

Comparative testing of natural and synthetic Fe-compounds in regenerating Fe-deficient plants

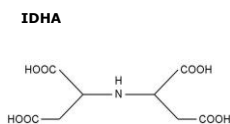
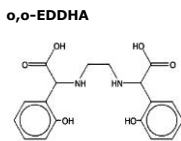
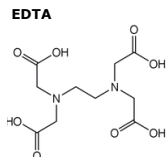
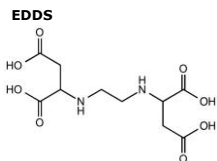
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Background



Fe-fertilizers

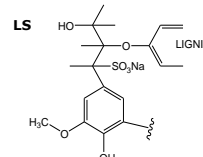
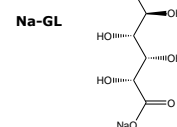
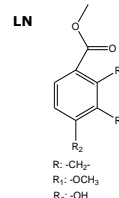
synthetic Fe-chelates

- stable in wide pH range
- not degradable
- expensive
- E.g. EDTA, EDDS*, EDDHA (Yunta et al. 2003), IDHA* (Lucena et al. 2008).

* biodegradable

natural Fe-complexes

- low stability
- biodegradable
- cheap (by products)
- E.g. lignosulfonates, leonardite, gluconates. (Carrasco et al., 2012, Kovács et al. 2013)



Objectives and Methods

Testing several natural Fe-complexes – Fe(III)-GL, Fe(III)-LN, Fe(III)-LS-Euc, Fe(III)-LS-Spr – as compared to synthetic chelates – Fe(III)-EDDHA, Fe(III)-IDHA, Fe(III)-EDDS, Fe(III)-EDTA –

Fe Application in: **nutrient solution:** 20 μM Fe-compound, **foliar spray:** 5 mM Fe-compound (inefficient) model plants.

Measuring:

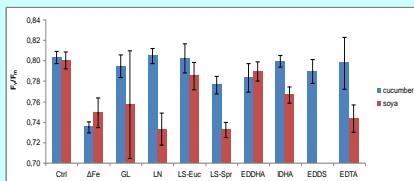
- recovery of Fe-deficient plants (grown on Fe-free solution containing CaCO₃) (all plants were pregrown on 5 μM Fe-EDTA)
- uptake and incorporation of Fe: Fe content of chloroplasts, chlorophyll concentration,
- quantum efficiency of the photosynthetic apparatus (chlorophyll-a fluorescence induction).

Abbreviation

ctrl: control plant grown on 20 μM Fe-EDTA
ΔFe: Fe deficient plant
GL: gluconate
HSS: humic substances
LN: leonardite
LS: lignosulfonate
LS-Euc: LS-Eucalyptus
LS-Spr: LS-Spruce

EDDHA: ethylenediamine-N,N'-bis(2-hydroxyphenylacetate)
EDDS: ethylenediamine-N,N'-disuccinate
EDTA: ethylenediaminetetraacetate
IDHA: imidodisuccinate

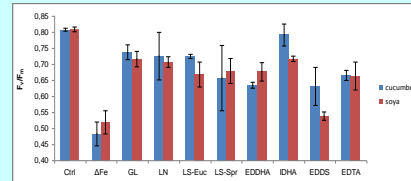
Results



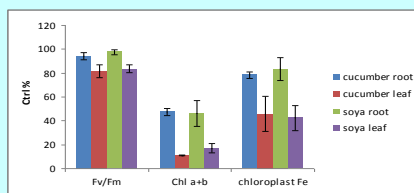
Maximal quantum efficiency (F_v/F_m) after one day of Fe resupply in nutrient solution in cucumber and soybean plants

Maximal quantum efficiency shows that all tested Fe-chelates and Fe-complexes applied in nutrient solution were very efficient in curing Fe chlorosis in cucumber. In soybean only Fe-LS-Euc, Fe-EDDHA and Fe-IDHA were efficient.

After applying the Fe-compounds in foliar spray both plants recovered, though the recovery was lower than at application in nutrient solution. In general, natural complexes were more efficient than synthetic ones, EDDS being the least efficient.



Maximal quantum efficiency (F_v/F_m) after one day of Fe resupply as foliar spray in cucumber and soybean plants

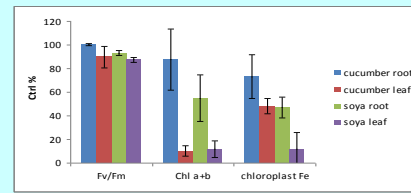


Recovery after one day of Fe resupply as Fe-EDDHA in nutrient solution and foliar spray

Chl a+b and chloroplast Fe content recovered much slower than F_v/F_m . Fe uptake from Fe-EDDHA and Fe-LN in foliar spray is similar but Fe-EDDHA is more efficient in nutrient solution for soybean.

The recovery of Chl a+b concentration generally followed that of Fe pools in chloroplasts. Chl a+b increased more rapidly after resupplying Fe-LN in nutrient solution in both plants compared to Fe-EDDHA.

The efficiency of Fe-LN is comparable with Fe-EDDHA or better in restoring physiological parameters in Fe deficient plants.



Recovery after one day of Fe resupply as Fe-LN in nutrient solution and foliar spray

Conclusions

- **Fe-complexes prepared from natural substances are equally efficient in restoring Fe-deficient plants as artificial Fe-chelates**
- **Application in nutrient solution is more efficient than application in foliar sprays.**
- **Fe-chelates are more efficient in nutrient solution for Fe-efficient plants**
- **Fe-complexes and Fe-chelates are equally efficient in foliar spray**

References

- ×Carrasco et al. (2012) J. Agric. Food Chem., 60: 3331-3340.
- ×Kovács et al. (2013) J. Agric. Food Chem. 61:12200-12210.
- ×Lucena et al. (2008) Agronomy J. 100:813-818.
- ×Yunta et al. (2003) Inorg. Chem. 42, 5412-5421.