



UnissResearch



Gessa, Carlo Emanuele; Deiana, Salvatore Andrea; Manunza, Bruno Mario Luigi; Usai, Marianna (1991) *Transfer of metal ions at the soil-root interface: role of  $VO^{2+}$  on  $Fe^{3+}$  mobilization from a Fe(III)-network.* Giornale botanico italiano, Vol. 125 (4), p. 476-478. ISSN 0017-0070.

<http://eprints.uniss.it/7867/>

# GIORNALE BOTANICO ITALIANO

FONDATO NEL 1844



PUBBLICATO DALLA SOCIETÀ BOTANICA ITALIANA  
CON IL CONTRIBUTO DEL CONSIGLIO NAZIONALE DELLE RICERCHE

Vol. 125, n. 4, 1991

**Società Italiana di Fisiologia Vegetale**

**31° Congresso Sociale**

Perugia

15-18 Ottobre 1991

RELAZIONI, COMUNICAZIONI  
DIMOSTRAZIONI - RIASSUNTI

## TRANSFER OF METAL IONS AT THE SOIL-ROOT INTERFACE: ROLE OF VO<sup>2+</sup> ON Fe<sup>3+</sup> MOBILIZATION FROM A Fe(III)-NETWORK.

C. Gessa, S. Deiana, B. Manunza and M. Usai.

Istituto di Chimica Agraria dell'Università di Sassari.

The transfer of micronutrientes from soil to plasmalemma is mediated by a mucilaginous interface composed predominantly of polisaccharides organized in a fibrillar structure. The flow of metal ions is regulated by their affinity for the functional groups of the fibrils: ions that interact electrostatically [e.g. Ca(II), Mn(II), Fe(II)] are more easily removed from the reticulation sites than covalently bound [e.g. Cu(II), Fe(III), VO(IV)]. The availability of the immobilized ions for the absorbing cells is mediated principally by the complexation, reduction and exchange processes.

As a part of our research in understanding the mechanisms involved in the ionic mobilization at the mucilaginous interface we synthesized a network of Ca-polygalacturonate with a fibrillar structure similar to that of the real systems (Gessa C. and Deiana S., 129: 211-217, 1990; Gessa C. and Deiana S., 00: 000-000, 1991).

The arrangement of the fibrils is altered following the substitution of Ca(II) with Fe(III) ions. We have shown that biomolecules as caffeic acid are able to reduce the reticulated iron and that the redox process re-establishes the porous system which characterizes the Ca-network (Gessa C. et al.: 136-141, 1990). This has important implications in plant nutrition as the porous structure of the interface makes easier the transfer of nutrients towards the plasmalemma.

This note reports the role of VO(IV) on Fe(III) mobilization from a Fe(III)-polygalacturonate network. The effect of the reaction on the physical properties of the system is also considered.

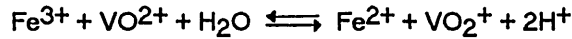
### EXPERIMENTAL

Kinetic tests were carried out at room temperature in 10<sup>-2</sup> M NaClO<sub>4</sub> aqueous solutions. The extent of occurrence of the reaction was monitored on the basis of the iron (II) content, in the form of the 1,10-phenantroline complex (absorption measurements in the visible region, at 510 nm).

The calcium and oxovanadium ions present in the external liquid phase and complexed by the organic matrix were determined by using a plasma emission spectrometer. Electron-micrographs were made by scanning electron microscopy (SEM) (Gessa C. and Deiana S.,00:000-000, 1991).

## RESULTS AND DISCUSSION

In aqueous phase the VO(IV) reduces the Fe(III) according to the following stoichiometry:



In Fig. 1A and 1B are reported the yield in Fe(II) as a function of pH and time, respectively. These plots show a high redox activity of the system in the pH range of 2 - 4.5: about 90% of the Fe(III) is reduced in few minutes.

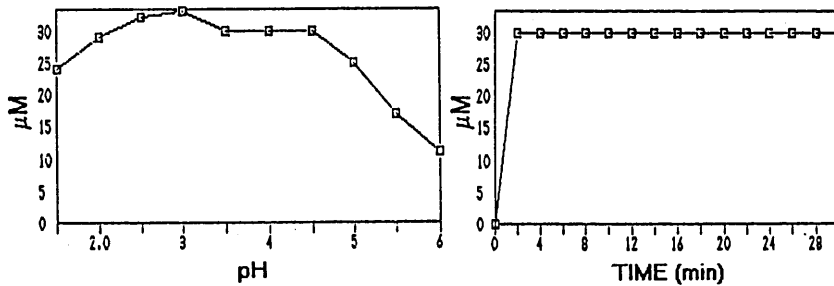


Fig.1A. Iron(II) yield as a function of pH after 3 h.

Fig.1B. Iron(II) yields as a function of time measured at pH 3.5; 4 and 4.5.

Initial concentrations:  $\text{Fe}^{3+}$ ,  $34.2\mu\text{M}$ ;  $\text{VO}_2^{2+}$ ,  $33.8\mu\text{M}$ .

The redox reaction was then studied by immersing a network, reticulated with 0.08 mmol of Fe(III) and 0.03 mmol of Ca (II), in 300 mL of solution containing 0.0187 (system 1) and 0.187 mmol(system 2) of VO(IV) at pH 3.8.

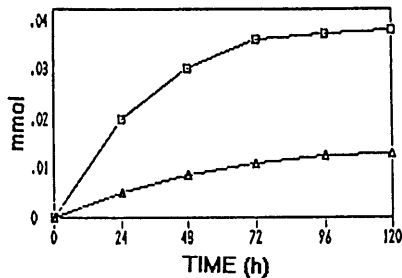


Fig. 2.  $\Delta$  Sistem 1;  $\square$  Sistem 2

In Figure 2 is reported the amount of Fe(II) released from the network during the diffusion of the VO(IV) into the mucilaginous material in function of the time. The redox reaction inside the membrane appears to proceed more slowly as a result of the strong interaction of the Fe(III) with the functional groups of the matrix. Furthermore, the redox kinetics could be influenced by the

diffusion time of both VO(IV) from the external solution to the reticulation sites and Fe(II) from the matrix to the external solution.

The metal ions in the external solution and those immobilized by the organic matrix, determined at the equilibrium, are reported in Table 1.

TABLE 1

	Liquid phase mmol	Solid phase mmol			
	Fe <sup>2+</sup>	Fe <sup>3+</sup>	Fe <sup>2+</sup>	Ca <sup>2+</sup>	(VO <sup>2+</sup> +VO <sub>2</sub> <sup>+</sup> )
SYSTEM 1	0.013	0.064	0.0030	0.03	0.010
SYSTEM 2	0.038	0.045	0.0041	0.01	0.066

The redox reaction is more active in the liquid phase: only 50% of the reticulating iron is reduced in the sistem 2.

These data suggest that three steps could be involved in the reduction process:

- 1 - diffusion of the VO(IV) into the network;
- 2 - exchange of iron by vanadium;
- 3 - reduction of the iron by VO(IV) in the free space volume.

The reduction of the iron does not improve the structural arrangement of the network which appears collapsed both in the Fe(III)-Ca(II) and VO(IV)-Ca(II)-polygalacturonate. Further studies at this regard as well as about the distribution of the vanadium species (VO<sup>2+</sup> and VO<sub>2</sub><sup>+</sup>) in the system are in progress.

#### REFERENCES.

- 1) Deiana S. and Gessa C.: (1991), Fibrillar structure of Ca-polygalacturonate as a model for a soil-root interface. II: A comparison with natural root mucilage. *Plant and Soil*; 00,000-000.
- 2) Gessa C. and Deiana S.: (1990), Fibrillar structure of Ca-polygalacturonate as a model for a soil-root interface. Part I. A hypotesis on the arrangement of the polymeric chains inside the fibrils. *Plant and Soil*; 129, 211-217.
- 3) Gessa C., Deiana S., Marchetti M. e Usai M.: (1990), Reazioni di complessazione e redox nell'interfaccia suolo radice. *Proceeding C.N.R. "Stress Ambientali nei Vegetali"*; 136-141.