes that cause cellular growth and cell division as follows:

1. Cell division enhancement
2. Regulation of the structure of the plant
3. Enhancement of cell enlargement
4. Delay of plants' degenerate aging
5. Activation of metabolism-directed transport
6. Substitution for or interaction with light
7. Increase in stomata opening and transpiration

Organic nucleic acids of DNA and RNA form the basic foundation of all heredity materials. Cytokinins can be rather easily formed from subunits of nucleic acids, allowing humic and fulvic acids to stimulate the production of high levels of chlorophyll, enzymes, etc., thus encouraging greater plant growth and general plant health.

Organic glycosides are widely found in nature and are made up of sugars or glucose, plus the natural plant alcohol or phenol molecule. Glycosides are found where plant metabolism is active. Glycosides include plant sterols and natural hormones that affect plant growth and help ward off harmful insects, foreign organisms, and plant infections.

Organic porphyrins furnished by humic and fulvic acids assist plants in trapping light energy and then assist in the transfer of that energy through the electron transport system. This accelerates the various growth mechanisms of plants through improved photosynthesis.

Organic morphogens assist in ending plant dormancy, while also stimulating the development of cyanobacteria, thus increasing nitrogen fixation. Vitamin A is critical to light reaction and energy transport in higher plants. These pigments serve to cause intermolecular excitation of the energy transfer through control of wavelengths of light, which assists in the development of chlorophyll and contributes to photosynthesis.

Is the unwinding of the sun's energy into the form of carbon, which is then stored in the form of humic and fulvic acids, related to the monopole-tachyon concept? Is water the conductor, transporter, and amplified activator of the electrolytes within fulvic acids? Is this electrolyte energy then duplicated in multiple templates or patterns of energy and dumped into the mass of water to distribute the information of growth energy through the plant's DNA? Does this energy message actually become part of the growth-regulator balance?

WATER AS A BALANCED GROWTH REGULATOR:

1. Water polymers are templates or patterns for the generation of more polymers.
2. Water carries the informational content of the solution which influences the plant DNA.
3. The effective blending of water with electrolytes, for example fulvic acids, propagates the information content of the fulvic acids by way of the templates which pass this information on to the water mass.
4. Fulvic acids, for example, have an influence on water in that the nuclei of atoms within the water are charged or magnetized; thus, minerals and compounds are involved in a specific magnetic configuration, assisting in the informational message to the plant's DNA.

Humic and fulvic acids affect plants and soil and activate DNA and RNA. This activity has a positive growth regulating effect on the cells of plants and microorganisms.

METABOLISM IS STIMULATED BY ORGANIC SUBSTANCES

1. Humic and fulvic acids facilitate oxygen uptake and intensify oxygen metabolism.
2. Humic and fulvic acids induce chelation, resulting in:
   a. Improved solubility and availability of nutritional trace minerals.
   b. Scavenging of toxic metals.
   c. Prolonged residence of phosphates, silicate, and other nutrients.
   d. Activation or triggering of the regeneration of additional nutrients.
   e. Delay of precipitation of trace minerals.
3. Humic and fulvic acids heighten metabolism through increased plant respiration.
4. Energy robbing stress is warded off by humic and fulvic acids, which also aid plant use of oxygen.
5. Root and foliar feeding of humic and fulvic acids greatly assist chlorophyll content.
6. Application of humic and fulvic acids aids in heat resistance of plants and allows plants to tolerate drought better.
7. Plants treated with humic and fulvic acids experience increased cell permeability and, thus increased uptake of nutrients.
8. Humic and fulvic acids change the pattern of metabolism of carbohydrates and thus cause an accumulation of sugars to help avoid wilting.
9. Humic and fulvic acids respond as, or similar to, auxin-like components.
10. The net effect of humic and fulvic acids on growth involves the interaction of a series of biochemical stimulations and inhibitions that have a direct and selective effect on plant metabolism.

PLANT RESPONSE TO HUMIC AND FULVIC SUBSTANCE

1. Activating materials are absorbed by the seeds, roots, and leaves; this affects plant metabolism and growth.
2. Researchers at the University of Georgia reported fresh weight yield increased by 13 to 170% for shoots and by 122 to 477% for roots; dry weight increased by 247 to 353% for roots.
3. Plants respond to humic and fulvic acids which function as hydrogen acceptors and oxygen activators. Small amounts enhance the efficient uptake of nitrogen.

ORGANIC VITAMINS AND ANTIBIOTICS

1. Organisms in the soil produce vitamins that influence the development of plant life.
2. Organic vitamins, auxins, and plant hormones are significant products of the decay or humification of organic substances.
3. Antibiotics produced by soil bacteria, fungi, and actinomycetes serve an important role in helping to maintain a safe, balanced microbial population.

ORGANIC REGULATION OF PLANT CELL METABOLISM

Humic and fulvic acids turn on the activator "switch" of genetic mechanisms. The plant cells respond by converting more carbon dioxide into carbohydrates, amino acids, and other energy producing materials. Thus:

1. More chlorophyll and various pigments are converted to plant substances.
2. Energy reserves are used for work functions such as osmotic transport, electric energy, mechanical maneuvers, and chemical actions and reactions.
3. Enzyme concentrations stimulate transcription and translation of nucleic acids (DNA and RNA).
4. Plant cells may be fed and stimulated by treatment of seeds, roots, or tops.

PLANT METABOLISM: ROOTS, RHIZOSPHERES, AND EXUDATES

1. Humic and fulvic acids activate plant leaves to cause spontaneous increases in root exudates.
2. Basically, root exudates or "mucigel" consist of carbohydrates, proteins, lipids, vitamins, and plant hormones, available for the plants' continued growth and the microorganism population in the rhizosphere.

ROOTS, HUMIC/FULVIC ACIDS, AND MICROORGANISMS

1. Balance by humic and fulvic substances neutralizes and possibly destroys the damaging effects of disease producing pathogens.
2. Humic and fulvic substances enhance a plant's own "immune system," increasing its ability to defend itself against all types of pathogens.
3. The parts of the plant above ground are affected by the plant's roots, rhizosphere, and their exudates or mucigel. Therefore, the health of the plant, in total, strongly depends on the good health of the root system.

THE RESPONSES OF PLANT PATHOGENIC NEMATODES TO HUMIC AND FULVIC SUBSTANCES AND A HEALTHY MICROORGANISM POPULATION

1. Loss of crops due to nematodes: 12% per year and over $70 billion annually.
2. Basic plant health, stamina, and balance are afforded by humic and fulvic acids and nonpathogenic (nondisease producing) microorganisms, warding off harmful plant parasites and strengthening their genetic control.
3. The plant defense system:
   a. Cytokinin-like response, including thickening of plant cell walls.
   b. Plants produce compounds toxic to nematodes.
   c. Plants can shut down the supply of nutrients, and thus starve the parasite.
   d. Plants give off nutrients that affect the sex ratio of the parasite. By withholding sugar, generally only male parasites (specifically, nematodes) survive.
4. Humic and fulvic substances are involved in energizing the plant to produce these various reactions in a natural manner, as a natural defense mechanism.

5. Nematodes usually occur in mass due to repetitious growth of crops--too frequently for too long in the same soil. This can be largely avoided with good soil conservation practices.
6. Nitrogen fertilizer can be reduced when nematodes are suppressed, allowing improved phosphorus nutrition for the plant.
7. Humates develop various compounds that may interfere with the nematode nervous system, producing a narcotic effect that causes many to become paralyzed and die.
8. The negative effects of pathogenic nematodes are not as severe in soil enriched with organic materials.

MYCORRHIZAE FUNGI (THE GOOD GUYS): A FORM OF ROOT FUNGI

1. Mycorrhizae:
   a. serve as predatory parasites with a network trapping device to catch and hold pathogenic parasites, including nematodes.
   b. produce a sticky, adhesive substance to catch and hold nematodes, for example.
2. Growth increases have been attributed to the existence of mycorrhizae. For example:
   a. 1,600% increase in citrus crop.
   b. up to 4,900% increase for grapes.
   c. an average increase of 122% for soybeans.
3. The mycorrhizal fungi obtain carbohydrates, proteins, and other carbon compounds from roots, and then extend them into the surrounding soil. This allows the plant to release more or fewer carbon compounds into the root cells and, thereby, the plant regulates the abundance of mycorrhizal colonization.
4. The goal is to reduce energy draining nematodes and other harmful parasites and to enhance the mycorrhizal fungi influence, thus yielding the following benefits:
   a. amplified growth and intensified plant development.
   b. cultivated resistance to plant pathogens and disease.
   c. minimized water stress and more drought tolerance.
   d. promotion of nodulation of symbiotic nitrogen-fixing bacteria.
   e. intensified absorption of minerals and trace minerals.
   f. better tolerance to the toxic influence of salts.
   g. increased efficiency in the use of fertilizers, particularly nitrogen and phosphorus fertilizers.
5. Mycorrhizae create a network of "filters" for root exudates and thus determine various absorption assignments, causing quantitative and qualitative changes in the root exudates.
6. Various ectomycorrhizae produce antibiotics to fight parasitic enemies.
7. Balanced humic and fulvic substances, along with a healthy microorganism population, serve as **growth regulating stimulation.**

DISEASE PRODUCING FUNGI: HUMIC AND FULVIC INFLUENCE

1. Disease producing fungi attack plants by entering the plant through root lesions caused by nematodes or other injury.
2. Disease producing fungi attack plants when the plants' chemistry has changed, allowing the pathogenic fungi to overpower the plants' defense mechanisms.
3. Well balanced humic and fulvic substances with a healthy microorganism population stimulate the plants' energy and health and:
   a. assist in the avoidance of disease producing fungi.
   b. allow the plant energy to be conserved and applied toward more intense plant growth and crop yield.

THE INFLUENCE OF HUMIC AND FULVIC NUTRITION AND ENERGY ON VIRUSES

1. Often a virus injects its own DNA into bacteria and thus causes its energy draining, disease producing self to be duplicated within the host bacteria.
2. The infected bacteria that had been helpful to plants are now on sick leave.
3. For example, a major problem develops when a virus attacks the nitrogen fixing bacteria and they are forced to stop their productive work of providing soil nitrogen to plants.
4. Balanced humic and fulvic substances and microorganisms serve to eliminate carriers of viruses and give strength and energy for plants' natural defense. Thereby the transmission of viruses can be limited.

DISEASE PRODUCING BACTERIA AND THE INFLUENCE OF HUMIC AND FULVIC ENERGY

1. Disease producing bacteria can enter plants not only through the roots, but also through the leaves and stems of the plant.
2. The healthy, strong plant can defend itself with its own defense system.
3. The battle against disease producing bacteria can be fought with adequate nutrients for the plant, which provide strength and vitality to assist in the plant's own defense mechanism. These disease producing parasites and the infection they cause can be limited with the balanced use of humic and fulvic substances along with the aid of a healthy microorganism population.

REMEMBER: "Beautiful bugs eat sick plants. They never become confused and eat a healthy plant....They just can't."

DYNAMIC SOIL POWER = DYNAMIC PLANT POWER

Successful management of productive soil involves:

1. Avoiding compaction of the soil which causes poor productivity due to restricted water percolation and air flow around the roots and makes it difficult for roots to expand through the soil.
2. Avoiding overuse of pesticides which destroy beneficial microorganisms and earthworms.
3. Using humic and fulvic substances along with microbial influence to provide polysaccharides for plant energy.
4. Encouraging the intensified activity of mycorrhizae contributes to soil quality.
5. Using humic and fulvic substances to encourage microorganisms and earthworm population which produce better aeration and soil stability, water infiltration, and percolation.
6. Carefully following dosage directions for the proper application of organic supplements to your soil. Remember, dynamic soil power = dynamic plant power, providing crop yields, safety, and profitability.

Chapter Summary:

We began this chapter with two questions: How much can we raise? How much can we salvage from natural predators, including the salvage of lost energy for plant defense? This chapter, "Growth Regulator Stimulants," addressed plant metabolism and stimulation, functions that involve many of the chemical energy transformations that occur in plant cells as repair, growth, and crop yield take place. Humic and fulvic substances enter the plant cell membrane, root, stems, and leaves, and sensitize multiple physiological functions.

Amino acids and proteins, daily available and stored energy, the plants' ability to generate some of its own energy, and coenzymes participate together in biological growth functions. Natural plant hormones and sterols are also a part of the biological growth process. **Auxins** are natural plant hormones that promote the growth of plant cells in roots, shoots, leaves, flowers, and fruits by controlling light reception and making sugars available to the plant. Humic and fulvic substances include auxins or function as auxins and thus affect plant metabolism in a positive manner. **Gibberellins** are natural plant hormones that regulate the balance in plant development, affecting cell division, stem elongation, and the triggering of DNA gene codes regarding enzymes that break down starches and awaken plant seeds and buds. **Cytokinins** are active in plant cell division and help prevent leaf aging while working with auxins to control the growth and development of plants in general. **Organic compounds** cause specific enzyme action which stimulates DNA and RNA activation and cellular growth.

Humic and fulvic substances include **glycosides** which are made up of sugars or glucose and are a part of the plants' metabolic system. Plant hormones and sterols not only affect plant growth, but also help ward off harmful insects, foreign organisms, and plant infections. The organic **porphyrins** furnished by humic and fulvic acids assist plants in trapping light energy. Then they assist in the transfer of that energy through the plants' electron transport system, thereby accelerating the various growth mechanisms of plants through improved photosynthesis. Organic **morphogens** assist in ending plant dormancy, while stimulating the development of **cyanobacteria** which can increase **nitrogen fixation.**

Water serves as a balanced growth regulator, carrying and amplifying the electrochemical message from humic and fulvic substances to influence plant growth responses. This electrolyte message, including trace minerals carried by the water mass, affects the nuclei of atoms within the water and activates the plant DNA and RNA. This activity has a positive growth regulating effect on the cells of plants as well as on microorganisms.

Humic and fulvic substances stimulate plant metabolism by facilitating oxygen uptake and oxygen metabolism, increasing chelation of trace minerals, improving plant respiration, reducing plant stress, improving chlorophyll production and photosynthesis action, and providing greater drought tolerance to prevent premature wilting. The net effect of humic and fulvic acids on plant growth involves the interaction of a series of biochemical stimulations and inhibitions, and has a direct and selective effect on plant development. It is well documented that plants respond to the presence of humic and fulvic substances because they function as hydrogen acceptors and oxygen activators. With the presence of only small amounts of humic and fulvic substances, plants experience enhanced uptake of nitrogen.

Vitamins and antibiotics along with auxins and plant hormones are natural products of the decay or humification of organic substances into humic and fulvic substances. Antibiotics produced by soil bacteria, fungi, and actinomycetes play an important role in helping to maintain a safe, balanced, and healthy microbial population. This activity works along with the plant cell genetic mechanisms to "switch on" or activate plant cell metabolism by converting more carbon dioxide into carbohydrates, amino acids and other energy producing materials.

Roots, rhizospheres, and their exudates are extremely important to the plants' growth success. Humic and fulvic substances activate plant leaves to cause spontaneous increases in root exudates. Root exudates consist mostly of carbohydrates, proteins, lipids, vitamins, and plant hormones, which can be made available for plants' continued growth and the enhancement of the microorganism population.

Disease producing or pathogenic predators represent serious energy drains to plants. They are the equivalent to holes in the bottom of your crop yield bucket. When energy is expended to defend the very life of a plant, little energy may be left for the production of a high crop yield. Nematodes, or roundworms, are probably the worst individual predatory enemy to the root zone of plants, followed by pathogenic fungi, various pathogenic viruses, and pathogenic or disease producing bacteria. Mycorrhizal fungi, humic and fulvic substances, and a healthy community of microorganisms all help fight the battle against the energy draining, life threatening pathogens, which equate to "holes" in the bottom of your bucket, **anti-stimulants** to your growing efforts.

When you think about growth regulator stimulants and dynamic soil power, also consider the wisdom of the old farmer: "Beautiful bugs eat sick plants; they never become confused and eat a healthy plant, they just can't!" Also remember to learn to fill your bucket to overflowing and prevent plant energy loss or the development of holes in the bottom of your bucket. **Raise all you can,** and **save as much** of your products from predators **as you can,** so you will **go to market with the most that you can.** You and Jack will be proud of your "bean stalk."

The next chapter, "Bless Our Fields," defines pay dirt. It includes examples of many, many reports from the United States and all around the world of percentages of crop yield increases attributed to the proper balance of humic and fulvic substances being applied, as well as the assistance of a healthy microbial family. These principals are ready to work for you. The proof can be found in the reports cited in Chapter 12.

Chapter Highlights:

(Research outlines and evaluations not included in this document)

Chapter Summary:

Have **you** hit "pay dirt" yet? "Bless this day our daily bread, and continue to bless our fields tomorrow." To this point we have considered:

1. The "why": Nature does have ultimate balance.

2. The "how it worked for others," including examples and reports from all around the world, plus the incorporation of reports and studies from research scientists and universities here in the United States. This involved the demonstration of prudent agronomy practices resulting in abundant crop yields and various confirmed percentages of increase due to the proper application and balance of humic, fulvic, and microbial substances.

3. The "how to," so each of us can follow the blueprint of natural balance and proceed successfully to survive today while protecting our environment, and thus survive tomorrow.

Remember: Raise all you can, and save as much of your product from predators and waste as you can, so you will safely survive and go to market with the most that you can. Inasmuch as we have the privilege of choice, we as trustees of spaceship earth have responsibility for what happens to our fields.

Chapter 13 deals with the unfortunate problems associated with payment for past abuse. But be of strong confidence. Humic, fulvic, and microbial balance give us hope! Nature has provided "correction burn" privileges, subject to our allowing them to be implemented. Our spaceship earth is troubled with toxic poisons, chemical imbalance, and people who suffer from greed, frustration, or ignorance. Thus, our plea, "Heal our lands." There is an answer, and the next chapter will touch on the possibilities for correction.

Chapter Outline:

Chapter Figures:

Chapter Appendices:

Chapter Highlights:

Our recovery concept must include remedy and retrieval of spaceship earth's natural balance. Natural functions must be restored. Unwholesomeness and destruction must be remediated with sound, functional reclamation. Perhaps the problems involved mishaps, mistakes, or general ignorance, but as trustees of spaceship earth, we are compelled to implement means of counteracting or removing the obvious problems to assure reparation and relief. This rescue is urgent. We must begin at once to initiate a recall from the wrong course of action. Salvage is possible with knowledge, a sound philosophy, and strong resolve to see it happen. Our property can be redeemed. Our lands can be healed!

The molecular configuration, charge distribution, polarity, pH, solubility, and hydrolysis characteristics of humic and fulvic substances are contributing factors in protecting spaceship earth's environment.

The complex phenomenon of humic and fulvic adsorption depends upon:

1. The nature of the humic and fulvic molecule;
2. The energy conditions available on the organic surface;
3. pH;
4. Salinity;
5. Temperature; and
6. The physicochemical properties of the herbicides and pesticides being adsorbed.

1. Many difficult environmental chemicals, including DDT and PCBs, are adsorbed onto humic acids IRREVERSIBLY.
2. Free radicals within humic acids adsorb, for example, chemical urea, and the resulting complex is even more stable than the original materials.

1. Interaction between humic compounds and environmental chemicals serve to control the transport, distribution, and often the revocation of harmful chemicals.
2. Once adsorbed, most of these chemicals are strongly held and are seldom desorbed because of the strong chemical bonding between pesticides (as an example) and the colloidal surfaces of humic compounds.

Humic and fulvic acids assist both the **adsorption** and the **solubilizing** of harmful environmental chemicals such as herbicides and pesticides. **Humic substances significantly help reduce the toxic effects of these harmful chemicals by serving as a vehicle for their control and elimination.**

The agricultural arena must deal with hydrocarbon and oil pollution problems. Organic compounds, especially fulvic acids, may dissolve many of these pollutants, demonstrating up to a 400% benefit in breaking down the hydrocarbons and oils and making them soluble. **Dissolution accomplished.**

The dissolution of hydrocarbons and oils by humic substances involves various mechanisms and interactions between polluting petroleum products and humic compounds and various types of dissolved organic matter that enhance the solubility of hydrocarbons and oils. This dissolution phenomenon has powerful implications in solving the oil spill pollution problems on our spaceship earth's agricultural lands.

Rashid concluded that the major mechanism of these impoundment interactions is chelation. Chelation reactions balance the chemical and physical properties of toxic metals, including solubility, which is enhanced, and precipitation, which is retarded. These organo-metallic reactions and their consequences in the properties of heavy metals affect the chemical behavior, physical transport, biological uptake, and the general availability of these metals.

Radioactive elements have an affinity for humic and fulvic acids. They form organo-metal complexes of different adsorptive stability and solubility. Uranium and plutonium are influenced by humic substances as are other polluting metals, each being solubilized and adsorbed, thereby annihilating that specific radioactivity.

HUMIC AND FULVIC SUBSTANCES IN ACTION

1. Revocation of toxic herbicides and pesticides
2. Dissolution of hydrocarbons and oils
3. Impoundment of heavy metals and inorganic pollution
4. Annihilation of radioactive pollution
5. Elimination of toxic waste water pollution

Microorganisms continue to cleanse spaceship earth effectively. Through **bioremediation,** these microbes assist in effectively decontaminating polluted sites and systems. Two **biodegradation** methods are **biostimulation** and **bioaugmentation.**

Microorganism activators reactivate or revitalize microbes present in soil, water, and out-of-balance toxic wastes. Once activated, the microbes stimulate naturally existing microbes as well as the bioaugmented microbe family. Microorganisms may be further stimulated by nutrients such as humic matter to promote healthy organic activity. Environmental biotechnology complements bioremediation and contributes to the HEALING OF OUR LANDS.

WHAT IS OUR ENVIRONMENTAL LEVERAGE?

1. Many hazardous wastes and toxic chemical pollutants are deadly, and their abuse is throwing our spaceship earth as well as our universe out-of-balance.
2. The U.S. government has initiated laws and specific procedures regarding hazardous and toxic waste. Penalties include stiff cash fines and in some cases prison terms for those who violate these rules.
3. Nature has its natural balance, but if it is forced out-of-balance, there are natural provisions (as discussed in this chapter) for remediation, if we allow it. Humic, fulvic, and microbial balance have redeeming and cleansing ability.
4. Remember, we do not break rules without consequences. Most often, at some point, violated rules break us. This is very applicable in nature.
5. If there are continuous violations of the laws of nature, let us hope that the laws of our government will punish the violators before nature, while out-of-balance, destroys all of us. Thus, the environmental legal leverage of the law may assist in remediation.
6. There is good news: Nature has answers, and for a responsible, responding society, there is HEALING FOR OUR LANDS!

Chapter Summary:

At the beginning of this chapter, the environmental question was, "Is toxic waste and pollution an inevitable result of our society?" The example of pesticides, having 45,000 different chemical formulations registered in the United States alone, makes us wonder. There is good reason for alarm because the chemical compounds when present in excess not only cause toxic deterioration in nature, but they also function as deadly toxins for inhabitants of spaceship earth. However, unwholesomeness and destruction can be remedied. With adequate information, a determined resolve to see remediation happen, and the assistance of natural processes through humic, fulvic, and microbial balance, sound, functional, and purposeful reclamation can be accomplished. With organic balance, herbicides and pesticides may be revoked, hydrocarbons and oil dissolved, heavy metals and inorganic pollution impounded, the ill effects of some radioactive materials reduced or annihilated, and the possibility of having toxic waste water pollution eliminated.

Through bioremediation, microorganisms **continue to cleanse spaceship earth effectively**. Their ability to decontaminate polluted sites and systems is used in various methods, including biostimulation and bioaugmentation. Microbial activity may be further

encouraged by nutrients found in humic matter, thus promoting healthy organic action and providing HEALING FOR OUR LANDS. Nature holds the answer for its own redemption from toxic conditions. The plea to the inhabitants of spaceship earth is: **Be responsible, responding, informed people, foregoing selfish greed while honorably playing by nature's rules of preservation. Each of us will then have had a part in the healing process and the productive future of spaceship earth.**

Our last chapter, Chapter 14, follows this trend of thought: WHAT CAN I DO TO HELP? The victory will be won, and our beautiful homeland preserved if we all take an aggressive role in assisting nature's natural balance.

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