Daymsa
Europe's leading producer of Leonardite

# Naturquel®-Fe Evolution

## The best solution for iron chlorosis

CROPtech Kenya
Better Yields More Profit

# Index

- Iron chlorosis
- Iron chelates
- Ortho-ortho importance
- New chelating agent: HBED
- Naturquel-Fe Evolution: features
- Naturquel-Fe Evolution: trial results

# Iron chlorosis

Iron has several functions, but it is essential for chlorophyll synthesis.

It is a limiting factor in yield.

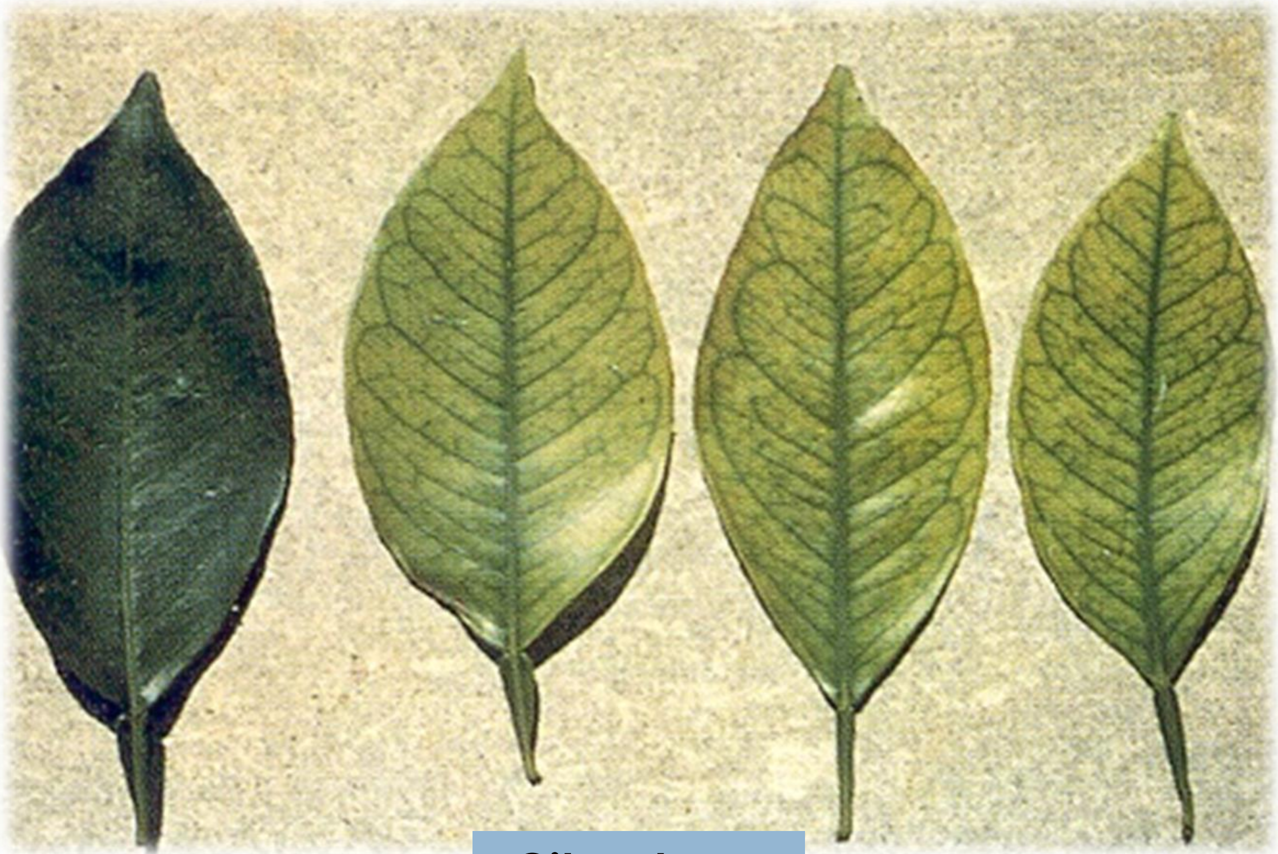
# Iron chlorosis

- Different iron uptake mechanisms according to species:
  - Soil acidification through the roots *(most crops)*
  - Secretion of natural chelates through the roots *(lawns)*
- Success depends on the species and crop.

Better Yields More Profit

Naturquel® Fe Evolution

# Iron chlorosis



Citrus trees

# Iron chlorosis

Iron chlorosis is not a consequence of iron deficiency in the soil, where it is one of the most profuse elements (3.8% on average), but the outcome of the low mobility of iron when it is insoluble in soil.

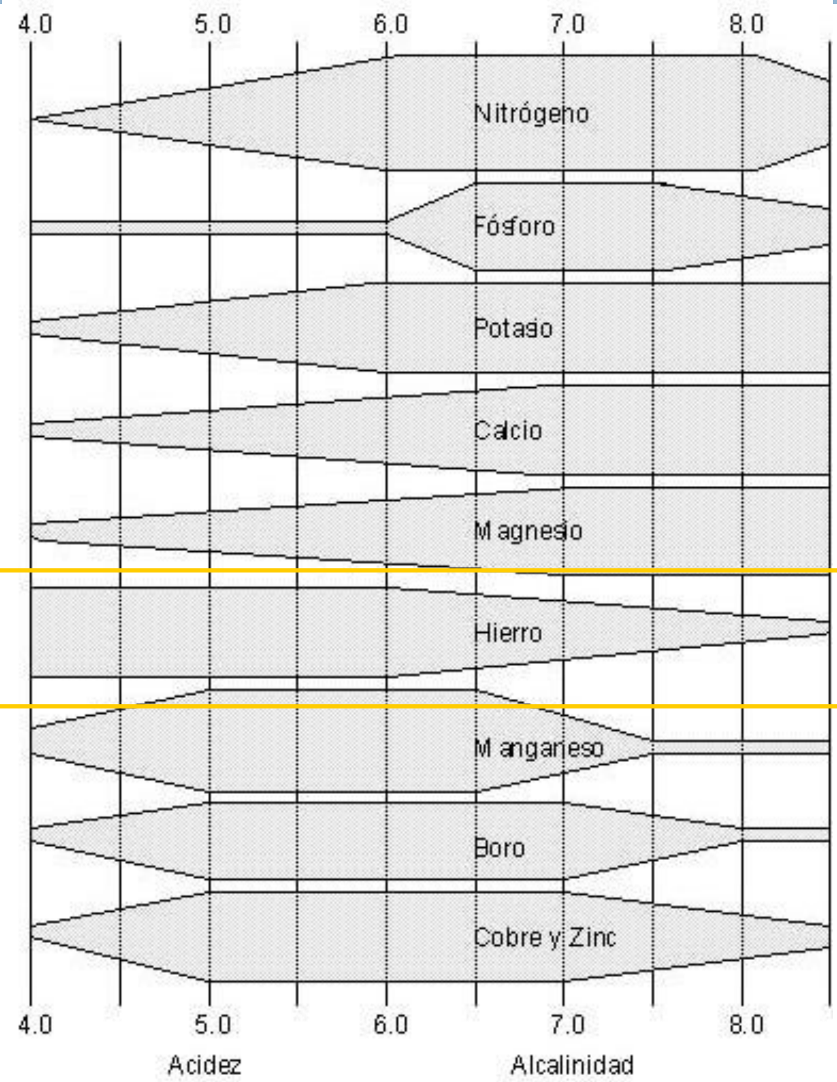
This low mobility (solubility) prevents plants from absorbing and distributing it.

Low mobility in calcareous soils:
High pH and presence of bicarbonate- held by the active lime in the soil.
Soil texture…

# Iron chlorosis

**pH and uptake**

**An increase in pH reduces solubility and absorption of Iron (Fe).**



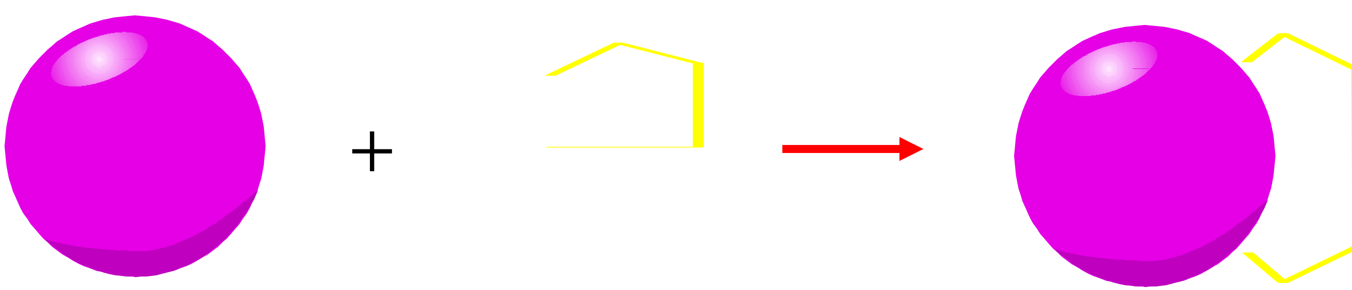

**IRON (Hierro)**

# Iron chelates

- Chelates are products of a high stability, able to keep metal ions surrounded by an organic molecule (chelating agent) to keep the metal safe from environment and avoid its precipitation, as insoluble hydroxide and non available for the plant  (Lucena, 2006).

## What a metal chelate is?

Metal ion + Chelating agent → Metal chelate



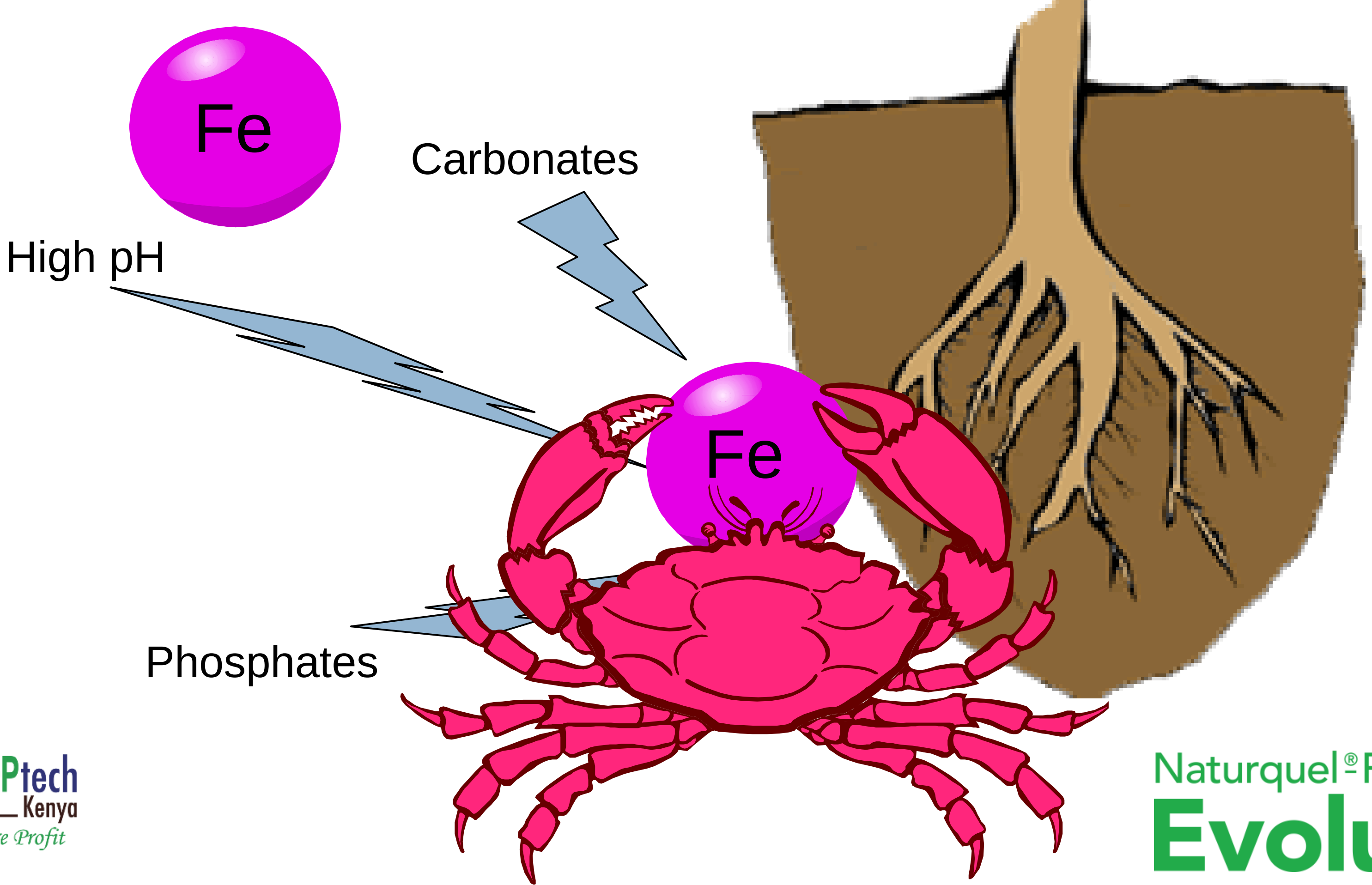
CROPtech Kenya
Better Yields More Profit

Naturquel® Fe Evolution

# Iron chelates

**What is exactly a metal chelate?**

“Chela” from latin means…. claw

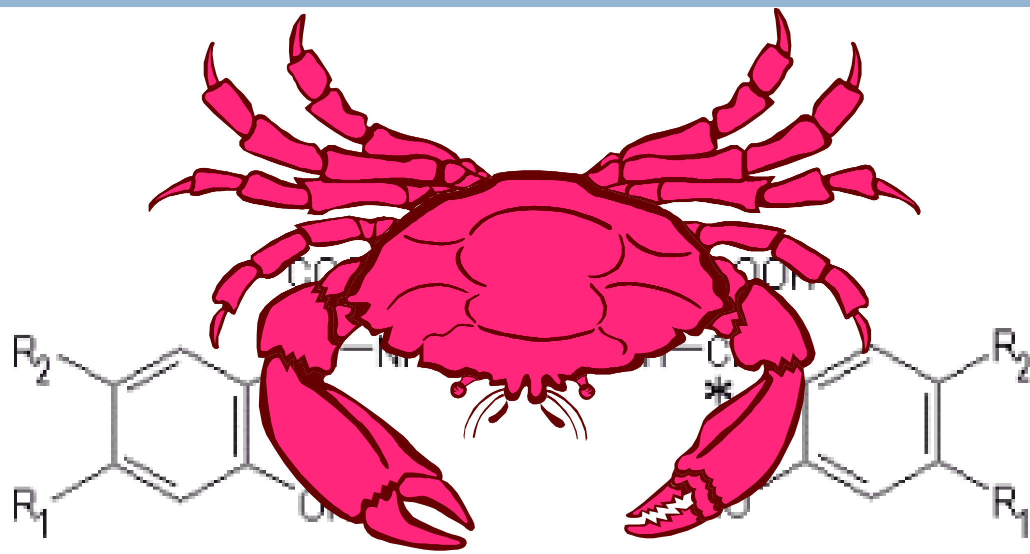



Naturquel® Fe Evolution

CROPtech Kenya

Better Yields More Profit

# Iron chelates



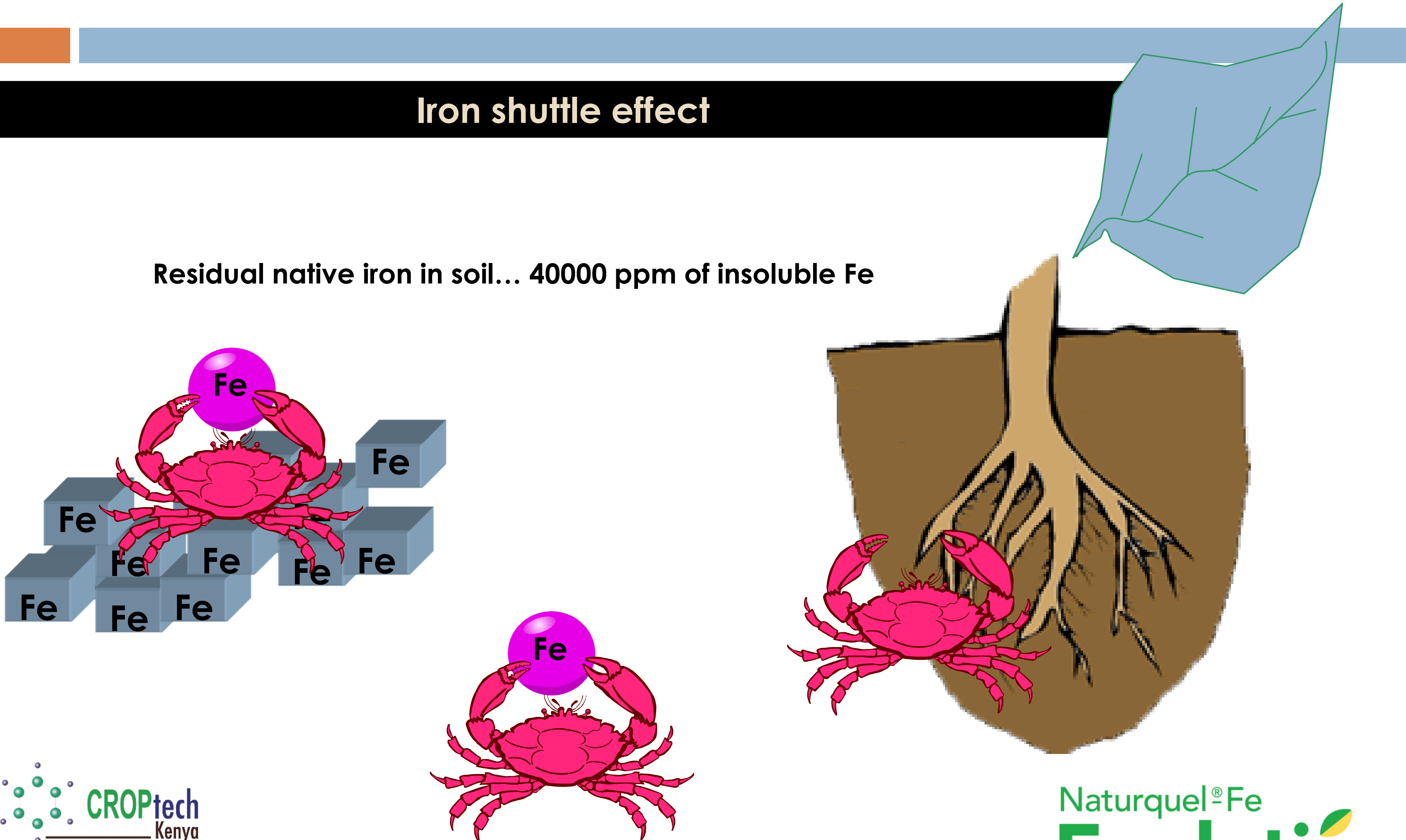

| | |
|---|---|
| $R_1$ y $R_2$ = H | EDDHA |
| $R_1$ = $CH_3$ y $R_2$ = H | EDDHMA |
| $R_1$ = H y $R_2$ = COOH | EDDCHA |
| $R_1$ = H y $R_2$ = $HSO_3$ | EDDHSA |

* Carbonos quirales

# Iron chelates

Iron shuttle effect

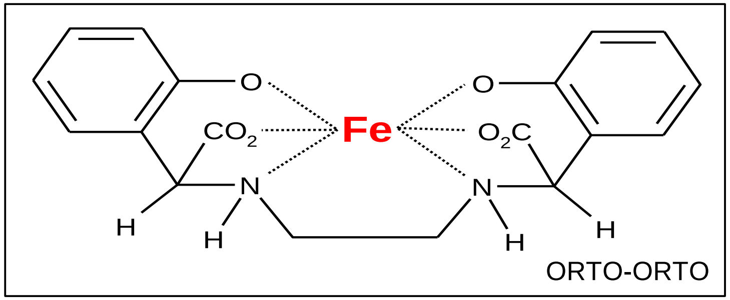
Residual native iron in soil… 40000 ppm of insoluble Fe

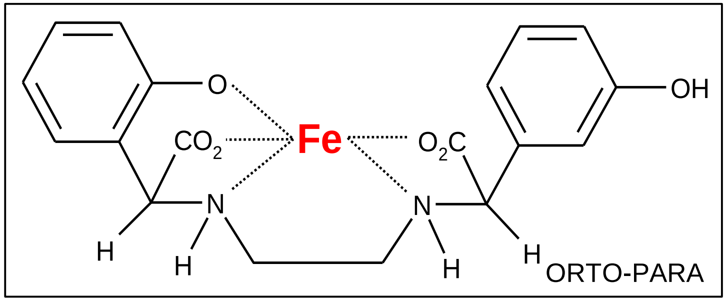


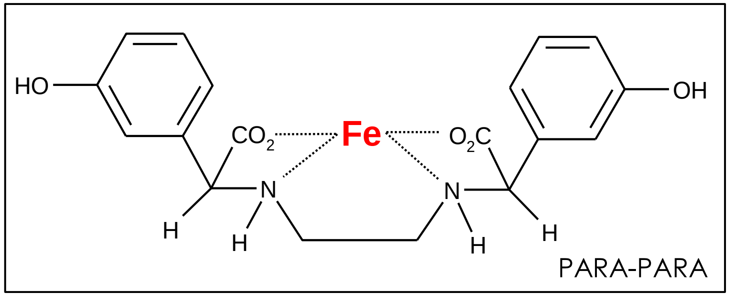

CROPtech Kenya
Better Yields More Profit

Naturquel®-Fe Evolution

# Ortho-ortho isomer importance




In “ortho-ortho ” isomer, there are six fixing points with iron, Fe is totally protected.

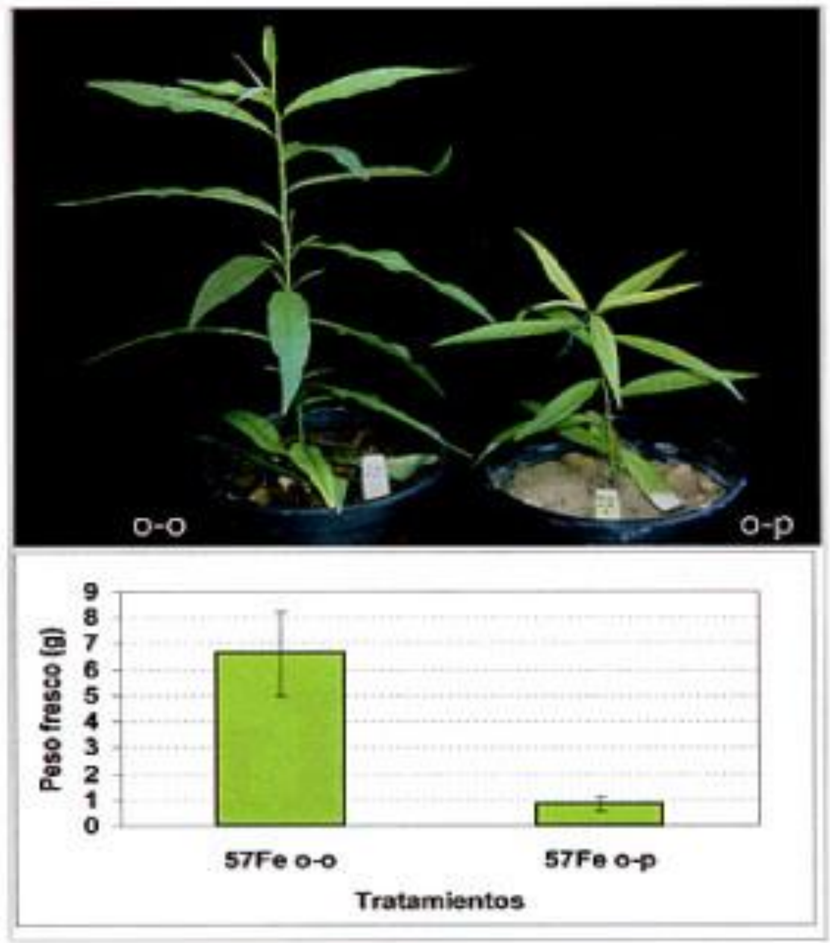
In “ortho-para” isomer, there are five fixing points with iron

# Ortho-ortho isomer importance

**CONCLUSIONS:**

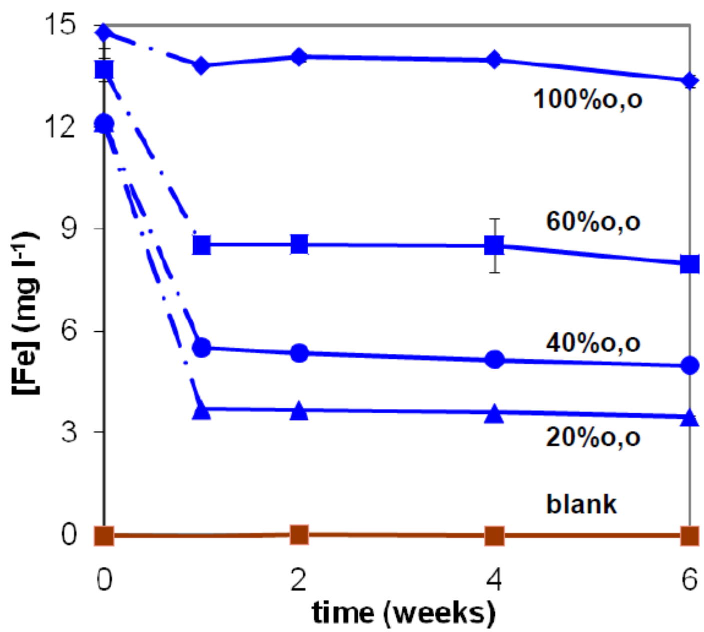
Ortho – ortho isomer is more able to put Fe available to plants than ortho – para when plants are grown in alcaline soils.

The efficacy of Fe-EDDHA on alcaline soil depends on ortho – ortho isomer.



# Ortho-ortho isomer Importance

## Soil Fe-EDDHA study: Fe in solution



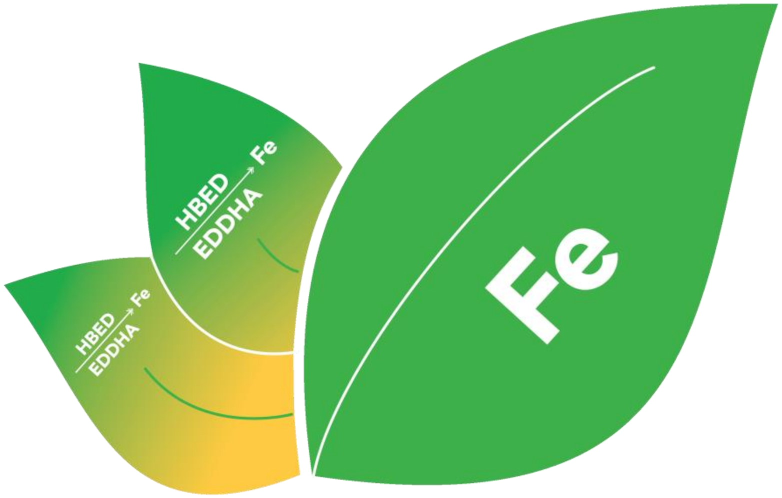

WAGENINGEN UNIVERSITY
ENVIRONMENTAL SCIENCES

<u>Santomera soil (Spain):</u>

- No Fe in blank
- Drop in Fe concentration in first week (in fact first day)
- o,o-content largely determines Fe concentration upon interaction with soil

Daymsa
Europe's leading producer of Leonardite

# Naturquel®-Fe Evolution




CROPtech Kenya
*Better Yields More Profit*

# Composition

- Iron (Fe) water soluble ........................................................ 6.0 % w/w
- Iron (Fe) chelated by EDDHA/HBED …………………..... 6.0 % w/w
- Iron (Fe) chelated by ortho-ortho EDDHA/HBED .......... 5.8 % w/w
- Iron (Fe) chelated by ortho-ortho EDDHA ....................... 1.8 % w/w
- Iron (Fe) chelated by ortho-ortho HBED ......................... 4.0 % w/w

Stability interval: pH between 3.5 and 12

# New chelating agent: HBED

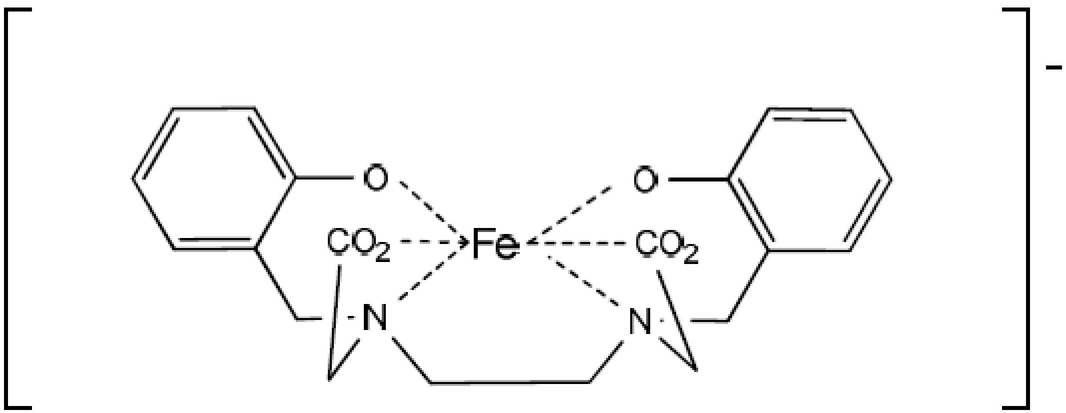
- EC fertilizer law 223/2012 (since 14 march 2012).
- HBED was syntesized in 1967 for medical use in human beings, for disease relative to iron.

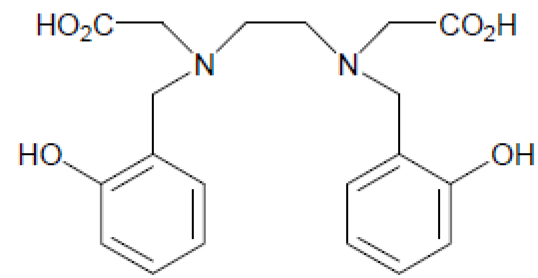
- HBED forms a very stable iron chelate.
- Its high stability ensures a high longevity in the soil.

- HBED = di (ortho-HydroxyBenzyl)-Ethylenediamine – Diacetic acid

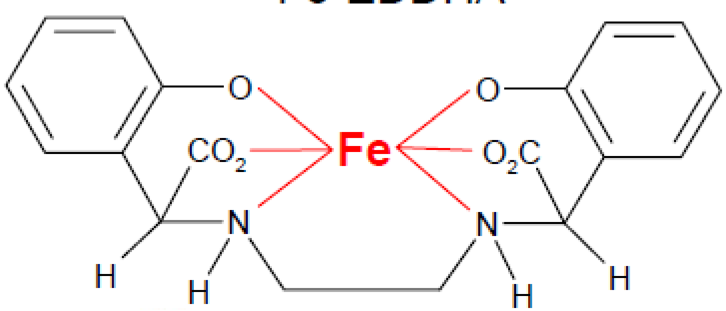
# Chemical structure of HBED-Fe

## Fe-HBED

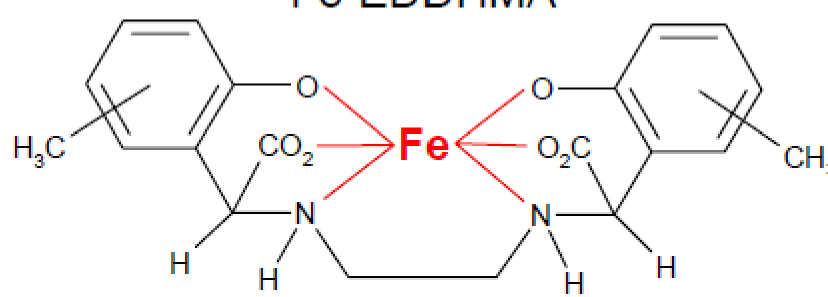



## Fe-EDDHA



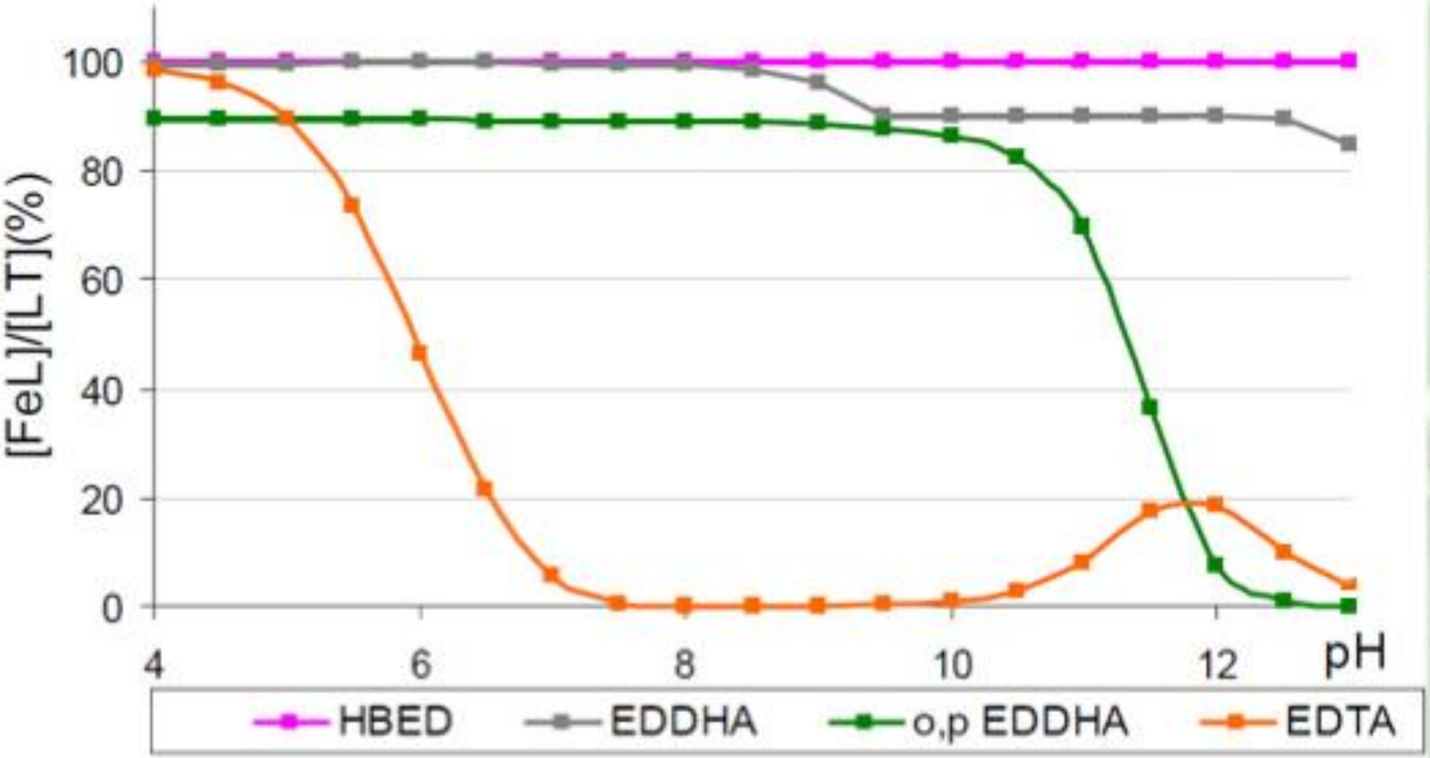

## Fe-EDDHMA



# New chelating agent: HBED

- Only ortho-ortho position
- Counter ion is Potassium
- Microgranules: No dust
- No insolubles.

# pH interval stability




% of Fe chelated, in presence of HBED, o-o-EDDHA, o-p-EDDHA and EDTA in soils condition of limited availability of Cu. [Fe(III) = [HBED] = [o-o-EDDHA]=[o-p-EDDHA]=[EDTA]= $10^{-4}$ M.

# Stability constant

- Chelating agents are often used to protect metal ions from unwanted side reactions such as precipitation. The interaction of a chelating agent with a metal ion can be described by its stability constant (K).

$$K = \frac{[\text{metal chelated}]}{[\text{metal}] \quad [\text{chelating agent}]}$$

# Stability constants: EDDHA and HBED

| | EDDHA [ML]/[M][L] | HBED [ML]/[M][L] |
|---|---|---|
| **$Ca^{2+}$** | 7,29 | 9,29 |
| **$Cu^{2+}$** | 23,90 | 22,95 |
| **$Fe^{3+}$** | 35,4 | 39,0 |
| **$Mg^{2+}$** | 9,76 | 10,51 |
| **$Mn^{2+}$** | 9,57 | 14,78 |
| **$Zn^{2+}$** | 17,8 | 18,95 |

- Log K $Fe^{3+}$ : EDDHMA 34; EDDHA 35; HBED 39
- The higher is the stability constant the higher protection efficacy of chelating agent on the metal. For example, a chelate of a metal X with a stability constant of 16 protects this metal one million times (16-10 = 6 zeros) more tan a chelate with stability constant of 10.

# Advantages of HBED-Fe vs other iron chelates

- Fe-EDDHA have a stability constant (log K value) of 35; this value for Fe-HBED is 39. As is a logaritmic value, that means that union force of HBED is several times higher than EDDHA.

- Stability constant determines the afinity between the chelating agent and the metal: HIGHER AFINITY OF HBED FOR IRON than other chelating agents.

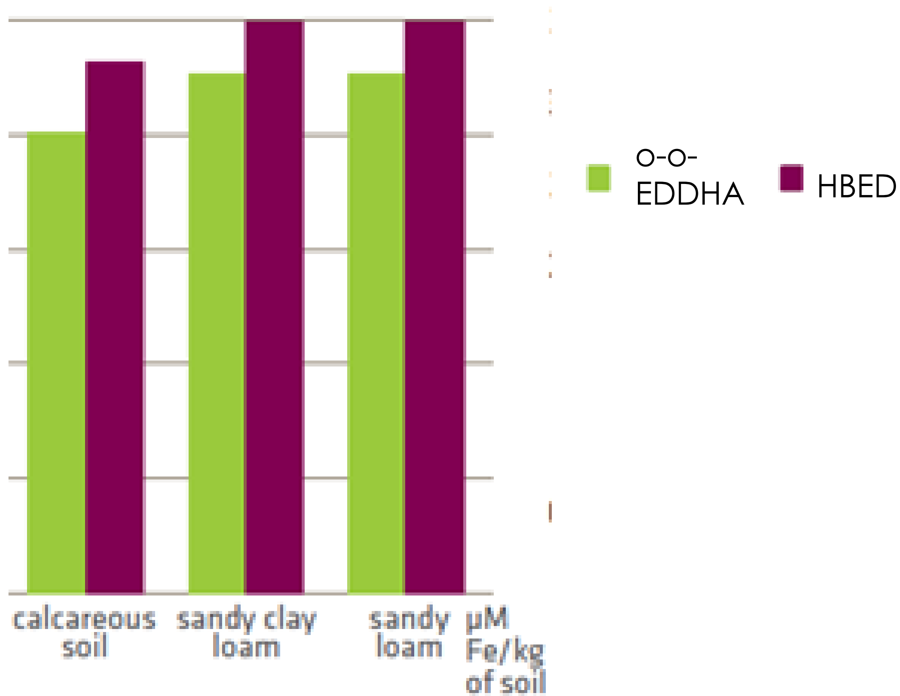
- Thus, Fe-HBED means an improvement respect to Fe-EDDHA with a great application potential in calcareous soils and alkalines where the use of iron chelates is needed.
- Higher longevity.

# Advantages of HBED-Fe vs other iron chelates

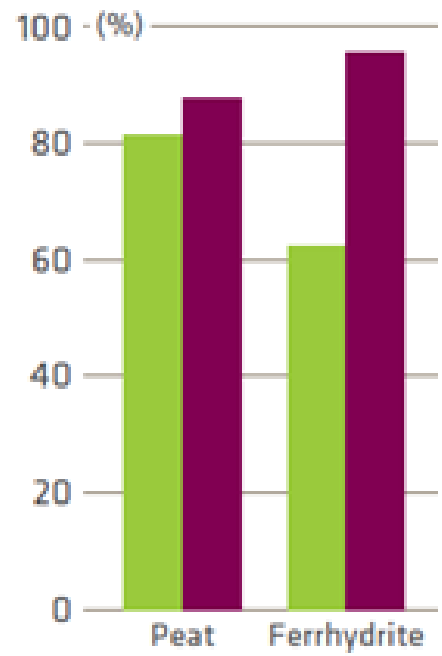
Daymsa
Europe's leading producer of Leonardite

**Lower biodegradability of chelating agent →**
**Higher % of iron concentration ramains in soil solution**

**Percentage of Fe HBED chelate remaining in solution after interaction with different soils for three days.**




**Percentage of Fe HBED chelate remaining in solution after interaction with different soils for three days.**




CROPtech Kenya
Better Yields More Profit

Naturquel® Fe Evolution

# Advantages of Naturquel-Fe Evolution vs other iron chelates

- 2 chelating agents of high efficacy.
- Higher action spectrum: speed and longevity.
- Higher iron storage in flowers as consequence of a better assimilation from previous season.
- Easy to dissolve
- No insolubles.
- Potassium content: 16% $K_2O$
- Excelent Solubility.

# Naturquel-Fe Evolution: Dosage

The product can be applied to the irrigation system or directly to the soil.

Split the total dosage in several applications.

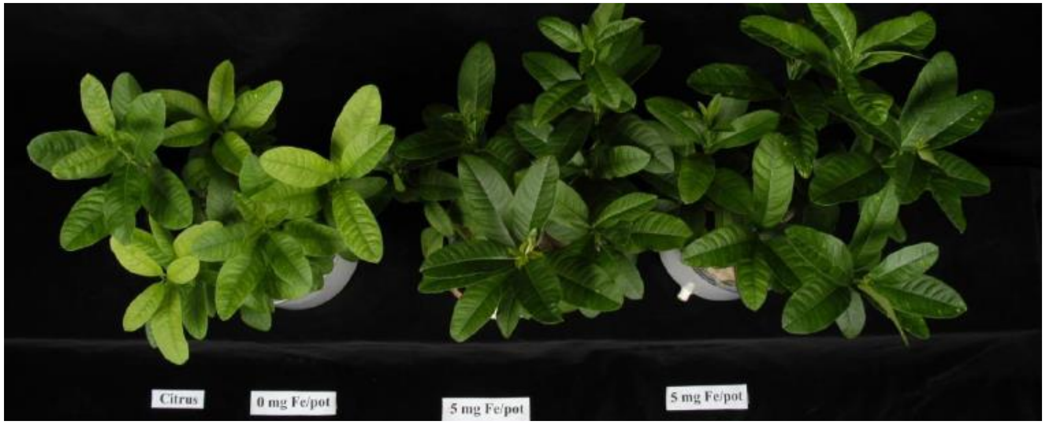
Dose rates to apply per cycle is the following:

- Vegetables and ornamentals 2.5 – 8 kg/ha
- Fruit trees 25 – 100 g/tree
- Olive tree 25 – 100 g/tree
- Citrus trees 25 – 100 g/tree
- Viña 4.5 – 10 g/tree

Reduce dosages in very young crops.

# Citrus trial – in plots

- Pot trial *Citrus medica*
- pH soil above 8 (Spanish Soil from Xeraco)
- *Both Fe-EDDHA and Fe-HBED* compared to the zero treatment:
  - No chlorosis
  - Higher fresh and dry weight
  - Higher Fe in the total plant
- Conclusion was that Fe-HBED has at least a comparable agronomic effectiveness as Fe-EDDHA

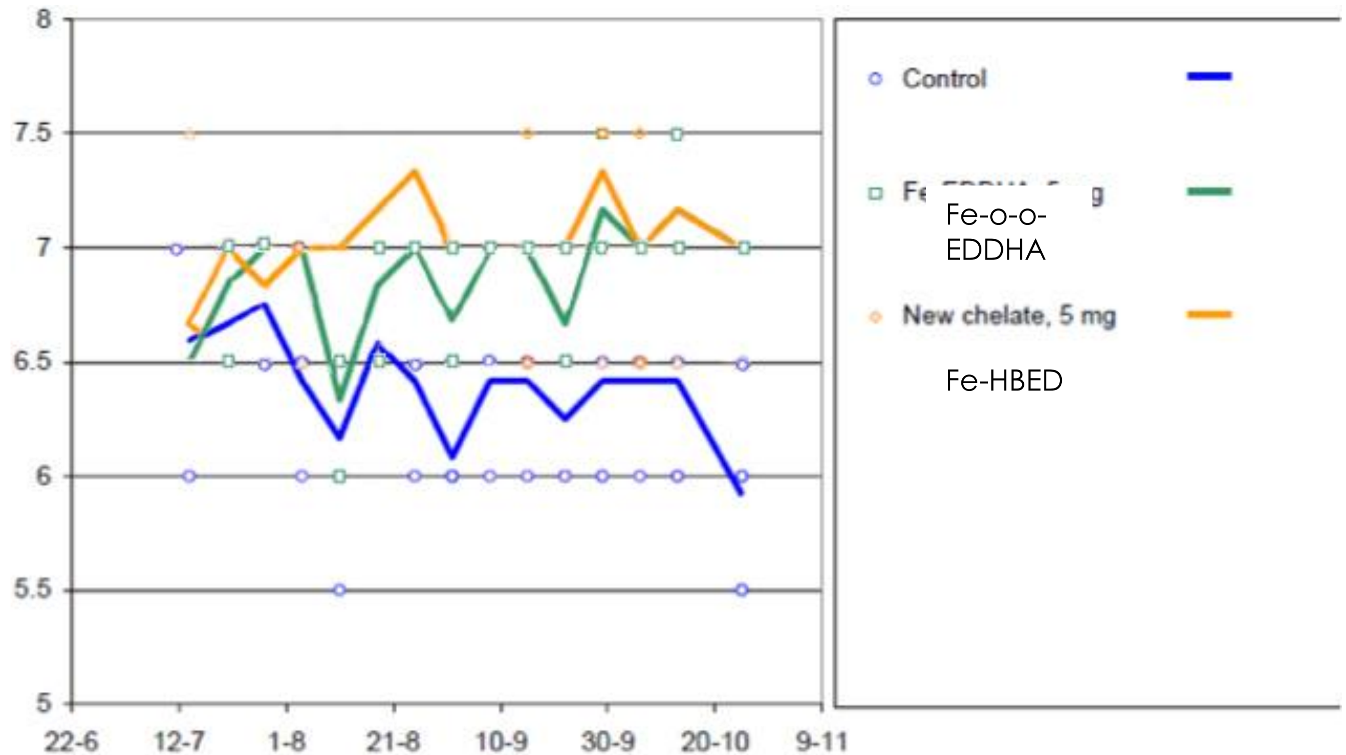



Fe-o-o-EDDHA Fe-HBED

Daymsa
Europe's leading producer of Leonardite

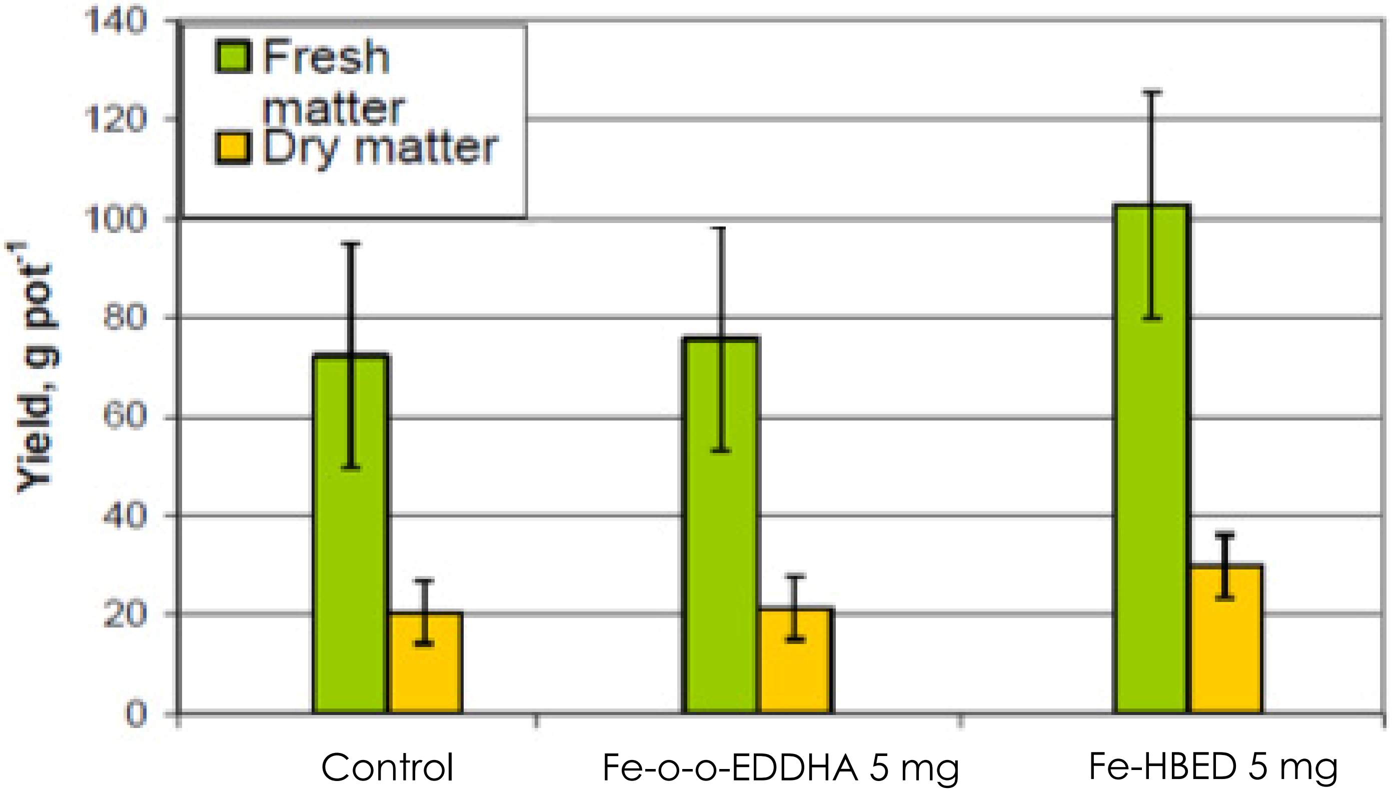
# Colour vs date


Fe-o-o-EDDHA Fe-HBED




CROPtech Kenya
Better Yields More Profit


Fe-o-o-EDDHA Fe-HBED



# Soybean trial – in plots

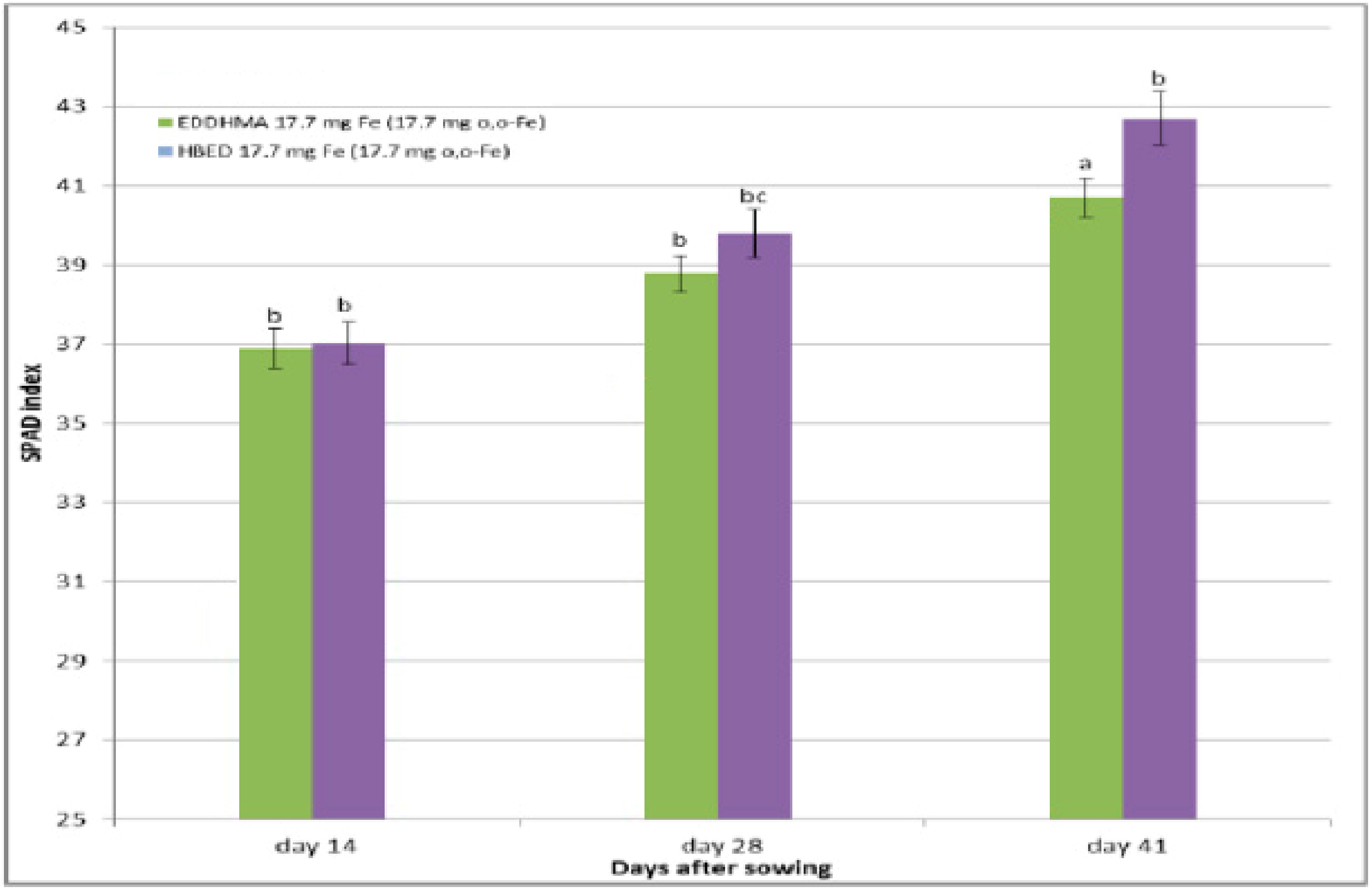
- Soil from Spain (pH 8, high $CaCO_3$, clay).
- 2 o-o-chelates: EDDHMA y HBED

WAGENINGEN UNIVERSITY
WAGENINGEN UR

CROPtech Kenya
Better Yields More Profit

Naturquel® Fe Evolution

# SPAD-Index for high Fe concentration treatment



# Efficacy of HBED/Fe3+ at supplying iron to Prunus persica in calcareous soils, **Lucena et al., 2013**

- Trial 1. Fe chlorosis prevention
  - Nectarine Zephyr
  - Treatments:
    - Control
    - Orto-orto EDDHA 0,90 g/tree of Fe chelated
    - HBED 0,90 g/tree of Fe chelated
    - HBED 0,45 g/tree of Fe chelated
  - Total dose was dividied into 3 aplications: enf of march (50% of total dose), end of may (30% of total dose) and end of october (20% dose).
- Chelates were directly injected into the soil below the drip irrigation emitter approximately 5 cm deep to avoid the photodecomposition of the chelates.
- Each treatment were replicated 8 times in a completely randomised design layout.

# Efficacy of HBED/Fe3+ at supplying iron to Prunus persica in calcareous soils, **Lucena et al., 2013**

- To compare the lasting effect of the chelates EDDHA/Fe3+ and HBED/Fe3+, the average Fe uptake per leaf and per day has been calculated as the difference in cumulative Fe uptake of the same treatment in each sampling time

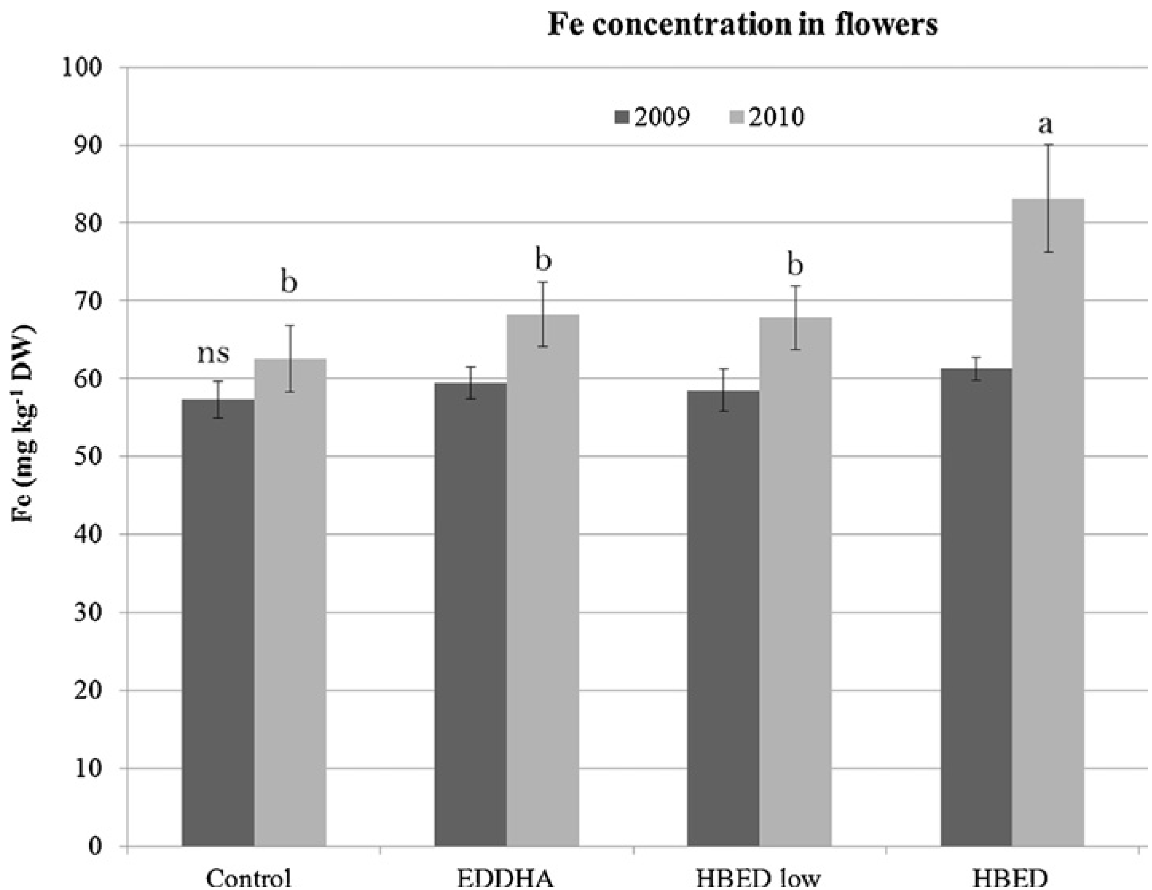
| (0-29 days after the first iron chelate application) | (29-65 days after the first iron chelate application) |
|---|---|
| EDDHA 8% more than HBED | HBED 11% more than EDDHA |

# Efficacy of HBED/$Fe^{3+}$ at supplying iron to Prunus persica in calcareous soils, **Lucena et al., 2013**

- 30 flowers per tree were collected after the treatment application to assess the storage of Fe during the previous season.

- Abadía et al. (2000) reported that most Fe present in the flower at blossom is already present in the peach tree during its dormancy. This observation suggests that the flower Fe concentration (and possibly Fe in winter buds) might be used to assess the storage of Fe during the previous season.

# Efficacy of HBED/$Fe^{3+}$ at supplying iron to Prunus persica in calcareous soils, **Lucena et al., 2013**




Data obtained in 2009 didn't show differences. However in 2010, as consequence of accumulation of 2 years, the highest Iron concentration in flowers was obtained with HBED.

# Efficacy of HBED/$Fe^{3+}$ at supplying iron to Prunus persica in calcareous soils, **Lucena et al., 2013**

- Trial 2. Fe chlorosis correction.
  - Flat peach Sweet Cap
  - Location: Ricla (Zaragoza)
- Chlorosis symptoms were evident at the beginning of the experiment due to an excess of irrigation that increased the chlorosis symptoms.
  - Treatments:
    - Control
    - EDDHA 0,90 g/tree of Fe chelated
    - HBED 0,90 g/tree of Fe chelated
  - Applied in 1: 12/06/2008
  - Chelates were directly injected into the soil below the drip irrigation emitter approximately 5 cm deep to avoid the photodecomposition of the chelates.

Daymsa
Europe's leading producer of Leonardite

# Nuevos agentes quelantes

HBED/$Fe^{3+}$ — Control -Fe — EDDHA/$Fe^{3+}$

**Photo** Visual aspect of the trees at August the 14th (63 days after the treatment application)

## HBED, Nectarina, Ensayo de recuperación



CROPtech Kenya
Better Yields More Profit

Naturquel® Fe Evolution

Daymsa
Europe's leading producer of Leonardite

# Conclusions

- Unique mixture of Fe-HBED and Fe-EDDHA: Two chelating agents of high efficacy: EDDHA and HBED
- Higher action spectrum: Combines speed of EDDHA with speed and long lasting effect of HBED.
- This higher longevity permits to increase the iron storage at the end of Winter and, therefore, a better quality of budbreak and flowering.


CROPtech Kenya
Better Yields More Profit

Naturquel®Fe Evolution

**THANK YOU VERY MUCH FOR YOUR ATTENTION**