Nutrient deficiency symptoms and uptake relations in juvenile Hazelnut (*Corylus avellana*) in response to macro nutrient supply

Tommaso Barbagli, Wim Voogt,

WAGENINGEN
UNIVERSITY & RESEARCH

Mineral Nutrition Project

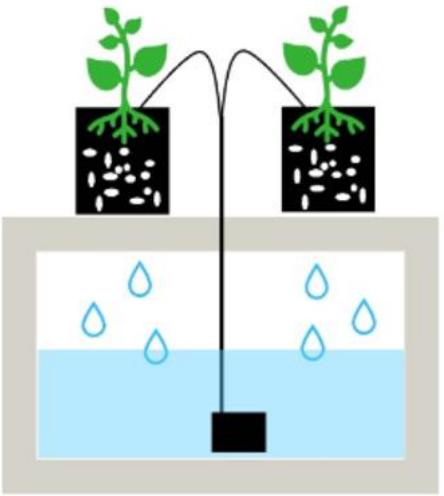
- Creation visual diagnostic guide that shows macronutrients deficiencies on *C. avellana* juvenile plants
- Recording of macro-nutrient uptake of juvenile *C. avellana*
- Reference data for mineral tissue content

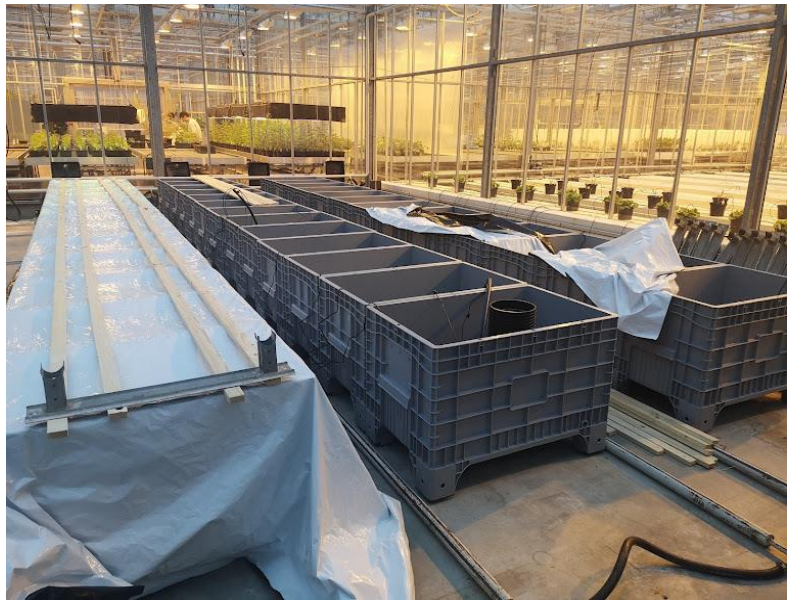
FHCo
FERRERO Hazelnut Company

WAGENINGEN
UNIVERSITY & RESEARCH

Material and methods

- Nutrient solutions with 50 % and 100 % reduction of macro nutrients
- Plants in 10 l. container, with fine perlite
- 13 Treatments: 3 replicates, 3 plants
- Drip irrigation, high drainage rate, recycling
- Greenhouse conditions Wageningen (NL) feb-’21 – June ‘21





WAGENINGEN
UNIVERSITY & RESEARCH

Treatments table

Treatment Code	N	P	K	Ca	Mg	S
1	+	+	+	+	+	+
2	50%	+	+	+	+	+
3	+	50%	+	+	+	+
4	+	+	50%	+	+	+
5	+	+	+	50%	+	+
6	+	+	+	+	50%	+
7	+	+	+	+	+	50%
8	-100 %	+	+	+	+	+
9	+	-100 %	+	+	+	+
10	+	+	-100 %	+	+	+
11	+	+	+	--100 %	+	+
12	+	+	+	+	-100 %	+
13	+	+	+	+	+	-100 %

How its done

Treatments																				
							ratios mmol/mmol							sum me/L		concentration mmol/L							
	N	P	K	Ca	Mg	S	Ca/Mg	K/Mg	K/Ca	N/S	N/P	S/P	E K	Cations	Anions	NH4	K	Ca	Mg	NO3	Cl	SO4	P
Ref	+	+	+	+	+	+	2.31	2.08	0.90	28.7	11.4	0.4		14.95	14.95	***1.36***	***3.25***	***3.61***	***1.56***	***12.92***	***0***	***0.45***	***1.13***
50 % N	-	+	+	+	+	+	2.31	2.08	0.90	4.6	2.7	0.6		14.95	14.95	1.36	3.25	3.61	1.56	6.46	3.29	1.40	2.40
ze																							

Fe	Mn	Zn	B	Cu	Mo
31.63	***18.07***	***6.78***	***31.63***	***1.36***	***0.45***

WAGENINGEN
UNIVERSITY & RESEARCH

Measured parameters

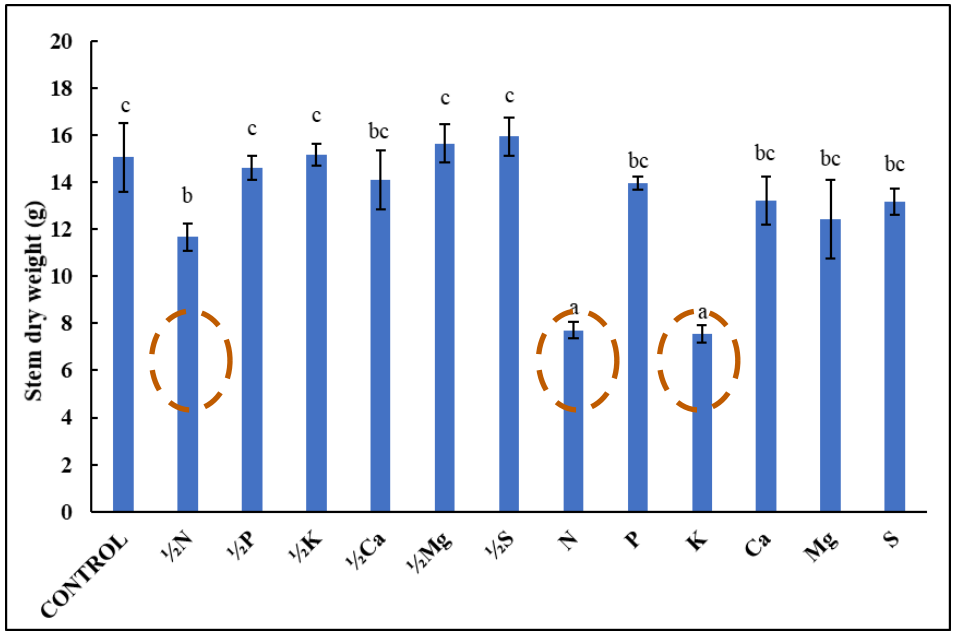
- Fresh/Dry weight of plants at the start and the end of experiment.
- Nutrient content of plants at the start and the end of experiment.
- Amount of nutrient solution at the start and the end of experiment.
- Nutrient content of of nutrient solution at the start and the end of experiment.

Systematic gathering of RGB images

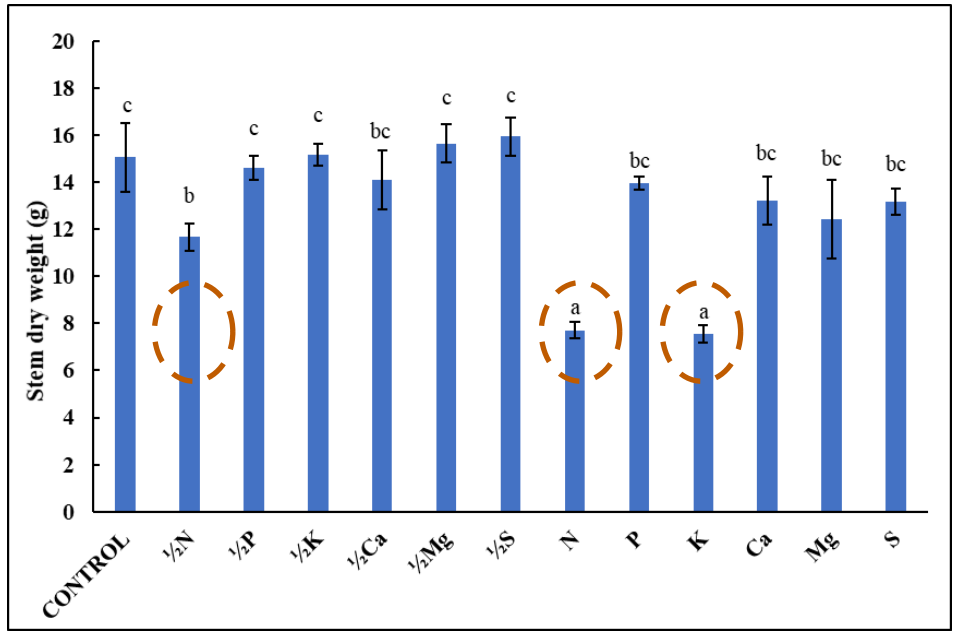
- The Robin PSI PlantScreenTM system
- DSLR Digital Camera
- Approx every 2 weeks – ALL PLANTS

Date of Photos (Treatment started on 15th/17th of march)
6 April
21 April
29 April
14 May
27 May
07 June

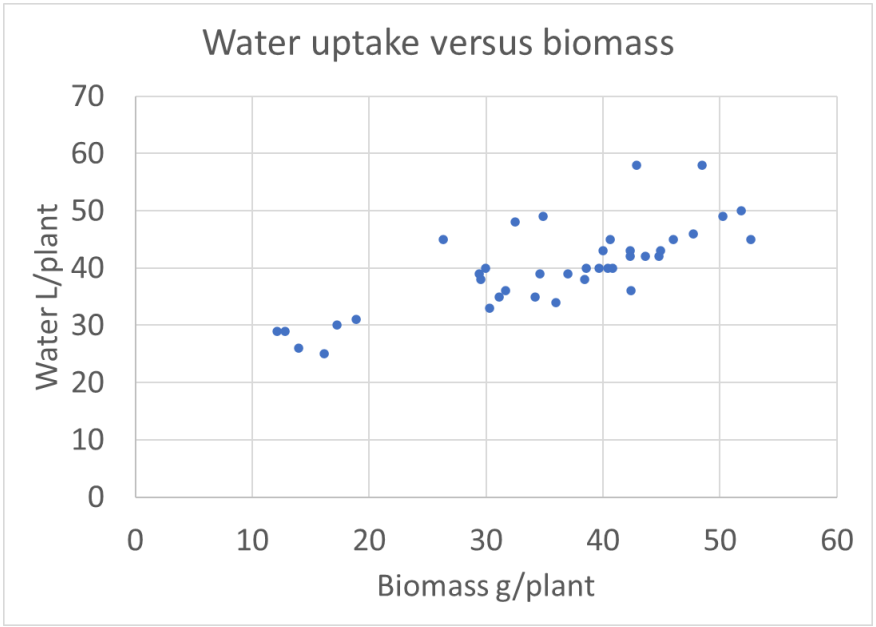
Results biomass



Dry weight of leaves



Dry weight of stems



WAGENINGEN
UNIVERSITY & RESEARCH

Nutrient deficiencies

Reference plant

Next slides:

Characteristics

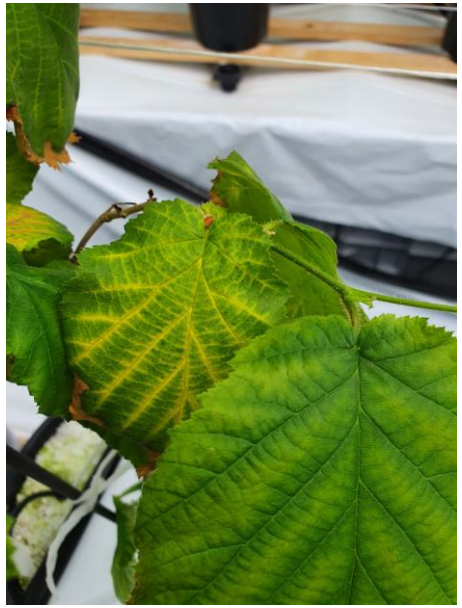
- Symptoms where ?
- First symptoms
- secondary symptoms
- Typical phenomena
- Performance of 50 % treatments

WAGENINGEN
UNIVERSITY & RESEARCH

Nitrogen (N)

Characteristics

- Symptoms in all leaves
- First: older leaves become yellowish, from leaf margin to inside
- Later: discoloration progressive, also younger leaves, typical chlorosis, green veins.
- Necrosis at leaf margins, eventually leaf senescence
- Very strong growth reduction
- 50 % same but less extreme

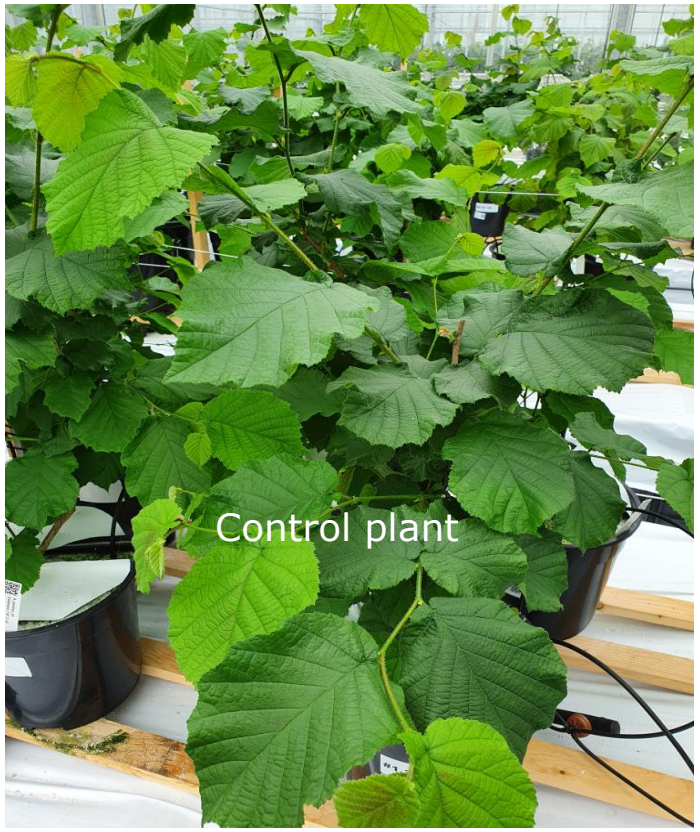



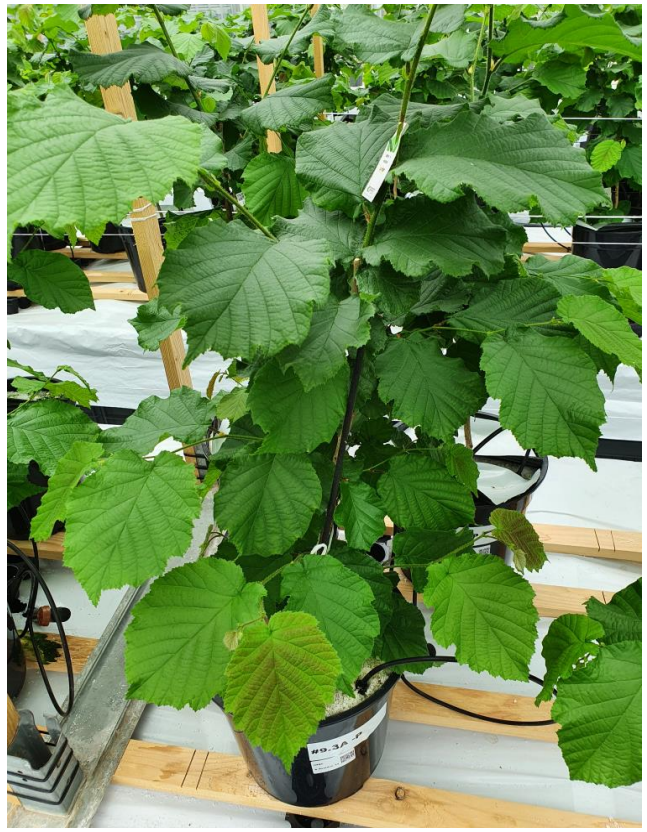


Phosphorous (P)

Characteristics

- No symptoms appeared
- Some anthocyanosis, but not specific in the –P treatments
- Growth slightly reduced
- 50 % no symptoms





Purple colouring (anthocyanine)

Occurring at low P

But also at other treatments

Indicator of stress ?

WAGENINGEN
UNIVERSITY & RESEARCH

Sulfur (S)

Characteristics

- Symptoms in young and old leaves
- First: very light chlorosis in top leaves
- Older leafs turned pale green
- Complete plant more light green
- Not easy to distinguish
- Growth slightly reduced
- 50 % hardly symptoms

WAGENINGEN
UNIVERSITY & RESEARCH

Potassium (K)

Characteristics

- Symptoms in old leaves
- First: brown/reddish intravenous necrotic spots
- Later: discoloration, yellowing of leaves, necrotic spots turned into nectrotic stripes
- Very poor growth
- Young leafs no symptoms
  but smaller size
- 50 % no symptoms

WAGENINGEN
UNIVERSITY & RESEARCH

Magnesium (Mg)





Characteristics

- Symptoms in old / mid leaves
- First: light chlorosis between veins, veins stay green
- Later: necrotic spots
- Eventually some leaf senescence
- Young leafs no symptoms
- No growth reduction
- 50 % no symptoms

WAGENINGEN
UNIVERSITY & RESEARCH

Calcium (Ca)

Characteristics

- Symptoms in young leaves only
- First: necrotic lesions at leaf margins in shoot tops
- Young leaves became ‘cupped’
- Necrosis in whole leaf : **tipburn**
- Growth slightly reduced
- 50 % less incidence symptoms

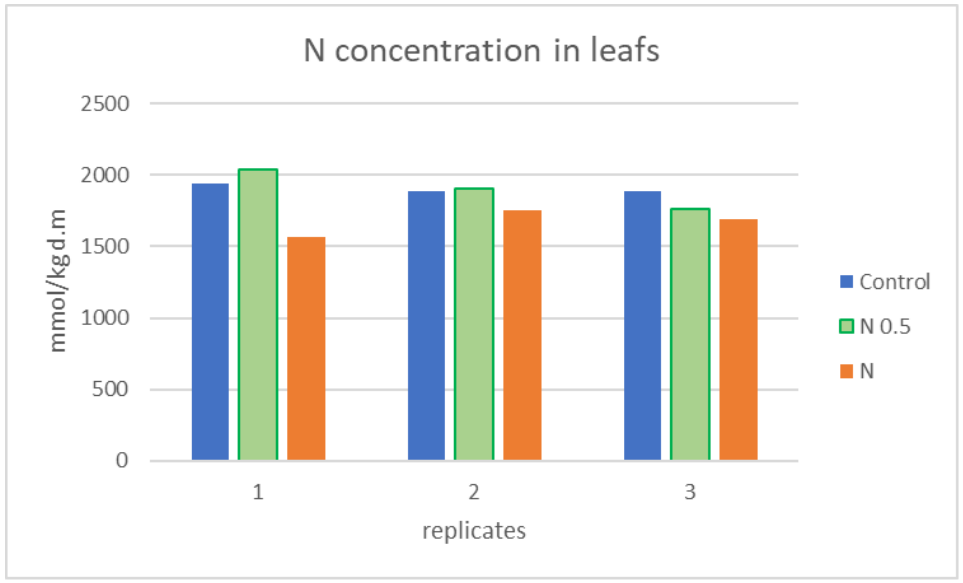
WAGENINGEN
UNIVERSITY & RESEARCH

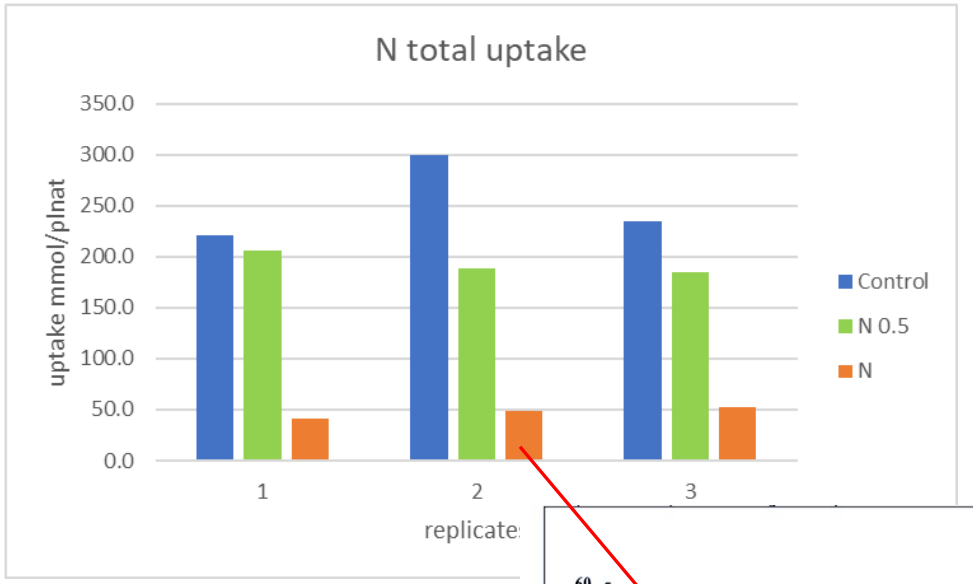
Note

- Anthocyanosis appeared in many plants, not only in P-treatments
- Tipburn appeared in many plants. Though 100 % in zero Ca.
  - Likely physiological disorder, quite common for greenhouse conditions
  - and outdoor also with excessive transpiration




Nutrient in plant material





!!! Be careful with Leaves analysis

Plants try to keep N in biomass constant
N-deficiency affect whole plant metabolism = growth

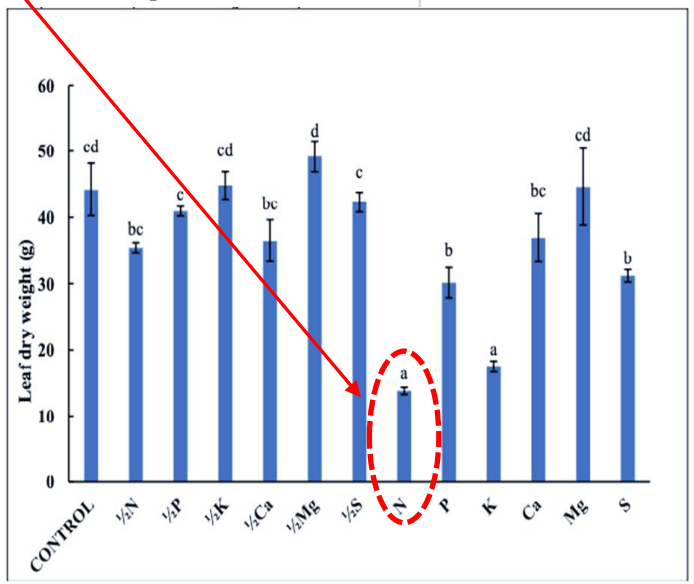
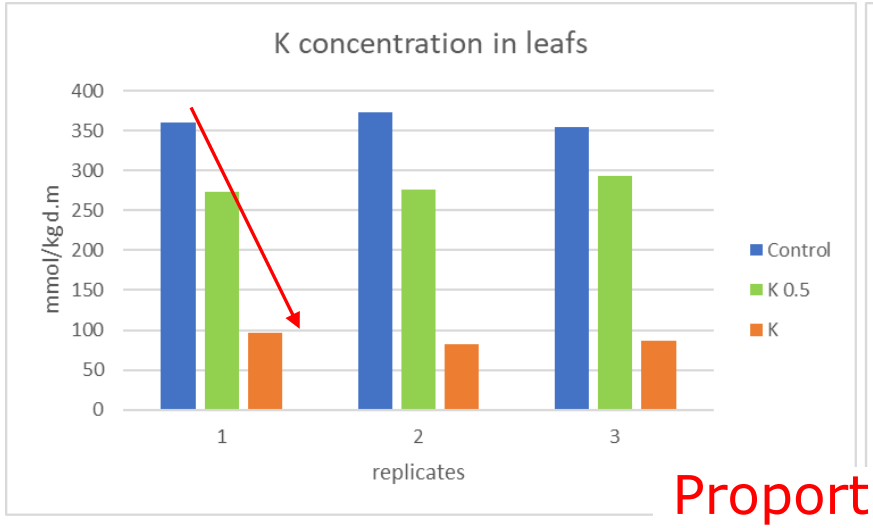
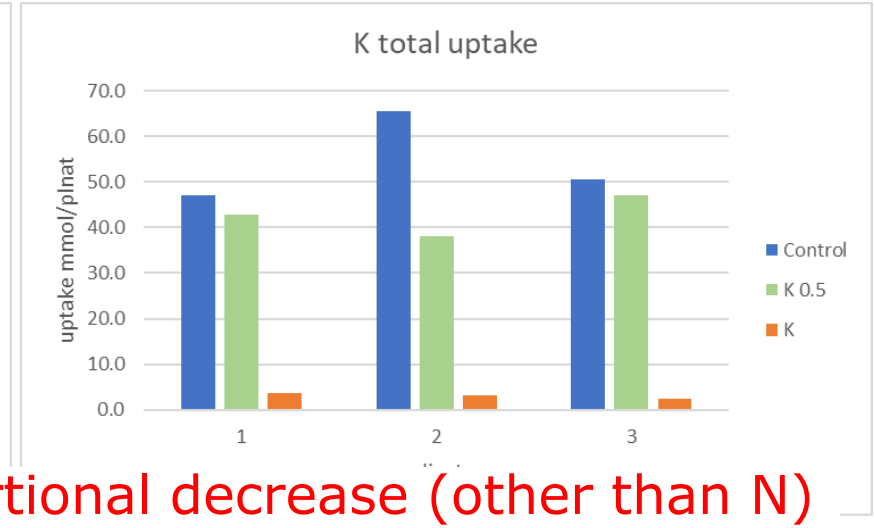


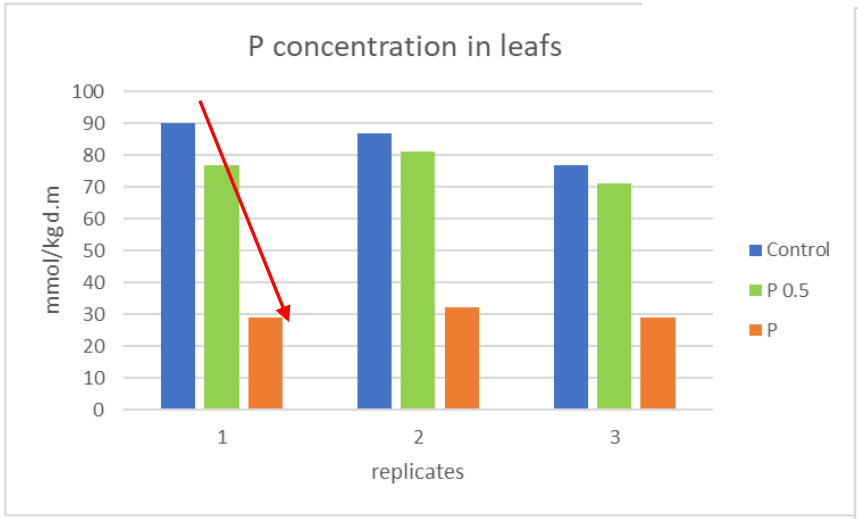
Figure 3.13. *Average dry weight of leaves at harvest of C. avellana plants under 13 nutrient treatments. Error bars represent SE (n=3). Different letters indicate significantly different means within treatments (P < 0.05).*

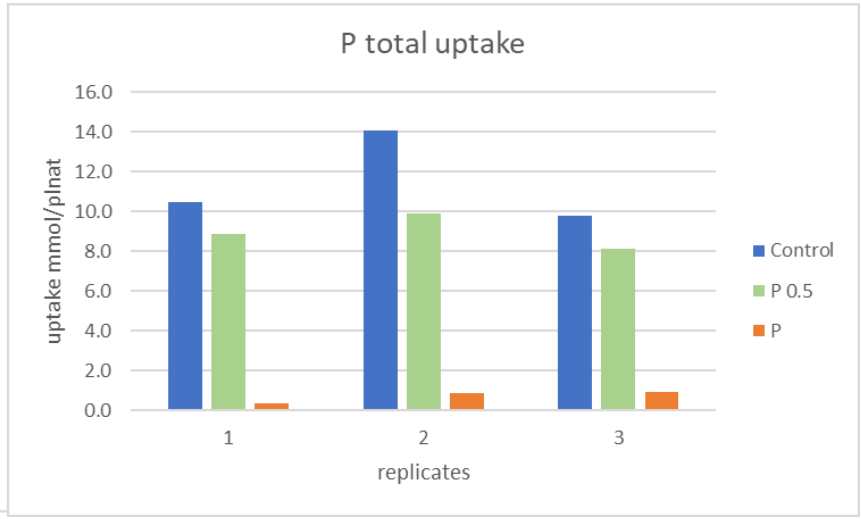
K and P in plant material





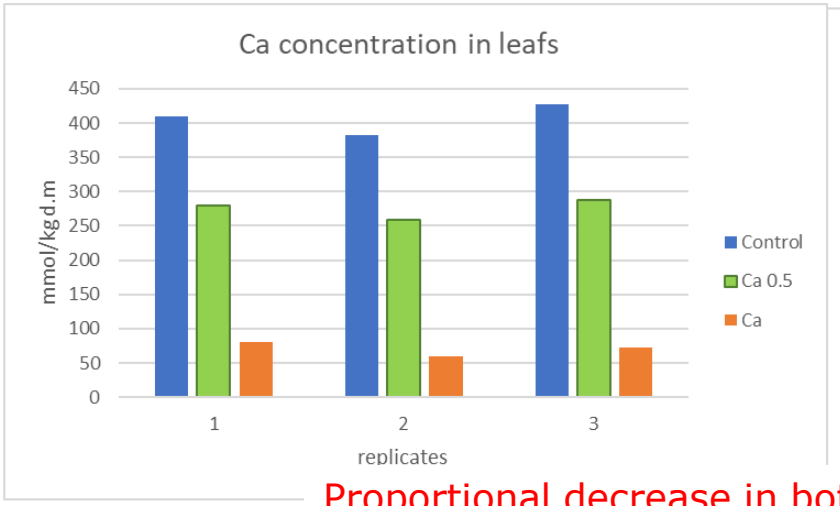
Proportional decrease (other than N)

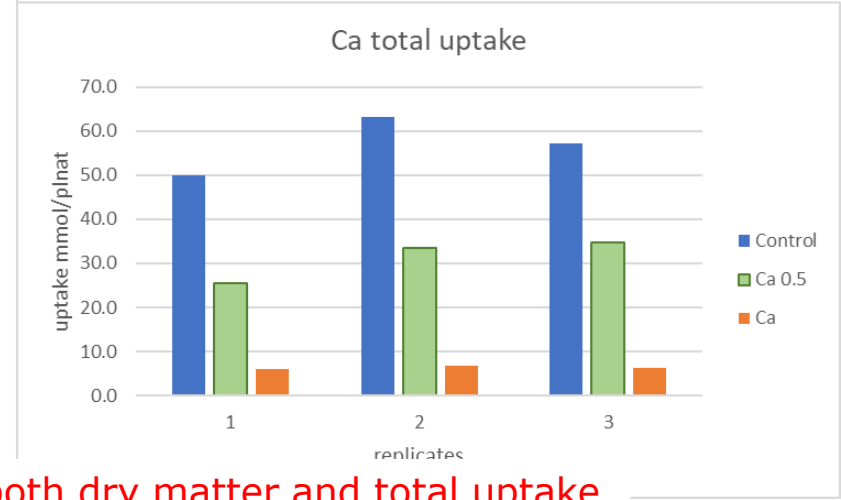




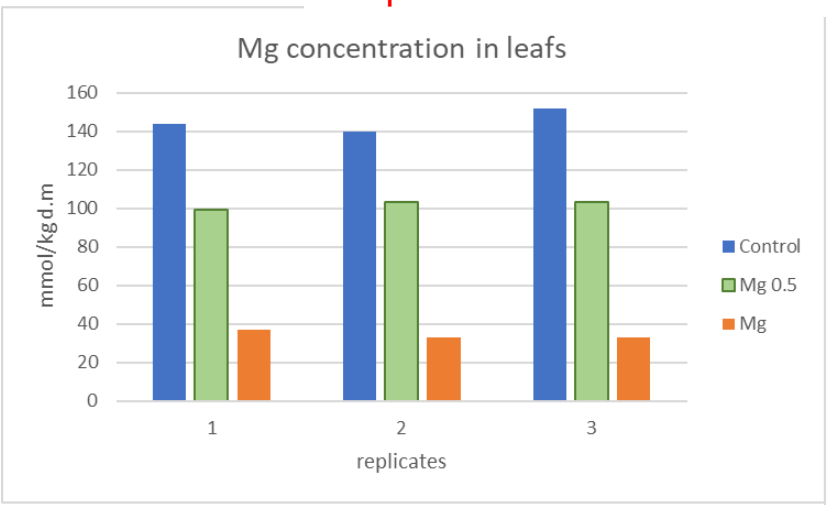
WAGENINGEN
UNIVERSITY & RESEARCH

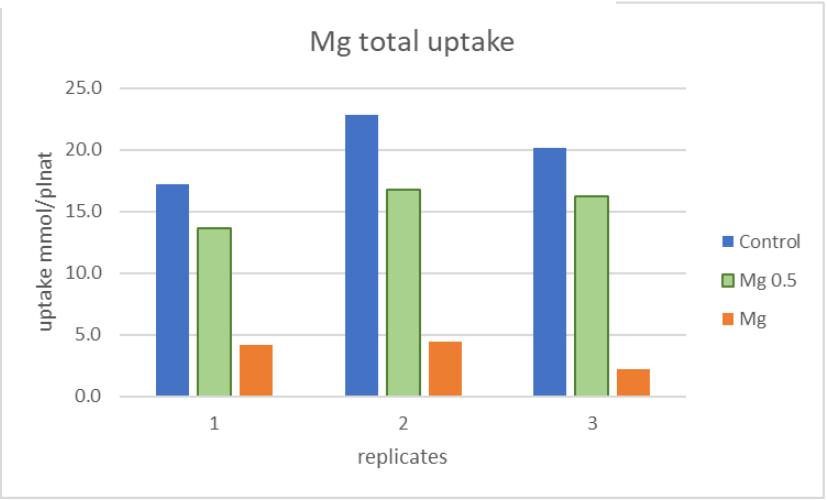
Ca and Mg in plant material





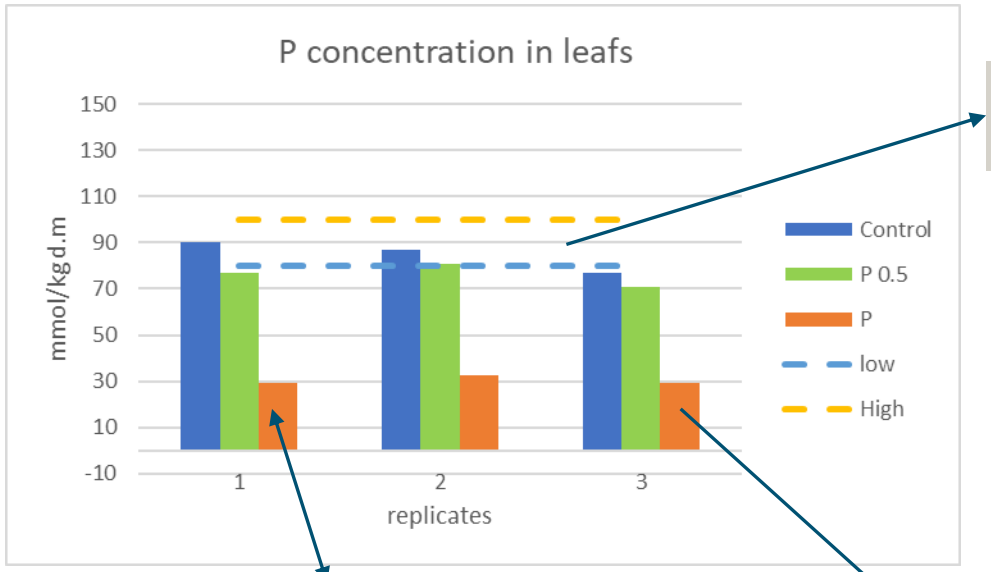
Proportional decrease in both dry matter and total uptake





WAGENINGEN
UNIVERSITY & RESEARCH

About P



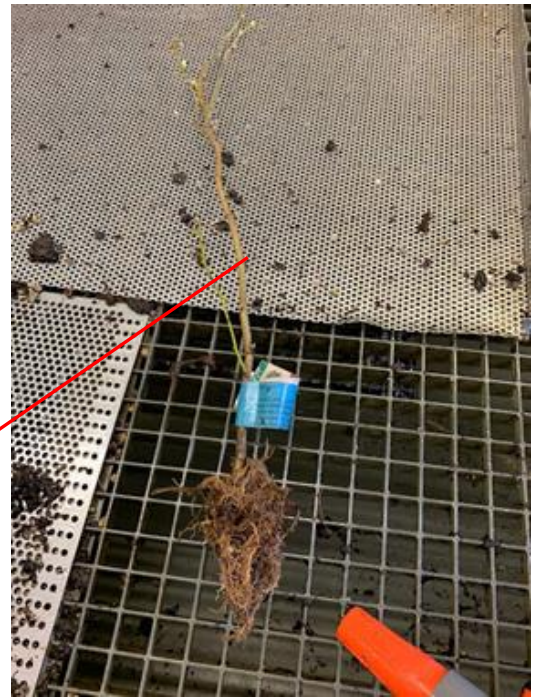
Ref data in Literature:
Özenç et al. (2009); Canalli et al. 2005; Miletic et al. 2001; Olsen, 2013

WHY NOT ?

No deficiency symptoms

Strong effect of the initial buffer in plant

23 % from total



WAGENINGEN
UNIVERSITY & RESEARCH

Discussion / conclusion

- N, K, Mg, S clear response to treatments – clear symptoms
- Ca – somewhat blurred by ‘physiological disorder effects’
- P- no symptoms, due to
    - Starting material (20 % in initial plant) ?
    - Overruled by growth reduction ?
    - Anthocyanin is a sign ?
- Uptake: K, Ca, Mg Cations:
    - Strikingly low K in tissue
    - Clear linear response, adaptation of cell concentration
- N
    - Symptoms, very strong response to supply
    - Plant growth strong reduced due to cell concentration

Eventually....


Atlas bolesti,
štetočina
i simptoma
nedostataka
hraniva
kod leske
AGRI SERBIA
kalijuma


AGRI SERBIA

Coming up next

Experiment with micro nutrients

- Two years:
- 1st year initiation (outside grown), Feb 2022
- 2nd year greenhouse (as macro nutrient trial), Feb 2023
- Both deficiency and toxicity
- Including Al
- Repeat P-deficiency

WAGENINGEN
UNIVERSITY & RESEARCH

Impression year 1

- Visible growth reduction in P
- Light chlorosis in Fe Mn

WAGENINGEN
UNIVERSITY & RESEARCH

Thanks for the attention

This project was made possible by financial support from Ferrero Hazelnut Company

Tommaso.Barbagli@wur.nl

WAGENINGEN
UNIVERSITY & RESEARCH