STUDY OF THE PLANT IRON FERTILIZATION WITH SYNTHETIC FERRIC CHELATES BY MASS SPECTROMETRY

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INTRODUCTION

The ferric chelate of the synthetic ethylenediamine di(o-hydroxyphenylacetic) acid (Fe(III)-o,oEDDHA) is one of the most efficient fertilizers to correct Fe deficiency in calcareous soils. Commercially available Fe(III)-o,oEDDHA fertilizers contain a mixture of approximately 1:1 of two groups of stereoisomers, a meso form [(R,S-Fe(III)-o,oEDDHA)] and a d,l racemic mixture [(R,R-Fe(III)-o,oEDDHA) + (S,S-Fe(III)-o,oEDDHA)], that have different stability constants with Fe (meso K = 10^{34.15} and racemic K = 10^{35.86} [1]). Previous studies dealing with the isomers, each one labelled with a different Fe low-abundant meso a stable isotopes (54Fe or 57Fe) to differentiate among the Fe isomer [4].

In this study the uptake and distribution of the Fe simultaneously provided by both groups of Fe(III)-o,oEDDHA stereoisomers was monitored in Fe-deficient sugar beet plants. For that, plants were treated with meso and racemic-o,oEDDHA isomers, each one labelled with a different Fe low-abundant stable isotopes (54Fe or 57Fe) to differentiate among the Fe provided by each isomer and the plant native Fe (mainly 56Fe).

RESULTS

Iron contents

- Plant contents of Fe come from the meso isomer were 1.5-3.0 fold higher than those come from the racemic one.
- Among plant materials the highest differences between contents of Fe come from each isomer were found in fine roots.
- Fe-resupply with both Fe(III)-o,oEDDHA isomers caused a remobilization of the native Fe from roots to shoots in sugar beet Fe-deficient plants.
- Old and young leaf contents of Fe come from either of both Fe(III)-o,oEDDHA isomers were 2.7-4.2 fold higher than those come from native Fe remobilized from roots.
- Plants treated for 6h had 1.7-fold higher Fe contents than those of plants treated for 3h.

REFERENCES:


MATERIAL AND METHODS

Preparation of Fe Stable Isotope Labelled Fe(III)-o,oEDDHA Chelates: Meso and racemic Fe(III)-o,oEDDHA isomers were separated by selective Mg precipitation according to [1], then was reacted with o,oEDDHA isomers were further chelated with 56Fe and 57Fe.

Plant Material: Three-week old sugar beet (Beta vulgaris L. cv. 'Orbis') plants were hydroponically-grown in absence of Fe for 2 weeks. Some of these Fe-deficient plants were Fe-resupplied for 3 and 6 hours with:

i) 30 μM racemic 54Fe(III)-o,oEDDHA : 30 μM meso 57Fe(III)-o,oEDDHA or
ii) 30 μM racemic 57Fe(III)-o,oEDDHA : 30 μM meso 54Fe(III)-o,oEDDHA.

Leaves and roots were sampled from both classes of Fe-deficient plants (Fe-resupplied and non Fe-resupplied). All plant material samples were divided in two aliquots before analysis preparation. An aliquot was immediately liquid N2 frozen and o,oEDDHA extracted as it is indicated in [4]. The other aliquot was dried at 60 ºC, ground in a zirconium oxide-ball mill and microwave acid digested.

Iron Stable Isotopes Determination: Iron-54, 56Fe, 57Fe and 58Fe contents in all plant material samples were determined by inductively coupled mass spectrometry, using isotope dilution analysis. Iron remobilization was estimated comparing the native Fe contents occurring in both Fe-resupplied and non Fe-resupplied Fe-deficient plant.

Old and meso labelled Fe(III)-o,oEDDHA determinations: meso and racemic-o,oEDDHA were determined in plant extracts by high performance liquid chromatography coupled to time-of-flight mass spectrometry using the method described in [5].