

Activated Humic Acids, Their Derivatives And Technologies For Effective And Sustainable Agriculture

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New Approach

Humic Substances in the Biosphere

Humic Acids

Fulvic Acids

Humin

Soil Organic Matter

Fluvial, Lacustrine & Marine Bottom Sediment

Caustobioliths (coal, peat, etc.)

Compost

Traditional Approach
Of Humic Acids Material Conversion into Usable Products

Mechanical/
Chemical
Treatment

Humic/ Fulvic
Acids &
Derivatives

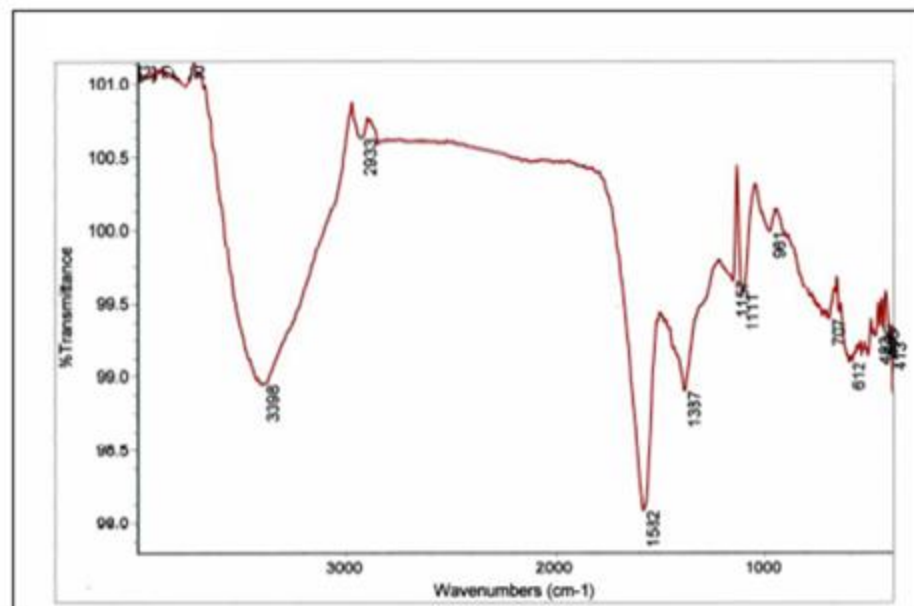
New Approach

Physical/ Chemical
Activation &
Conversion into
PEB

Activated
Humic/Fulvic
Acids, Humin &
Derivatives

PEB Typical Composition

Organic part		Mineral part	
Element	Content, mass%	Element	Content, mg/g
C	51.5	Ca	11.1
		Fe	7.45
H	3.16	Al	3.52
		Mg	1.6
O	44.1	Mn	0.22
		Zn	0.05
N	0.64	Cu	0.02
		Na	15.5
S	0.6	K	1.43



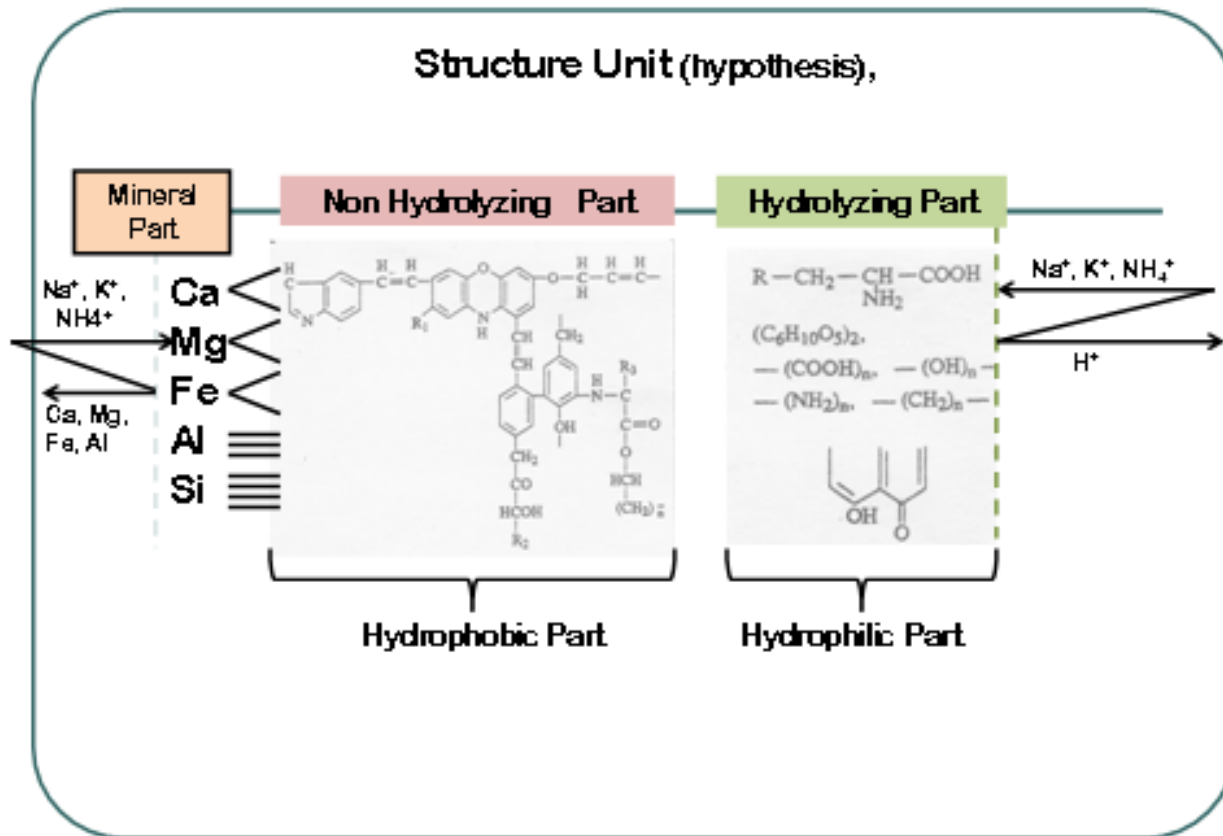
Functional groups, meq/ g	
Carboxyl	4.3
Phenolic	2.5
Total acidic functional groups	6.8

Molecular mass distribution	
Molecular mass, D	Content, mass. %
200-500	2
22000 - 27000	64
Exceeding 35000	5

Groups:

- OH (3500-3300 CM⁻¹)
- CH₃, CH₂ (2520-2860 CM⁻¹)
- C=O, C=C (1720 CM⁻¹)
- C=N (1640 CM⁻¹)
- Minerals (below 700 CM⁻¹)

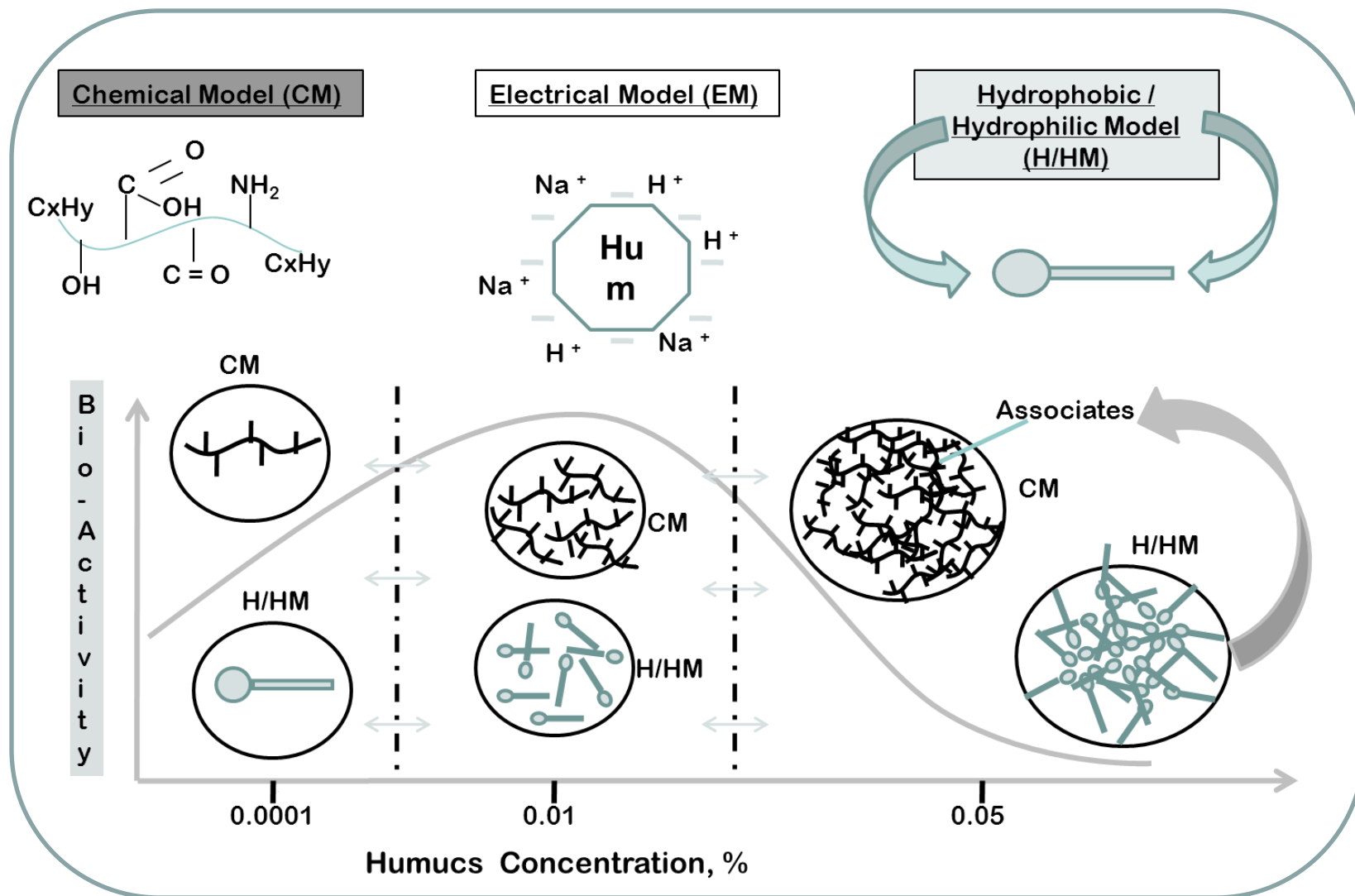
PEB Structure Unit (hypothesis)



PEB properties, effects and functions in connection with AHA and AHAD areas of application.

No	Properties	Effects and functions	Application
1	Natural surface active substance	Water tension reduction. Absorbing onto hydrophilic and hydrophobic organic and mineral surfaces. Dispersing and coagulating organic and mineral aggregates. Surface physical and chemical properties control.	Increased soil water holding capacity. Soil optimal porosity formation. Soil optimal organic and mineral aggregates formation. Optimal soil gas and water conditions formation. No-till soil decompaction and aeration. Irrigation water additive.
2	Natural ions exchange substance and absorbent.	Mobil compounds including nutrients absorption, accumulation, storage and leaching prevention. Toxic mineral and organic compounds binding and neutralization.	Soil absorption capacity including CEC increasing. Improved macro and micro nutrients uptake by plants and native soil bacteria. Fertilizer dozing rate reduction. Soil toxicity reduction/ elimination.
3	Natural organic mineral catalyst	Fresh organic matter decomposition/ composting regulation to Humification and Humus formation. New soil minerals formation. Toxic compounds detoxification.	Contaminated, disturbed and degraded soil restoration. Soil organic matter and native minerals increasing. Optimal natural soil composition formation.
4	Natural biologically active substance	Photosynthesis intensification. Plant growth and development stimulation. Plant protection from adverse climatic and ecological factors. Native soil bacteria support.	Higher plant biomass formation. Plant stability increasing. Higher yield of sugars, starch, oil, protein, vitamins, etc. Soil native microbial balance restoration.
5	Combined properties (1, 2, 3, 4).	Natural catalyst. Natural and balanced bio cycles of carbon, nitrogen, sulfur, etc. Potential soil fertility support.	Optimal soil structure, composition, properties and functions restoration and formation. Stronger crops, higher yield and better quality. Reduced use of chemicals. Sustainable agricultural support.

PEB Typical Bioactivity & Functional Models



Soil Readings & Calculations

№	Parameter	Content		№	Parameter	Content	
		Before	After 6 months			Before	After 6 months
1	Soil pH	6.2	6.1	8	Sulfur, mg/kg	5	7
2	Soil organic matter (OM), %	0.7	1.5	9	Boron, mg/kg	0.84	0.89
3	Cation Exchange Capacity, meq/100 g	3	5	10	Zinc, mg/kg	0.7	2.3
4	Phosphorus, mg/kg	13	30	11	Iron, mg/kg	55	72
5	Potassium, mg/kg	56	75	12	Manganese, mg/kg	5	5
6	Calcium, mg/kg	522	783	13	Copper, mg/kg	0.5	0.6
7	Magnesium, mg/kg	63	113	14	Sodium, mg/kg	11	22

$$\text{SOM} = (1.7-2) \text{ OC (14)}$$

$$\text{OC} = 0.2727 \text{ CO}_2$$

$$\Delta\text{SOM} = 0.8\% \rightarrow 12 \text{ Tons/Ha} \rightarrow$$

$$6-7 \text{ T/Ha OC} \rightarrow 22-26 \text{ T/Ha CO}_2$$

Soil Physical & Chemical Properties

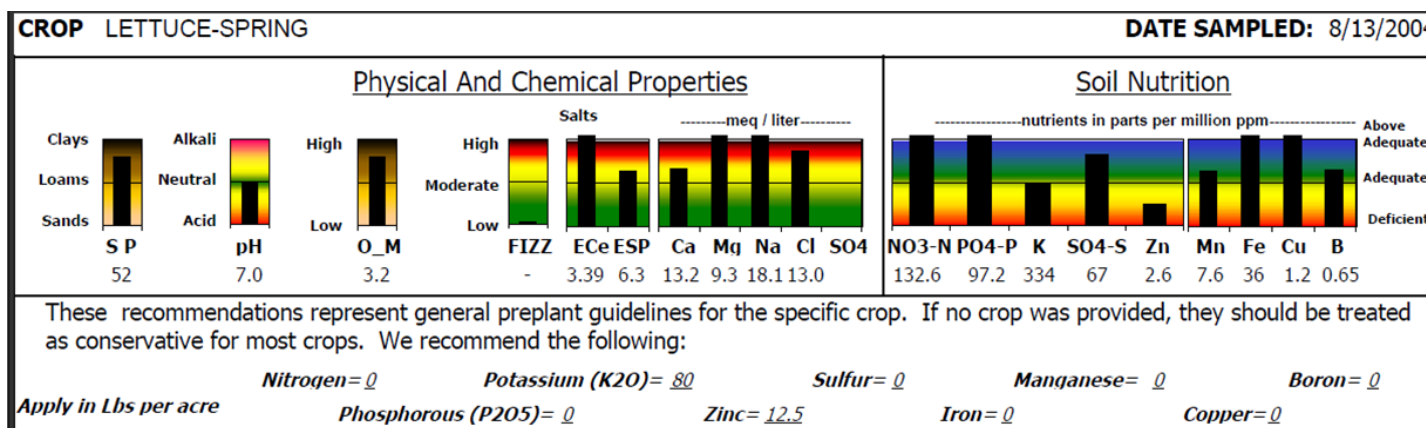


Figure 4: Soil physical and chemical properties before PEBBM application.

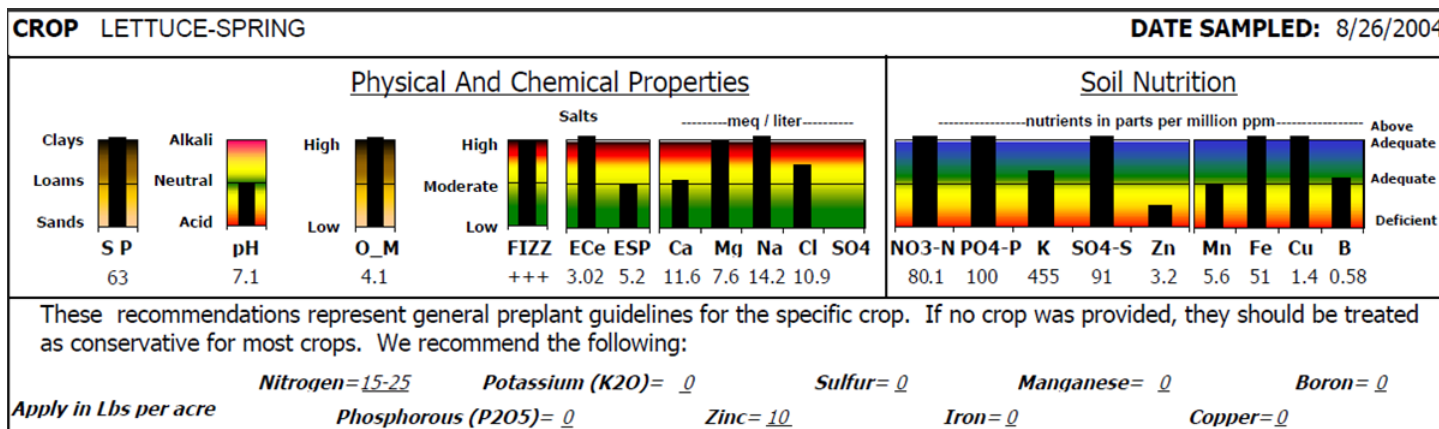


Figure 5 : Soil physical and chemical properties 2 weeks after PEBBM application.

Conclusion

- ✓ Activated Humic Acids and their derivatives have bio-geo-chemical activity
- ✓ PEB biological activity depends on its concentration
- ✓ AHA and AHAD's soil application in dosage rate of several hundred grams to several kilograms per one hectare results in a significant increase in soil organic matter
 - ✓ SOM \ll organic carbon \ll CO₂ sequestered from the atmosphere.
- ✓ CO₂ sequestration through soil organic matter/ organic carbon formation and soil mineral carbon
- ✓ AHA and AHAD soil application results in a Saturation Percentage increase
- ✓ AHA and AHAD soil application results in bound phosphates liberation and conversion into plant available forms and other nutrient content availability for plants.
- ✓ AHA and AHAD is an important Sustainable Agricultural Technology