Role of different N sources on Iron and Nitrogen interplay in tomato plants

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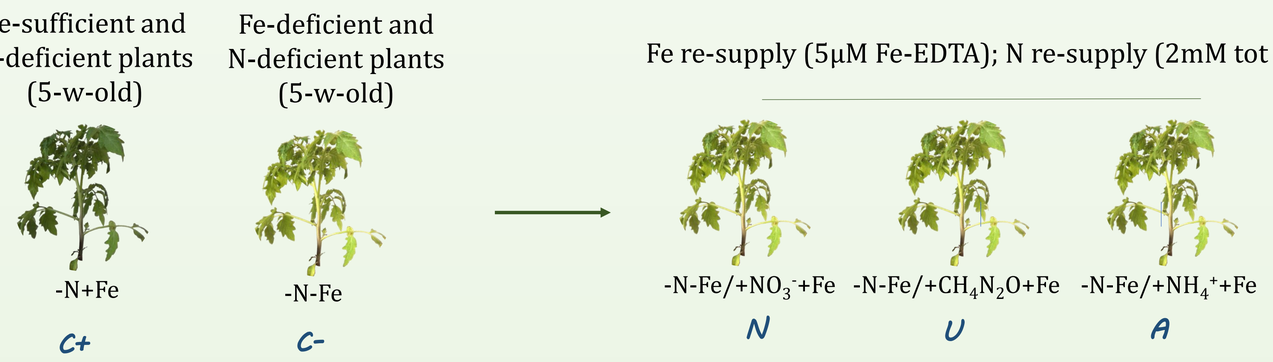
Introduction and aim

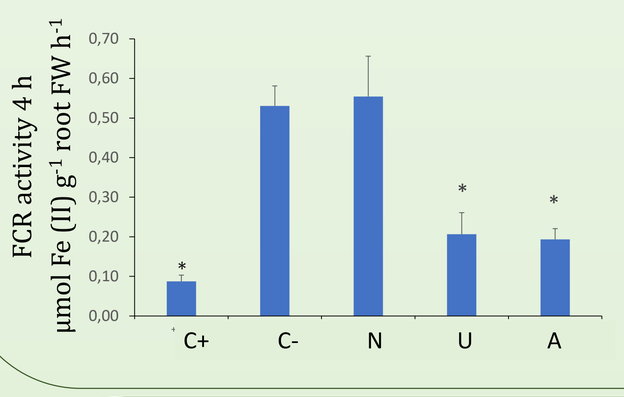
Iron (Fe) is one of the most abundant metal on the Earth's crust, but it is poorly bioavailable under aerobic and calcareous conditions. Nitrogen (N) is the most required macronutrient by plants, and it has the peculiarity to be acquired by plants in multiple forms. Iron and N availability are two widespread limiting factors for plant growth in agricultural fields as they are involved in innumerable physiological processes in living organisms and thus their poor bioavailability in soils frequently exerts a strong constraint on crop yield. Aim of the present work is to investigate the effects of different nitrogen sources (nitrate, N; ammonium, A; urea, U; 2mM total N supplied) on tomato plant capability to acquire Fe and the resulting changes in transcription and metabolism.

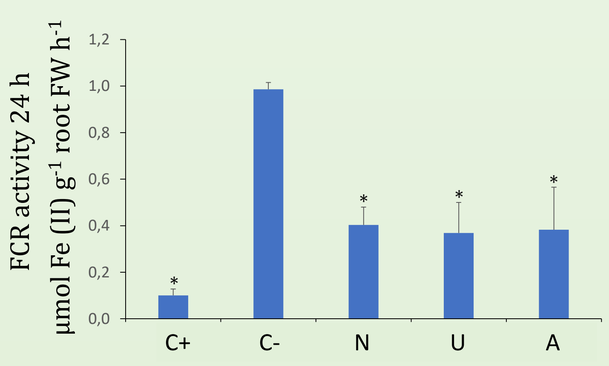
Experimental setting



Results

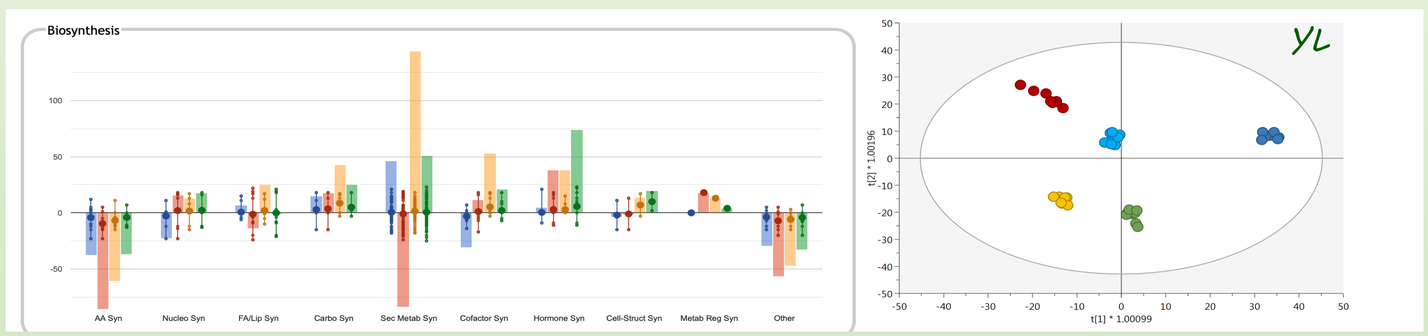
Fe III –chelate reductase activity evaluation (FCR) → Already 4 hours of Fe supply, the FCR activity of Fe-deficient plants slowed down if reduced nitrogen-forms were applied (U or A). While Fe resupply did not limit the FCR activity when N was applied (*referred to significant difference between each thesis vs –N-Fe; One way ANOVA, Holm-Sidak p<0.05, N=3) .



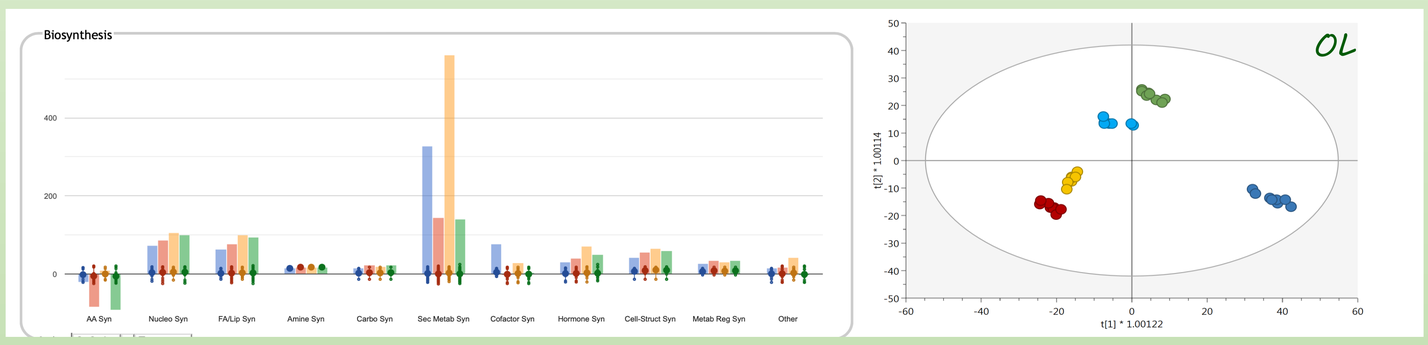


Metabolomic analysis → Biosynthetic pathways modulation and Orthogonal Projections to latent structures discriminant analysis (**OPLS –DA**)

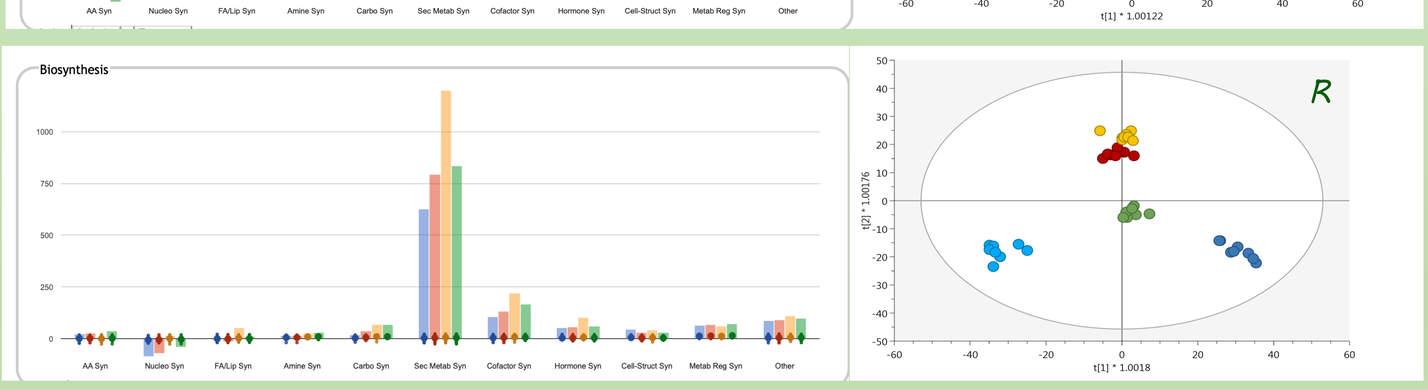
Young leaves



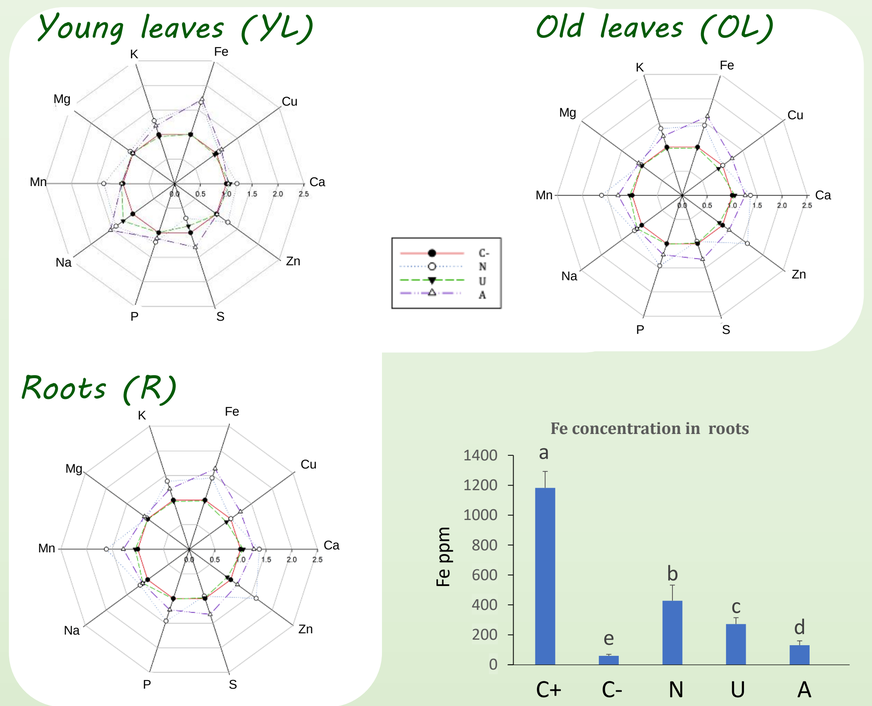
Old leaves



Roots

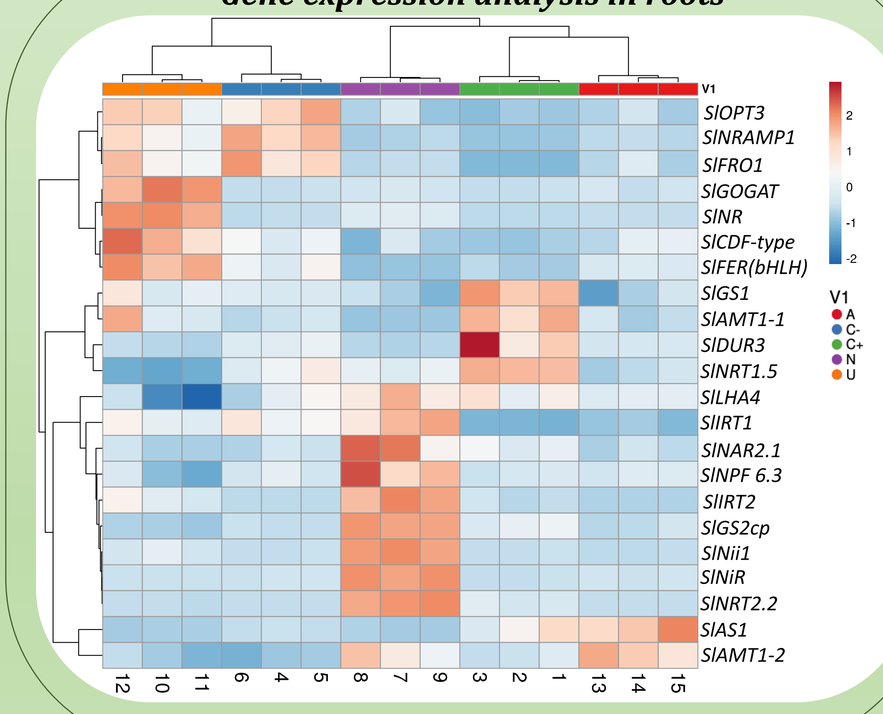


Ionomic analysis → Performed by ICP-OES and CHN-IRMS (C, Ca, Cd, Co, Cu, Fe, K, Mg, Mn, Mo, N, Na, P, S, Zn)



- N: increase of Mn and Zn concentration in YL and OL, of P in OL, and of Fe and Mg in R in comparison to A, U or C-.
- A: increase of S concentration in OL in comparison to N, U or C-.
- U: increase of Na concentration in OL, YL and R in comparison to C-

Gene expression analysis in roots



Conclusions

Ionomic profiles were influenced by applied nitrogen form, in general, mineral nutrients content was more modulated in Fe-deficient plants treated with N rather than reductive nitrogen forms or C-, while U seems to led to a higher accumulation of nutritional elements in Fe-sufficient ones in comparison to N, A or C+. FCR results were further supported by gene expression analysis results, that showed an increased expression of transporter genes that may explain the observed higher micronutrients content in plants treated with N in comparison to other nitrogen forms or C-. Moreover, metabolomic profiles were influenced by nitrogen treatment, and overall, nitrogen supply seems to promote the biosynthesis of secondary metabolites in all the considered vegetal organs. Obtained results and the ongoing molecular analyses will help to better define the interactions between nitrogen sources and iron acquisition that could give clues on how to improve the use efficiency of nitrogen and Fe in crops.