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PS7.3 — TH

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THE INFLUENCE OF COMPLEXATION ON MICRONUTRIENT UPTAKE BY PLANTS: A COMBINATION OF COMPUTER SIMULATION AND PLANT GROWTH EXPERIMENTS

Chelation of the micronutrient metal ions (Cu, Fe, Mn and Zn) is known to be an important factor in the efficacy of their uptake by plants [1,2]. Chelation may occur by plant exudates [3], in substances released from decaying organic matter [4], and in bacterial excretions [5]. It is reasonable to postulate that chelation is essential (i) for the solubilization of the metal ions, particularly under alkaline conditions; (ii) for metal transportation; and (iii) for selectivity between the metal ions.

Over the past 30 years there has been a large number of studies on the application of synthetic chelating agents to overcome plant nutritional problems, most noticeably the use of EDTA and related chelating agents to overcome plant iron deficiencies [6]. In other cases, *e.g.* with Cu, chelation with EDTA reportedly decreases plant uptakes [7]. In fact, there is little agreement on the influence and mechanism of chelation of the micronutrient metal ions in relation to the subsequent plant growth and health. Many of these conflicts can be attributed to a lack of knowledge or consideration of the metal speciation and to ignoring the mutual influence of one metal upon another.

Fortunately, plants may be grown from aqueous solutions which contain known levels of metal salts and chelating agents. The speciation in such solutions can now readily be calculated via computer simulation, provided the relevant thermodynamic data are available. A number of computer programs are available for assessing metal speciation in multi-metal multi-ligand systems (*e.g.* ECCLES, GEOCHEM, PSEUDOPLOT), such programs lead to the same results in general [8].

We have begun a series of studies on the influence of complexation upon metal ion uptakes from nutrient solutions and the effects upon plant growth and health. The emphasis is on a multi-metal study. Thus, barley seeds are allowed to germinate under carefully controlled conditions and then grown in nutrient solutions containing EDTA. A «continuous replenishment» method is being used to avoid changes in solution concentrations and pH. The solutions used differ in EDTA level and/or pH. The plants are harvested at set times, washed, weighed, and then the roots and tops separately analysed for all elements with an ICP instrument. The complexation of each metal ion in each of the solutions is determined by computer simulation. By small changes in EDTA and/or pH quite wide variations in the degrees of chelation can be obtained for one or more of the metal ions. In our initial studies solutions of the same nutrient composition (Long Ashton nutrient solutions) and pH but with varying EDTA concentrations were used. The barley plants were grown in these solutions at 20°C under regulated lighting conditions and humidity. The computed speciation of the metal ions is shown in the Table. The data in column 1 show that the assumption that

Table
Computed Percentages of Metal Ions Complexed by EDTA. Temp. 20°C, pH 5.2, EDTA the only variable

EDTA/Fe Ratio:	1.0	1.05	1.10	1.15	1.20
Ca	0	0	0	0.1	0.2
Cu	53.8	100	100	100	100
Fe	99.5	100	100	100	100
Mg	0	0	0	0	0
Mn	0	21.6	53.4	73.2	83.1
Zn	0.8	99.3	99.8	100	100

EDTA only binds Fe, when FeNaEDTA salt is used, is invalid. Statistical analyses show that increasing EDTA results in decreased Fe and P uptakes but enhanced Cu and Mn uptakes. Al, Ca, Mg, Na, K, Mo and Zn levels were not affected neither were the plant growths. Both complexation and mutual metal ion interactions are seen to influence the metal uptakes. Further work is proceeding.

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PS7.4 — MO

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VARIATION OF METAL CONCENTRATIONS IN DIFFERENT PARTS OF SUGARCANE

The average concentrations and the relative standard deviations for K, Ca, Mg, Mn, Cu, Fe and Zn in different parts of 10 samples of sugarcane were obtained. The relative standard deviations ranged from 12 to 87%.

The low productivity of sugarcane crops in the Northeast of Brazil is attributed to deficiency of nutrients, including some metals, in the soil. Knowledge about the absorption of nutrients by a plant would be useful for an efficient soil correction. It is also important to verify the antagonistic effects of these elements, since the excess of one can imply in the deficiency of the other. Some metals also play an important role in the fermentation of molasses in the production of ethanol.

Several authors have studied metals in sugarcane: ORLANDO *et al.* [1,2] studied the influence of age and soil and HUMBERT [3] the effect of variety. A review on the subject was done by MALAVOLTA *et al.* [4]. CAMPOS and CURTIUS [5] studied the distribution of metals in different internodes of three varieties of sugarcane. They found that generally, the upper internodes are enriched in metals, and that different samples of a same variety, showed, for the same internode and metal, very different