Ammonia Emission Measurements After Urea Fertilization on Different Soil Types

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BACKGROUND

2016: Directive (EU) 2016/2284 of the European Parliament:

national emissions of certain atmospheric pollutants must be reduced in all European countries

↓

- Ammonia emission must be reduced with 32% in Hungary compared to the 2005 base year
- This is one of the largest reduction obligation in the EU

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BACKGROUND

Agriculture is responsible for 95% of ammonia emissions


https://kepesujsag.com/wp-content/uploads/2021/06/10-11-lengyel-tehen-8.jpg


https://agrarium7.hu/data/kepek/0/eredeti/305.jpg

Reduction obligations cannot be achieved without more efficient use of organic and inorganic fertilizers and accurate measurement and assessment of the impact of different factors on NH_3 emissions

https://gazdamarket.cdn.shoprenter.hu/custom/gazdamarket/image/cache/w800h800wt1/Egyebek/genezis_karbamid_25_kg.png?lastmod=1675024052.1672832052

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BACKGROUND

2004 – experience with CO_2 emission measurements

2019 – experience with NO_2 emission measurements (Picarro G2508)

2020: Support from the Ministry of Agriculture → PICARRO G2103

COVID → difficulties, home office

2021: First NH_3 emission measurements with Picarro G2013

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FIRST STEPS – Laboratory experiments

Effect of urea fertilization on gaseous NH_3 losses in the case of:

- incorporation
- surface spreading
- usage of urease inhibitor

We used two different doses of urea fertilizer

- 150 kg ha-1 (N active agent)
- 180 kg ha-1 (N active agent)

and two different soil types

- sandy soil
- chernozem soil

At soil water content of pF2.3

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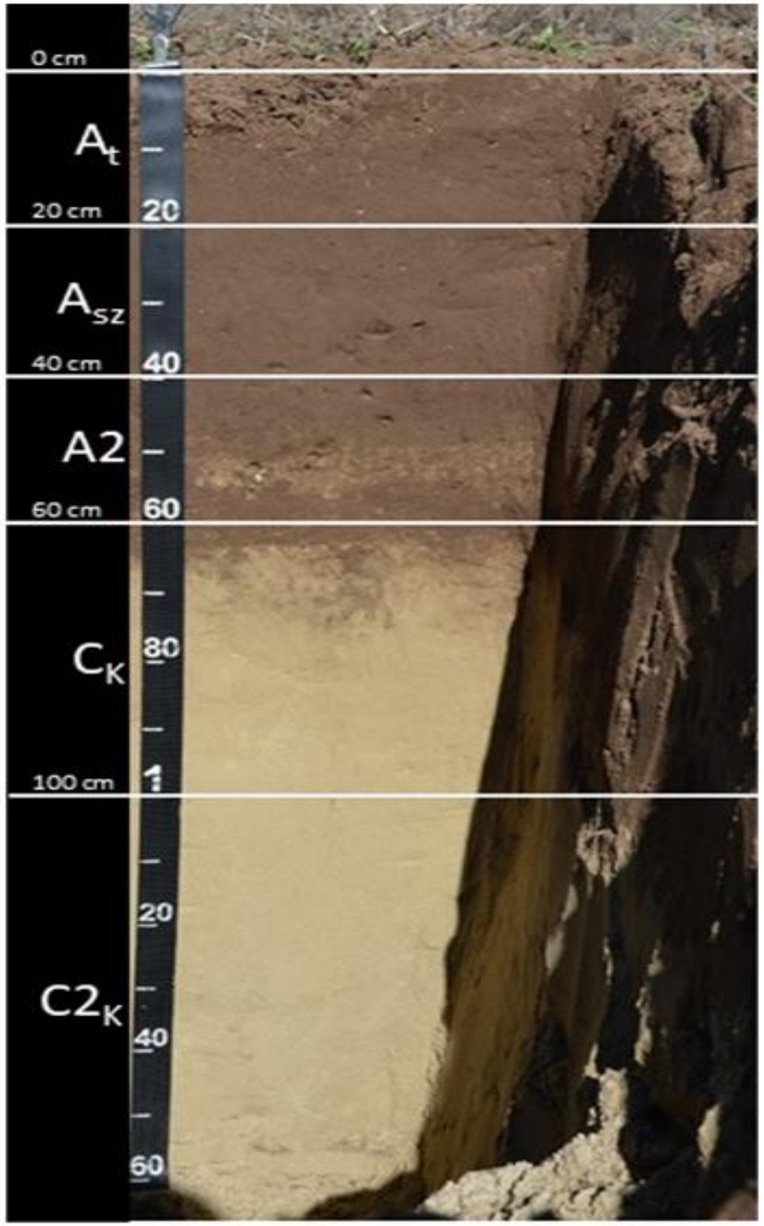

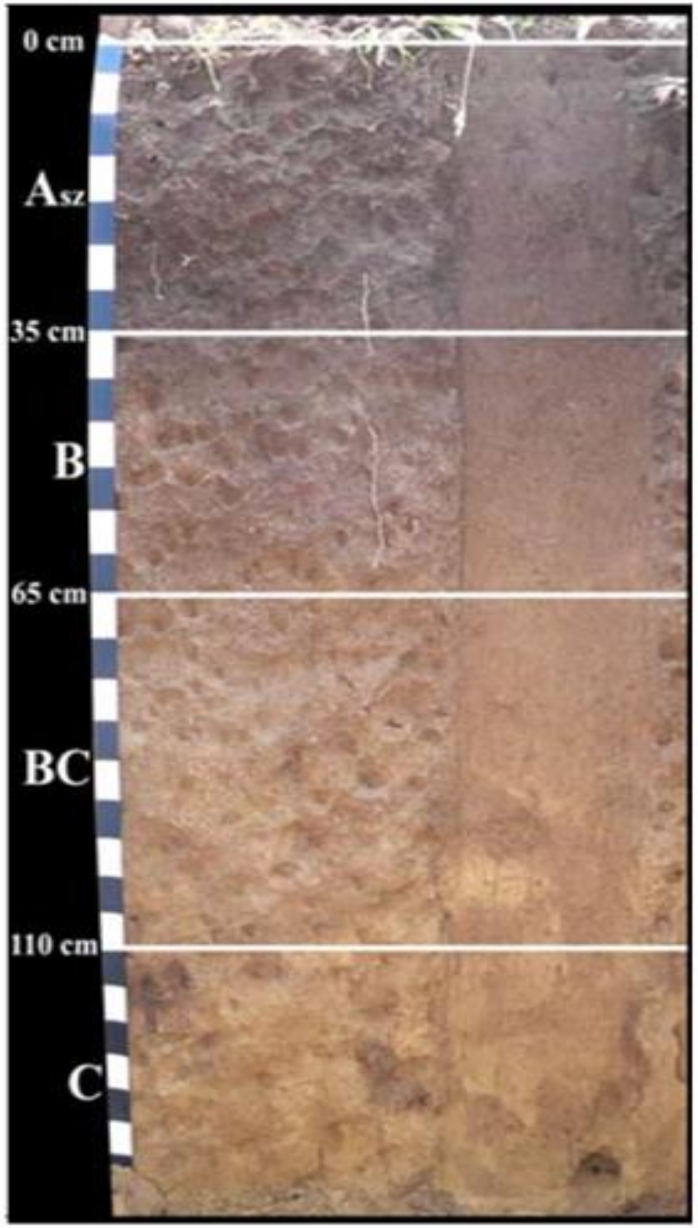

	Soil water content at pF 2.3
Sandy soil	14-16%
Chernozem soil	39-40%

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Treatment	Active Agent Nitrogen doses [kg ha^{-1}]	Fertilizer amount [g/ container]	Urease inhibitor	Type of fertilization
K	0, controll	0	no	-
150	150	3.04	no	Spread on surface
180	180	3.65	no	Spread on surface
150i	150	3.04	yes	Spread on surface
180i	180	3.65	yes	Spread on surface
150b	150	3.04	no	Incorporation at 10 cm depth
180b	180	3.65	no	Incorporation at 10 cm depth

NH_3 emission measurement:

- 0. day – before fertilization
- 12 times after fertilization during 3 weeks

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SECOND STEP– Microcosm experiment

Effect of urea fertilization on gaseous NH_3 losses in the case of:

- surface spreading
- usage of urease inhibitor

Treatment	Active Agent Nitrogen doses [kg ha^{-1}]	Fertilizer amount [g/ mesocosm]	Urease inhibitor	Type of fertilization
K	0, controll	0	no	-
150	150	6.92	no	Spread on surface
180	180	8.31	no	Spread on surface
150i	150	6.92	yes	Spread on surface
180i	180	8.31	yes	Spread on surface

NH_3 emission measurement:

- 0. day – before fertilization (2 weeks after sowing)
- 10 times after fertilization during 2 weeks
- the same methodologyafter the second fertilization event

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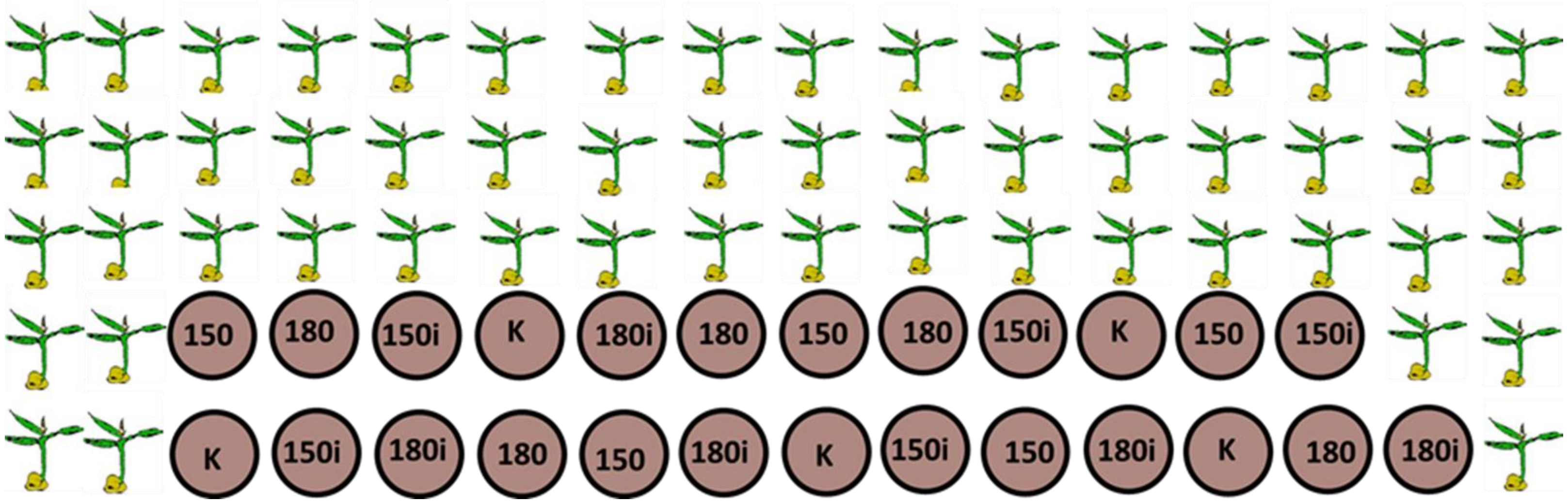

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THIRD STEP– Small plot experiment

Effect of urea fertilization on gaseous NH_3 losses in the case of:

- surface spreading
- usage of urease inhibitor

Treatment	Active Agent Nitrogen doses [kg ha^{-1}]	Fertilizer amount [g/ mesocosm]	Urease inhibitor	Type of fertilization
K	0, controll	0	no	-
150	150	6.92	no	Spread on surface
180	180	8.31	no	Spread on surface
150i	150	6.92	yes	Spread on surface
180i	180	8.31	yes	Spread on surface

NH_3 emission measurement:

- 0. day – before fertilization
- 11 times after fertilization during 2 weeks

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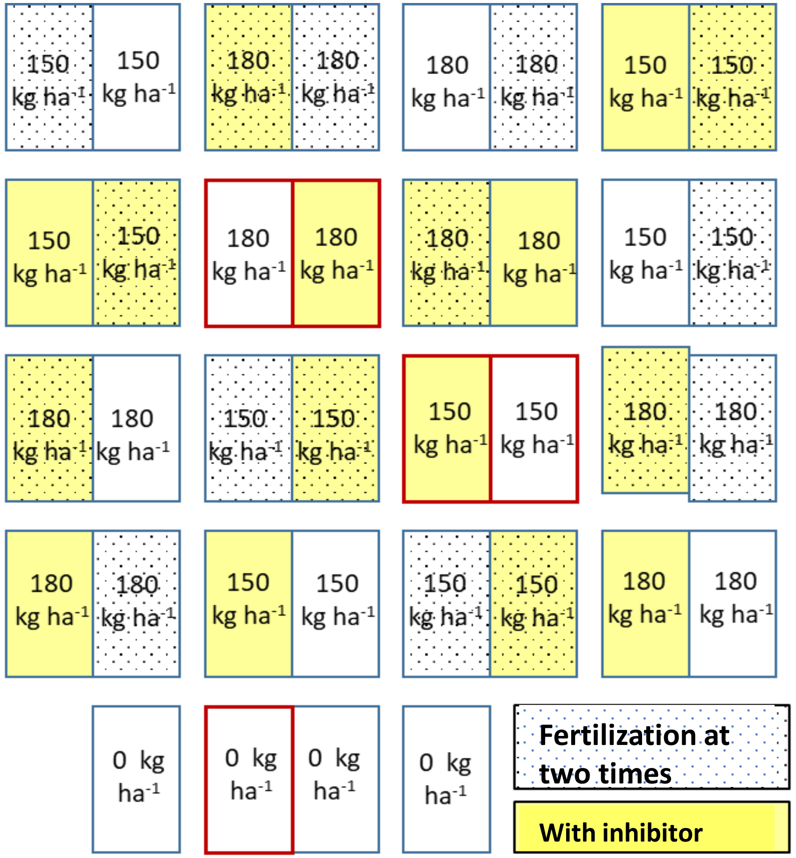

Plot size: 5m x 8 m

NH_3 emission measurement only in one from the five replicates (with the red lines)

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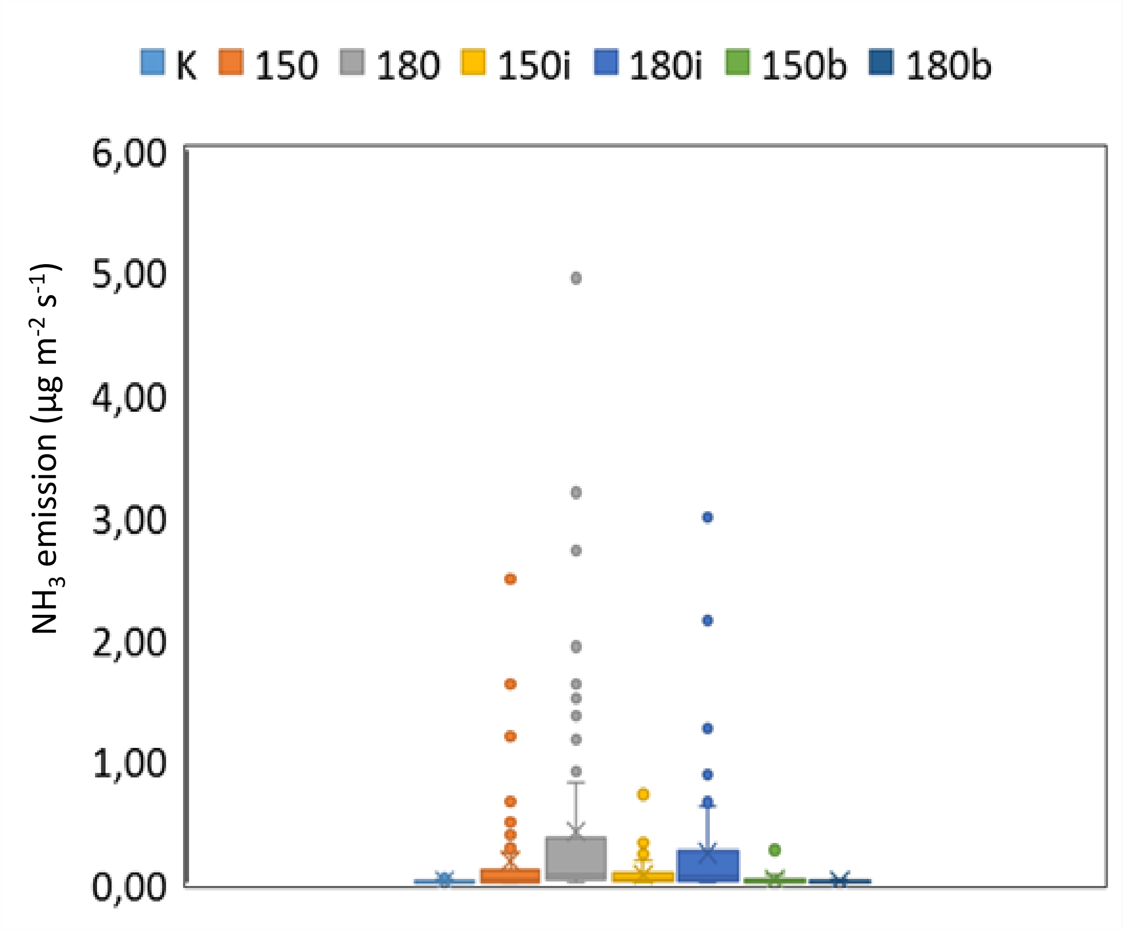
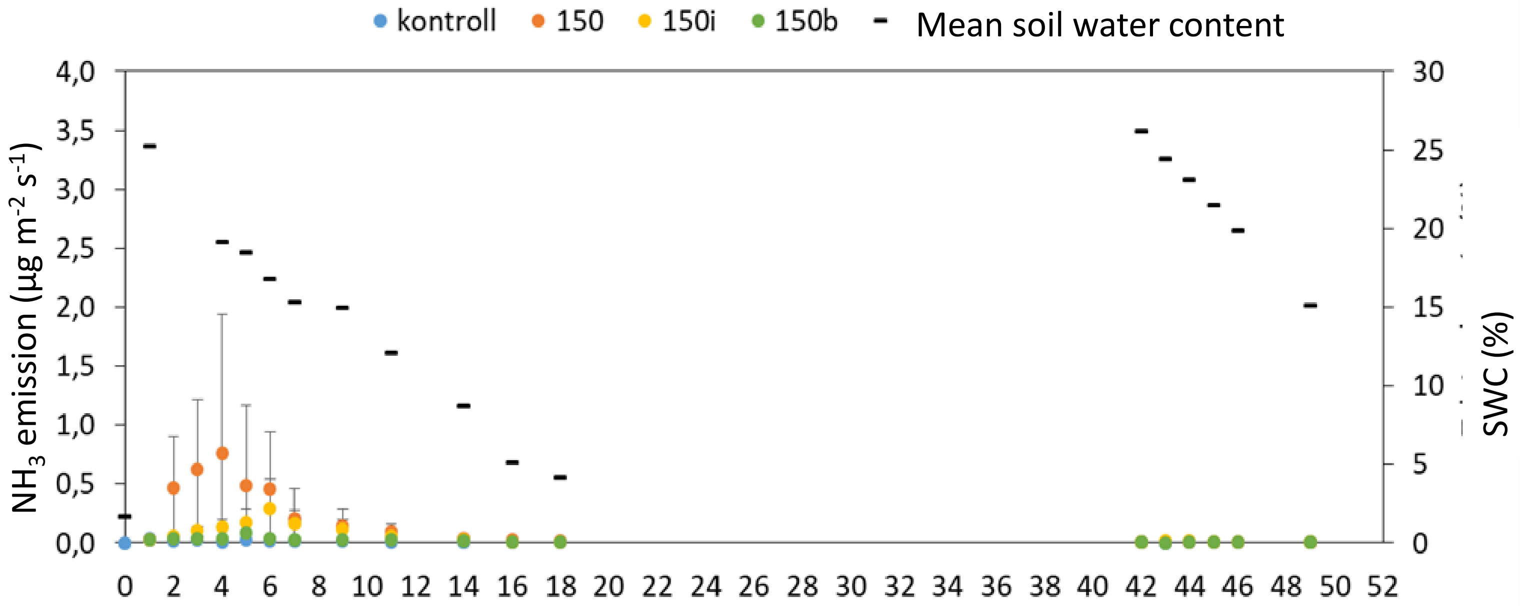
RESULTS – in laboratory

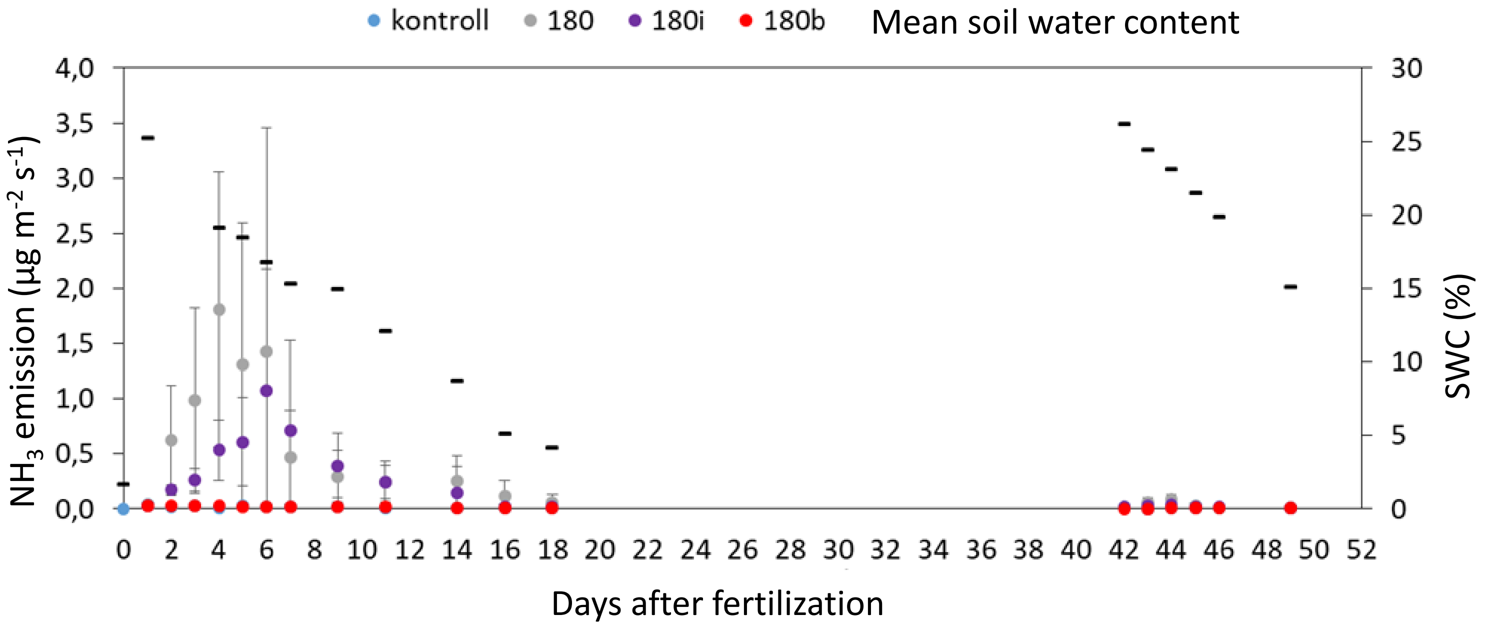


ON SANDY SOIL

- Highest emission in 180 and 180i treatment (with the highest doses)
- Lowest emission in the contoll (K) and the 150b and 180b treatment (where fertilizer was incorporated)
- We measured outstanding values (hot-spots) in all treatments

RESULTS – in laboratory





- 1st day: no big differences between NH3 emission
- 2nd day: elevated emission (not in the controll and the incorporated treatments)
- 4th day: highest emission in 150 and 180 treatment
- 6th day: highest emission in 150i and 180i treatment

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Soil average NH_3 emission (µg m^{-2} s^{-1})							
Treatment	Kontroll	150	180	150i	180i	150b	180b
Before fertilization	0,000± 0,000	-	-	-	-	-	-
After fertilization and irrigation	0,016± 0,011[c]	0,273± 0,474[ab]	0,616± 0,941[a]	0,100± 0,116[b]	0,355± 0,508[ab]	0,031±0,0 34[c]	0,020±0,0 09[c]
After the second irrigation	0,007± 0,004[c]	0,007± 0,004[bc]	0,035± 0,039[a]	0,012± 0,005[ab]	0,023± 0,021[a]	0,007±0,0 04[c]	0,006±0,0 05[c]
The whole period	0,013± 0,010[c]	0,184± 0,405[b]	0,420± 0,813[a]	0,071± 0,103[b]	0,243± 0,442[ab]	0,023±0,0 30[c]	0,016±0,0 10[c]

- NH_3 losses can be most effectivley reduced with the incorporation of the urea fertilizer
- 30 kg ha^{-1} inceasment in the active N agent significantly incresed NH_3 losses

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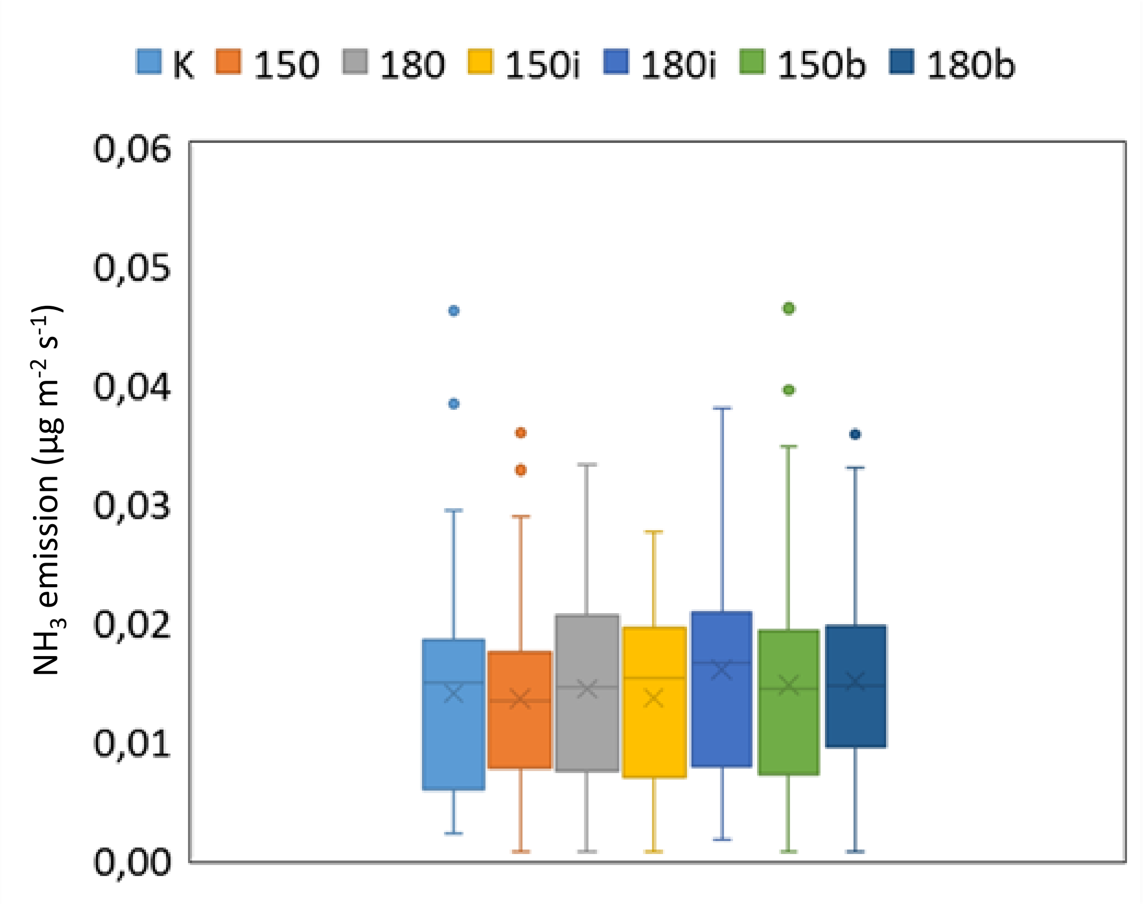
RESULTS – in laboratory



ON CHERNOZEM SOIL

- Highest emission in 180 and 180i treatment (with the highest doses) –but not significant
- Emission values were two orders of magnitude smaller than in sandy soil
- Lowest emission in the contoll (K) and the 150b and 180b treatment (where fertilizer was incorporated)
- We measured outstanding values (hot-spots) in all treatments

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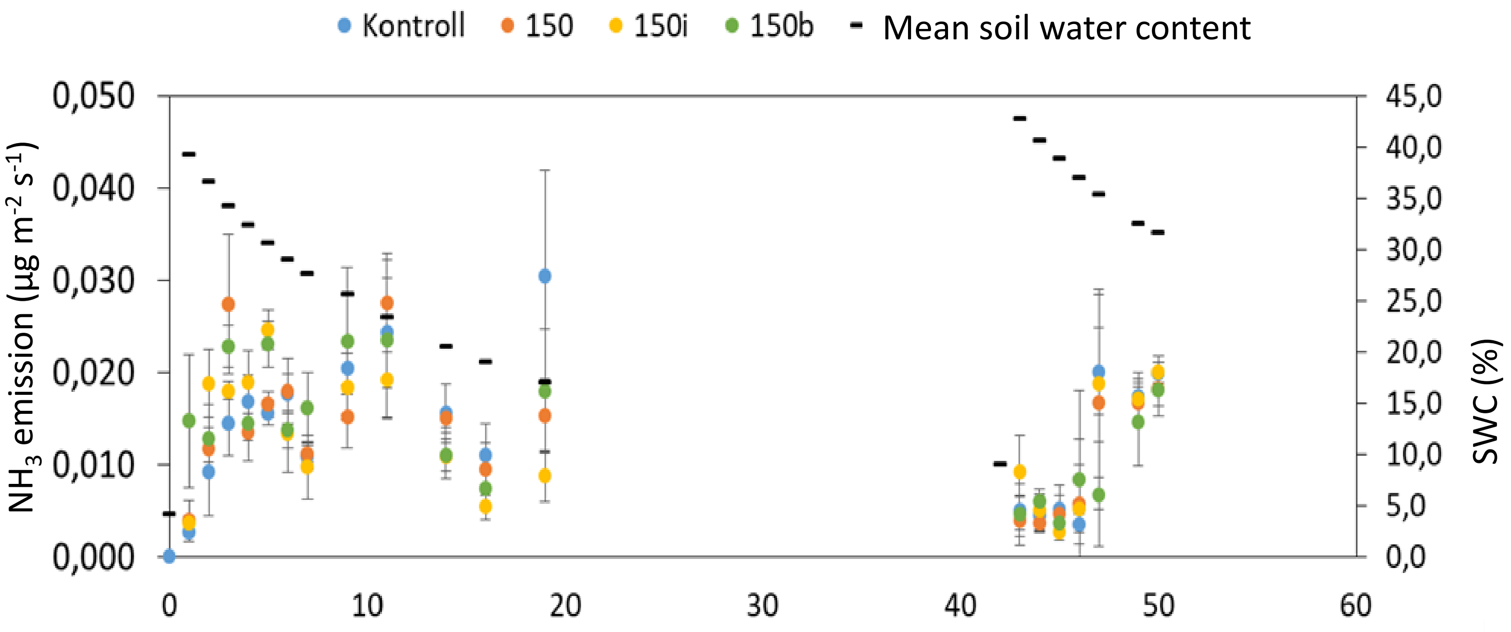
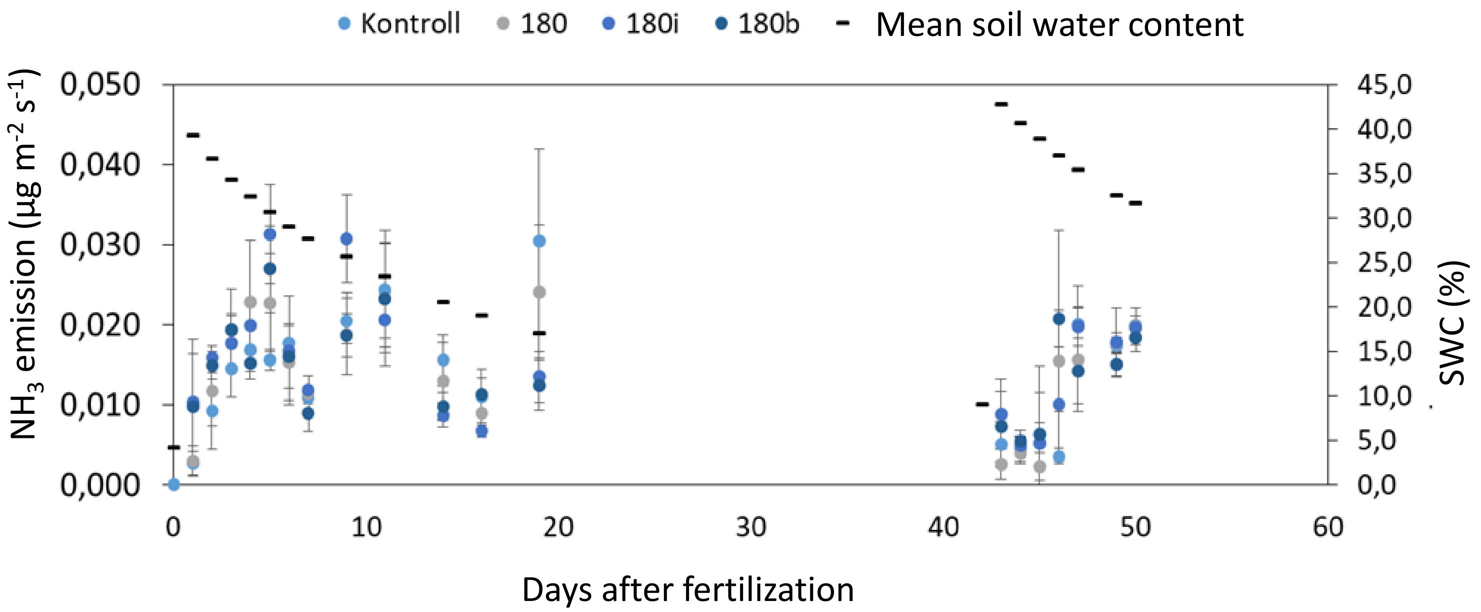
RESULTS – in laboratory





- No clear trends can be observed
- No higher emissions in the 180 or 180i treatments
- No lower emissions in the incorporated treatments
- ***Further laboratory experiments are needed on soils with different physical and chemical parameters (in pH, CEC, humus content) to evaluate the differences***

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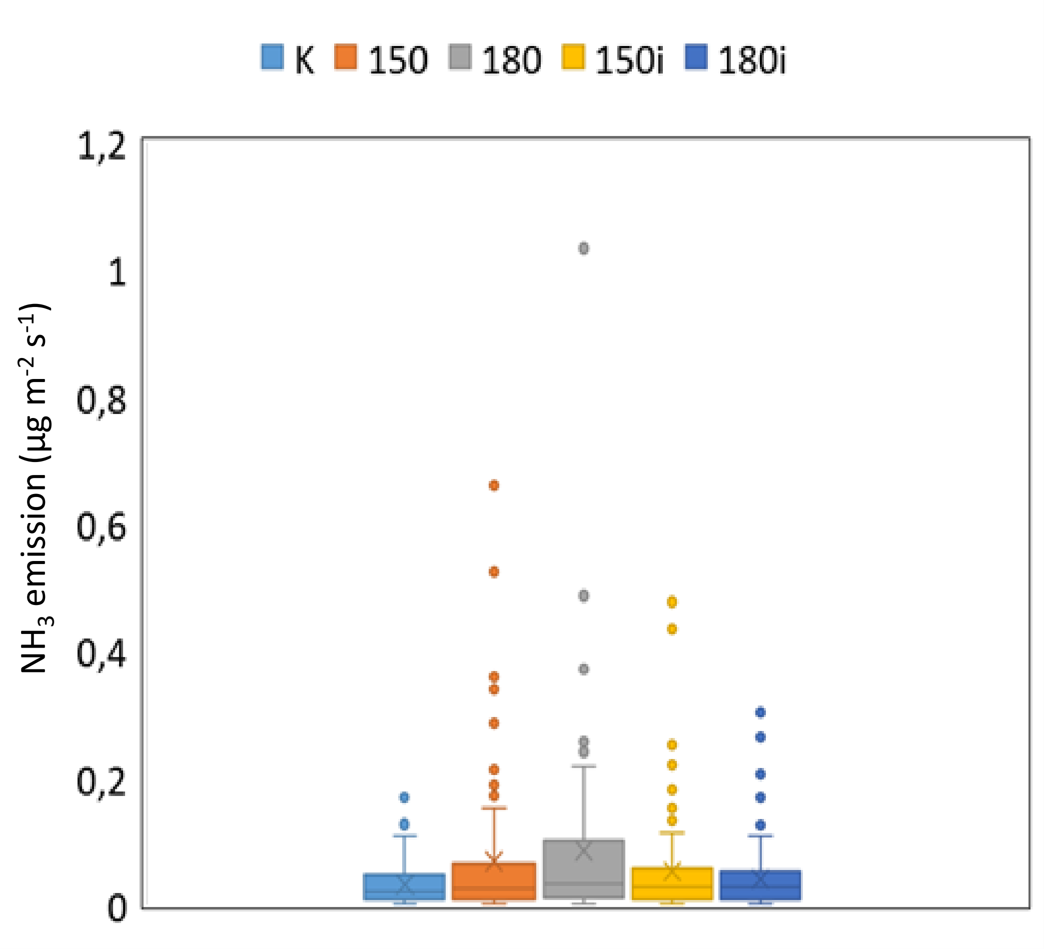
RESULTS – in mesocosm experiment



- Significantly higher emission in the 180 treatment
- 180i and 150i treatments have lower NH_3 losses than 180 and 150 treatment, seperately (not significant)
- Lowest emission is in the controll treatment

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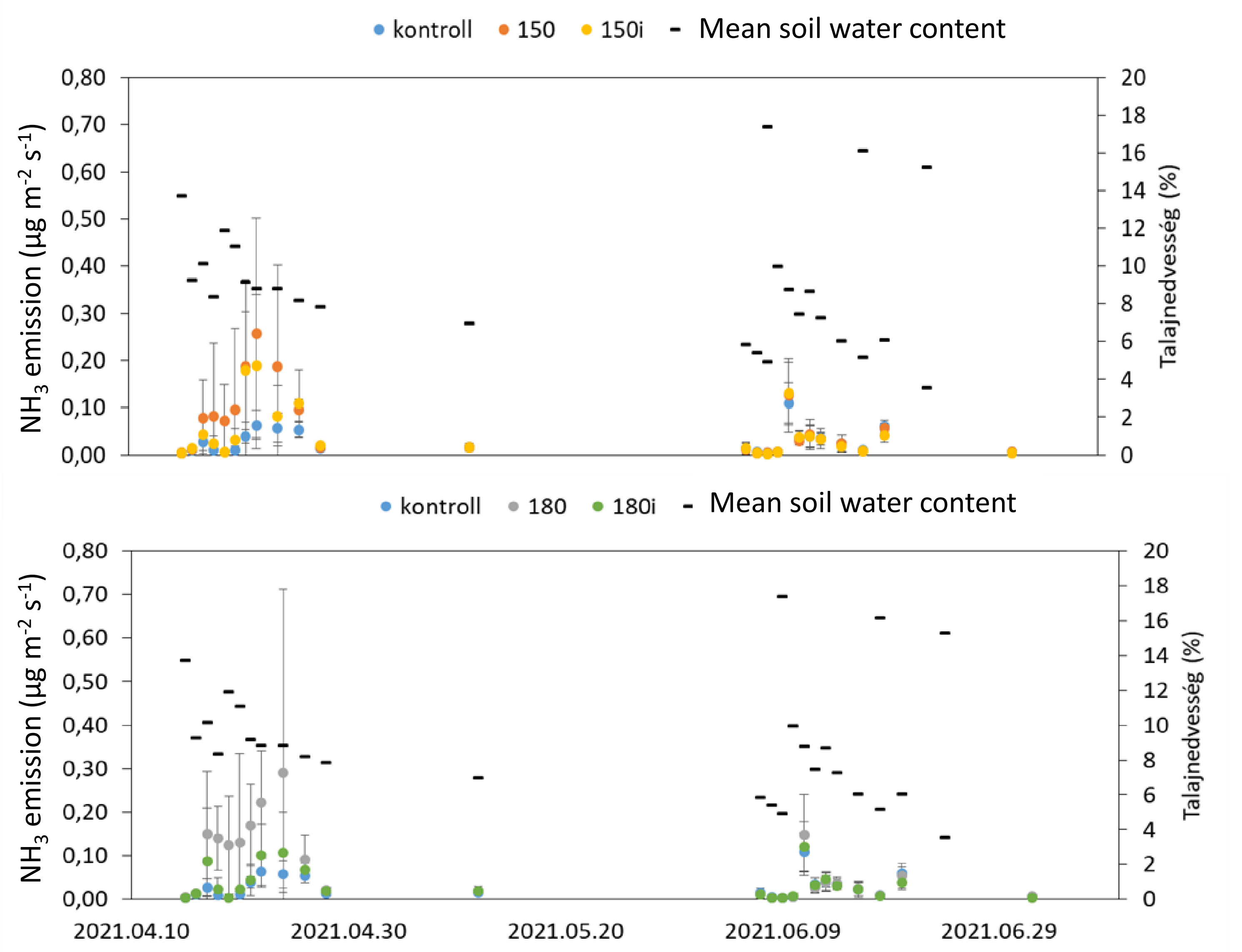
RESULTS – in mesocosm experiment



Slower effect than in the laboratory:

- Emission increasment starts at the second day after fertilization (not in the first)
- Peaks in the 7th and the 9th day

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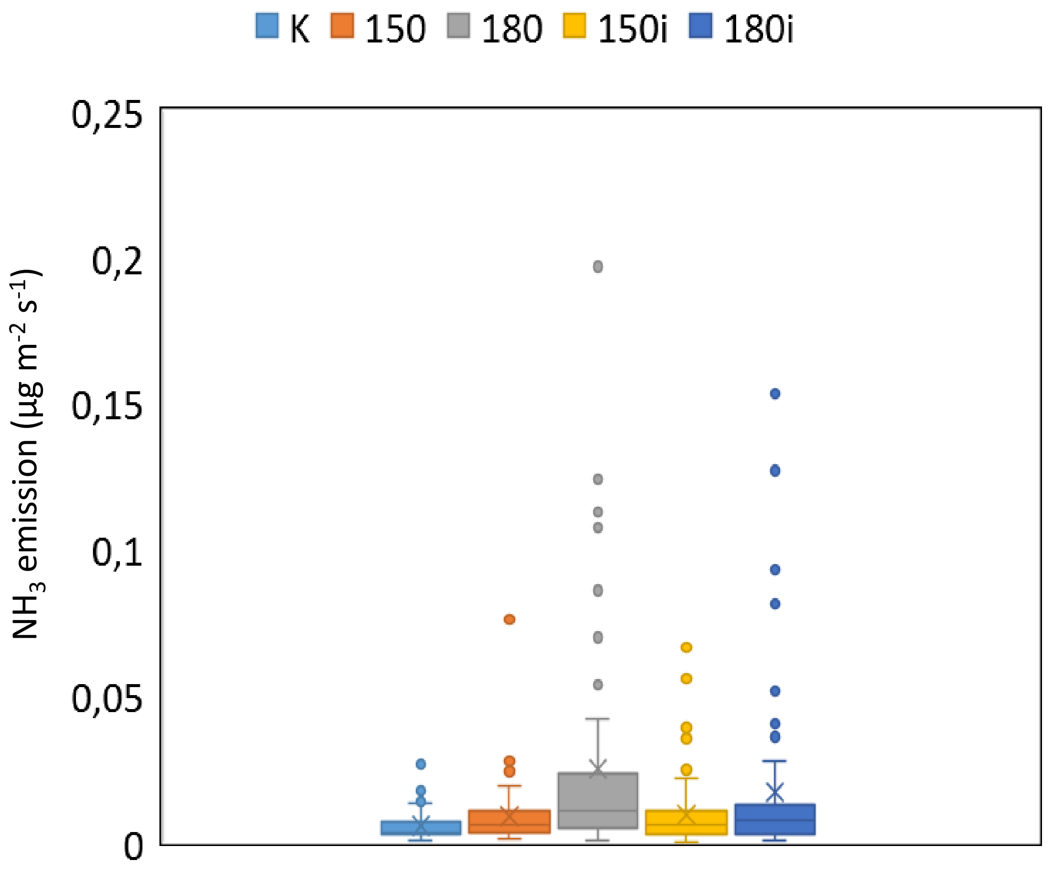
RESULTS – in plot experiment



- Highest emission in the 180 treatment
- Significant differences only betweeen the 180 and the control treatment
- Outsanding values in the 180 and 180i treatments
- Lowest emission is in the controll treatment

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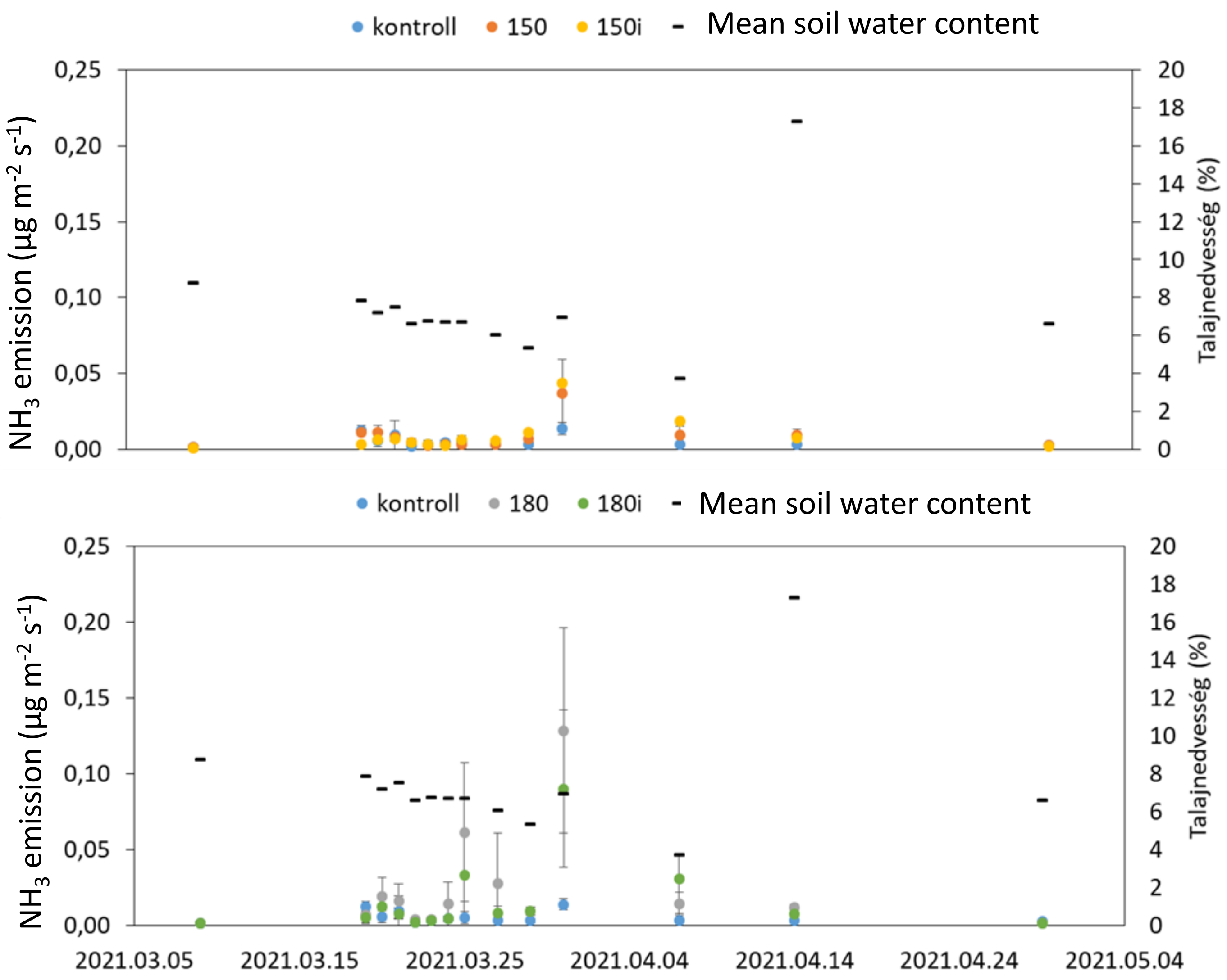
RESULTS – in plot experiment



- No differences before fertilization
- No significant differences between the treatments (except 180)
- 180i treatment has higher emission than 150i treatment (not significant)
- NH_3 losses peaks only two week long – highest emissions were observed after the 13th day

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SOME OWN EXPERIENCE WITH PICARRO G2103

- Sometimes the background NH_3 concentration seems too high (100-150ppb)
- NH_3 can stuck in the screw which is used to connect Picarro with the teflon tubes of the chamber
- In case of humid weather purification of the Picarro can be very slow – and values turn back to the beckground concentration very slowly

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THANK YOU FOR YOUR ATTENTION!