# *All About Humates*

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Please note, this "book" has been translated into English from its Russian form. Any small grammatical flaws that occur are simply the result of this translation.



## 1. INTRODUCTION

Dear Reader,

This small book was first written in 1996 and has been published in Russia four times. Even though humates have been used for over fifty years, the first industrial production of highly concentrated humate powders containing at least 70% *active* humic acids was established at the time of this book's first publication, using the technology developed by its author. This technology allowed the production of reasonably priced humates, so that they became affordable for everyone. On the basis of this technology a whole series of new humic preparations was created. Apart from the Russian farmers and the large rural production associations (the former collective farms and State farms), the major buyers of humates are the millions of ordinary people who use them on their small plots of land, where they grow vegetables, fruit, and berries for their personal use. The Russian people do not particularly believe in advertising, and they had to see for themselves the advantages of the humates' use. When convinced, they became my best advocates in advertising this wonderful product. As a result, our yearly production more than tripled, and we began exporting our product to several countries, including the United States.

There are many differences in the land cultivation and agriculture between these countries and Russia. With the help of a close business partner in New Zealand, I was able to visit his wonderful country, as well as some of the agricultural regions of Australia and a few Oceania Islands. During these visits, I met with many farmers, scientists, agriculturists, and businessmen. I was able not only to share my knowledge with them but also to learn many new and interesting things.

In 1999 the American distributor initiated a new project, which ultimately resulted in the formation of TeraVita LLC and the construction of its humate manufacturing facility in Lancaster, Pennsylvania. Together with Australian and the American engineers we managed to create the new equipment needed to increase production capacity and considerably to improve the original Russian technology. This business project and the opportunity to speak and meet with many respected businessman and scientists greatly enriched my previous experiences. The result of it all is the book which I bring to your attention now.

### A Little History

"The duty of scientist is that: the Earth should be pure, and people should be full" – L. Khristeva

About 50 years back at Kherson University a young Soviet scientist named Lydia Khristeva made an important discovery. Using ordinary soil, she educed humic acids from the samples as a solution of sodium salts and then watered plants with the solution. The plants had increased growth and an increased root mass over the control plants. **Thus, the biological activity of soluble humates was discovered for the first time!**

All further scientific activity of Lydia Khristeva was devoted to this problem. She found a way of to extract humates from Ukrainian coal and together with pupils and employees she carried out thousands of experiments with the various kinds of plants. Later, scientists from Byelorussia, Moscow, Uzbekistan and other regions of our country joined them. In distant Siberia enormous stock piles of humic acids in coal deposits were discovered and scientists from Irkutsk, led by Professor Valentina Larina began active work in this area. At this time I was just a student of the chemical faculty of Irkutsk University and my first scientific work was related to studying humic acids. On time, similar research began in Czechoslovakia, Poland, Italy and the USA. The results of applying humates in agriculture, animal industries, poultry farming, and also in some areas of engineering were gradually collected. These results were widely discussed in scientific publications and at scientific conferences, but remained mostly unknown to the general public. The main reason for this, in my opinion, was the absence of a reliable and effective technology for the production of soluble humates from their raw sources. At that time humates were extracted from brown coals and peats by extraction with diluted solutions of alkalis. This was, as it seemed, the most simple and reliable method, but it appeared extremely unprofitable in terms of large-scale industrial production because it produced only diluted solutions of humates with 5% to 7% humic acids. Many years later I had an epiphany for a better and more efficient method of extracting humates from their raw materials.

The first patent protecting this technical discovery was received in the early 1990's. In 1996 we created the first industrial production in Russia. The humates created with this technology had a number of important qualitative differences from their predecessors and it resulted in the creation of essentially new preparations of humates with no analogues. **It was the beginning of humic preparations of a new generation.**

The major factor in the enhanced quality of these new preparations is the quality of the raw material itself. The new production technology allows for greater conversion of humic acids into humates and also allows silica to transfer into its useful form - soluble salts of silicon acid. Beyond that, part of the insoluble fraction of the organic substance, the humins, are able to be oxidized during the conversion and to transferred in humates.

Table 1.1.

The comparative characteristics of oxidized coals and the humates produced from them using our technology.

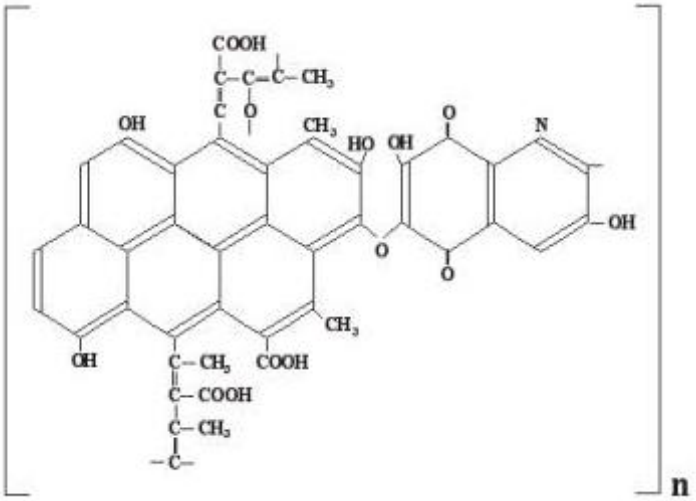
| Indexes | Oxidized coals (lignites) various deposits | | | | |
|---|---|---|---|---|---|
| | **Russia I** | **Russia II** | **USA I** | **USA II** | **Canada I** |
| Humic acids , % | 62.3 | 50.0 | 53.6 | 79.5 | 81.3 |
| Fulvic acids, % | 8.6 | 2.3 | 12.5 | 4.3 | 4.6 |
| Humins, % | 19.6 | 22.1 | 11.2 | 7.1 | 1.2 |
| **Total organic part, %** | **90.5** | **74.4** | **77.3** | **90.9** | **87.1** |
| The mineral part connected with humic acids, % | 3.6 | 3.1 | 11.7 | 3.0 | 5.1 |
| The mineral part not connected with organic part, % | 5.9 | 19.4 | 25.5 | 6.1 | 7.8 |
| **Total mineral part, %** | **9.5** | **22.5** | **37.2** | **9,1** | **12.9** |
| The contents water-soluble humates after processing, % | 83.0 | 72.0 | 65.9 | 86.0 | 84.0 |
| The mineral part in solution, % | 3.5 | 1.0 | 3.0 | 4.0 | 7.0 |
| The insoluble residue, % | 13.5 | 27.0 | 31.1 | 10.0 | 9.0 |

## 2. THE THEORY BEHIND HUMATES

The term "humus" has been known to science for over two hundred years. Humus is a transformation product of the animal and vegetable organisms' remains, which are much more resistant to the further

decomposition than the initial biomass. Dozens of hypothesises were offered to explain the process of humus formation. None of them gave an exact answer why the relentless process of dead organic matter decomposition in the soil does not come to its completion (which would be carbonic acid and water) but stops at a certain stage, when comparatively simple decomposition products, such as phenols, carbohydrates, and amino-acids transform into much more complex compounds - the humic acids.

Fig. 1. Diagram of the structure of the humic acid fragment.




Humic acid is a substance of very complex structure (its molecular mass is 1500), which is practically insoluble in water, except for a very small part called fulfonic acids.

These fragments use hydrocarbon bonds to create molecule-forming chains, which in their natural state are rolled into a ball. These balls form large aggregates that constitute the organic part of the soil - humus. Because of their low water solubility, biological activity of the natural humic acids is very poor. Therefore, in order to ensure fertility of the soil, its humus content should be rather high; similar to the famous chernozem (black soils in the south of Russia). However, the treatment of the humic acid by alkaline agents, as Lydia Khristeva did, transforms it into water-soluble salts, sodium and potassium humate.

ÎÍ Î- +

HUMIC ACID + Na OH = HUMATE + Na + H2O

ÑÎÎÍ ÑÎÎ-

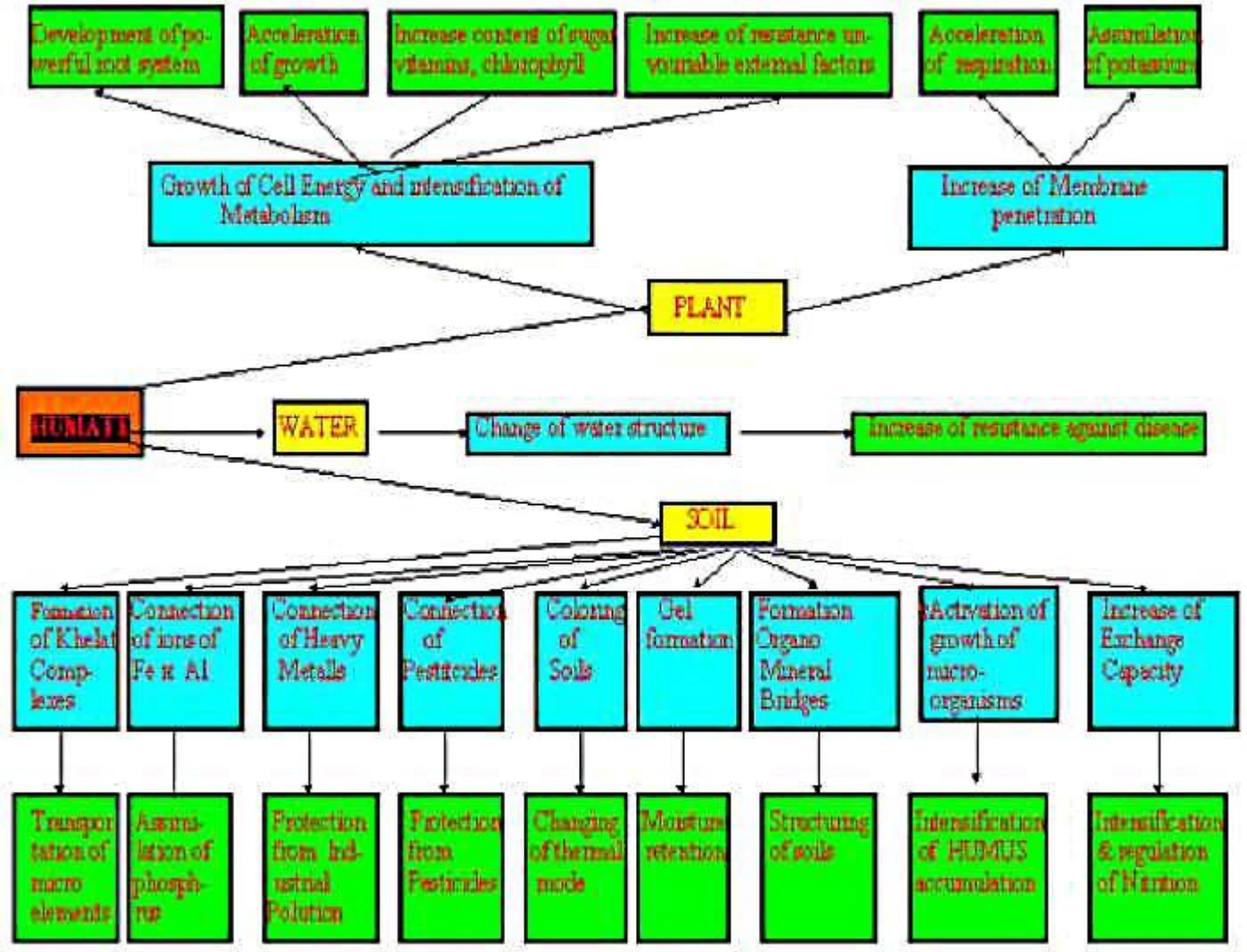
The above illustrates how, as a result of this treatment, hydrogen atoms in carboxyl and hydroxyl groups are replaced by alkali-metal ions. As a result of the following dissociation, the humate molecule acquires a charge. These charges are located throughout the molecular chain. The charge-charge repulsion takes place, and the ball unrolls, allowing the humic acid molecules to pass into solution and to become biologically active. Each functional group shown on the fragment has its own function. There are many of these groups, therefore the influence of the humates on all stages of plants' growth and development is versatile. For example, carboxyl (ÑÎÎÍ) and phenol (OH) groups are able to form chelate complexes with microelements and transport them into plants in this form. They also provide a high ion-exchange capacity of these compounds. Other groups, which are called quinones (ÑÎ=Ñ Í =ÎÑ), contain non-localized charges, which are able to capture and accumulate solar energy. At the right moment, when a vegetable cell needs it, electrons supply the energy to the cell and increase the cell's own energy. These two particular examples illustrate only partially the humates' influence. An important role is played not only by the existence of functional groups but also by their mutual location. Nature made sure they were located in a way that allowed the humic acids and ions of metals to interact in the most optimal direction for plant development.

Analyzing the results of research conducted by different scientists, we were able to create a diagram of the humates' effect on a complex system **water-plant-soil**. (See **Fig. 2**.)

We determined 16 factors of the humates' effect, and each of them, independently from the others, leads to a certain result. As a pianist touches the piano keyboard and creates a beautiful melody, the humates influence the plants during their different growth stages, which leads to wonderful results. It is no coincidence that the leading

Russian soil scientist, Professor Dmitry Orlov, considers humic acids a connecting link in the evolution of animate and inanimate matter.

**Fig. 2.** Diagram of interaction of the humates and the system **water-plant-soil**




Let's look at the simple system **humate-water**. The research carried out at Irkutsk University (D. A. Kalabin, D. F. Kushnaryov) found the dependence in NMR spectral parameters of water, its structure, and concentration of the humates dissolved in it. When the concentration of the humate reaches 0.005-0.009% (this particular concentration is recommended for watering plants), 17Î signal increases from 52.7 Hertz to 103 Hertz, which indicates structurization of water.

The course of the curves in **Fig. 3** shows that the humates cause water to obtain the structure of melted water (previously frozen), which is known to have a medicinal effect on animate organisms and plants.

**Fig. 3.** The connection between value of NMR signal and humate concentration

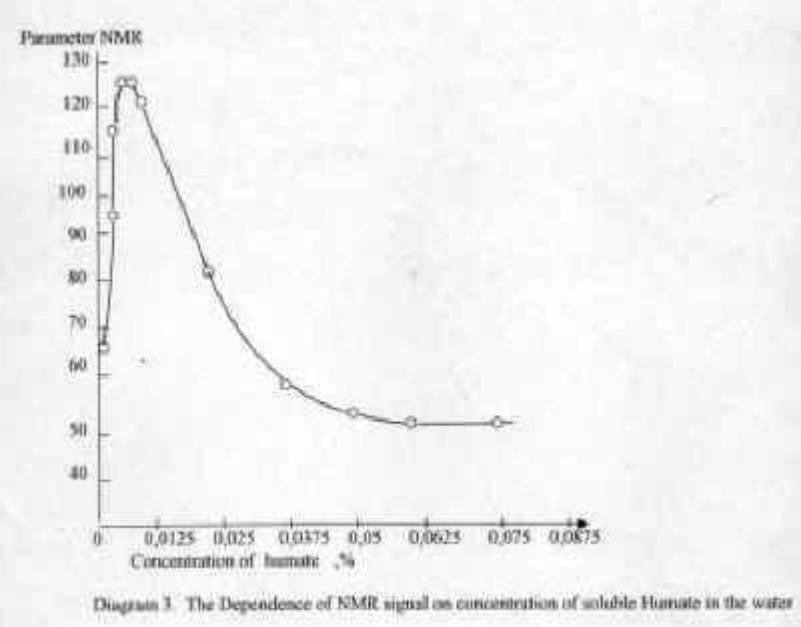



Diagram 3. The Dependence of NMR signal on concentration of soluble Humate in the water

The system **humate-plant** can be characterized by two independent processes that are very important to plants' growth and development. *The first process is the increase in the cell's energy and the intensification of ion-exchange process as a result of it*. Nature made sure there were quinoid groups in a humic acid structure. Electrons of the four conjugated p-bonds are able to capture a quantum of solar energy accompanied by a transition to a higher energy level. They accumulate the energy and supply it to the cell when needed. It intensifies the ion-exchange process. As a result, the root system develops more rapidly, and special ferments form to improve the plants' resistance to unfavorable conditions, such as drought and frost. These ferments also assist the process of nitrogen assimilability that does not lead to the formation of nitrates. At the same time, the synthesis of chlorophyll, sugars, vitamins, essential amino-acids, and oils accelerates.

*The second process is the increase in penetrability of the cell membrane*. (T. L. Senn and A. R. Kingman, 1973.) It facilitates the penetration of nutrients into the cell and accelerates the respiration of the plants. It is important to point out that this process is rather elective. For example, the penetration of potassium ions increases a hundred times while sodium penetration increases ten times, which favourably influences plants' nourishment.

A particularly large number of processes can be observed in system **humate-soil**. The humic acids are natural complex generators. All essential microelements, being the variable-valence metals, form chelate complexes with the humates. This is a determinant for plants' nourishment. As for heavy metals, such as lead, mercury, chrome, cadmium, and others, their penetration into fruit and further into the human and animal organisms leads to serious illnesses. The humates form insoluble compounds with heavy metals, which creates the barrier for their penetration into the cell. With the use of space photography, it was established that the regions with soil rich in humates have higher ecological balance in spite of the intensive technogenic pressure. Another important quality of the humates is their ability to bond iron and aluminium ions into complexes, since their excess amount in soil results in poor phosphorus nutrition of the plants. Iron forms complexes with the humates, which ensures its transportation to the plants, while aluminium creates insoluble compounds with the humates, which neutralizes damaging effect of aluminium on phosphates. Long-term wide scale experiments have been conducted in Russia, which showed that humates neutralize the negative effects of residual amounts of pesticides (atrazine was used in tests). It ensures good crop capacity and ecological purity of the product. For the countries with cold and moderate climates it is very important that the humates have the ability to change the colour of soil to a darker colour. Forming the colouring, the humates change thermal conditions. For instance, cold clay soils become warmer. Colloidal structure of the humic acid and the high level of hydrophilicity of terminal functional groups give them the ability to gelatinize. That is how many researchers explain the increase in soil water retention after the humate treatment. This is particularly important for drought-afflicted regions.

We have already mentioned the important role of interaction between the humates and metals, which results in formulation of complexes and insoluble salts. It was discovered that this process is very important not only for nourishment of the plants but also for soil structuring. The humate reacts with potassium, magnesium, aluminium, and iron that are always present in soil, and forms organomineral bridges that bond mechanical particles of the soil into a life-sustaining structure for micro organisms. This structure is capable of withstanding erosion, retaining water and air, and creating favourable conditions for the existence of the micro organisms. It is no

coincidence that all researchers have noted the increase in the activity of all types of soil micro organisms with the presence of the humates. Efficient functioning of micro organisms is the vital part of humus formation. That is why the humate treatment is the only effective measure to restore the fertility of soil emaciated by intense exploitation, as well as soil that has not been originally rich with humus.

Note that the humate molecules, which entered the soil structure as described earlier, contain a lot of functional groups capable of ion-exchange reactions. Therefore, the soil's ion-exchange capacity dramatically increases in their presence. Humates in soil are a treasury where nutrients are stored and supplied to the plants when needed.

Concluding my remarks to the presented information, I'd like to point out that the acknowledged 16 factors are not the results of purely theoretical preconditions. Both laboratory analysis and wide scale field tests experimentally proved each of them. Naturally, in all cases there has been a general effect of direct increase in crop capacity, quality of the agricultural product, and the ecological purity.

## 3. THE EFFECTS OF HUMATES ON CROPS

Information from the previous chapters answers the question: Why do humates stimulate growth and plant development? In this chapter I shall try to answer the question: How does this happen? On one level, experience of Humates usage has a 50-year history and during that time a huge amount of practical material has been accumulated, but on another level, the new technology relative to the Irkutsk Humates production, characterizes a new stage of development. Today we have evidence that this new technology allows us to not only decrease production costs, but to produce a new high quality product. Firstly, let us consider the 50-year experience of Humate usage, based on brown coal and peat, then consider and analyse content and quality of Irkutsk humates and the results of their usage.

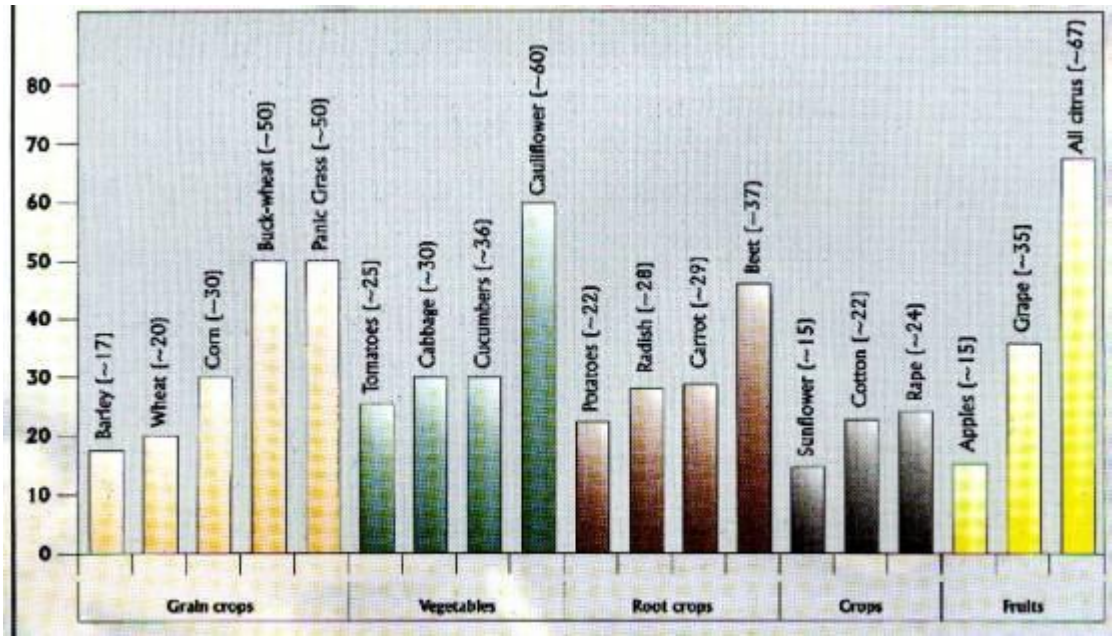
Long-term experience in the use of humates in Russia has shown that their presence is important during all stages of plants' development but particularly vital in the early stages. That is why the pre-planting treatment of seeds is very important. Even before germination begins, vital forces are awakened, and the immune system is stimulated. A young sprout develops a strong root system, and its endurance increases. Intensification of the root system growth was studied on barley. (L. Ekaterinina, T. Kukharenko, 1971.) As a result of humate treatment, the root length of the plants increased by 2.5 times, and average stem length increased twice, in comparison with the control group. Similar results were obtained in the course of other research and were confirmed by the experience of California citrus growers. (T. Senn & A. Kingman, 1973.)

The treatment of seeds is particularly important for potatoes. Soaking the potato tubers in the humate solution prior to planting is practically the only necessary operation in treatment of potatoes, especially since spraying the vegetating potato plants can lead to growth of the over-ground parts of the plant at the expense of the tubers' development. As you will observe in the following photograph, the treatment of the tubers prior to planting results in an increase of quantity and vigour of the shoots.

**Fig. 4.** Potatoes after the humate treatment (right) in comparison with the control group (left). (Photo by V. I. Butakov, Irkutsk, 1998)

Naturally, the strengthening of the root system and stems has a positive effect on crops. As plants develop, however, other factors are involved. A strong, developed root system provides plants with the necessary nutrients of a higher quality. Because they are already a part of a certain organic structure, the humates' chelate complexes with microelements can penetrate into the cell more easily than ordinary ions. The humates increase the penetrability of a cell membrane and, as a result, are conducive to potassium retention in intra-cell fluid, which leads to the increase of cell division. Due to the additional energy supply, a photosynthesis process in the cells proceeds more intensively, leading to an increased amount of chlorophyll. A determining factor in plants' growth, nitrogen assimilation proceeds more rapidly, and nitrate formation is averted. All together, it leads to an increase in crop capacity. Throughout a long-term history of humate use at the experimental fields, plots, greenhouses, and gardens a lot of data has been collected and published. In mean form, these results are presented in the following diagram. (See **Fig. 5**.)

**Fig. 5.** Humates and the increase in crop capacity in agriculture.




It is important to note that the tests (particularly the ones on vegetables planted in both open and closed conditions) were carried out on a wide scale, which ensured accuracy of the results. For instance, the tests of the oxy-humate preparation were simultaneously carried out at twenty greenhouse farms in Ukraine and Byelorussia. The test technologies included soaking of the seeds prior to planting in water-based humate solution, as well as two-time watering of the vegetating plants and prophylactic spraying with the humates against disease. Complex tests of non-ballast humates educed from brown coal of the Kansk-Achinsk and Dnepropetrovsk coal fields, as well as coal fields near Moscow, were carried out. Tests on vegetables, wheat, cotton, and other cultures were carried out in dozens of hectares of open fields in different regions of the country. Average humate consumption amounted to 5-10 kg/hectare or 400 litters of 0.005% solution per treatment. When the first industrial production of ballast humates was established during the 1960s in Ukraine, at the Semenovsky mineral wax works, up to 60 tons per year were used for agricultural needs.

**Thus, with this extensive research it was established that humates are conducive to a direct increase in the yield capacity of most agricultural crops.**

Important data in humate use in floriculture was also published. The root and non-root treatment of arboreal plants (such as Crimean pine), shrubs (three types of roses), and lianas by the ammonium humate was tested at the Donetsk botanical gardens. (Science Academy of Ukraine.) The increase in growth of these plants, particularly of roses and lianas, by the end of vegetation reached 1.3-2 times, compared with the control group. In 1990-1992, humates were used for treatment of roses, tulips, hydrangea cuttings, and socotra, as well as for singling of plants. In all cases, the flowering accelerated by 5-10 days, while the amount and size of the buds and their stamina improved. Other research proved the effectiveness of humate use in ornamental gardening.

**Irkutsk Humates** the mentioned data was published in the 1960s-1980s, and it generalized the experience of using the humates educed according to the old extracting technology. These humates were educed from Belo Russian peat and brown coal from Ukraine, the Kansk-Achinsk coal fields, as well as coal fields near Moscow. As it was mentioned earlier, these products were not cost-efficient, and their use in the republics of the USSR was

confined to individual, though wide scale, tests. With the creation of the Irkutsk high-concentrate humates, substantial changes took place, both quantitative and qualitative. It was proven by new research and by field tests carried out in the Irkutsk region during the last three years.

Obviously, the quality of any preparation depends on its composition, which in turn depends on the initial raw materials. Brown coal and peat contain a 25% to 50% mineral component that is mostly composed of silicon compounds, as well as calcium and magnesium salts. After alkali treatment, these salts, along with the humic acid salts, pass into solution in high concentrations. They form water-insoluble compounds with low biological activity. That is why many technological conditions recommend acid pre-treatment of raw materials prior to alkali treatment in order to remove most of the mineral ballast. However, the process was so complicated by this operation that it was not widely used in practice. It also made the process much more expensive and presented the problem of acid waste treatment. The technology developed to produce Irkutsk humates is free of these drawbacks because it uses naturally oxidized coal of weathering crust, containing at least 75%-80% humic acid and not more than 8%-10% mineral compound. It also allows further oxidation of the coal during the process, which increases the output of biologically active components. Thus, Irkutsk humates contain a minimal amount of both mineral and organic ballast. **Table 1** (See below) is based on the research data obtained during the studies of different humates with the use of NMR spectroscopy at Irkutsk university. (B. Levinsky, D. Kalabin, D. Kushnaryov, 1995.)

**Table 1.** Characteristics of the commercial samples of humates.

| Source of Sample | The contents of ash in the initial raw Material, % | The general contents of humates in commodity product, % | Fragmentary structure on functional groups, % | | | | | | **Total, %** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ketones | Kinones | Carboxyl's | Polyphenols & N-replaced | Aromatics & Heterocycles | Aromatic profanation atoms of carbon | Biologically active | Biologically inactive |
| "Gumat LTD' IRKUTSK, RUSSIA | 8 - 10 | 70 - 80 | 1,7 | 3,4 | 6,8 | 19,4 | 7,8 | 44,7 | 83,8 | 16,2 |
| "MARS Ltd" Stupino, RUSSIA | 29 - 32 | 24 - 26 | - | - | 0,4 | 26,3 | 7,1 | 46,4 | 79,9 | 20,1 |
| Joint-stock company "KUBOST", MOSKAW, RUSSIA | 36 - 43 | 19 – 20 | - | 0,5 | 1,0 | 29,05 | 5,4 | 36,5 | 72,6 | 27,4 |
| SPP "VIOST" MOSKAW | 29 - 32 | 24 – 26 | - | 0,8 | 1,0 | 30,7 | 5,0 | 24,9 | 62,4 | 37,6 |
| The plant of ozokerit ALECSAND-RIA UKRAINA | 20 - 24 | 35 –36 | 0,8 | 0,9 | 3,1 | 24,2 | 5,6 | 28,8 | 63,4 | 36,6 |

It was discovered that Irkutsk humates contain more biologically active components, and it directly affects their use. Practical tests confirmed it. In 1996, the experiments on potatoes and oats were carried out. (M. Butyrin.) The results showed crop capacity of potatoes and oats increased by 22% and 61%. Particularly good results were obtained when testing cucumbers and carrots, with a crop capacity increase of 80% and 60%. These are twice the average indices in the diagram.

The data presented in **Fig. 6** is particularly important. It shows the connection between the humate solution concentration and the crop capacity of carrots. The extreme increase in the crop capacity when the concentration reaches 0.015% (0.009% of pure humate) confirms, once more, our recommendation of using only diluted solutions, accordingly to data in **Fig. 3**.

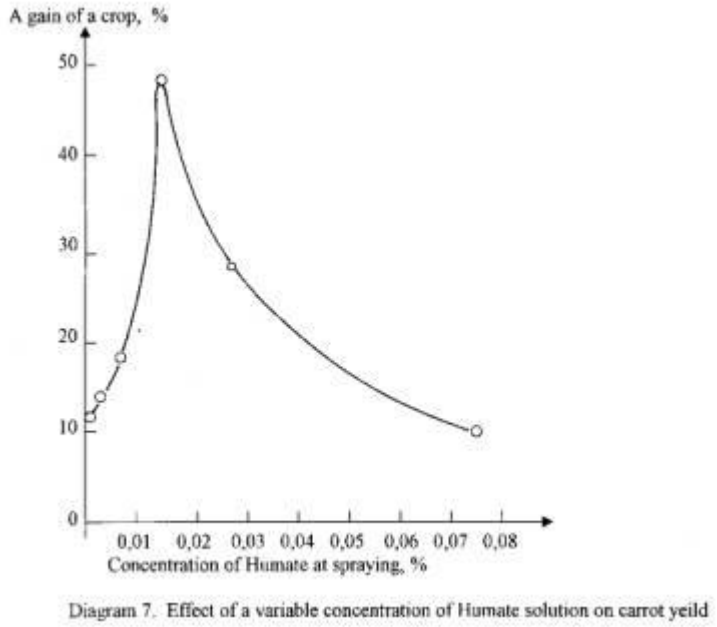



Diagram 7. Effect of a variable concentration of Humate solution on carrot yeild

**Fig. 6.** Above. The connection between the increase of the crop capacity in carrots and the humate concentration in the spraying solution.

Other interesting data was obtained in strictly comparable conditions when testing cucumbers. Mineral fertilizer and humus were used on the control group, while the humates were used along with the same fertilizer on the experimental group. A total of 30 kg of humate per hectare was used to spray crops four times a season with 0.015 % humate solution. The seeds were also soaked for 48 hours in 0.04% humate solution prior to sowing. The results of these experiments are presented in **Table 2**.

**Table 2**

The effect of humates on cucumber crops. (Irkutsk young naturalist station, 1997.)

| Indices | Humate tests | Control group |
|---|---|---|
| Date of sowing | 13.06.97 | 13.06.97 |
| Beginning of flowering | 15.07.97 | 17.07.97 |
| Average flower-bearing amount | 5 | 4 |
| Beginning of ripening | 27.07.97 | 02.08.97 |
| Crops, ton/hectare | 45 | 25 |

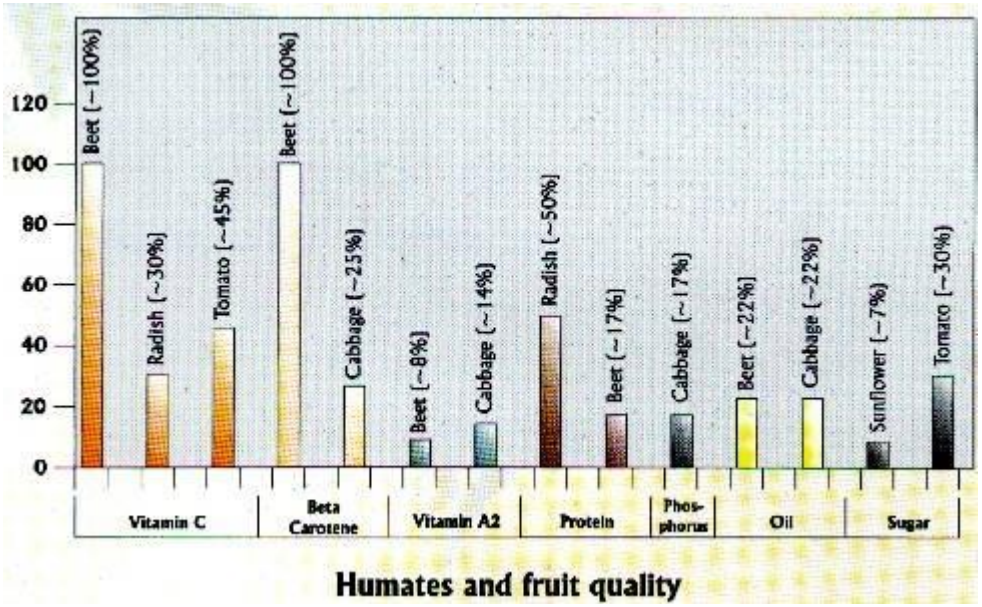
Along with the published results of the tests, there are also the experiences of gardeners, who used the humates for a number of years. Some of them achieved unique results in taking of cultivated trees (their stamina improves), as well in increasing the crop capacity of potatoes (60-90 tubers per plant) and strawberries (flower-bearing increased up to 120-170 per plant). However, in some cases there were no visible results. We will mention the possible reasons for that later, when we talk about the use of humates. It is important to realize that the increase in crop capacity is just a visible effect of humate use. It is neither the only nor the most important effect, since there are many other means to increase the crop capacity. Other effects of humic preparation use include an increase in the quality of the produce.

## 4. HUMATES AND THE QUALITY OF PRODUCE

One of the most important biological activity factors of humates is the quality characteristics of the produce. Wide research noted the increase in produce quality which was achieved in two independent ways: by accumulating biologically active nutrients and by decreasing the amount of harmful admixtures. The latter happens due to the protective effect of humates and will be looked at in detail in the next chapter.

Nutrition value and taste quality of the produce depends on its vitamin, sugars, phosphorus, nucleic acid, and oil content. Data published in the 1970s is summarized in the following diagram. (See **Fig. 7**.)

**Fig. 7.** Humates and the quality of produce.




We can see that an increase in the vitamin and sugar content takes place in the presence of the humates, and it determines taste and goodness. Unfortunately, the quantitative data on the Irkutsk humates is not available yet, however, we have a number of interesting feed-backs from our foreign customers. The New Zealand company "BioStart" tested our humates in vineyards and reported a considerable improvement in vine quality. Farmer George Moala (Tonga) wrote to us, "I used your product on six hectares of watermelons. Even though the increase in crop capacity was not tremendous, the watermelons ripened a week earlier, and, most importantly, **I have never eaten such sweet watermelons**."

**The use of humates guarantees high quality, vitamin-rich produce.**

## 5. THE PROTECTIVE EFFECT OF HUMATES

The increase in ionized radiation and pollution of our environment with herbicides, pesticides, heavy metal compounds, and other toxic mutagenic and carcinogenic substances presents a real danger to living organisms today and their progeny in the future. Considering the soil pollution by water soluble heavy metal salts in the industrial regions and the long-term excessive use of mineral fertilizer, pesticides, and herbicides in agricultural regions, the crops, particularly vegetables and root-crops, accumulate excess amounts of harmful admixtures. That is why the creation of pure agricultural technologies is one of the most important tasks of our time.

The protective effect of humates develop in the following directions:

1. Protection from radioactive irradiation and its consequences.
2. Protection from harmful admixtures in the atmosphere, soil, and subsoil waters in technogenic districts.
3. Protection from the consequences of the pesticides and other chemicals used in agriculture.
4. Protection from unfavourable environmental factors in zones of risky agriculture.

5. Decrease in content of the nitrates that form when nitrogen fertilizer is used.

Long-term research showed that humic substances bond many organic and non-organic substances into poorly soluble or insoluble compounds, which prevents their penetration from soil into subsoil waters and growing plants. It reduces the toxic effect of residual amounts of herbicides, soil polluting radio nuclides, heavy metals, and other harmful substances, as well as radiation and chemical contamination. Tests showed that even after 50% affection of the plant, its vital functions are completely restored due to the humic preparation effect. This unique quality of humates is particularly important for the regions in Russia, Byelorussia, and Ukraine that are contiguous to the Chernobyl region. In the future it could be used to gradually restore contaminated land.

Modern floriculture is not possible without the use of different chemicals necessary to fight weed, pest, and plant disease. It is widely known, however, that the use of those chemicals causes a number of negative effects due to their accumulation in the soil. The infamous fact of DDT accumulation led to its complete banning. However, DDT appearance still occasionally occurs in crops. Science proved that sodium humate reduces the damaging effect of the pesticide atrazine by increasing its decomposition, which leads to an increase in the crop capacity of barley.

The use of humates in zones of risky agriculture is particularly important. Unfortunately, most territories of Russia can be considered risky. In the south, the humates help to fight the effect of droughts, since it has been established that the humate treatment of plants ensures their drought resistance. In Siberia and in the north of Russia, humate treatment can save the plants from late frosts. In the 1960s, a corn crop was saved by colleagues of Irkutsk university, after an unexpected frost. In 1996, in the Angarsk region, a strong frost happened on the 19th of June. The parts of the potato fields that had been treated with the humates were the only undamaged parts.

Watering soil with a 0.01% humate solution substantially increases the biological activity of the soil and boosts plants resistance against the harmful waste in technogenic zones of chemical and coking industries. In 1998, in Buryatia, wide scale tests were carried out in treating of saline soils with humates. The results showed a 214% increase in crops of green herbage, in comparison with the control group.

The ability of humates to create complexes and their high sorption activity are used to bond the ions of heavy metals in contaminated soil. That is why increased amount of humates (up to 20-30 kg per hectare) should be used on contaminated soil to ensure the contact and create favourable conditions for forming of complexes.

**Humates accelerate water-exchange processes and physiological processes in the cell and participate in oxidation processes at the cell level. They are conducive to complete assimilation of mineral nutrients in the plant, particularly in abnormal cases, such as saline soils, drought, and other unfavourable environmental factors.**

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 soils. 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 19%-20%. However, the residual amounts of the herbicide reduced the crop capacity in barley, which was sown after the corn in crop rotation, by 16%. The use of sodium humate considerably changed the situation. It stimulated corn growth and increased the crop capacity by an additional 10%, while the nitrates content (NO3) in the corn of honey and pearl ripeness decreased from 280.1 mg/kg to 199.7 mg/kg in laboratory tests and to 707 mg/kg in field tests. Barley grown after the corn was noted to improve its germination, growth, and mass gaining, while containing less atrazine and more chlorophyll in the leaves. The crop capacity of the barley increased by 5.2 centner per hectare, with a total crop capacity reaching 30.9 centner per hectare. 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, ionizing radiation, etc.).

## 6. THE EFFECTS OF HUMATES ON SOIL

The fertility of the soil was always related to its humus content. It was determined that humic substances participate in the regulation of most important characteristics. *First of all*, they are accountable for the colouring

and, therefore, thermal conditions. It is particularly important for cold clay soil which under the effect of humates becomes warmer. *Secondly*, long-term humate treatment is conducive to the improvement of soil structure. When humates enter the soil, they form potassium and magnesium humates that bond mechanical element of the soil and act as organo-mineral bridges between aggregates. *Thirdly*, one of the important qualities of humates is their ion-exchange activity. It ensures humates' ability to regulate the process of transformation of mineral nutrients in soil-plant system. *Fourthly,* humate treatment increases water saturation of soil. It is particularly important for sandy soils. Its water saturation ability increases by more than ten times after humate treatment. The same principal applies when preparations are used for melioration. *Fifthly*, the most important challenge of our times is restoration of the fertility of the soil in suburban zones of the industrially developed regions. Modern ecological overload makes the soil's natural self-rectification with micro-organisms insufficient. Traditionally, organic fertilizers (manure, compost) were used to increase biological activity of the soil and to improve its self-rectification. However, in spite of high nutritious value of these products, their bond with organic mass is too close, and it decreases their assimilation. That is why these products are used in large quantities (up to 60-80 ton/hectare). Introduction of humic substances solves the problem very effectively.

**Humic substances determine the structure and the fertility of the soil. They are an effective measure in solving ecological problems, such as pollution of soil and subsoil waters by chemicals used in agriculture.**

## 7. HUMATES AND CHEMICAL FERTILIZERS

Intensive agricultural systems demand the use of large quantities of mineral fertilizers in order to supply the plants with basic micro-elements, such as nitrogen, phosphorus, and potassium. In doing so, we often forget that mineral fertilizer is for plants what illegal drugs are for sportsmen - you can immediately see high results but tend to ignore the future consequences. The higher the amount of mineral fertilizer used, the more intensive is the erosion of the soil, the poorer the soil's humus content, and the environment is more polluted. The problem of effective mineral fertilizer assimilation is central in plant-growing. The difficulty of its solution lies in the fact that water soluble potassium and nitrogen fertilizers are easily washed out of the soil, while phosphorus fertilizers, on the contrary, bond with ions of Ca, Mg, Al, and Fe that are present in soil and form inert compounds, which are inaccessible to plants. The presence of humic substances, however, substantially increases effective assimilation of all mineral nutrition elements. It was shown in the tests of barley that humate treatment (with NPK) improved its growth, development, and the crop capacity while decreasing the use of mineral fertilizer. (V. Kovalenko, M. Sonko, 1973.) The tests on wheat showed that one-way use of nitrogen fertilizers on winter wheat crops did not have a high positive effect on the crop capacity, while its use along with humates and super phosphate achieved an expected positive effect. (L. Fot, 1973.) Interestingly, the mechanism of interaction between humates and micro-elements of mineral nutrition is specific for each of them. The positive process of Nitrogen assimilation occurs due to an intensification of the ion-exchange processes, while the negative processes of "nitrate" formulation decelerates. Potassium assimilation accelerates due to a selective increase in the penetrability of cell membranes. As for phosphorus, humates bond ions of Ca, Mg, and Al first, which prevents the formation of insoluble phosphates. That is why the increase of humate content leads to an increase of the plant's phosphorus consumption. (Lee & Bartlett, 1973.)

**Therefore, the combination of humates and mineral fertilizer guarantees their effective assimilation by plants.**

Thus, the idea of combined use of humates and mineral fertilizer naturally comes to mind. Creation of such a combined fertilizer is a new step in plant-growing development. It was no coincidence when over ten years ago an Italian company, "Vineta Mineraria," published a project, "Umex: a new technological tool at service for agriculture of 2000." This project was about establishing the production of humate-coated granulated nitrogen, potassium, and phosphorus fertilizers. From 1988 to 1990, in Byelorussia, the vegetation field tests and production experiences were carried out to comparatively study new humate-coated forms of mineral fertilizers, such as urea, super phosphate, and potassium chloride, produced in Italy and Russia. The tests showed that use of humate-coated urea in the production experiences with potatoes increased the crop capacity by an average of 28-31 centner/hectare, whilst at the same time decreasing the nitrate content by 40%, in comparison with the control group (urea). For root-crops, the crop capacity reached 200-220 centner/hectare, with an improvement in the quality of the produce. However, in spite of the impressive results, this project was not developed further, and these new preparations did not appear on the international markets. Perhaps, the high cost of the humates, in comparison with the mineral base, was the reason, so the new type of fertilizer was not competitive. However, with the new manufacturing technologies today, these materials can be cost-effective in modern agriculture.

Field tests (M. Butyrin, 1996) showed that use of humate-coated urea increased the crop capacity of potatoes by 20% and that of oats by 50%.

Other important components of plants' nutrition are micro-elements - Fe, Cu, Zn, B, Mn, Mo, Co. Plants use a very small amount of them, measured in one thousandth or one hundred thousandth of a percent. Nevertheless, they are vital to plants' development. For instance, boron resists certain diseases and increases the amount of ovaries and vitamin content in fruit. Manganese is vital for the photosynthesis process and the formulation of vitamin C and sugars. Copper assists in albumen synthesis, which ensures drought and frost resistance in plants, as well as their resistance to fungal and viral infections. Zinc is part of many vegetable ferments participating in fertilization, breathing, albumen, and carbohydrates synthesis. Molybdenum and cobalt are important to nitrogen assimilation from the atmosphere. Considering what was said in previous chapters, the readers might pay attention to our explanations of similar effect. We explained it was due to humate use. But if you consider that the humates transport micro-elements to plants most efficiently and form complexes with micro-elements that are easily assimilated by plants, the seeming contradiction is easily resolved.

Humic acids form complexes naturally. For thousands of years, they accumulated vital elements. When applied, humic acids also extract these vital elements from the soil in an accessible way for plants to form. For example, iron and manganese, according to respected professor D. Orlov, are assimilated only in humic complex form. Research by A. Karpukhin showed that the presence of these complexes determine the mobility of most macro- and micro-elements and their supply and travel inside plants' organs.

**Therefore, treating vegetating plants with humates ensures their continuous nutrition with vital macro- and micro-elements.**

## 8. HUMATES AND ORGANIC FERTILIZERS

**"Humus is the basis of soil fertility. Humate is the concentration of humus's vital forces."**

We can conclude that humate is an alternative to all types of organic fertilizers, such as humus, compost, bio-humus*, organic ooze, peat, and others. Furthermore, we have objective data to confirm this conclusion. (See **Table 4**.)

** bio-humus - a mixture of processed poultry manure using California worms and soil. It is produced in Russia and Ukraine.*

**Table 4:** Humates' effect on crop capacity in comparison with organic and mineral fertilizers

| Type of Fertilizer | Dose quota, ton/ hectare | Average crop capacity, Centner/hectare | | Increase in crop capacity, centner/hectare | |
|---|---|---|---|---|---|
| | | Potatoes | Oats | Potatoes | Oats |
| The control | - | 119 | 138 | - | - |
| Manure | 20.00 | 142 | 174 | 23.0 | 36.0 |
| Bio-humus | 6.00 | 136 | 174 | 17.0 | 36.0 |
| N P K | N P K | 143 | 216 | 24.0 | 78.0 |
| Humate | 0.06 | 144 | 222 | 25.0 | 84.0 |
| Humate+ N P K | 0.06 | 158 | 282 | 39.0 | 144.0 |

However, let's not rush conclusions before considering the essence of this problem. After carrying out many years of experiments, the Russian soil science concluded that combined use of manure (20 ton/hectare) and mineral fertilizers (N P K) was conducive to sustaining humus balance in the soil. However, the cost of applying manure in such large quantities decreases the profitability of the process. Data in **Table 4** shows that an exchange of 20 tons of manure for 120 lbs of humate is more profitable and leads to more productivity. Comprehensive proof can be obtained through many years of experiments. Naturally, we do not have this data yet. We have mentioned earlier that one of the most important factors in humus composition and accumulation is the effect of micro-organisms. Scientific studies in many countries showed that humates stimulated the development of all soil micro-organisms, such as fungi, bacteria, and ray fungi (actinomycetes). They increased

soil' aeration and were conducive to stimulation of oxidation activity of microbes. In other words, **humates stimulate micro-organisms and therefore are conducive to humus restoration.**

### 9. Humates in Poultry and Stock Farming

A unique capacity of humic preparation's is to effectively intensify metabolic processes in vegetable cells. A series of important scientific tests have shown that this is also evident in relation to animal organisms. The use of humic preparations, as part of a food supplements, has been fully researched using highly productive broiler poultry. It was established that the use of humates in broilers' feed activated the synthetic phase of albuminous exchange. As a result, there was a 10% increase in mass growth, and the poultry's immunity rose by 5%-7%. In the course of these experiments, soluble humate was added to the feed at 250 mg per 1 kg of feed, starting from the age of twenty days. In August of 1996, the industrial experiments were carried out together with the Megetskaya poultry farm in the Irkutsk region. Sodium humate in the form of a water solution containing 1 gram of sodium humate to 1 litre of drinking water was given to chickens from the day they hatched. This experiment not only confirmed the high efficiency of the preparation, but it also provided new data. The experiment was carried out on 11,000 chickens under the unfavourable conditions, where the quality of the incubated eggs was substantially below standard. The results showed that the exchange of vitamins and antibiotics for sodium humate in the feed caused a decrease in the poultry losses for the first forty days by 47%. At the same time, their average weight gain increased by 10%. Once more, this data supports the brilliant hypothesis by L. A. Khristeva, who first suggested the high efficiency of the humates under unfavourable conditions. In 1998, similar tests were carried out on a wide scale at the Severny pedigree poultry breeding state farm near the town of Bratsk. The results, shown in the following diagram (See **Fig. 12**), confirmed the previous data. The poultry losses decreased by 50%, while the active (live) weight in five weeks increased by 30%.

**A** **B**

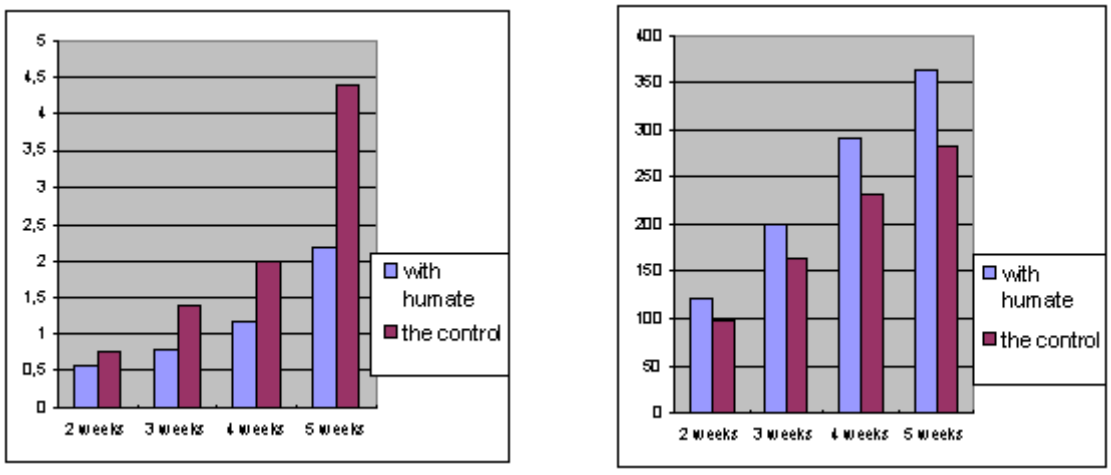



**Fig. 12.** The effect of the humate supplements on poultry loss (a) and active (live) weight gain in poultry (b).

Very important results were also accumulated when humates were used in stock-breeding. In one review, it was noted that the general effectiveness of the fodder increased by 10%-20% when 1% humic acid was added to the fodder. This effect was explained because the addition of the humates is conducive to the increase of red blood cells in sheep. Detailed research was carried out on 2 groups of animals: calving cows and new-born bull-calves. For 21 to 30 days, the animals in both groups were fed sodium humate at 10 mg per 10 kg of active (live) weight, in addition to the fodder. (N. Maslov and others, 1983.) It was observed that the calves born from cows that have been fed humates, within four months had a 13.4% increase, when compared to the control group. The bull-calves that had been fed with humates, had an increase of 21.2%, compared to the control group. The haematological data of animals in both humate-fed groups showed the animals had high metabolism. For example, the blood tests on experimental animals showed the haemoglobin level increasing by 11.5%, the phosphorus level increasing by 6.7%, the albumen level increased by 24.3%, and the beta-globulin level increased by 32%. **Professor L. Khristeva had obviously developed a physiologically active concentrate of humic acid.** The experiments showed that this preparation had a wide spectrum of pharmacological and anti-toxic characteristics. The use of humic preparations by veterinary science was based on these experiments.

Obviously, the next step would be to create medications based on humic acids. A serious scientific base already exists. The research carried out by T. Lotosh established high anti-toxic effect of humate preparations educed from peat (sodium humate). G. Pulkovoi, along with his colleagues, demonstrated the therapeutic effect of sodium humate, when rats were exposed to lethal dose of X-rays. A preparation containing fulfonic acids and colloidal silver was created; it is used to effectively improve general health. Interestingly, the idea of creating this preparation was adopted from the recipes of ancient Chinese medicine from the XV century.

## 10. CONCLUSION

Dear reader,

You have just finished the last page of this book. Probably, some chapters you may have found basic, but this book is intended for a wide group of readers. I am confident that every person involved with growing, whether growing flowers on the balcony, or working in the garden or owning a big plantation will find something useful within this publication.

We have been through a checkered history in my Country regarding many fields of scientific achievement, so please have some thought on the fortunes of serious discoveries relevant to this field. In the middle of the 20th century, which will soon become part of history, the young Ukrainian scientist Lydia Khristeva made a serious discovery, watching a simple trial, included in practice of all students studying soils, which has the potential to tremendously change life and go a long way to solving the food shortage problem on earth. Please note that much of this happened in my country as it passed through the devastation, fire, hunger and ruins of World War II. Nevertheless, as a problem of the times in this country, she received little acknowledgement and support for her ideas, which would have had significant results at a time when they were needed. That happens at times when politicians do not hear the voice of scientists, and when eminent academics do not pay due attention to new ideas and findings, which appear outside of their own areas of interest. Imagine if we had just a small percentage of the funds used in the last half of this century for useless melioration, or of the funds used in the building of giant industrial fertilizer production works…if those funds could have been applied and aimed in a timely fashion to the ideas of Lydia Khristeva, Tatiana Kukharenko , Valentina Larina and Dmitry Orlov, just to name but a few. The agriculture of Russia and other countries could have become more productive and would not have had the same problems of fertility. It would have been of immense help to me as author of this book as I would have had easier access to knowledge instead of collecting small pieces of information on Humates in scarcely known publications, obscure sources and even in newspaper articles.

The knowledge on Humates touched on in this publication is only "the tip of the iceberg". We need to seriously study not only humates, but their combinations with other macro and micro fertilizers of organic and non organic origin used for every type of plant and soil. I am confident that various types of specific preparations for plants, animals and humans will be created on the base of humic acids. We are at the beginning of the need to start creating food abundance and humic acids are the main way to serve this agricultural need of the 21st century.

**Acknowledgement**

Lastly ladies, gentlemen, fellow scientists, students and anyone else taking the care to read this book, it would be remiss of me to ignore the assistance, time taken and practical advice from others, most importantly my wife, a distinguished scientist in her own right Dr. Svetlana Kourtchenko. Special thanks to Mr. Graeme McRae who arranged and financed my research trip to New Zealand, Australia and the Pacific Islands, interpreters Natalia Jaffarian and Andrei U. Ageyev. To my American partners at TeraVita LLC for having the faith in me to set-up the industrial production in the USA. Of course thanks to everyone I have had the opportunity to meet and share with and, last but not least, to the memory of the late Dr. Lydia Khristeva and Dr. Valentina Larina, without whose inspired discoveries, I would not have had the interest to continue my research in this area of study though all the difficult times.

Thank you again all.

Dr. Boris Levinsky

## Myths vs. Realities

If you have been trying to research information on humic acids, you probably know how difficult it is to find the information you need. How do these products work, why do they work, how much do I need? Unfortunately, humic acids are extremely complex substances, and much of the information available is the same information reformatted over and over again.

Here at TeraVita Ltd, we are extremely fortunate to be working with Dr. Boris V. Levinsky, a world-renowned colloidal scientist and advanced humic acid researcher for over 45 years!

This page is his outlet for common misconceptions about humic acids that he feels the public needs to understand. His dedication to science and the preservation of the environment have been his passion for his entire life. His Russian heritage has instilled in him a strong desire to help everyone and his humble goal is to educate anyone who wants to learn.

**Myth #1: The cheapest and the most effective way to improve the fertility of soils is to apply raw lignites (Leonardites) from New Mexico or North Dakota at their recommended application rates of 250 – 1000 pounds per acre. By penetrating a soil the Fulvic and Humic Acids of these lignites slowly dissolve, stimulating growth and plant development.**

**Reality #1** We have explained elsewhere in this website why raw Leonardites do not give the same stimulating results as soluble humates. To help clarify those reasons, we have done extensive testing on many available raw lignites (Leonardites) and have found that many claims are inaccurate. For example, lignites from New Mexico contain 63 - 65 % organic mass, of which about 60% are humic and fulvic acids. About 35 - 37% of this material consists by mineral ballasts. The total amount of humic and fulvic acids in these raw lignites are chemically and biologically inactive, because their functional groups are blocked by ions of Fe, Ca, Mg, Al and other metals. Therefore, both the humic and fulvic acids in these raw lignites are insoluble.

**Table 1: Comparing characteristics of various lignites**

| Name of the indices | New Mexico | Canada | Russia | TeraVita Lignite Mix |
|---|---|---|---|---|
| Seller claim of Humic and Fulvic Acids, % | 80 | 85 | 75 | - |
| 1. Total mineral mass, % | 37.2 | 12.9 | 9.5 | 9.1 |
| 2. Total organic mass, % | 62.8 | 83.1 | 90.5 | 90.9 |
| **Total, %** | 100.0 | 100.0 | 100.0 | 100.0 |
| 3. Mass part of lignite, soluble in NaOH, % | 65.3 | 91.0 | 74.5 | 86.9 |
| 4. Mass part of lignite , insoluble in NaOH, % | 34.7 | 9.0 | 25.5 | 13.1 |
| **Total, %** | 100 | 100.0 | 100.0 | 100.0 |
| 5. Mass part of Humic Acids and their salts precipitated at pH 2, % | 50.8 | 83.3 | 65.9 | 79.6 |
| 6. Mass part of metals connected with Humic Acids, % | 5.1 | 3.1 | 3.5 | 3.0 |
| 7. Mass part of Fulvic acids,% | 9.4 | 4.6 | 5.1 | 4.3 |
| **Total, %** | **65.3** | **91.0** | **74.5** | **86.9** |
| 8. Mass part of Humins, % | 11.2 | 1.2 | 19.6 | 7.1 |
| 9. Mass part of mineral part not connected with Humic Acids, % | 25.5 | 7.8 | 5.9 | 6.0 |
| **Total, %** | 34.7 | 9.0 | 25.5 | 13.1 |

**Rows 1 & 2** of the above table show the ash content of various lignites. The method to determine the ash content of lignite is based on burning a sample in a muffle oven at 850°C (1,562°F). This allows us to accurately determine the quantity of a lignite's mineral part by using the difference of its initial dry mass and its ash. The data of the above table shows that New Mexico lignites have 3-4 times higher content of mineral ballast than the other examined products.

**Rows 3 & 4** show the results of another basic test to determine the Humin content of the lignite. For this test the lignite samples are boiled in a 1% caustic solution for several hours. Within this boiling process all Humic and Fulvic acids, and also the metals connected with them, move into solution. At the same time the lignite's organic part that has not naturally approached the necessary degree of oxidation (called Humins), stays in precipitation. The precipitate is carefully separated, dried and weighed. Again the results prove the fact that Canadian lignites and the lignite mix used by TeraVita Limited for manufacturing have the highest quantity of the available organic part necessary for plant assimilation.

**Rows 5 & 6** of the table give the results of a Humic Acid solution test; those solutions were extracted in previous experiments. Aliquot parts of those solutions were treated with hydrochloric acid to precipitate Humic Acids at pH 2. When precipitating, Humic Acids also take with them ions of metals, which were connected to them in initial lignite mass. Therefore, separating the precipitated part and drying it to a constant weight allows us to determine the Humic Acid content (During this test, the precipitated part is dried and burned in a muffle oven; only the non-organic part is left after the burning process; the difference between the mass of the precipitated part and the ash part gives us the content of Humic Acids). We should bear in mind the fact that Fulvic Acids stay in solution and their quantity is defined by the difference between the mass of the precipitated Humic Acids, their salts and the lignite mass transferred into solution.

Despite that the results of the test show New Mexico lignites have a higher content of Fulvic acids (still far less than is often claimed), the greater than 5% content of metal ions show that the Fulvic as well as Humic Acids are connected into insoluble complexes and are not able to perform biological activity because they are insoluble in water. This also means their natural activation under exposure to moisture, temperature and microbial activity is an extremely slow process. Therefore, the expected achievement of positive results in agriculture with these products is a very lengthy process that requires high dosages of lignites and more importantly, an existence of active and healthy soil micro flora. The last condition, unfortunately, does not exist everywhere, because the natural balance of soils has been largely been damaged by intensive usage and excessive applications of chemical fertilizers. The economic advisability of using raw lignites is also very arguable because the actual cost to treat an acre per season is approximately $30 to $100 USD.

**Rows 8 & 9** are the test results of the lignite's precipitation (insoluble in alkaline solution). Burning of this part in a muffle oven removes the Humins, leaving the non-organic mineral part of the lignite, not connected with Humic Acids.

**Myth #2: The usage of soluble humates in their dry powder form is not economical because of their high manufacturing cost. The only method of their production is through the extraction of humic acids from lignites with the help of alkaline solutions and then further evaporating and drying the liquid into powder.**

**Reality #2** In 1994, Dr. Levinsky developed a theory for a special method to transform raw Leonardites into soluble humates (humic acid salts). With the help of custom engineered machinery and by utilizing a unique series of precisely timed tense environments, a new process was created that allows TeraVita to produce high quality humate products with a lower cost than traditional methods. For the grower, this means that the use of soluble humates has reached a new level of affordability and it allows soluble humates to be successfully used through a much wider range of application techniques with improved economic returns. The average cost per acre per year with these products is approximately $10 - $30 USD, but even more importantly, the results can begin to appear within two weeks after their application. There is no need apply raw lignites in the fall in hopes that they may become available to the plant by spring! Our soluble humates show consistent and positive results every season, producing harvests with much higher yields compared to the usage of raw lignites.

**Table 2** Comparing the characteristics of finished Humates manufactured with TeraVita's new technology using lignites from various deposits.

| Indices of quality | New Mexico lignite | TeraVita Lignite Mix* | Russian lignite |
|---|---|---|---|
| Content of humic acids, based on dry matter,% | 67.2 | 88.0 | 80.5 |
| Insoluble part,% | 31.2 | 11.6 | 17.4 |
| Solubility in water,% | 74.4 | 90.5 | 85.9 |
| pH 0.01 % solution | 9.2 | 8.9 | 9.0 |

* Since every lignite deposit has different characteristics, TeraVita has combined the beneficial attributes of several lignites and therefore, is able to produce end products of higher quality than ever before!

When compared to the lab analysis of each raw lignite used, the data of table 2 shows that our method of production converts the total organic part of each lignite into soluble humates, ensuring the highest quality possible in each final product.

**Myth #3: Liquid Humic Acid solutions are dangerous for foliar application because they have caustic soda content.**

**Reality #3** Depending on the technology utilized, liquid humic acids derived from Leonardite may be made with some amount of caustic soda, but those remotely familiar with basic chemistry will know that this is simply executing a neutralization process, which is fully described in chemistry books for junior students. In this instance, the neutralization process results in two products Sodium, Potassium, or Ammonium Humate and water.

However, it **is** possible for a liquid humic acid product to become dangerous if it is improperly made with an **excessive** amount of caustic substance. Therefore it is very important to carefully check the pH of any liquid humic acid product you may decide to use.

Liquid humic acid products should be safe to use if they are properly made and have a pH of about 10.0 or less. Generally, the lower the pH, the better. At pH 7.0, there would be no "excess" caustic soda ($OH^-$) at all in the solution as the product is completely neutral. At a pH of 9.0 there would be an "excess" of caustic equal to only 0.0004 grams per liter of solution. However, some companies do produce liquid humic acid products with pH levels higher than 10 (we have seen up to pH 13!). Because the pH scale is logarithmic, the actual caustic content at higher pH levels is exponentially increased and these products can be dangerous and should not be used for application in agriculture. For example, a liquid humic acid product with pH 13 would contain 4 grams of caustic per liter of solution or 10,000 times more caustic soda than a product with a pH of 9.0. Keep in mind that as you go up in pH the plant will have to use increasingly larger portions of it energy to fight off the effects of the "excess" caustic, thereby reducing the benefits of the humic acids as a whole. This is why the pH of products is so vitally important when trying to obtain the maximum effect of humic acids.

TeraVita uses advanced technologies in making liquid humic acid products and monitors every batch with thorough laboratory testing before releasing the product for sale. We always make sure our products are very safe and friendly for foliar application so they will positively promote plant growth and development.

**Myth #4: Only Fulvic Acids are responsible for plant growth stimulation and development, while the Humic Acids are responsible for improving the soil's structure.**

**Reality #4** Humic and fulvic acids are compounds of one chemical nature and origin. Their fragments do not have principal differences in elementary content. They only differ in their degree of polycondensation, or in other words, in molecule weight. Based on the fact that in natural humus the content level of fulvic acid is statistically insignificant, the stated arguments that fulvic acids are more important for plant stimulation are fully void on scientific grounds. This is also confirmed by the well-known fact that the maximum effect of humic acid application is achieved through foliar treatment of the plants, when the humic acids are easy assimilated by the overhead foliage of the plant. This myth is most often portrayed by commercial entities trying to sell "more value" to their product over the competition. In a majority of cases, we have found that the actual fulvic acid content is **greatly** overstated by commercial companies, leaving even less credence to this myth! Many various aspects of this

ongoing topic will be covered in our Technical Articles section. See article "The ferment activity of humic and fulvic acid preparations" below on this subject.

**Myth #5: Humic acids penetrating a soil with a pH lower than 7 will cause the humic acids to precipitate into insoluble forms.**

**Reality #5** To fully precipitate humic acids a soil would have to have much lower pH readings than those we usually refer to as "acid soils". Non-modified humic acids start to precipitate from pH 3 and lower. We can easily confirm this fact by looking at a simple humate solution. The solution remains stable until it is lowered to a pH level of about 3.0. At that point the humic acids do begin to precipitate into insoluble forms. It is highly unlikely that anyone is growing crops in soils with a pH of 3.0 or less! Therefore precipitation of humic acids during application of humates on soils does not really take place. Again, this is simple science that cannot be disproved.

## The ferment activity of humic and fulvic acid preparations.

By Boris V. Levinsky, PhD
December 2001

In recent years most of the soil and agrochemical scientists have paid serious attention to the research of humus acids (humic, ulmic, and fulvic acids) and their action on plant growth and development and the direct processes running in soils. William R. Jackson in one of his books "Environmental Care & Share" writes:

"The ecological significance of the biological effects of humic substances becomes more meaningful when we consider the overall impact of these humic materials on the productivity and fertility of soil and water ecosystems. In addition to facilitating the dissolution of most otherwise insoluble metallic salts, humic substances are involved in a variety of reactions in soils, sediments, and water with major nutrients such as ammonia, nitrates phosphates, and silicates. Research indicates that these interactions not only considerably increase the retention and residence time of the nutrients in the growing media, but also enrich and biologically condition the growing media. These interactions and effects together have profound influence on the biological production process"

In various research works and publications scientists make an attempt to announce that fulvic acids play the most important role in those processes, because of their mobility and lower molecule size. These statements are often made without scientific validity and without direct research confirmation. In fact, this theory conflicts with much of the "serious" research works, much of our practical application experience, and also with simple common sense, based on our understanding of the chemical nature of these complex and unique compounds.

To help confirm my statement I would like to share some results obtained by Russian scientists during extensive research in 1983. ("Theory of action of physiologically active substances" Dnepropetrovsk, 1983.). They have proved that ferments executing carbohydrate, nitrogen and phosphorous exchange are tightly connected with humus acids (humic and fulvic); they are extracted with them and fully preserving their activity.

**Table 1** Ferment activity of Humic and Fulvic Acids of Sod – Podzol soil.

| **Activity of ferments per 100g of Humus Acid** | **Humic Acids** | | **Fulvic Acids** | |
|---|---|---|---|---|
| | Organic mineral background | Control | Organic mineral background | Control |
| Invertease, mg glucose | 196.0 | 190.0 | 34.6 | 16.0 |
| Protease, mg amino nitrogen | 90.4 | 63.0 | 63.0 | 55.0 |
| Urease, mg NH4 | 15.3 | 12.5 | 3.8 | 2.8 |
| Phospotease, mg P2O5 | 130.0 | 40.0 | 60.0 | 20.0 |
| Peroxidase, mg Ag | 3.2 | 0.4 | 160.0 | 110.0 |
| Polyphenolxidase, ml 0.1 KIO3 | 34.0 | 15.0 | 10.0 | 3.0 |

The humic part of the humus acids had a higher active concentration of hydrolytic ferments, than the fulvic part. The activity of the Invertease ferment of humic acids was higher by 5-6 times, the Urease 3.5 times and the Protease 1.5 times compared to fulvic acids.

This data shows that ferments of the soil's oxidized enzymatic system are connected with different types of Humus. Polyphenolxidase, executing in soils oxidizing synthesis of Kinones for further heterocondesation of humus acids, is mostly concentrated being a part of humic acids. Its active concentration is 3.5 times higher than that of fulvic acids.

Just one ferment, Peroxidase, taking part in oxidizing decomposition of Humus is almost fully extracted together with fulvic acids.

The data of the research proves that of the 6 most important soil ferments, 5 are more active in humic acids, and just one in fulvic acids. This indicates that the complex structure of humus acids cannot be divided into "the most important or the least important ones", because they are all unique creations of Mother Nature, acting together in a system and they can never act separately in their real natural action.

**Are there really naturally occurring fulvic acids?**

Synopsis by Dr. Boris V. Levinsky, PhD
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For the last 50 years there has been a lot of confusion on the differences between humic and fulvic acids. Studies have constantly shown that the two materials are very closely related and are from the same origin, but somehow they offer slightly different functions in the soil or plant. Our position at TeraVita has always been that it is pointless to worry about specific ratios of fulvic and humic acids because they are so closely related and once they are both in a soluble state, they both perform an array of beneficial tasks.

Most of this confusion has stemmed from various claims by mining operators regarding the fulvic acid content of their lignite. It is widely known that the humic acids in lignite are bound in a very tight ball and are insoluble. In this state, the humic acid molecules are bound so tightly that it is nearly impossible to break them apart. It requires years (if not decades) of strong biological activity to slowly pick apart the ball and open it up so that it can perform its many biological functions.

The caveat to this problem, however, has been the fact that fulvic acids are soluble in water and could therefore be released immediately from raw lignite and provide measurable stimulation to the crop. Mines began rating their lignite by fulvic acid content in an attempt to justify sales to farmers. The higher the better! We have seen some mines promoting lignite with as much as 30% fulvic acid! One must remember, however, that lignite is essentially a waste product for mining operations. The mines want the high carbon fuel coal below the upper level oxidized lignite we call Leonardite. Like any industry, piles of waste need to be dealt with and the prospect of selling it off to be applied to land was a very promising concept.

Another problem in this debate is the fact that there is no universal standard for measuring fulvic acid content. It has been proven countless times that by changing the type of extractant used or the concentration of extractant differing levels of fulvic acids can be obtained from the same lignite sample.

In 1999, professor Dmitry Orlov, a world-renowed Russian specialist of Soil Sciences published an important article in the magazine "Agrology" (Pochvovedenie) N 9, pages 1165 - 1171. The article allows us to practically finish the ongoing scientific discussion about the "so to speak" advantages of Fulvic Acids over Humic Acids.
This research work is based on the materials obtained by leading specialists in Russia, England and Germany in addition to his personal research and observations over the last 25 years.

He made the very important conclusion that natural materials such as soil, peat, lignite or other sources of Humus Acids, do not contain Fulvic Acids in the form of an **independent fracture** as previously thought. Those Fulvic Acids, which can be determined as a part of Humic Acids, can be moved into solution only after treatment of those natural materials (soil, lignite, peat etc.) with alkaline agents and are left there only after the precipitation of Humic Acids in an acid environment with a pH of 2. They do not represent an independent group, but are only formed in the solution as a results of external analytical procedures, executing partial hydrolysis of higher-molecular weight Humic Acids. Practically all experiments show that Fulvic Acids appear, or exactly speaking, "are determined" only after alkaline or acidic hydrolysis of the whole organic material and Humic Acids especially. Consequently, the analytically determined content of Fulvic Acids witnesses only a degree of hydrolysation of natural Humic Acids without particular dependence of the object of their origin.

What all of this means is that raw materials do not contain fulvic acids at all. Fulvic acids are only formed after some form of hydrolysis process breaks apart fragments of humic acid molecules. The conditions necessary for this process to work are outside the normal range of soil pH (must be very alkaline or acidic). Pure water itself can facilitate a small degree of hydrolysis that creates fulvic acids. However, a small amount of lignite, peat or soil in large amounts of water will still take weeks to release only a tiny fraction of fulvic acids. This new research also serves to explain the commonly known fact that any sample of material (soil, peat, lignite) that is treated to extract its humic acids can be made to yield widely varying levels of fulvic acids by changing the extraction solutions and/or techniques.

This does not undermine the value or the role of fulvic acids, but it does bring into question the value of **raw** products being sold with claims of "high levels" of fulvic acids. Even though soluble products may be "creating" fulvic acids, they are still present in the final product along with the humic acids.