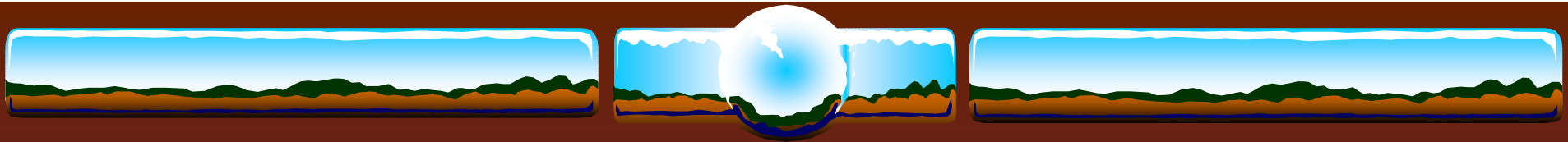


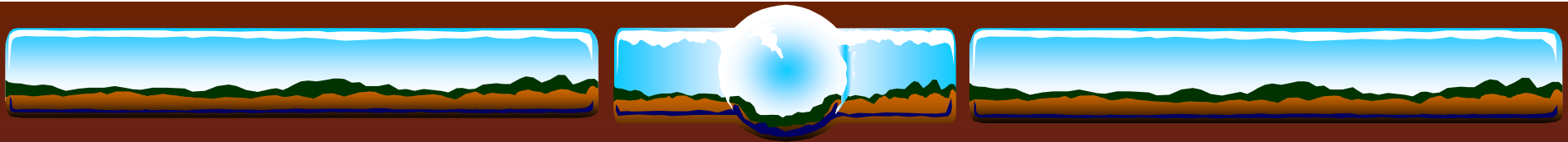
Humates-Modern Applications of Ancient Acids





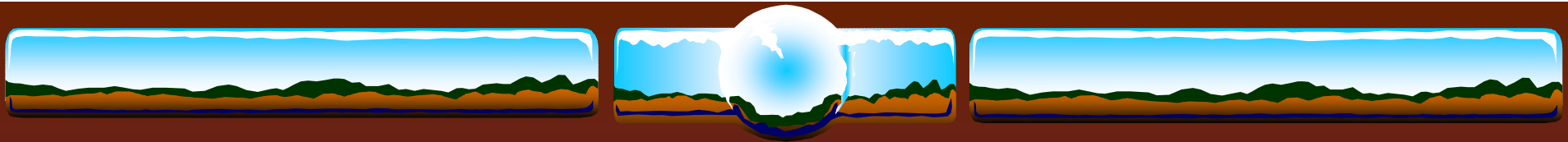
Humic substances and the environment

Humic substances exist in all environments including soils, groundwater, streams, estuaries, and oceans. They are very reactive and are important participants in many geo-chemical reactions and processes.



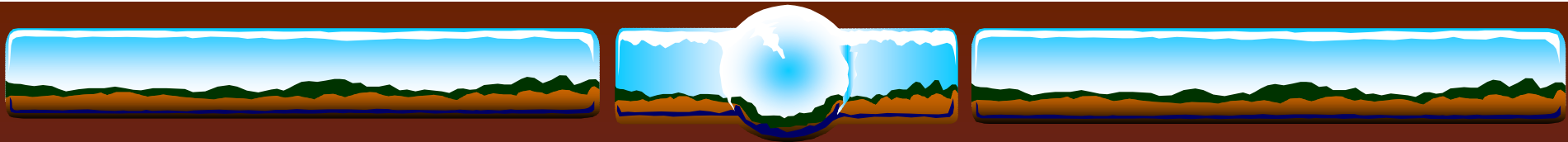
Humic substances and the environment

Humic acids are found in large quantities in brown coals, peat, sapropel, and some other organic matters.



What are the humic substances?

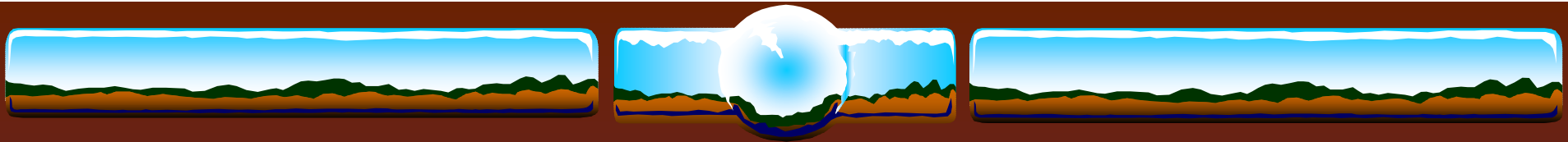
Humic substances can be divided into three main fractions: Humins (HM), Humic acids (HA), and Fulvic acids (FA). This division is conventional and is based on solubility of each fraction in water with certain pH level.



What are the humic substances?

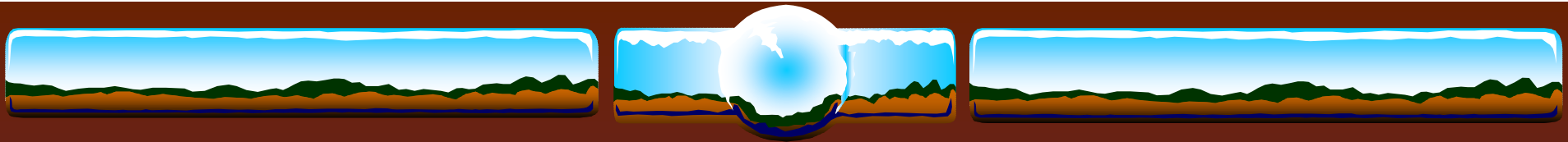
Among the various sub-fractions of the organic matter the division between **humic** and **fulvic** fractions is of most practical importance.

- ❖ **Humic acids** are naturally present in soil organic matter, they are a large family of organic compounds with similar characteristics.
- ❖ **Humates** are the salts of humic acids and come from the remains of plant and animal life.
- ❖ **Fulvic acids** are generally more plant active because of their higher oxygen content, and because of the abundance of carboxyl (COOH) groups.



Humin

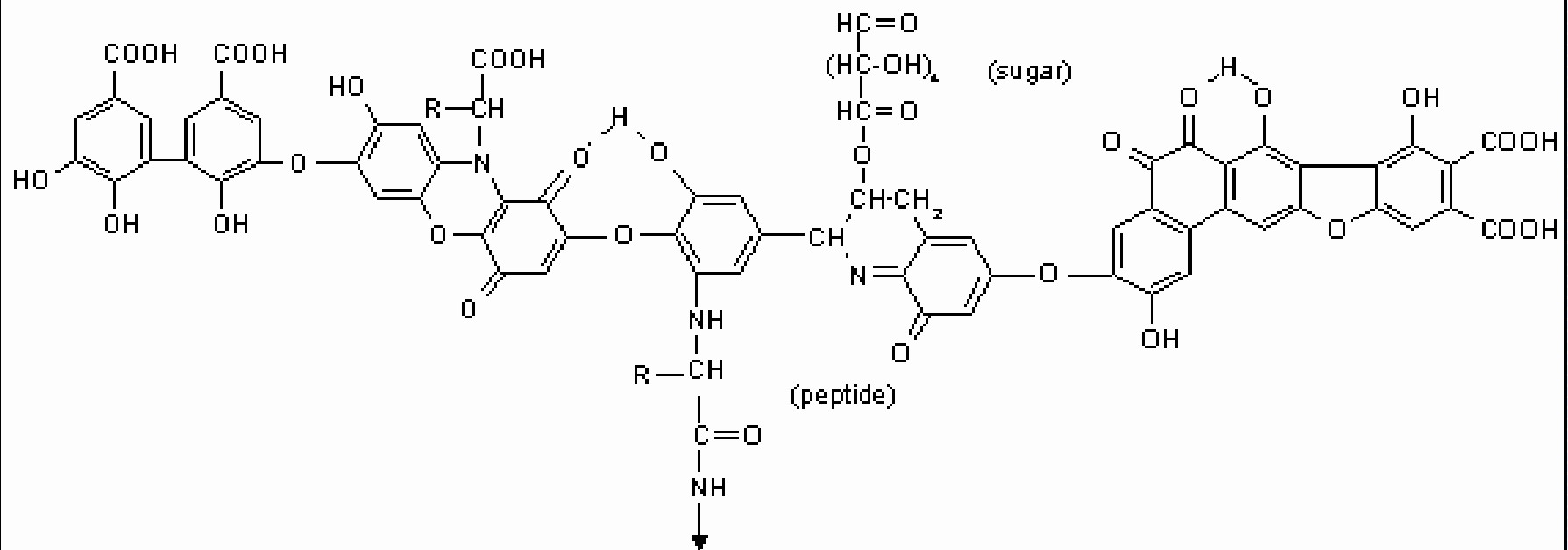
- ❖ Humin is humus (organic fraction of soil) soluble neither in alkali, nor in acid solution. Chemical and physical properties of humins are not studied enough, but it is known that humins of all humus fractions are the most resistant to disintegration due to high molecular weight (10,000,000) and relatively low content of functional groups.



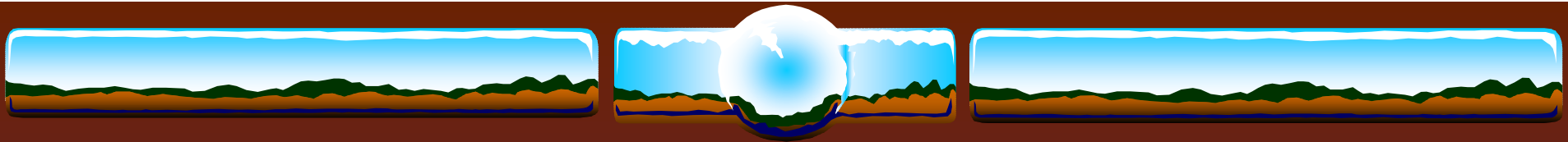
Humic acids

- ❖ Humic acid is one of the major components of humic substances which are dark brown and major constituents of soil organic matter humus that contributes to soil chemical and physical quality.
- ❖ Humic acids are defined strictly on their solubility in alkali (water with high pH).

Molecular structure of humic acid



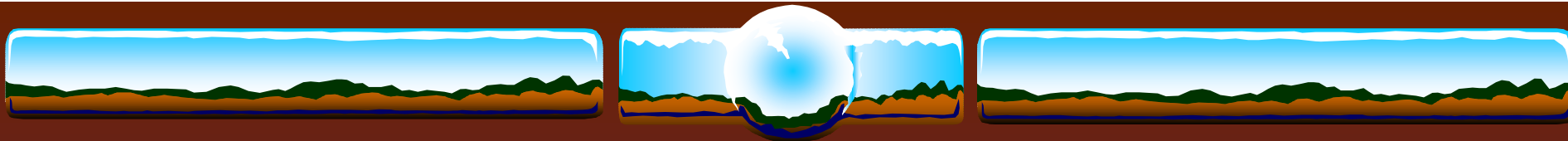
Model structure of humic acid



Humates

Humates are salts of natural humic acids with a hydrogen ion of carboxyl and (partially) hydroxyl groups exchanged for a metal atom.

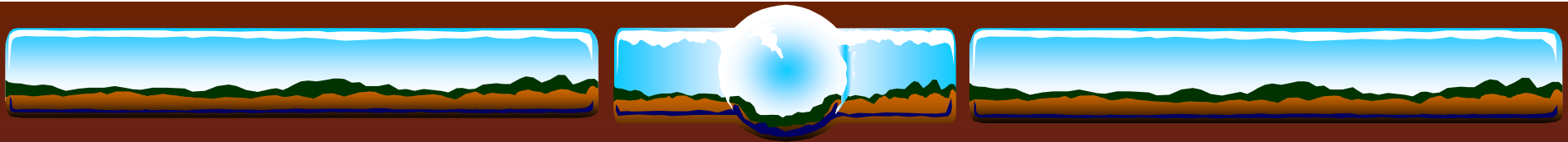
Natural humates appear in soil in the form of insoluble salts as a result of interaction between humic acids and metal ions of soil solution. It is humates that determine soil's genetic, environmental, and agronomic functions.



Sodium and Potassium Humates.

These humates possess all positive features of soil humus substances as biopolymers (high cation and anion exchange capacity, chelating capacity, ability to stimulate protective functions, growth and development, facilitate interaction with soil ferments, vitamins, etc.), but due to high solubility in water their biological activity increases by a number of orders of magnitude, and natural origin ensures their absolute environmental safety.

In order to save space, the authors with some exceptions, use the term “humates” meaning just water soluble potassium and sodium humates.



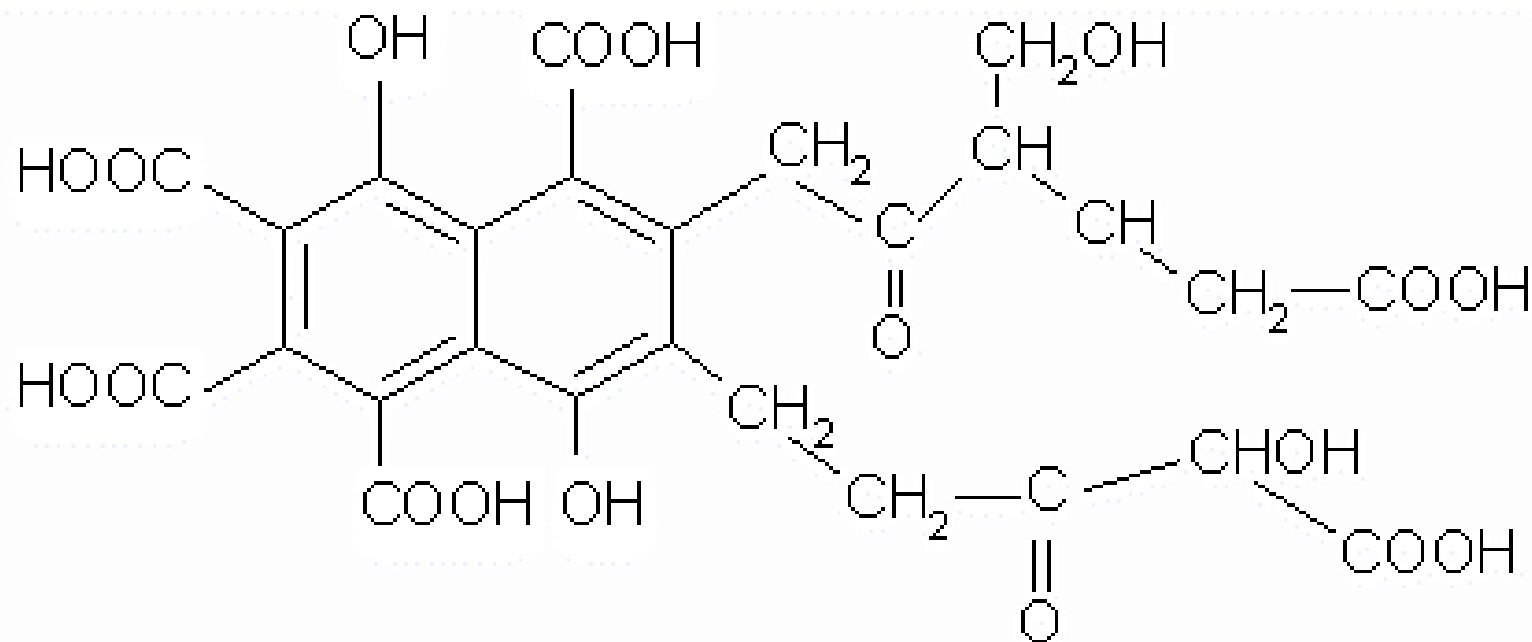
Fulvic acids

Fulvic acids (FA) is the mixture of weak organic acids of aliphatic and aromatic groups that are water soluble at all pH levels (acid, neutral, and alkaline). Their composition and form are variable. Molecular weight of FAs (1,000 – 10,000) is less than that of HAs, and oxygen content is twice as much higher.

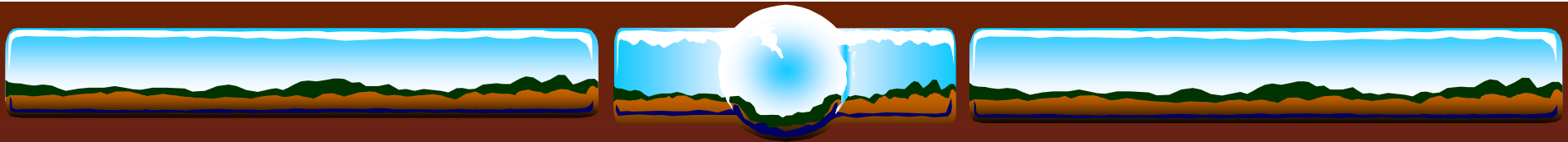
Due to relatively small size, FA molecules may easily penetrate into plant roots, stems, and leaves, bringing in nutrients. Fertilizers used as sprays and containing FAs in the form of chelates with microelements may be effective means of increasing plant productivity at certain stages of plant development.



Structure of fulvic acid



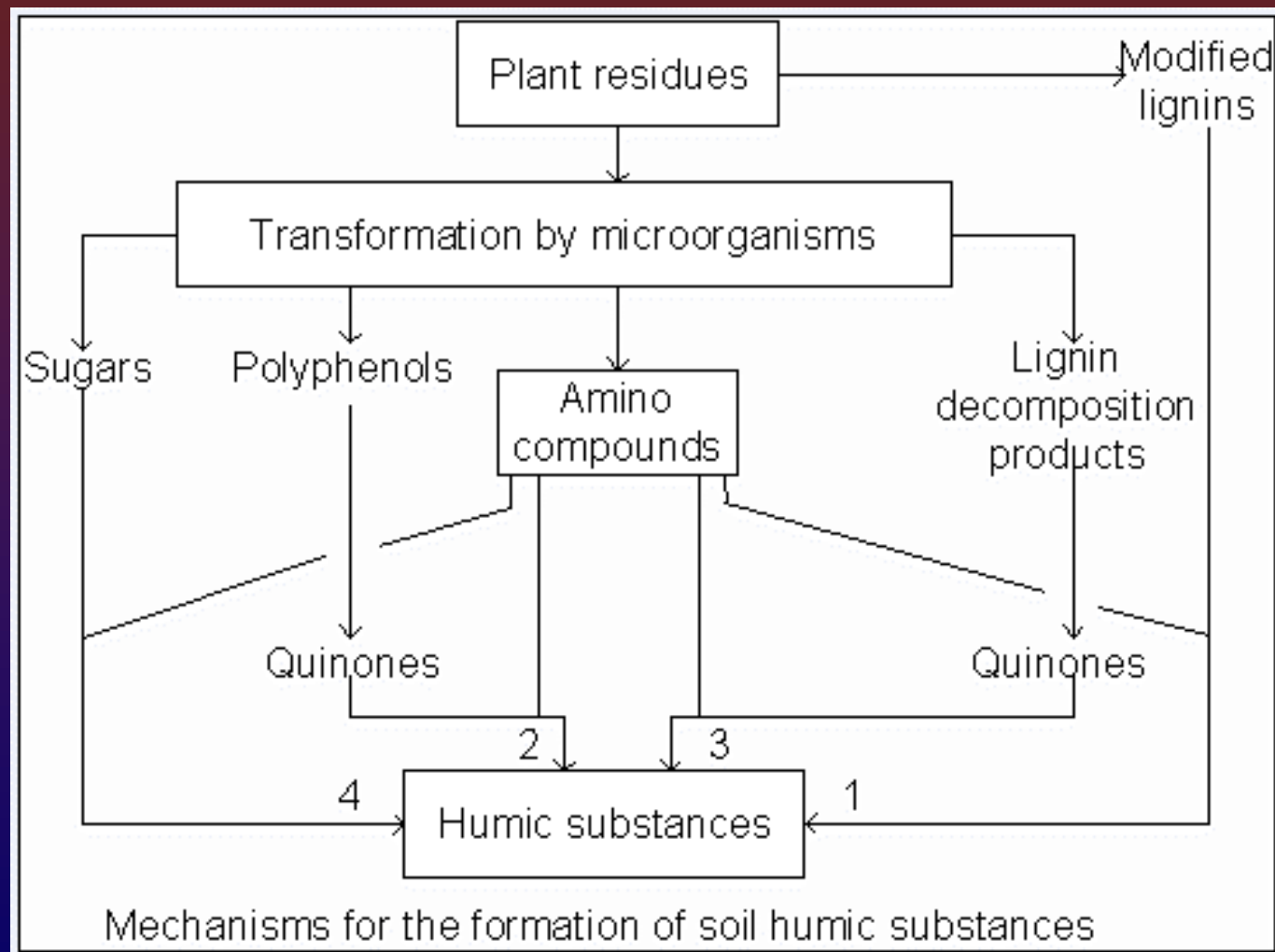
Model structure of fulvic acid

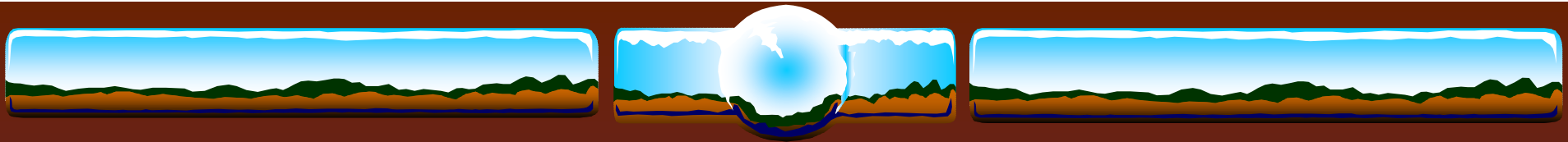


The functions of Humic substances

The functions they perform are multiple and varied and include, but are not limited to, the mobilization and transport of metal ions, contribution to the cation-exchange capacity of peat, soil, and water and binding of various organic molecules such as carbohydrates, lipids, and proteins. Furthermore, they may also reduce the toxicity of certain toxic compounds found in soils and waters.

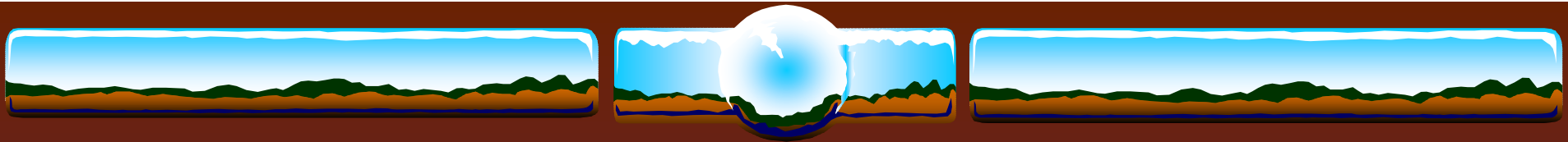
Formation of Soil Humic Substances





What do humic acids do?

- ❖ First of all, they physically modify and improve the soil then biologically stimulate the plant.
- ❖ They can increase germination of seed and viability and stimulate plant growth by accelerating cell division, increasing the rate of development in root systems, and increasing the yield of dry matter.
- ❖ Humic acids can improve the uptake of phosphates from banded fertilizers.
- ❖ An added benefit of applying humic acids with liquid fertilizers is their ability to buffer the salinity and toxicity of fertilizers.

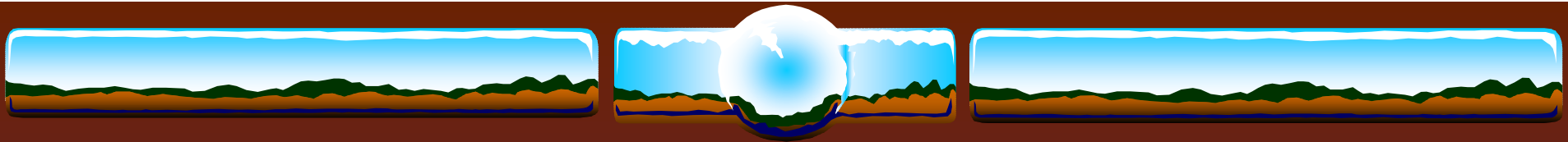


What do humic acids do?

Water Structuring of water with dissolved humate: formation of «ice water» structure. Increase in permeability of water molecules into cell and intercellular plasma. Binding harmful admixtures and purification of water and atmosphere from pollutants.

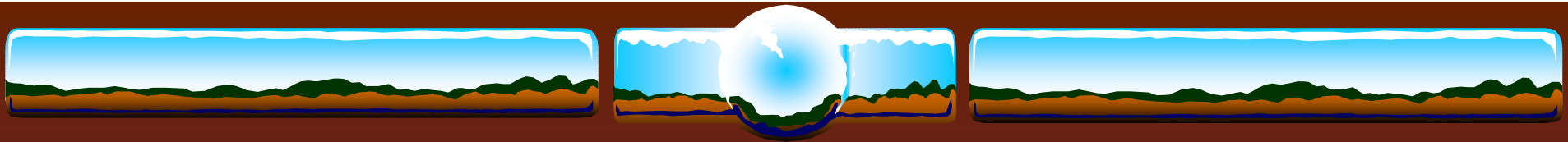
Stimulation of immune system, mobilization of organism's protective functions, increased resistance to stresses and unfavorable factors of climatic, atmospheric, and soil impact. Improvement of transportation of nutrients into plant cells, increased water saturation and water holding in plant, decreased consumption of water required for normal plant development.

Improved water purity and exclusion of plant uptake of harmful substances, neutralization of harmful substances coming with water from the atmosphere.



The significance of humic acids

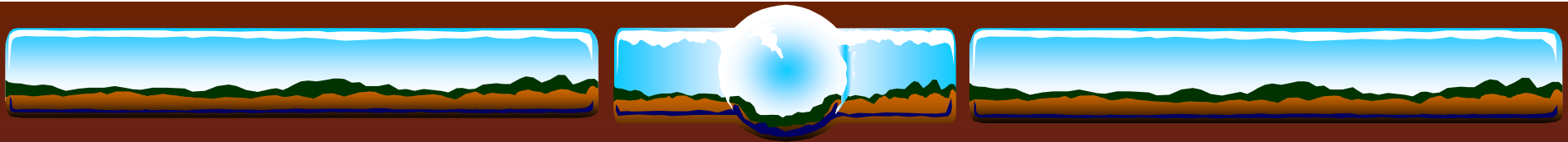
In soil humic acids are bound with other cations, mainly with Ca, Mg, Fe, and Al. Therefore they are almost insoluble in water, which allows them to accumulate, forming certain humic reserves and then very slowly, as mineralized and consumed by microorganisms, serve as a source of nutrients, growth stimulators, ferments, vitamins, and many other biologically active substances, needed for plant growth and development.



Humic acids and metal binding capacity

The variable molecular composition of humic acids, different metals are bound (chelated) to humic acids with varying strength.

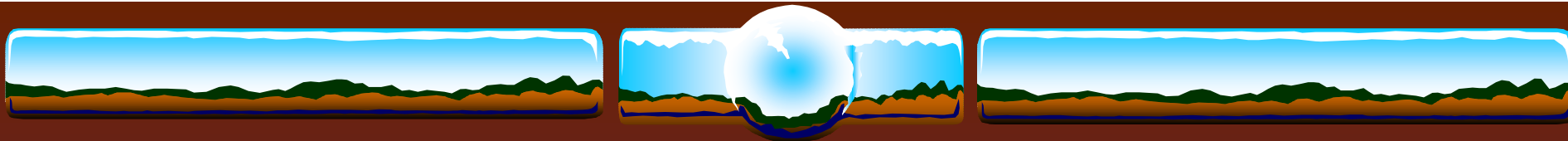
This peculiar metal binding capacity protects plants by the ability of water-soluble fractions of humic substances (humic and fulvic acids) to form precipitates with a number of metals (Ca, Cd, Hg, Pb, Ba), forming insoluble complexes. The complexes formed are not available to plants and the concentration of toxications in the soil solution is reduced.



**It has been determined that humic substances
take part in controlling almost all
major soil features:**

They form a darker soil color, thus increasing the solar radiation absorption coefficient.

Colloidal structure of humic acids and high hydrophilic properties of functional groups give them a gel-forming capacity. It is this feature that explains numerous cases of increased soil water holding capacity after humate treatment. This is extremely important for arid regions since humate treatment increases water saturation. For instance, sandy soils increase water holding capacity by more than ten times. This phenomenon is a basis for the use of humates as ameliorants.



Humate and soil structure

Continuous humate treatment helps to improve soil structure.

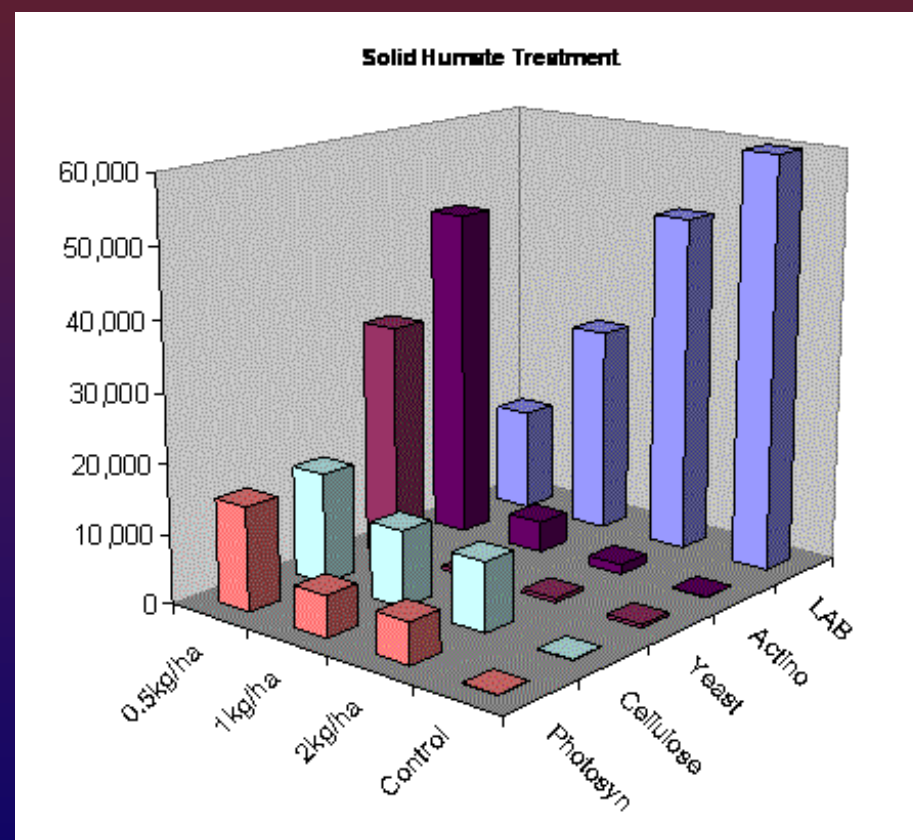
Getting into soil, humate interacts with calcium, magnesium, aluminum, and iron, always present in soil, and forms organic-mineral bridges binding soil particles into certain structure able to resist soil water and wind erosion, to hold moisture and air, to create favorable conditions for microorganisms' activity, and to increase soil fertility.

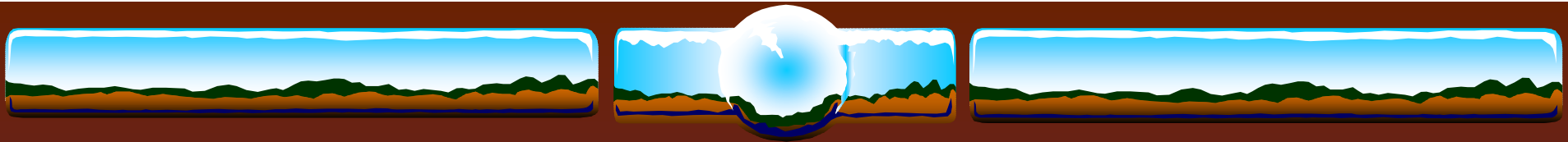
Humates form insoluble substances with heavy metals (lead, mercury, chromium, cadmium, etc.) – which penetration into fruits and later into human and animal bodies lead to serious illnesses – and thus create a barrier to their penetration into plant cells.

It is not less important the humate ability to bind into complexes ions of iron and aluminum, which excessive amounts are detrimental to plant phosphorus nutrition. At that iron forms complexes with humates, which ensures its transport into plants, while aluminum is bound into insoluble substance, and therefore its harmful influence on phosphates is neutralized.

Effect of Humic substances on soil micro-organisms

- ❖ Humates dramatically stimulate biological (microbial) activity in the soil, enhancing the normal biological balance of the soil.
- ❖ Soil becomes healthier as the results of humate application and it improves seed germination.



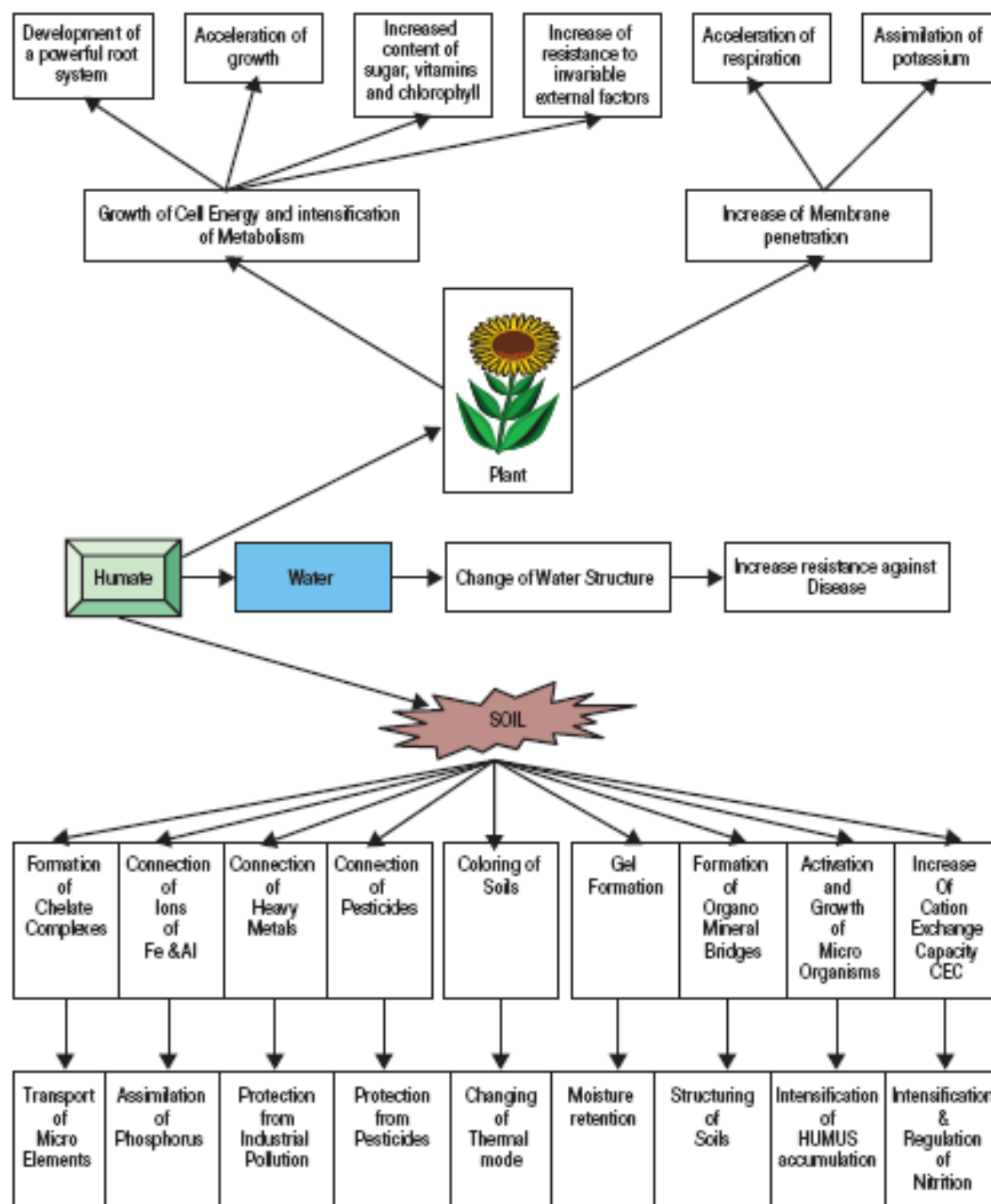


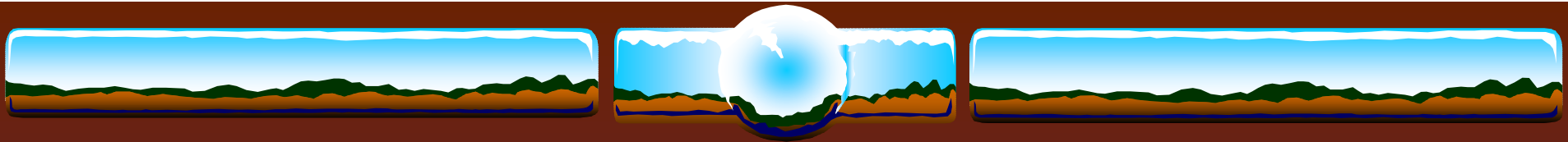
Humates increase the plant resistance

A fundamental difference of humates from many other biologically active substances is that they increase plant resistance not to certain environmental factors, but directionally increase organism's resistance to any particular factor, compensating lack of natural protective resources.

L. Khristeva supposed that this occurs because humate influence is targeted at normalization and stimulation of those key processes of cell metabolism that are restrained or blocked by inhibiting environmental factors.

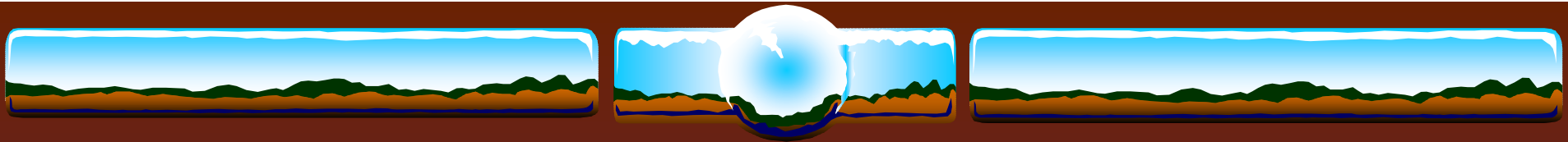
Interaction of Humates with the Water-Plant-Soil System (Bogoslovsky, Levinsky, 2006)





The importance of humic substances:

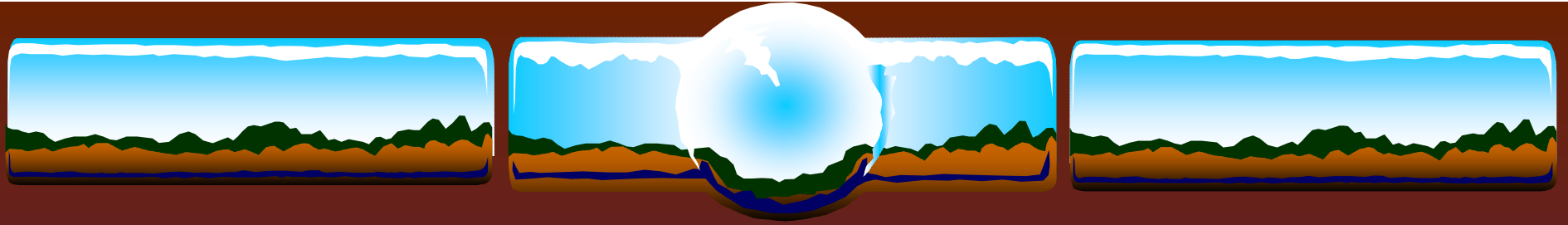
- ❖ The possible benefits of supplementing with affordable humic and fulvic acids products are great. It is important for today`s agronomists, field-men, and growers to learn how to best utilized these products to improve fertilizer efficiency, yields, and farm profitability.
- ❖ Humates have the potential to reduce global warming and reduce toxic substances (heavy metals, etc.) in the food supply and the ground water. They can protect plants from UV radiation and pollution as well.



Humic substances: humic and fulvic acids

- ❖ Humic and fulvic acids and their salts (humates) possess a phytohormone- like physiological activities, contain valuable plant nutritional substances. Humates can be utilized as soil conditioners, and soil supplements under various conditions and climates.
- ❖ Humates are natural products and have no external chemical additives.





The development of new technology for seed enhancement with humic substances



HMP— Humate- Mineral Powder

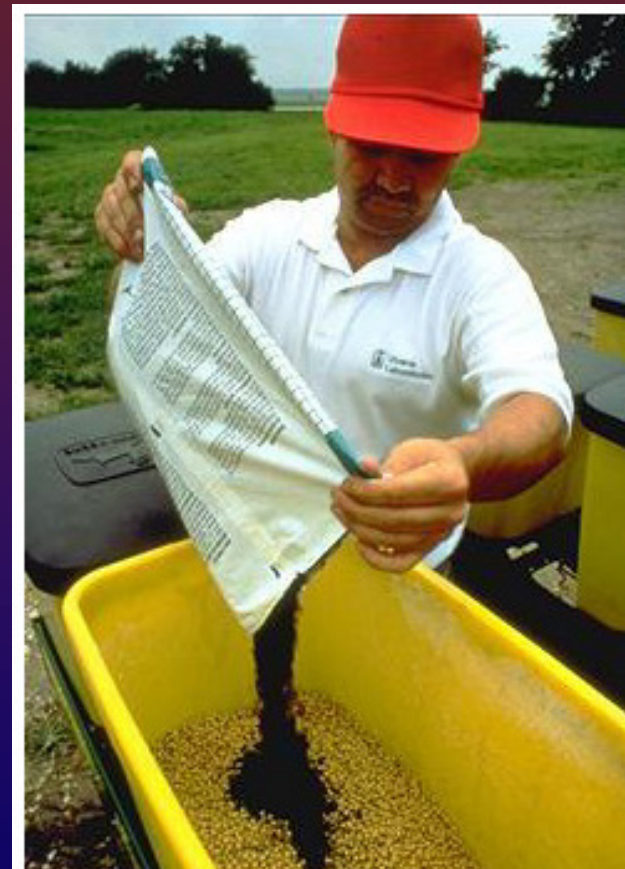
- ❖ Dry seeds of vegetable crops can be coated or pelleted with “humate-mineral powder”. HMP is prepared by mixing humates with some water-soluble minerals

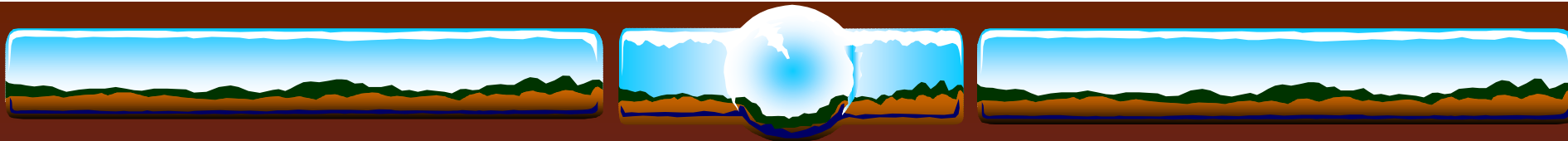




HMP- ways of application

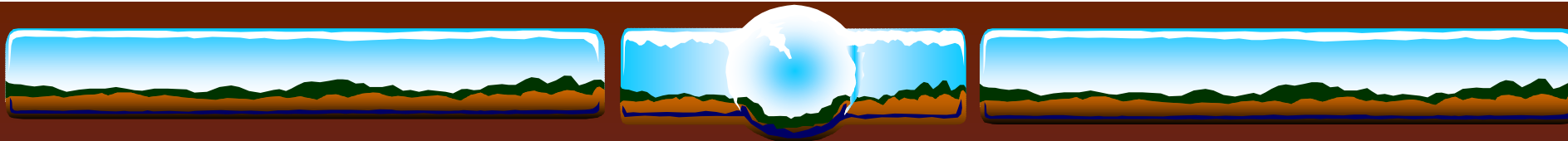
- ❖ HMP may be applied to the seed, mixed with rhizobia, may be applied directly to soil, either in the furrow or below the seed, or may be watered onto the soil at or after planting.





Wheat and Rice seed coated with the Humate- Mineral Powder:

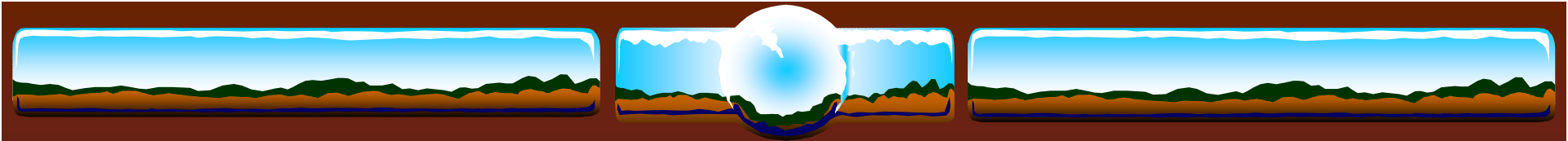




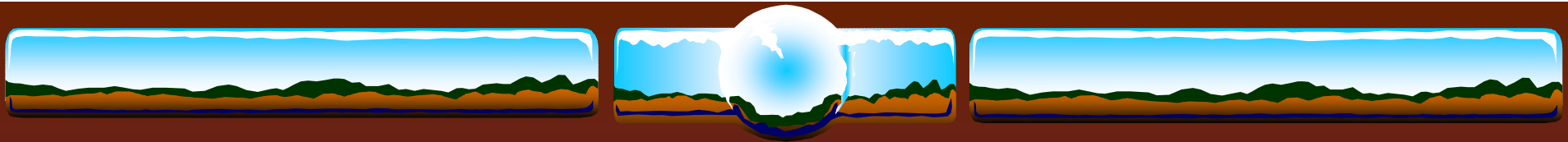
HMP and Seed Pelleting

The lettuce seeds pelleted with using of humate- mineral powder:





Application of humic substances in hydroponics



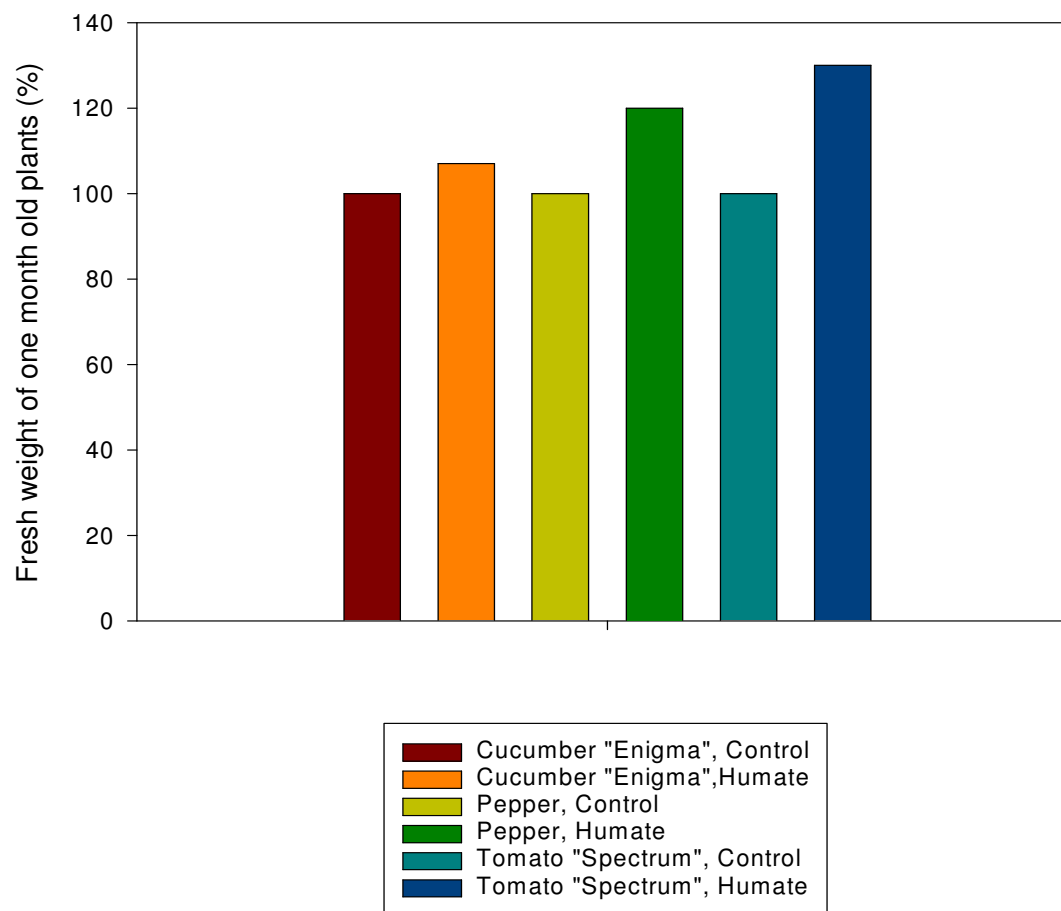
Humates for Hydroponics (the background)

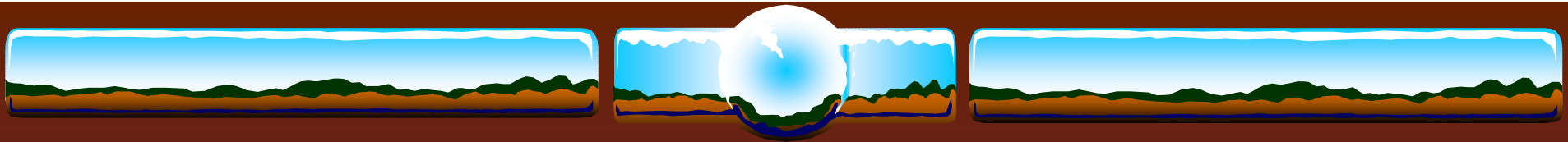
- ❖ Sladky (Sladky Z., 1959) demonstrated that humic acids improved not only the vegetative growth of tomato plants grown in nutrient solution, but increased the respiration rate and the chlorophyll density of the plants;
- ❖ Experiments conducted on wheat (Vaughan and Malcolm, 1985) using distilled water and Hoagland Solution demonstrated that humic acids improved Hoagland's solution and increased root and shoot biomass in distilled water as well.



**Effect of Humate "Togum" upon the relative growth rate (RGR)
of hydroponic vegetable crops- Tomato, Cucumber and Pepper**

*(Trials at "Crystal Heart Plant Raiser Ltd.",
North Humbershire, England, 1996, V.Vasilenko)*

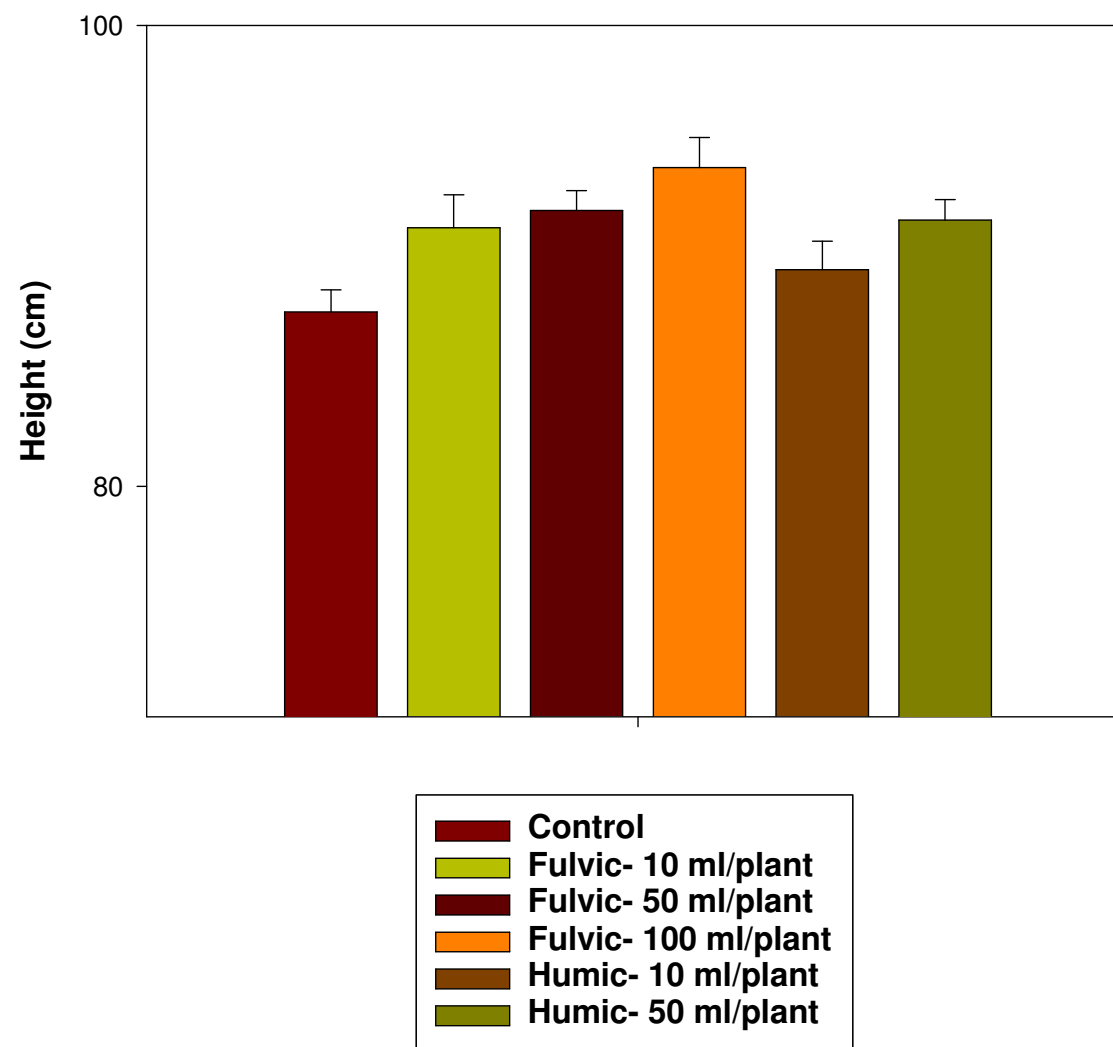


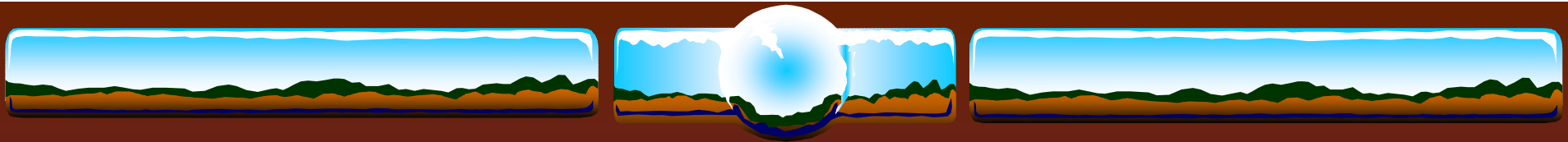


Humates for Hydroponics (2001: Research on hydroponic tomatoes)

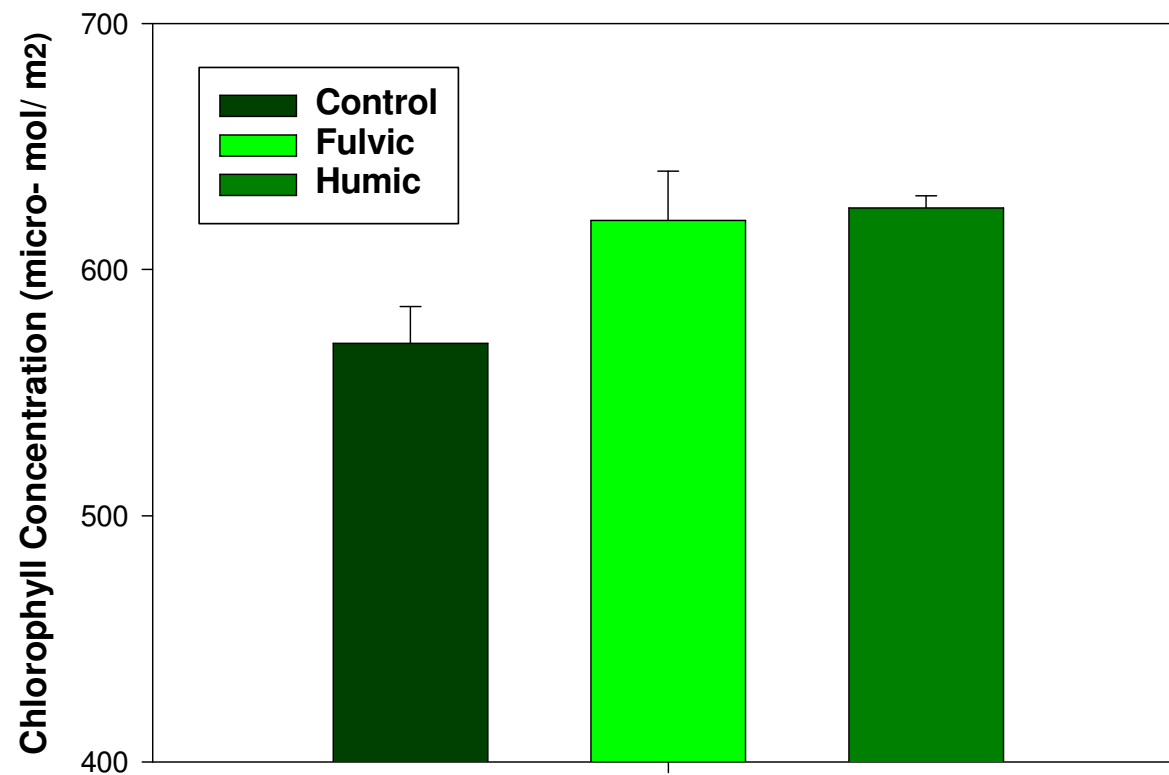
- ❖ Dr. Vladimir Vasilenko's research on humic substances were conducted in conjunction with company U-Mate International Inc.(Scottsdale, Arizona) which provided a source of humic and fulvic acids- "Encient Earth"TM and company- Pioneer Fruits& Vegetables (Leamington-Ruthven, Ontario) where the trials were done on hydroponic tomatoes. A micro-biologically activated working solutions of humates and fulvates (the salts of fulvic acids) has been prepared to the experiment with using an original formula (property of Dr.Humate).

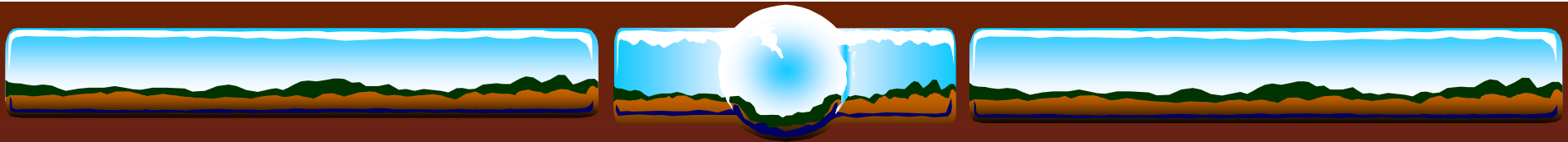
Effect of Humate Substances on Plant's Height, Tomato "Rhapsody" ("PIONEER F&V" hydroponic, Leamington, ON, July 2001)





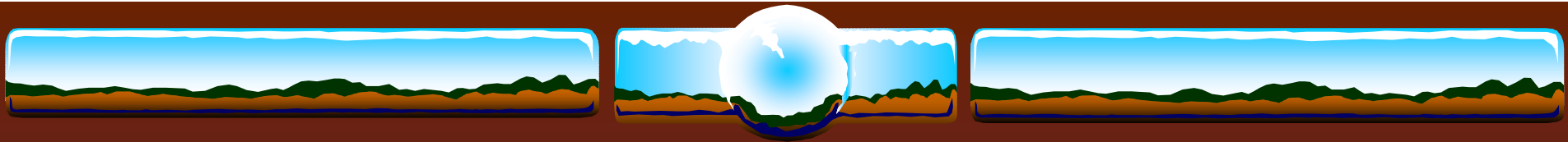
Effect of Humic Substances on Chlorophyll Content in Tomato leaves (upper level)





Humates for Hydroponics (Results)

- ❖ The author's results showed that height and stem's diameter of the tomato plants increased as result of humate application in hidroponics. A positive effect of humic substances upon chlorophyll content in leaves correlates with higher yield of treated plants. The humates substantially increased the average diameter of fruits and number of fruits per a cluster. Total biomass of fruits of treated plants exceeded control up to 38-42%. New technology of humate application can be lucrative for hydroponics.

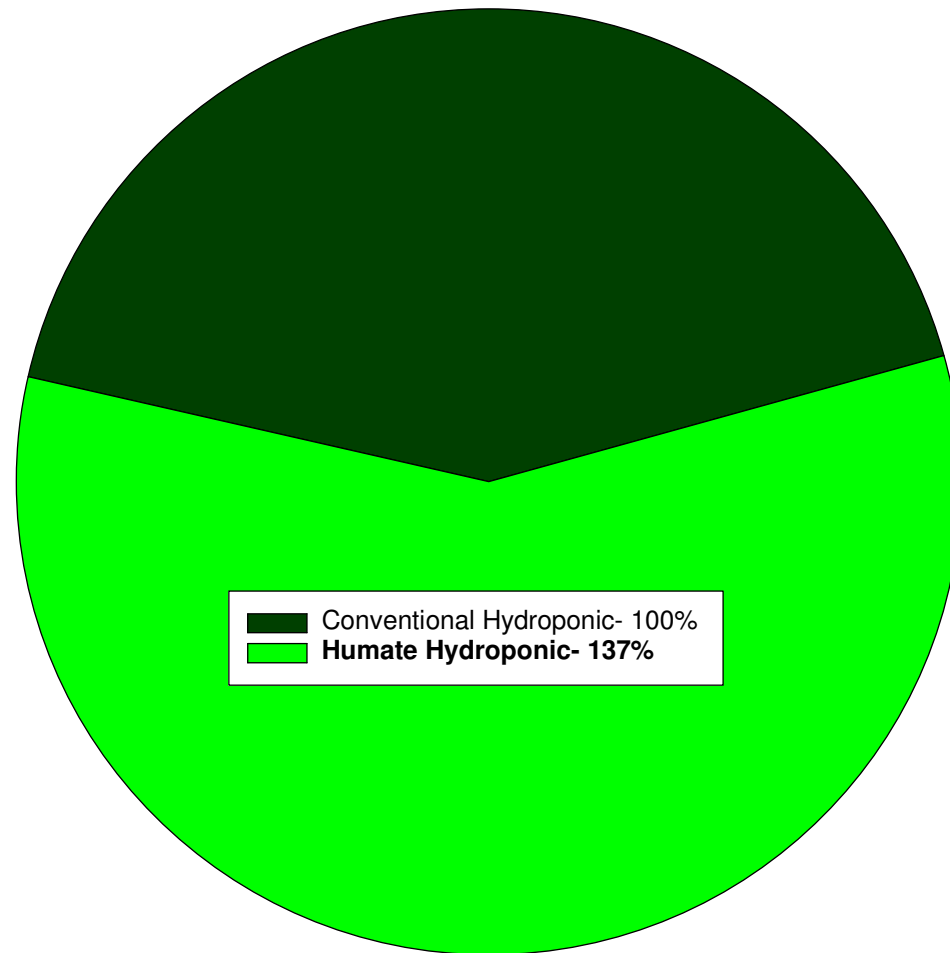


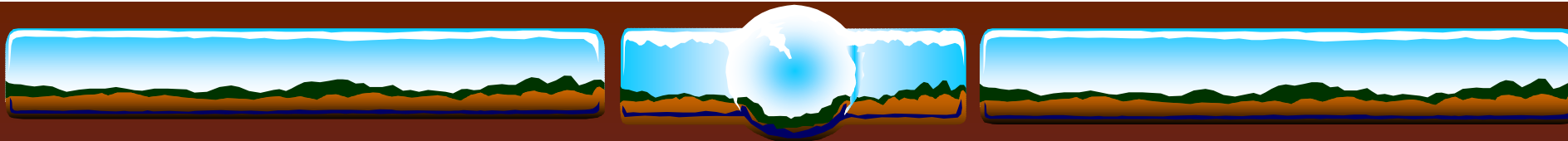
The Humate- Hydroponic Company of Organic Vegetables (project)

Humates can bring the following benefits to new company:

- ❖ Increase the yield of vegetables on hydroponics;
- ❖ Increase the nutritional quality of vegetables (amount of vitamins and sugars) and physical quality of the fruits;
- ❖ Increase plant`s tolerance to fungi, bacterial and fungal infections;
- ❖ Increase the shelf life of vegetables and cut flowers.

**The Hydroponic based on Humate Application
Gives up to 37% Savings to the Growers:**





Increase in productivity of different crops due to humate treatment
(Bogoslovsky, Levinsky, 2006)

