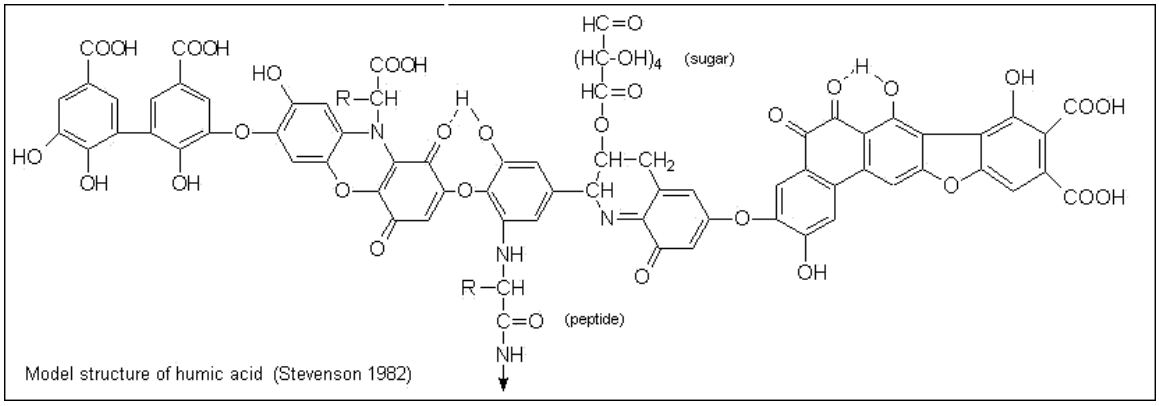
Humates and Humic Acids. How do they work?

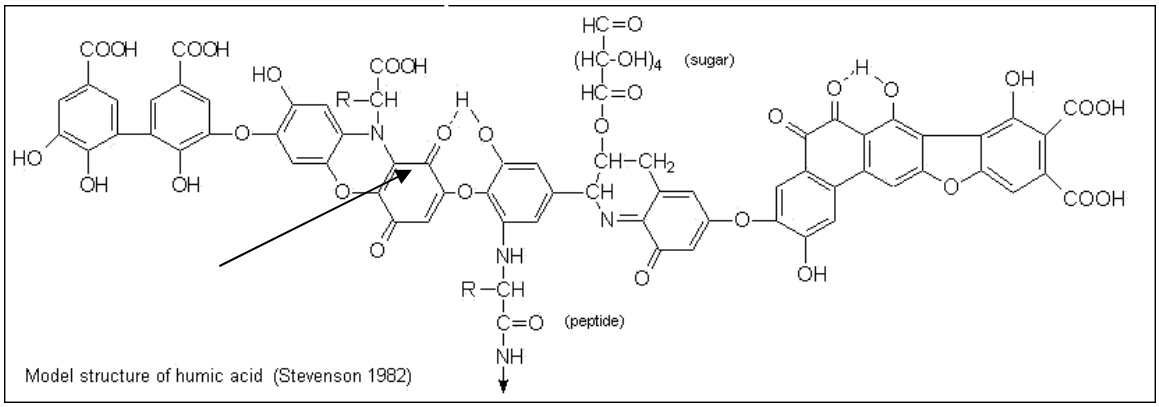
by Dr. Boris Levinsky

Important role of Humus in agricultural growing is known since ancient times. However, a change from a primitive understanding to serious scientific research had happened only in the middle of the last century, when young scientist from Kherson State University, Ukraine, Lydia Khristeva had made a simple experiment. She had educed humic acid in a form of solution of sodium salts from an ordinary soil sample, further having watered plants with it, discovered that plants considerably increased their growth and developed much stronger root system. Thus, the biological activity of Humates was discovered for the first time. The essence, novelty of this discovery proved the fact that a conversion of natural Humic acids into their Sodium (Potassium) salts, Humates sharply increases (over hundred times!) their biological activity.

Let's consider the most important factors of Humates influence on a whole system defining future harvests, Water – Plant and Soil

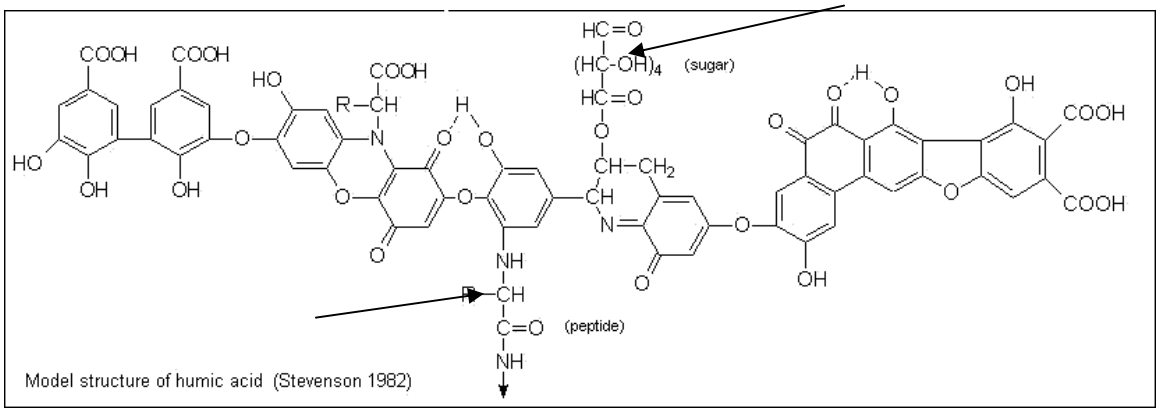


This is a molecule of Humic Acid. You can see here just one fragment of this huge molecule. These fragments are connected to each other in long chains and total weight of molecules, naturally depending on the chain length, is in the range from 35 000 to 80 000 Daltons.



This is a Quinoid group. Here we can see four single and four double connections (bonds). However, this pattern is just a basic description. In reality this part of a molecule is an electron cloud with valency electrons positioned at definite energy level. Receiving a quantum of solar energy these electrons move to a higher energy level, so this constantly repeated action provides accumulating of solar energy. During nights those electrons return to their previous positions providing cell with accumulated energy during daylight time. Exactly in this way Humates increase cell energy balance.

This leads to an intensification of exchange processes. As a result it is noticed a rapid development of a root system, formation of special ferments that increase plants' resistance to unfavorable stress factors, such as drought and frost, improve a process of nitrogen assimilability, but preventing formation of nitrates, at the same time facilitating synthesis of chlorophyll, sugars, vitamins, essential amino-acids, and oils etc.



Model structure of humic acid (Stevenson 1982)

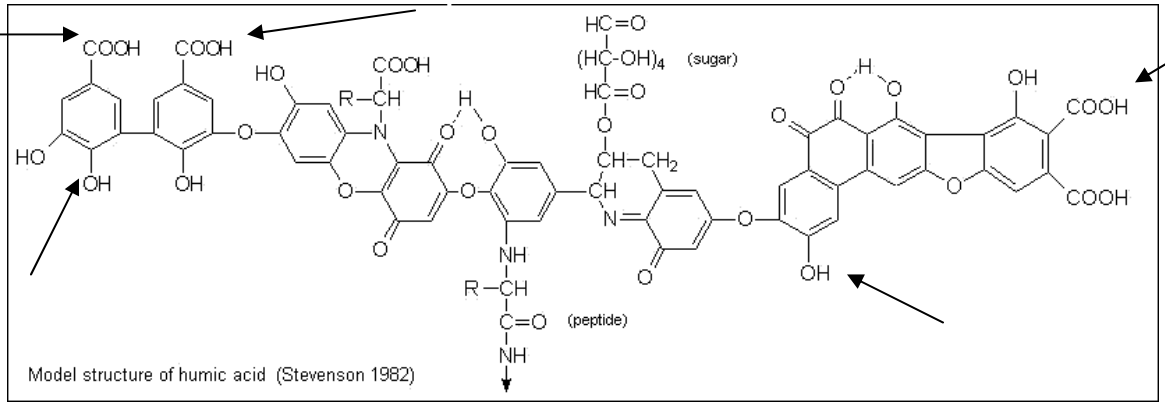
This group is called Peptide group

Structure of this group is very close to a lipid structure of a cell film. Therefore it can easy interact with it and form protective net / film around it. During growth and development cell is always exposed to stress, such as attacks of peroxide compounds, toxins, and free radicals and others. Scientific research proved that 30% of cell energy is always used for protection, but under the circumstances this protective film created by Humic Acids around a plant cell is able to take over those attacks and a cell gets a chance to use 100% of its energy balance for positive growth and development.

This group is called Carbohydrates or Sugars.

These groups together with Peptides are fine food for microorganisms.

Peripheral part of this molecule has Carboxyl and Hydroxyl Groups



These groups are responsible for several important functions.

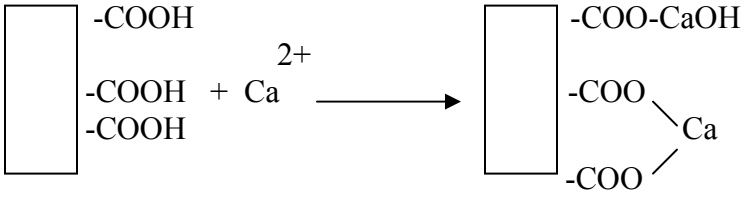
Firstly, these groups have an affinity to water, this feature provides solubility of Humic Acid molecules in water. Diluted solutions of Humic Acids restructure water, in away that gives it properties of melted water structure. I can talk much about structure of the water, and this subject deserves a separate lecture, but I tell you just one thing today - Melted water is very close to structure in cell water, I mean moisture as a part of a cell juice, therefore restructured water can easy penetrate plant cell and be more useful for a plant development. In connection with this we recommend to use within the range from 0.008 to 0.01% solutions of Humates for foliar applications.

Secondly, please note that these groups are capable to substitute their hydrogen atoms by ions of metals. How does it happen ?

If we use single valency metals, such as sodium or potassium, we produce water soluble Sodium / Potassium Humates.

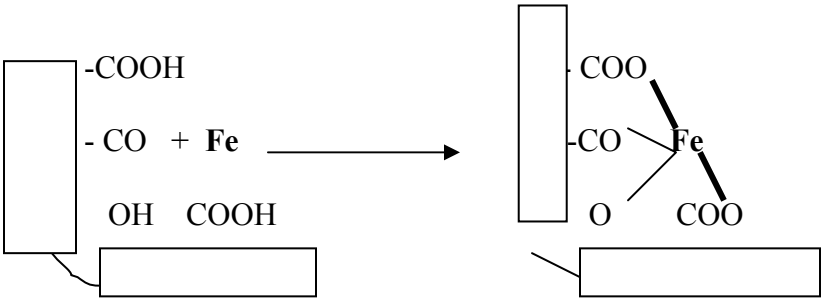
During dissociation, potassium moves into a water phase, but ion of Humate gets a negative charge. Mutual resistance of negative charges unrolls tight molecule of Humic Acid into a long chain, giving it high biological and chemical activity. Therefore we recommend to use salt of Humic Acids or Humates, instead of raw Humic Acids, presented in lignites, also known Leonardites.

What happens if we use double valency metals, like calcium or magnesium?

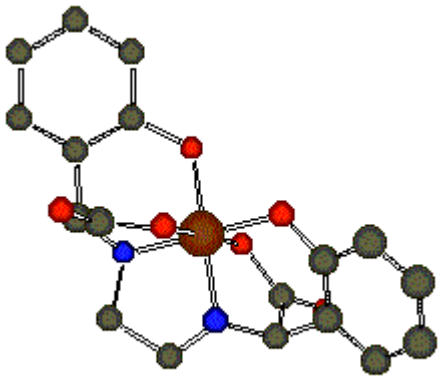


Calcium and Magnesium Humates are insoluble in water unlike Sodium and Potassium.

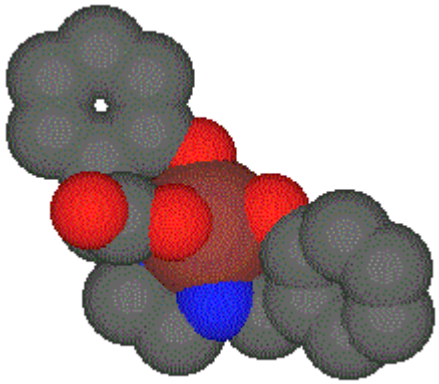
When Humic Acids interact with multi valency metals, such as Iron, Zinc, Copper and others they form new type of compounds, called Chelates. Additionally to usual valency connections they form coordination bonds.



Chelates of poly valency metals under particular circumstances can be soluble in water, whilst in their usual condition they are insoluble. This gives us an important tool of management. From one hand we can provide plants with necessary metals: iron, copper, zinc, boron, magnesium, molybdenum and cobalt in their soluble forms, from the other simultaneously protect plants of harmful elements, like mercury, lead, cadmium, radionuclides and others, converting them into insoluble forms.



Fe(III)-*meso*-EDDHA: ball and stick representation.

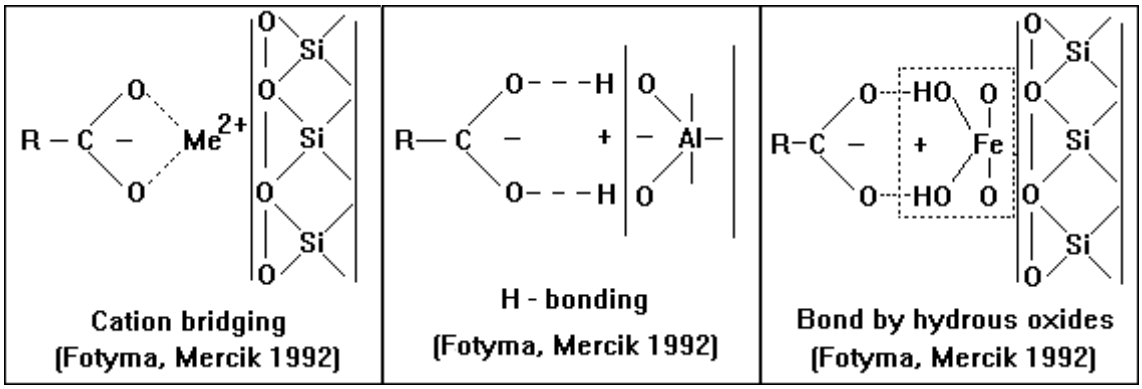


Fe(III)-*meso*-EDDHA: space-filling representation

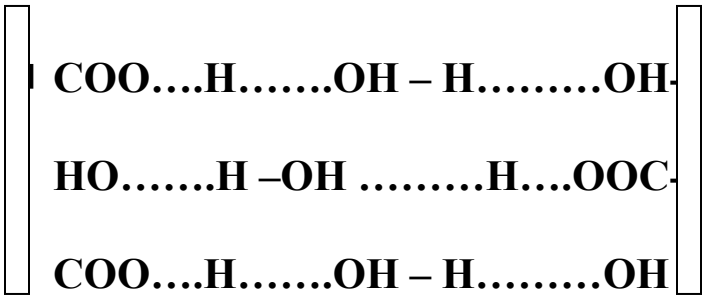
Consequently, Humates can play a role of a transportation mean of valuable micronutrients and also can be protective agents of harmful ones. For instance, Satellite photography proved that regions rich in Humic Acids manage to keep environmental balance in spite of intensive industrial pressure.

Humic Acids and Humates also play an important role during interaction with soils.

Firstly, I would like to point out an ability of Humates to lock up ions of Iron and Aluminum. Their excessive amounts block phosphor assimilation. During an interaction with Humates Iron forms available for a plant compound, but Aluminum is connected into insoluble form. This process neutralizes harmful action of these metals on phosphates.



Colloid structure of Humic Acids and high degree of hydrophility of their functional groups gives them an ability for gel formation. This explains their ability to increase water holding capacity of soils. This is very important for arid regions.



Water is tightly kept between Humic Acid molecules with the help of hydrogen bonds, and this allows to perform storing of moisture for a draughty season.

Reacting with calcium, magnesium, aluminum, and iron, which are always presented in soils, Humate forms organic mineral bridges, connecting soil' particles in some structure, ready to resist erosion, keep more oxygen and moisture and create favorable environment for soil's microflora development. Activation of soil's microbial activity in Humate presence was also noticed by various researches. It is well known fact that active and intense work of microbes is the key to Humus formation.

The above information is just a small part of the information on potential mechanics of Humate action and influence on a whole system water- plant – soil. However, I think at this stage this amount of information gives you basic knowledge on these remarkable compounds.

In conclusion I would like to emphasize one an important moment. Here in America it is difficult to find clear definition and difference of terms: Humate and Humic Acids. Most of the time, under the term Humate, people understand and distribute raw lignite. The problem is the following: in natural forms Humic acids, being a part of lignites or peat, are always connected into insoluble forms of calcium, magnesium, aluminum forms, and there they are low biologically active and insoluble. Recommend application norms of those products are close to 2 000 pounds an acre. It is simply not practical and economical. They need to be converted into soluble Humates, soluble Chelats or pure Humic Acids to release their biological activity. Only after this conversion they are capable to perform early described actions.

Humic Acids and Agrochemicals, their role in detoxification.

Practically all types of industrial pollutions, such as heavy metal compounds, vehicle emissions and other industrial toxic wastes are accumulated in soils. In big cities this problem is even more complicated, because this leads to mortality of green plantation, always aggravating a risk of human poisoning. But, Mother Nature gives us a tool to solve this problem.

Space satellite photography shows that regions with high pressure of industrial pollution, on areas covered with soils rich in Humus still allows producing safe agricultural products. In this particular episode Humic Acids may become our main defenders and assistants. Studying detoxification parameters of Humic acids to remove toxic consequences of salt pollution of root nutritional environment proved that Humates neutralize toxic action at the rate of a pollution exceeding the norm 6 to10 times. Also wide scale field experiments with Humates on polluted areas over Buriat republic (Eastern Siberia, Russia, neighbour of Irkutsk region) in 1988 showed that treated areas with Humate solutions had incr

The growth of production and wide application of plant protection chemicals, both pesticides and fungicides, lead to their accumulation in soils in quantities badly affecting microflora, plants, and further destroying functions of practically all alive organisms. Liquidation of those consequences can be achieved in several ways: an increase decomposition time of chemicals in soil, improve plant resistance to their action, and activation of metabolism and redox processes on a plant cell level. The analyses of the vast experimental data obtained by Russian scientists proved that Humic Acid substances presented in natural soils, as well as Humates added artificially, can actively promote those processes. For instance an experiment on wheat held in 1952 (Ehenhart, 1952) pr

Russian scientist Lydia Khristeva also proved that highly active of humic acids increase synthesis of nucleic acids and protein, activating redox processes. At the same time Humic acids stimulate activity of microorganisms responsible for decomposition of poison elements. The set of experiments on root nutritional environment with strong poisons, Phtalan and Hexochlorine helped her to prove that Humates could sharply decrease their accumulation.

The influence of Humates on accumulation of poisons in plants (by Lydia Khristeva).

Part of a plant	Concentration of poison per 100g of a plant part			
	Phtalan		Hexochlorine	
	Control	Treated	Control	Treated
Roots	17.2	5.8	12.9	1.6
Stalk	4.8	2.1	Marks	Marks
Leaves	2.1	0.3	2.74	0.95
Fruit	0.7	0.4	1.8	0.5

It is very important to note and repeat that detoxification of plants is mainly based on the stimulation of microbiological (soil) and inside cell (plant) decomposition processes and it is not connected with direct interaction of Humate and Chemical. Also it is very important to know that Humate solutions with herbicides and pesticides may increase their efficiency. For instance, we have proved that join application of herbicides and Humates has allowed decreasing quantity of chemicals to 30-40%, without decrease of their efficiency. Particular results were obtained during joint application of Humate solution and “Roundup”.

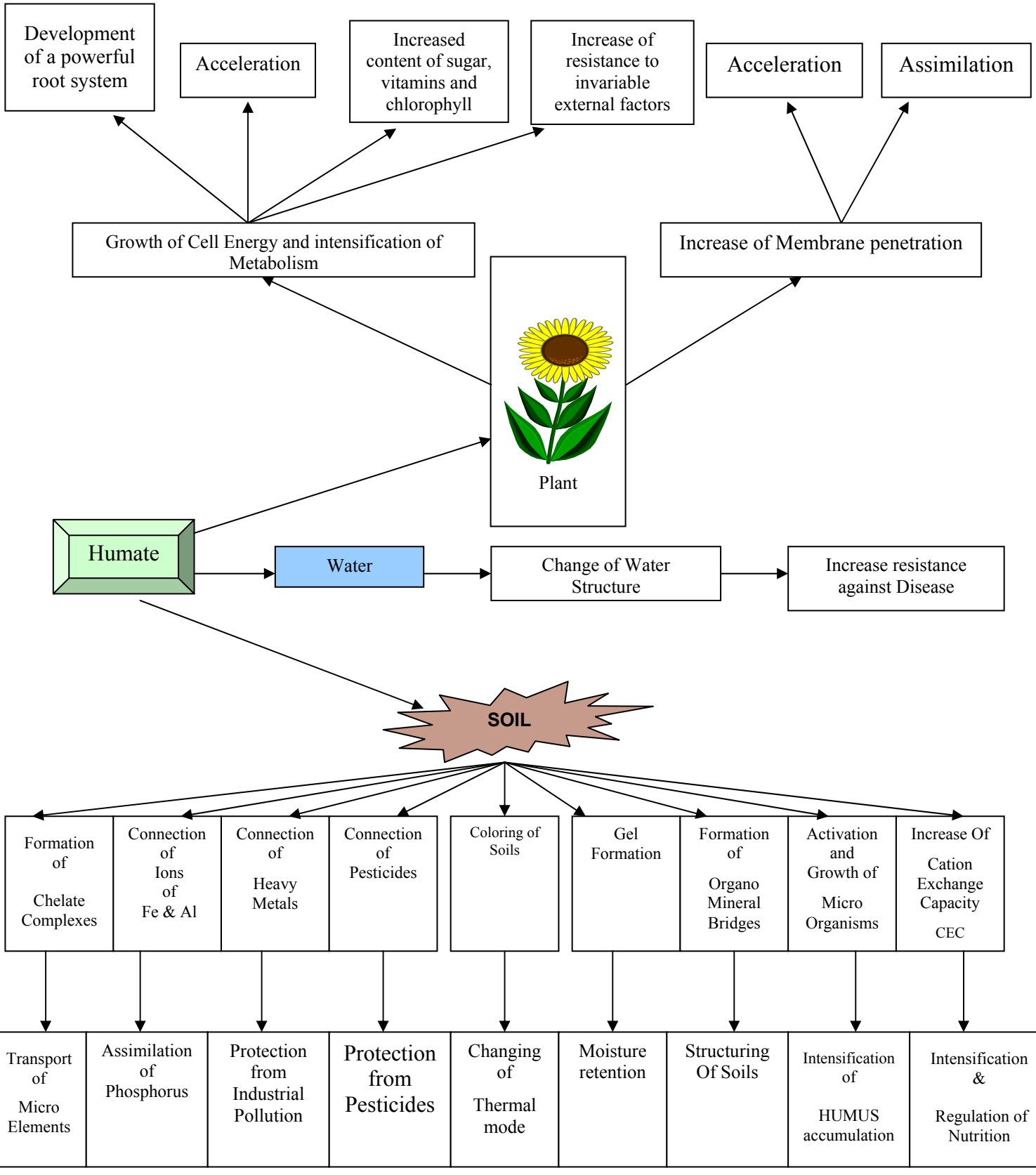
In conclusion I would like to repeat that Humic Acid substances determine and define structure and fertility of soils. They should be considered to be very effective means of solving ecological and other environmental problems, such as pollution of soils and subsoil waters by chemicals still widely used in modern agriculture.

The excerpt from my book

An important quality of humates is their ability to decrease the level of nitrate nitrogen in produce. It was proven by tests on a variety of crops (oats, corn, potatoes, root-crops, lettuce, cucumbers) that humate use decreases the nitrate content by 50% on average. At the Dnepropetrovsk agricultural institute, field tests were carried out on chernozem. Two crop cultures were tested - corn and barley (as second in the crop rotation). The herbicide atrazine (4 kg per hectare) was used on the corn. The results showed that atrazine reduced the growth of weeds by 80% and increased the crop capacity of the corn by 1 It was also noted that the atrazine content in the final produce decreased by 52%-71%, which made it an ecologically pure produce.

Thus, humic preparations are the reliable protection for plants and crops against harmful admixtures from our environment (soil, subsoil waters, rain-water, and the atmosphere), which is more polluted each day. They also protect crops from unfavourable environmental factors (drought, ionising radiation, etc.).

Diagram of interaction of Humate and the **water-plant-soil** system



The Benefits of TeraVita Humates

BIOLOGICAL BENEFITS:

1. Stimulates plant enzymes
2. Acts as an organic catalyst
3. Stimulates growth and proliferation of desirable soil microorganisms as well as algae and yeasts
4. Increases root respiration and formation
5. Increases the availability of micronutrients
6. Increases the permeability of plant membranes, which increases the uptake of nutrients
7. Increases the vitamin content of plants
8. Increases the viability and germination of seed
9. Accelerates cell division and root development
10. Contains a wealth of micro-elements such as Si, Fe, Mg, S, Ba, B, Mn, Co, Ni, Ti, Mo, Cu, Pb, Ag and more
11. Increases photosynthesis in plants
12. Contains soluble silicon
    a. Silicon strengthens cell walls
    b. Silicon helps block disease invasion at the cell level
    c. Silicon helps plants maintain more uniform cell temperature, which increases drought and frost tolerance

CHEMICAL BENEFITS:

1. Increases buffering properties of soil
2. Rich in both organic and mineral substances essential to plant growth
3. Retains water soluble fertilizers in the root zones and releases them to plants when needed
4. Has an extremely high CEC (cation exchange capacity)
5. Promotes the conversion of insoluble nutrients into forms available to plants
6. Reduces or eliminates many soil-related phenomenon, such as dry spots on golf greens

PHYSICAL BENEFITS:

1. Makes soil more friable and crumbly
2. Improves soil workability
3. Increases aeration of soil
4. Reduces thatch build-up in turfgrasses
5. Increases water holding capacity
6. Improves thermal coloring of soil

LITERATURE CITED:

1. Levinski, Boris, 1999. Everything About Humates. Irkutsk University, Siberia, 1-23, January.
2. Senn, T.L. and Kingman, A.R., 1973. A Review of Humus and Humic Acids. Clemson University, Dept. of Horticulture, Research Series No. 145, March.
3. Freeman, P.G., 1969. The Use of Lignite Products as Plant Growth Stimulants. Technology and Use of Lignite, IC Bureau of Mines Information Circular, 8471: 150-153; 160; 162; 164.
4. Burdick, E.M., 1965 Commercial Humates for Agriculture and the Fertilizer Industry. Economic Botany. Vol. 19, No. 2: 152-156.

Usage Guide for LC-12

Soil Applications

Crop	Soil rates per acre per treatment*	Suggestions and Methods
Corn and Sorghum	1 to 2 gallons	Apply soil treatment before emergence and again as late as machinery passage allows
Rice – Dryland	1 to 2 gallons	Apply soil treatment before emergence and again between joining and early heading
Rice – Lowland	1 to 2 gallons	Apply first treatment 7 days before flooding and make foliar treatment at the boot stage
Winter Grains	1 to 2 gallons	Apply soil treatment before emergence and again at spring green-up
Spring Grains	1 to 2 gallons	Apply soil treatment before emergence and again at the onset of flowering
Beans, field beans, soybeans, peas, and peanuts	1 to 2 gallons	Apply soil treatment before emergence and again at the onset of flowering
Cotton	1 to 2 gallons	Apply soil treatment before emergence and again at the onset of flowering
Hay and Forages	1 to 2 gallons	Apply soil treatment in spring at the beginning of growth and again after each cutting
Pastures	1 to 2 gallons	Apply soil treatment in the spring at the beginning of growth, again at midseason and a 3rd treatment before dormancy
Tropical Grasses	1 to 2 gallons	Apply soil treatment every 3 months
Potatoes	1 to 2 gallons	Apply soil treatment before emergence and again at the hook stage
Sugar Cane	1 to 2 gallons	Apply soil treatment before emergence and again at 3 months and 6 months after planting
Root Crops (beets, radishes, carrots, etc)	1 to 2 gallons	Apply soil treatment at or within 15 days of planting
Vegetables (tomatoes, okra, eggplant, cucumbers, cauliflower, broccoli, peppers, etc).	1 to 2 gallons	Apply soil treatment at planting or before emergence and then every 6 weeks during active production
Leaf Crops (lettuce, parsley, dill, herbs)	1 to 1 2/3 gallons	Apply before emergence and again 6 weeks after emergence
Citrus	2 gallons	Apply soil treatment every 2 months during the active/productive season
Fruits (apples, peaches, pears, apricots, plums, cherries, walnuts, pecans, etc.)	2 gallons	Apply soil treatment 1-2 weeks prior to leaf emergence and again at the beginning of fruiting
Topical Fruits (mangos, papayas, guavas, bananas, pineapples, pistachios, brazil nuts, etc)	2 gallons	Apply soil treatment every 2 months during the active/productive season
Vineyards (Grapes)	1 to 2 gallons	Apply soil treatment at leaf emergence and again when fruit is half mature
Berries (strawberries, raspberries, blackberries, blueberries, etc.)	1 to 2 gallons	Apply soil treatment at the beginning of growth and again when fruit is half mature
Melons (watermelons, cantaloupes, etc.)	1 to 2 gallons	Apply soil treatment at planting or before emergence, and again at the onset of flowering
Landscape Ornamentals	6 oz per 1000 square feet of beds	Apply soil treatment in spring at green-up or at transplanting and again prior to dormancy. Year-round climates should make soil applications every 3 months.
Flowers	1 ounce per 10 gallons of irrigation water	Apply weekly in irrigation water
Greenhouse plants	1 ounce per 10 gallons of irrigation water	Apply weekly in irrigation water
Potting Mixes	16 ounces per cubic yard of mix	When moistening the dry potting mix, add enough LC-12 into the water/fertilizer/fungicide solution to deliver 16 ounces of LC-12 per cubic yard of potting mix.

Hydroseeding	2 to 5 gallons	Once the water is added to the hydroseeding tank, add enough LC-12 to deliver 2 gallons of LC-12 per acre. In very harsh environments, add up to 5 gallons of LC-12 per acre in the hydroseeding solution.
Turf and Golf Course	1 to 2 gallons	Apply soil treatment at spring green up and with (or at the time of) each normal fertilizer application. Tees and greens may be treated more frequently with half-rate applications.

* Soil applications can be made in numerous ways. LC-12 can be sprayed onto the soil or dripped into the crop row, or it can be run through overhead, trickle, or underground irrigation systems.

Irrigation Applications

When making soil treatments through irrigation equipment it is important to keep the final concentration of LC-12 to water being emitted to the soil within the parameters listed below. It may be necessary to adjust the irrigation system to deliver more or less water per acre per cycle to deliver the desired amount of LC-12 listed for the crop you are treating.

Maximum Concentration	Optimal Concentration	Minimum Concentration
1 ounce LC-12 per 1 gallon of water	1 ounce LC-12 per 10 gallons of water	1 ounce LC-12 per 20 gallons of water

Foliar Applications

All crops will benefit from foliar applications of humic acids when it fits into the crop management practice. Foliar applications should be made *in addition* to the soil treatments. Foliar applications should be made at the rate of 16 to 32 ounces of LC-12 per acre per treatment. Foliar treatments with LC-12 are strongly recommended during four growth stages of the crop: immediately before the appearance of buds, before blossoming, after the flowers have fallen, and during ripening. When soil treatments are not possible, foliar treatments may be made every 14 days using 16 ounces of LC-12 per acre. It is important to always use LC-12 within the concentration parameters listed below.

Maximum Concentration	Optimal Concentration	Minimum Concentration
1 ounce LC-12 per 1 gallon of water	1 ounce LC-12 per 10 gallons of water	1 ounce LC-12 per 20 gallons of water

Additional Usage Notes

- When applied together with fertilizers or pesticides, the use of humate increases the efficacy of the companion materials. In most cases, systemic pesticide rates can be reduced by 25% or more when the humate is added to the application. The total annual need for nitrogen can be reduced by 30% or more when the full program of soil treatments using humate are applied to the crop. In all cases, we suggest using personal experience and experimentation to determine the rates of companion products that will provide acceptable performance.
- Humates have proven compatible with virtually all companion products except those with a very low pH. In laboratory experiments, no problems have been found other than when companion materials have a pH less than 3.0. However, if there is any doubt about compatibility, a jar test is strongly recommended. To be safe, a jar test is recommended with any material that has a pH less than 4.0.

"Discover the New Generation of Humic Acids"

The important differences between raw Leonardites and water-soluble humic acids:

The term **humic acid** represents a group of powerful natural substances that are so complex that science will not be able to replicate them for generations to come. Because they are impossible to replicate, all humic acid products are derived from highly concentrated natural deposits. The most common deposits are called Leonardites (forms of oxidized lignite), but humic acids can also be found in natural deposits of peat and silt. These deposits are formed over millions of years, yet the humic acids have not broken down or leached out of the earth into the water table. Therefore, they are extremely insoluble and inactive in their natural state.

In fact, the presence of insoluble humic acids can commonly be found in ordinary soil, only at much lower concentrations (0.2% to 10%) than is found in Leonardites or other natural deposits. In 1949 at Kherson University, USSR, Lydia Khristeva was able to educe the insoluble humic acids from ordinary soil in the form of a sodium salt solution. She then watered plants with the solution and discovered that it greatly enhanced plant growth and root development. This discovery lead to a great deal of research with the use of humic acids in stimulating plants. Despite the fact that this discovery utilized a soluble humic acid solution, over time a common belief emerged that applying raw Leonardites to the soil will boost the natural humic acid levels and stimulate plant growth as it did for Lydia Khristeva.

The principle "problem" with this concept is that Leonardites (insoluble humic acids) are very low in chemical and biological activity because the valent vacancies of their molecules are occupied with metals from soil minerals and the molecules themselves are rolled up very tightly in a ball. In order for Leonardites to provide a response to a plant, the humic and fulvic acids must be "activated" through chemical and biological processes in the soil. Unfortunately, this process is dependent on an infinite combination of factors in the soil and this makes it nearly impossible to know if, how, or when the humic acids will ever be released. This is the primary reason Leonardites have still failed to gain universal acceptance in agriculture 50+ years after the benefits of humic acids were first discovered!

Because Leonardites do closely match the structure of natural soil humus, they can slowly increase the soil organic matter over many years, which is an obvious benefit to any soil. However, the end user must be aware of which goals they are trying to achieve when they use humic acids; are they trying to build their soil, or are they looking to immediately stimulate crops, or both? This will help decide which materials to use.

To effectively stimulate plants through the use of humic acids, it is necessary to convert them into forms that have very high chemical and biological activity levels. This conversion "unrolls" the tight molecular ball and creates water-soluble humic acids, either as a liquid or in the form of sodium, potassium, or ammonium salts (known as Humates). In their soluble form, humic acids can readily chelate nutrients, preserve nitrates from leaching, enhance root development, and improve overall crop vigor and yields. Positive results can be obtained using soluble humates alone, or they can be used in combination with raw Leonardites to achieve both short term and long term results.

The difference between sodium, potassium, and ammonium salts of humic acid:

There are three primary forms of humates (humic acid salts), the sodium form, the potassium form, and the ammonium form. Although they are all similar, each form actually has its own special benefit at various stages of plant development. However, the ammonium form is generally not used because it has a

greater degree of chemical instability and it can often produce unpleasant ammonia odors. Of the remaining two, many people favor the potassium form simply because potassium itself is a valuable component of plant nutrition. However, because of the very high chemical and biological activity of water-soluble humic acids, the application rates are very low and the applied amount of potassium does not play a significant role in plant nutrition. TeraVita, through years of research, has developed humic acid products with the ideal ratio of their sodium and potassium forms to promote the ideal response in soils and plants without the risk of chemical instability or odor issues.

The roles of humic acids versus fulvic acids:

A lot of attention is often given to the role of fulvic acids over humic acids. It is often stated that the "primary action" of humic acids comes from the fulvic acids because their chemical and biological activity is higher than the humic acids. This theory does not properly take into account the many complex aspects involved in soil fertility (such as the formation of ferments in the soil), but relies more on the simplest message many commercial entities can give for people to use their product. Quite simply, it is not true, and we can only guess that this opinion originates from the concept that fulvic acids are the only portion of raw Leonardite that is potentially soluble and mobile through water in the soil.

Fulvic and humic acids have the same source of origin and are very similar in structure and elementary content. The main difference is that the molecular size of fulvic acid is smaller, which provides it with increased solubility in water throughout the pH range. However, this is only relevant if you are attempting to use raw Leonardite to stimulate crops. As mentioned before, raw Leonardites are primarily insoluble and have very low chemical and biological activity. If a natural Leonardite deposit is very high in fulvic acid content, it would be possible to see some positive result to the crop if the application rate were high enough and there were enough free water-soluble fulvic acids to act on the plants.

However, once raw Leonardites are converted into water-soluble humates, all of the humic and fulvic acid components are biologically active and play important roles in plant and soil stimulation. They both work together in various stages of soil and plant development and no one component is necessarily more important than another.

Additional notes on water-soluble humic acids:

Another benefit of using water-soluble humic acids is that their application and utilization by soil and plants can be predicted much more accurately than Leonardites. As mentioned earlier, it is nearly impossible to predict if, how, or when, the humic acids from raw Leonardites will ever be released or utilized by the plants and soil. With soluble humates, the usage rates can be narrowed down to within small margins and the overall response to crops can be achieved with only 1/100 of the typically used rates of Leonardites.

It is also important to note that humic acids are not a significant source of plant nutrients, but are a soil stimulant and a transportation vehicle for carrying nutrients into plants. Once connected to the humic acid molecule, nutrients are carried into a plant in available forms that help intensify the plant's metabolism and stimulate the soil's natural activities.

Because of their strong ability to chelate nutrients, humic acids greatly increase the efficiency in which plants utilize nutrients from the soil. In turn, this enables a significant reduction in the amount of fertilizer historically required to maintain optimal plant growth. Obviously, this provides enormous economic and ecological value to growers wishing to reduce their fertilizer input costs and/or reduce the potential side-effects of heavy fertilizer usage.

Specifications of SP-85 Soluble Humic Acid Powder (Humate)

SP-85 is potassium-sodium humate powder that acts a natural soil and plant growth stimulant. It is a dark brown to black powder with an 85-95% humic acid content. SP-85 is 88-92% soluble in water. It is easily assimilated by plants and some of its main functions include improving plant immunity, improving plant metabolism, improving plant root development, improving the supply of plant nutritional elements and increasing the formation of ferments. SP-85 promotes the increased accumulation of chlorophyll, sugar, amino acids and more and improves the efficiency of nitrogen utilization, allowing for reduced fertilizer rates. One of the primary actions of SP-85 is to increase the plant's ability to withstand the stresses of heat, drought, cold, disease, insect and other types of environmental or cultural pressures. SP-85 also increases general plant productivity, in terms of yield, as well as plant stem strength. Within the soil, SP-85 stimulates soil microorganisms, promoting Humus formation.

Differences from other Humate products:

- *The optimal combination of Potassium and Sodium Humic Acid Salts, which allows for the full and effective use of the properties of our SP-85 in Plant nutrition.*
- *The presence of soluble Silicon (Si) compounds in SP-85 provides plants with the nutrition for stronger stems, making them more resistant to natural stress situations and insects.*

Application rates: (Please refer to the TeraVita SP-85 Usage Guide that is most relevant to what you are growing. TeraVita created these guides to empower each user with the knowledge needed to properly utilize our new humate products for the improvement of plants and soils. Although it may require repeated readings, taking the time to study the usage guide you need will provide you with the ability to increase your crop's health and performance and to reduce your overall input costs.)

General Specifications:

Content of soluble humic acids	85% - 90%
Moisture	11% - 15%
Insoluble part (on dry basis)	9% - 12 %
Solubility in water	88% - 92%
pH in 0.01% solution	8.5 - 9.2
Organic carbon (active carbon)	53%

Spectrum Analysis Data:			
Element	**%**	**Element**	**ppm**
Si	2.25	Ni	1
Al	1.25	Co	9
Mg	0.70	V	8
Ca	5.0	Cr	1.5
Fe	2.0	Mo	70
Na	8.0	Zr	8
K	5.0	Nb	4.5
Ti	0.35	Cu	4
P	0.05	Pb	2
B	0.05	Ag	2
Ba	0.02	Ga	9
Sr	0.03	Y	1
Mn	0.012	Zn	70
Other elements including Cd, Hg, and Ar were not found			

Specifications of SG-70 Soluble Humic Acid Granules (Humate)

SG-70 is a soluble potassium-sodium humate in granular form. It is dark brown to black in color, with irregular shaped granules of 1mm - 3.6mm in size (SGN 100 - 360) and has a minimum content of 80% soluble humic acids. SG-70 is 80% -85% soluble in water. Like SP-85, plants easily assimilate the SG-70. SG-70's functions include improving plant immunity, improving plant metabolism, improving plant root development, improving the supply of plant nutritional elements and increasing the formation of ferments. SG-70 promotes the increased accumulation of chlorophyll, sugar, amino acids and more in plants while decreasing the uptake of nitrates. SG-70 increases the plant's ability to withstand the extremes of heat, drought, cold, disease, insect and other types of environmental or cultural pressures. SG-70 also increases general plant productivity, in terms of yield, as well as plant stem strength. Within the soil, SG-70 stimulates soil microorganisms, promoting Humus formation. It is easily mixed with fertilizers, improving their efficiency by approximately 20-30%.

Application rates: Please refer to the TeraVita SG-70 Usage Guide that is most relevant to what you are growing. TeraVita created these guides to empower each user with the knowledge needed to properly utilize our new humate products for the improvement of plants and soils. Although it may require repeated readings, taking the time to study the usage guide you need will provide you with the ability to increase your crop's health and performance and to reduce your overall input costs.

General Specifications:

Content of soluble humic acids		70% - 73%	
Moisture		15% - 18%	
Insoluble part (on dry basis)		10% - 13%	
Solubility in water		80% - 85%	
pH in 0,01% solution		8.5 - 9.2	
Organic carbon (active carbon)		45%	
Spectrum Analysis Data:			
Element	**%**	**Element**	**ppm**
Si	1.85	Ni	1
Al	1.00	Co	1
Mg	0.80	V	10
Ca	2.00	Cr	10
Fe	1.50	Mo	9
Na	6.00	Zr	35
K	3.50	Nb	marks
Ti	0.40	Cu	4.5
P	0.04	Pb	3
B	0.03	Ag	0.2
Ba	0.02	Ga	2
Sr	0.02	Y	marks
Mn	0.007	Zn	70
Other elements including Cd, Hg, and Ar were not found			

Specifications of SP-100 Soluble Humic Acid Powder (Humate)

SP-100 is a 100% soluble potassium-sodium humate powder. It consists of small shiny-black irregular shaped beads. SP-100 is pure enough to use in professional laboratory work. SP-100's functions include improving plant immunity, improving plant metabolism, improving plant root development, improving the supply of plant nutritional elements and increasing the formation of ferments. SP-100 promotes the increased accumulation of chlorophyll, sugar, amino acids and more in plants while decreasing the uptake of nitrates. SP-100 increases the plant's ability to withstand the extremes of heat, drought, cold, disease, insect and other types of environmental or cultural pressures. SP-100 also increases general plant productivity, in terms of yield, as well as plant stem strength. Within the soil, SP-100 stimulates soil microorganisms, promoting Humus formation.

Application rates: Please refer to the TeraVita SP-100 Usage Guide that is most relevant to what you are growing. TeraVita created these guides to empower each user with the knowledge needed to properly utilize our new humate products for the improvement of plants and soils. Although it may require repeated readings, taking the time to study the usage guide you need will provide you with the ability to increase your crop's health and performance and to reduce your overall input costs.

General Specifications:

Content of soluble humic acids		99.7% - 99.8%	
Moisture		0.2% - 0.3%	
Insoluble part (on dry basis)		0.0%	
Solubility in water		100%	
pH in 0,01% solution		7.9 - 8.0	
Organic carbon (active carbon)		64%	
Spectrum Analysis Data:			
Element	**%**	**Element**	**ppm**
Si	0.20	Ni	2
Al	1.50	Co	1
Mg	0.50	V	15
Ca	1.50	Cr	12
Fe	2.00	Mo	1.7
Na	3.00	Zr	60
K	1.50	Yb	2
Ti	0.40	Cu	45
P	marks	Pb	1
B	marks	Ag	0.4
Ba	0.02	Ga	4
Sr	0.03	Y	20
Mn	0.0025	Zn	70
Other elements including Cd, Hg, and Ar were not found			

Specifications of LC-12 Soluble Humic Acid Liquid

LC-12 is a liquid concentrate containing 12% sodium-potassium humic acids. It is a very stable and sediment free solution. LC-12 is also characterized with a pH close to neutral that promotes its very effective consumption during foliar application. It is easily assimilated by plants and some of its main functions include improving plant immunity, improving plant metabolism, improving plant root development, improving the supply of plant nutritional elements and increasing the formation of ferments. LC-12 promotes the increased accumulation of chlorophyll, sugar, amino acids and more and improves the efficiency of nitrogen utilization, allowing for reduced fertilizer rates. One of the primary actions of LC-12 is to increase the plant's ability to withstand the stresses of heat, drought, cold, disease, insect and other types of environmental or cultural pressures. LC-12 also increases general plant productivity, in terms of yield, as well as plant stem strength. Within the soil, LC-12 stimulates soil microorganisms, promoting Humus formation. A very important benefit of LC-12 is that it has been specially formulated to improve the fruit formation on agricultural plants by the enhancement of a special functional group within the humic acids. In fact, compared to competing liquid humic acids currently available, our LC-12 shows a 20%-30% increase in fruit formation.

Application rates: Please refer to the TeraVita LC-12 Usage Guide that is most relevant to what you are growing. TeraVita created these guides to empower each user with the knowledge needed to properly utilize our new humate products for the improvement of plants and soils. Although it may require repeated readings, taking the time to study the usage guide you need will provide you with the ability to increase your crop's health and performance and to reduce your overall input costs.

General Specifications:

Content of humic acids		12% - 13%	
Solubility in water		100%	
pH		7.5 - 8.5	
Organic carbon (active carbon)		7.7%	
Spectrum Analysis Data:			
Element	**%**	**Element**	**ppm**
Ca	0.14	Mn	11
Mg	0.036	Cu	2.2
Fe	0.053	Zn	4.7
K	0.38		
Na	1.2		

* Other elements including Cd, Hg, and Ar were not found

Specifications of Super-9 Organic Chelates

Super-9 Organic Chelates is a liquid concentrate containing 9 vital nutrients needed for plant health and nutrition. The 9 nutrients are Calcium, Magnesium, Iron, Copper, Zinc, Manganese, Boron, Cobalt, and Molybdenum. Super-9 Organic Chelates is easily assimilated by plants and some of its main functions include improving plant immunity, improving plant metabolism, improving plant root development, improving the supply of plant nutritional elements and increasing the formation of ferments. Super-9 Organic Chelates promotes the increased accumulation of chlorophyll, sugar, amino acids and more and improves the efficiency of nitrogen utilization, allowing for reduced fertilizer rates. One of the primary actions of Super-9 Organic Chelates is to increase the plant's ability to withstand the stresses of heat, drought, cold, disease, insect and other types of environmental or cultural pressures. Super-9 Organic Chelates also increases general plant productivity, in terms of yield, as well as plant stem strength. Within the soil, Super-9 Organic Chelates stimulates soil microorganisms, promoting Humus formation. Super-9 Organic Chelates was specially formulated to restore the micro-elementary balance of soils and to provide plants with the most important micronutrients in their available (chelate) forms, which helps to prevent various fungal and viral diseases.

Application Rates: Please refer to the TeraVita Super-9 Organic Chelates Usage Guide that is most relevant to what you are growing. TeraVita created these guides to empower each user with the knowledge needed to properly utilize our new humate products for the improvement of plants and soils. Although it may require repeated readings, taking the time to study the usage guide you need will provide you with the ability to increase your crop's health and performance and to reduce your overall input costs.

General Specifications:

Content of soluble chelates of metals and humic acids			10% - 12%
Solubility in water			99.3%
pH			8.0 – 8.5
Atomic Adsorption and Spectrum Analysis:			
	Chelate,%	**Element,%**	**Element, PPM**
Fe	1.14	0.035	350
Cu	1. 34	0.064	640
Zn	1.00	0.051	510
Mn	1.70	0.077	770
Co	0.06	0.003	30
Ca	2.51	0.083	830
Mg	1.25	0.025	250
B*	1.21	0.037	370
Mo*	0.09	0.006	60

* Boron and Molybdenum form anion complexes with the amino acid groups of humic acids.

Specifications of TVH Soluble Humus Liquid

TVH is very black, pure and stable liquid humus. TVH is a 100% soluble product. TVH is used for direct soil application to facilitate humus formation, to restructure the soil and to improve the water - holding capacity of all types of soils. TVH should be used: (1) to restore soil fertility, (2) to restore the structure of soils damaged during intensive use of mineral fertilizers, and (3) to improve clay, salty and/or sandy soils not suitable for agriculture.

Application Rates: Please refer to the TeraVita TVH Usage Guide that is most relevant to what you are growing. TeraVita created these guides to empower each user with the knowledge needed to properly utilize our new humate products for the improvement of plants and soils. Although it may require repeated readings, taking the time to study the usage guide you need will provide you with the ability to increase your crop's health and performance and to reduce your overall input costs

General Specifications:

Content of pure Humic and Fulvic Acids		7.5% - 9.0%	
Solubility in water		100%	
pH		4.8 – 5.2	
Organic carbon (active carbon)		15%	
Results of atomic adsorption analysis			
Element	**PPM**	**Element**	**ppm**
Ca	520	Mn	3.0
Mg	59	Cu	4.0
Fe	270	Zn	9.0
K	620		
Na	3800		

* Other elements including Cd, Hg, and Ar were not found

Specifications of L-85

Granular Leonardite

L-85 is granular raw Leonardite that contains a minimum of 85% humic acids in their natural insoluble state. L-85 is used for direct soil application to help improve the organic matter content of soils and to introduce valuable carbon to the soil. L-85 should be used in conjunction with TeraVita's soluble humic acid products to obtain immediate results.

Application Rates: Please refer to the TeraVita L-85 Usage Guide that is most relevant to what you are growing. TeraVita created these guides to empower each user with the knowledge needed to properly utilize our new humate products for the improvement of plants and soils. Although it may require repeated readings, taking the time to study the usage guide you need will provide you with the ability to increase your crop's health and performance and to reduce your overall input costs

General Specifications:

Content of insoluble Humic and Fulvic acids (dry basis)		85% - 90%	
Moisture		10% - 16%	
Insoluble part (on dry basis)		100%	
Solubility in water		0%	
Organic carbon (active carbon)		56%	
Spectrum Analysis Data:			
Element	**%**	**Element**	**ppm**
Si	3.0	Ni	1
Al	1.0	Co	1
Mg	0.4	V	8
Ca	2.0	Cr	4
Fe	1.5	Mo	3
Na	0.4	Zr	30
K	-	Nb	-
Ti	0.03	Cu	3
P	0.03	Pb	1
B	0.02	Ag	0.5
Ba	0.02	Ga	1.5
Sr	0.02	Y	0.5
Mn	0.06	Zn	-
Other elements including Cd, Hg, and Ar were not found			

Specifications of L-85 + 5% SG-70

Granular Leonardite-Humate Mix

L-85 + 5% SG-70 is a granular product that contains a minimum of 3.5% soluble humic acids plus a minimum of 80% insoluble humic acids. L-85 + 5% SG-70 is used for direct soil application to help improve the organic matter content of soils and to introduce valuable carbon to the soil while also adding soluble humic acids for immediate results. L-85 + 5% SG-70 may also be used in conjunction with TeraVita's other soluble humic acid products to obtain optimal results.

Application Rates: Please refer to the TeraVita L-85 + 5% SG-70 Usage Guide that is most relevant to what you are growing. TeraVita created these guides to empower each user with the knowledge needed to properly utilize our new humate products for the improvement of plants and soils. Although it may require repeated readings, taking the time to study the usage guide you need will provide you with the ability to increase your crop's health and performance and to reduce your overall input costs

General Specifications:

Content of insoluble humic acids		80% - 85%	
Content of soluble humic acids		3.5% - 4.0%	
Moisture		10% - 16%	
Insoluble part (on dry basis)		96% - 96.5%	
Solubility in water		4%	
pH		4.2 – 4.4	
Organic carbon (active carbon)		58%	
Spectrum Analysis Data:			
Element	**%**	**Element**	**ppm**
Si	3.0	Ni	1
Al	1.0	Co	1
Mg	0.4	V	8
Ca	2.0	Cr	4
Fe	1.5	Mo	3
Na	0.8	Zr	30
K	0.25	Nb	-
Ti	0.03	Cu	3
P	0.03	Pb	1
B	0.02	Ag	0.5
Br	0.02	Ga	1.5
St	0.02	Y	0.5
Mn	0.06	Zn	-
Other elements including Cd, Hg, and Ar were not found			

Usage Guide for SP-85
Soil Applications

Crop	Soil rates per acre per treatment*	Suggestions and Methods
Corn and Sorghum	1.5 to 3 pounds	Apply soil treatment before emergence and again as late as machinery passage allows
Rice – Dryland	1.5 to 3 pounds	Apply soil treatment before emergence and again between joining and early heading
Rice – Lowland	1.5 to 3 pounds	Apply first treatment 7 days before flooding and make foliar treatment at the boot stage
Winter Grains	1.5 to 3 pounds	Apply soil treatment before emergence and again at spring green-up
Spring Grains	1.5 to 3 pounds	Apply soil treatment before emergence and again at the onset of flowering
Beans, field beans, soybeans, peas, and peanuts	1.5 to 3 pounds	Apply soil treatment before emergence and again at the onset of flowering
Cotton	1.5 to 3 pounds	Apply soil treatment before emergence and again at the onset of flowering
Hay and Forages	1.5 to 3 pounds	Apply soil treatment in spring at the beginning of growth and again after each cutting
Pastures	1.5 to 3 pounds	Apply soil treatment in the spring at the beginning of growth, again at midseason and a 3rd treatment before dormancy
Tropical Grasses	1.5 to 3 pounds	Apply soil treatment every 3 months
Potatoes	1.5 to 3 pounds	Apply soil treatment before emergence and again at the hook stage
Sugar Cane	1.5 to 3 pounds	Apply soil treatment before emergence and again at 3 months and 6 months after planting
Root Crops (beets, radishes, carrots, etc)	1.5 to 3 pounds	Apply soil treatment at or within 15 days of planting
Vegetables (tomatoes, okra, eggplant, cucumbers, cauliflower, broccoli, peppers, etc).	1.5 to 3 pounds	Apply soil treatment at planting or before emergence and then every 6 weeks during active production
Leaf Crops (lettuce, parsley, dill, herbs)	1.5 to 2.5 pounds	Apply before emergence and again 6 weeks after emergence
Citrus	3 pounds	Apply soil treatment every month during the active/productive season
Fruits (apples, peaches, pears, apricots, plums, cherries, walnuts, pecans, etc.)	3 pounds	Apply soil treatment 1-2 weeks prior to leaf emergence and again at the beginning of fruiting
Topical Fruits (mangos, papayas, guavas, bananas, pineapples, pistachios, brazil nuts, etc)	3 pounds	Apply soil treatment every month during the active/productive season
Vineyards (Grapes)	1.5 to 3 pounds	Apply soil treatment at leaf emergence and again when fruit is half mature
Berries (strawberries, raspberries, blackberries, blueberries, etc.)	1.5 to 3 pounds	Apply soil treatment at the beginning of growth and again when fruit is half mature
Melons (watermelons, cantaloupes, etc.)	1.5 to 3 pounds	Apply soil treatment at planting or before emergence, and again at the onset of flowering
Landscape Ornamentals	1 oz per 1000 square feet of beds	Apply soil treatment in spring at green-up or at transplanting and again prior to dormancy. Year-round climates should make soil applications every 3 months.
Flowers	1 ounce per 55 gallons of irrigation water	Apply weekly in irrigation water
Greenhouse plants	1 ounce per 55 gallons of irrigation water	Apply weekly in irrigation water
Potting Mixes	3 ounces per cubic yard of mix	When moistening the dry potting mix, add enough SP-85 into the water/fertilizer/fungicide solution to deliver 3 ounces of SP-85 per cubic yard of potting mix.
Hydroseeding	3 to 8 pounds	Once the water is added to the hydroseeding tank, add enough SP-85 to deliver 3 pounds of SP-85 per acre. Allow to mix for at least 5 minutes before spraying. In very harsh environments, add up to 8 pounds of SP-85 per acre in the hydroseeding solution.

Turf and Golf Course	1.5 to 3 pounds	Apply soil treatment at spring green up and with (or at the time of) each normal fertilizer application. Tees and greens may be treated more frequently with half-rate applications.

* Soil applications can be made in numerous ways. SP-85 can be mixed into or coated onto dry fertilizers and soil amendments, it can be mixed with water and sprayed onto the soil or dripped into the crop row, or it can be run through overhead, trickle, or underground irrigation systems.

Irrigation Applications

When making soil treatments through irrigation equipment, the total amount of SP-85 to be used should be thoroughly pre-mixed in a separate container before adding it to the final irrigation tank or system. SP-85 has a particle size ranging from 50-80 microns and will not block irrigation openings if it is properly pre-mixed with water. It is important to keep the final concentration of SP-85 to water being emitted to the soil within the parameters listed below. It may be necessary to adjust the irrigation system to deliver more or less water per acre per cycle to deliver the desired amount of SP-85 listed for the crop you are treating.

Maximum Concentration	Optimal Concentration	Minimum Concentration
1 ounce SP-85 per 5.5 gallons of water	1 ounce SP-85 per 55 gallons of water	1 ounce SP-85 per 110 gallons of water

Foliar Applications

All crops will benefit from foliar applications of humic acids when it fits into the crop management practice. Foliar applications should be made *in addition* to the soil treatments. Foliar applications should be made at the rate of 3 to 6 ounces of SP-85 per acre per treatment. Foliar treatments with SP-85 are strongly recommended during four growth stages of the crop: immediately before the appearance of buds, before blossoming, after the flowers have fallen, and during ripening. When soil treatments are not possible, foliar treatments may be made every 14 days using 3 ounces of SP-85 per acre. It is important to always use SP-85 within the concentration parameters listed below.

Maximum Concentration	Optimal Concentration	Minimum Concentration
1 ounce SP-85 per 5.5 gallons of water	1 ounce SP-85 per 55 gallons of water	1 ounce SP-85 per 110 gallons of water

Additional Usage Notes

- When applied together with fertilizers or pesticides, the use of humate increases the efficacy of the companion materials. In most cases, systemic pesticide rates can be reduced by 25% or more when the humate is added to the application. The total annual need for nitrogen can be reduced by 30% or more when the full program of soil treatments using humate are applied to the crop. In all cases, we suggest using personal experience and experimentation to determine the rates of companion products that will provide acceptable performance.
- All humate powders contain a small portion of mineral content that is not soluble in water. If humate powders are added directly to a final spray or irrigation tank (not pre-mixed and settled in a separate container), the insoluble portion will settle to the bottom of the tank once any agitation is stopped. When high concentrations of humate powders are added to the final spray or irrigation tank and the liquid is not fully run-out (applied), the insoluble material that settles to the bottom may necessitate more frequent tank and filter cleaning.
- Humates have proven compatible with virtually all companion products except those with a very low pH. In laboratory experiments, no problems have been found other than when companion materials have a pH less than 3.0. However, if there is any doubt about compatibility, a jar test is strongly recommended. To be safe, a jar test is recommended with any material that has a pH less than 4.0.

Helpful Conversions:

When it is not possible to accurately weigh the SP-85 powder, the following table will provide close approximations for measuring the amount needed:

Humate By Weight	Humate By Measure
0.5 ounces	1 tablespoon
1.0 ounces	2 tablespoons
8 ounces	1 cup