MÖSSBAUER SPECTROSCOPY STUDIES OF IRON SPECIATION IN THE IRON HUMATES

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Design of bioavailable and environmentally friendly iron fertilizers is an unsolved problem of modern agriculture. Humic substances (HS) are ubiquitous in the environment and represent an abundant class of organic compounds, which constitute organic matter of soil, groundwater, peat and coal. Rich in functional groups and aromatic structures, HS are natural macroligands and possess complexing properties. As a result, HS play a role of depot for nutritional metals in the soil environments.

Bioavailability of complexed iron depends on its redox speciation and nearest chemical surroundings of iron atom. Plant roots take up iron from soil solution in oxidation state Fe^{2+}. This motivated us to apply ascorbic acid for stabilizing Fe(II) in iron humates.

The goal of this research was to study redox speciation of iron present in the iron humates produced in the presence and absence of ascorbic acid. The iron humates synthesized were studied using Mössbauer spectroscopy.

Iron humates were obtained from commercially available potassium humate and saturated with iron sulfate in the presence and absence of ascorbic acid under pH control.

Iron content of preparations obtained was 8.9±0.2 mass %, solubility was 127g/l for humate with ascorbic acid and 52 g/l for humate without ascorbic acid.

Efficiency of iron humate for correcting iron deficiency of higher plants was evaluated using seedling technique. Wheat *Triticum aestivum* L. was used as a target plant. Plants were grown at the iron concentration of 25 μmol/l. An increase in root weight was observed when iron was added as iron humate synthesized with ascorbic acid.

The Mössbauer spectra were registered for both humates (Figure 1). The calculated parameters are given in Table 1. The obtained spectra demonstrated clearly that iron humate in the absence of ascorbic acid contained only Fe(III) species alone, whereas the iron humate synthesized in the presence of ascorbic acid contained both Fe(III) and Fe(II) species. The conclusion can be made that ascorbic acid stabilizes only a small portion of Fe(II) in iron humates.

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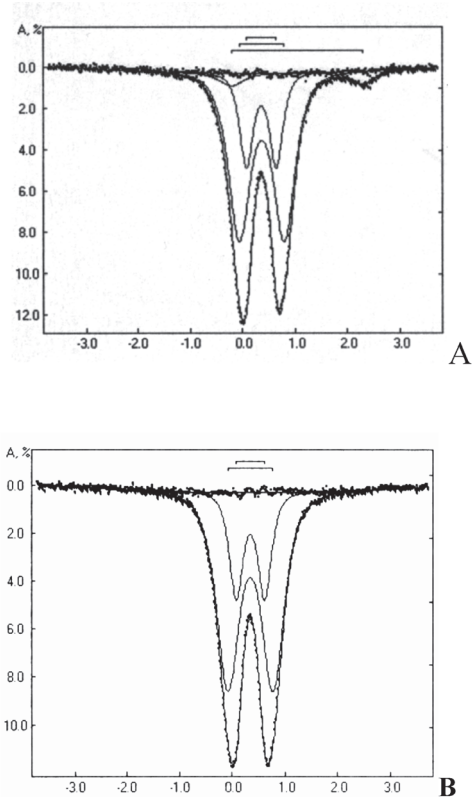

Figure 1. Mossbauer spectra of iron humates with ascorbic acid Fe-HS-A (A) and without ascorbic acid (Fe-HS) (B). Axes : X-absorbance A,%, Y-velocity V, mm/s.

Sample	Iron species	δ	Δ	Γ_{exp}	S, %	χ^2
		mm/s				
Fe-HS	Fe(III)	0.35	0.54	0.30	25	1.4
	Fe(III)	0.35	0.85	0.50	75	
Fe-HS-A	Fe(III)	0.36	0.56	0.30	24	1.5
	Fe(III)	0.37	0.85	0.49	70	
	Fe(II)	1.05	2.51	0.54	6	

Table I. Mössbauer parameters of iron humate samples (errors for γ, Δ, Γ_{exp} ±0.01 mm/s; for S ±3%; δ-relative to α-Fe).