Environmental tradeoffs of nitrogen fertilization in Arava

הרצאה ביום עיון שרש דבר

במסגרת יום פתוח מו"פ ערבה

מרכז ויידור, תחנת יאיר 23/2/2022

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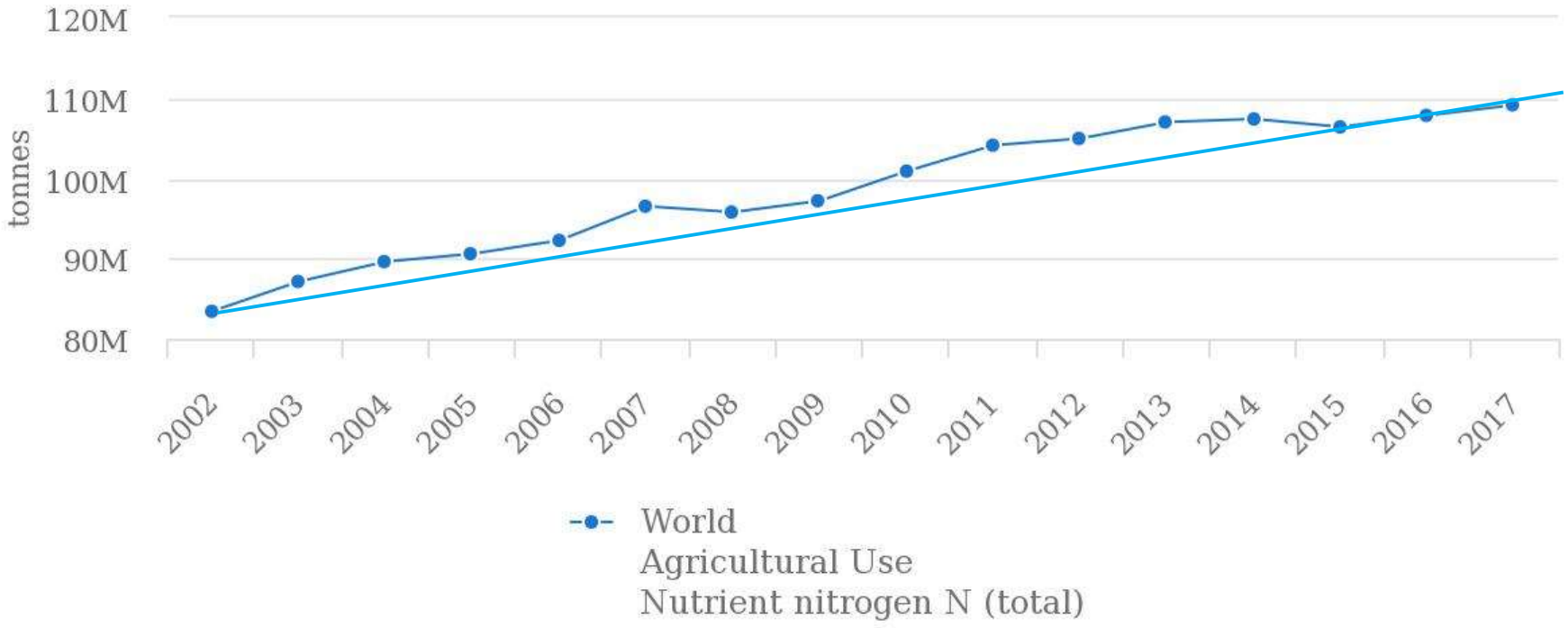
Agriculture in XXI century

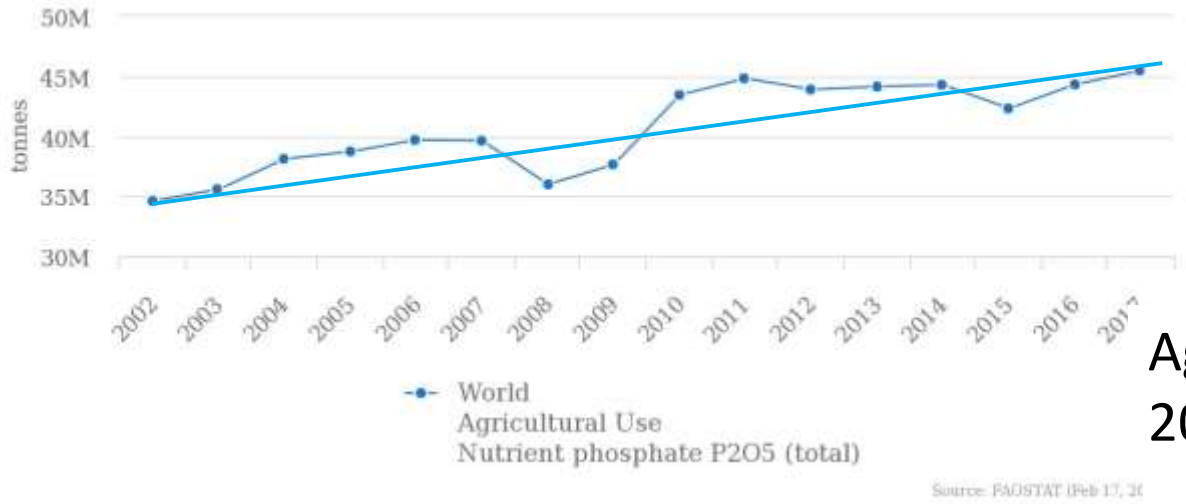
Agricultural Use of Nitrogen (N) in world
2002-2017



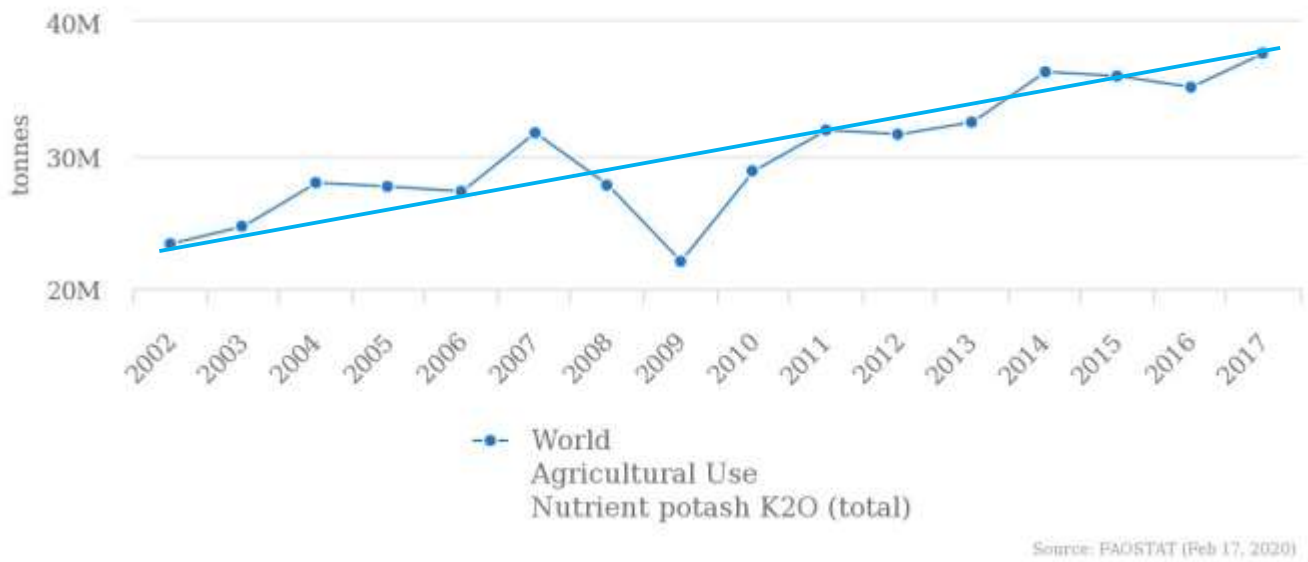
Source: FAOSTAT (Feb 17, 2020)

Agriculture in XXI century

Agricultural Use of Phosphate (P_2O_5) in world 2002-2017

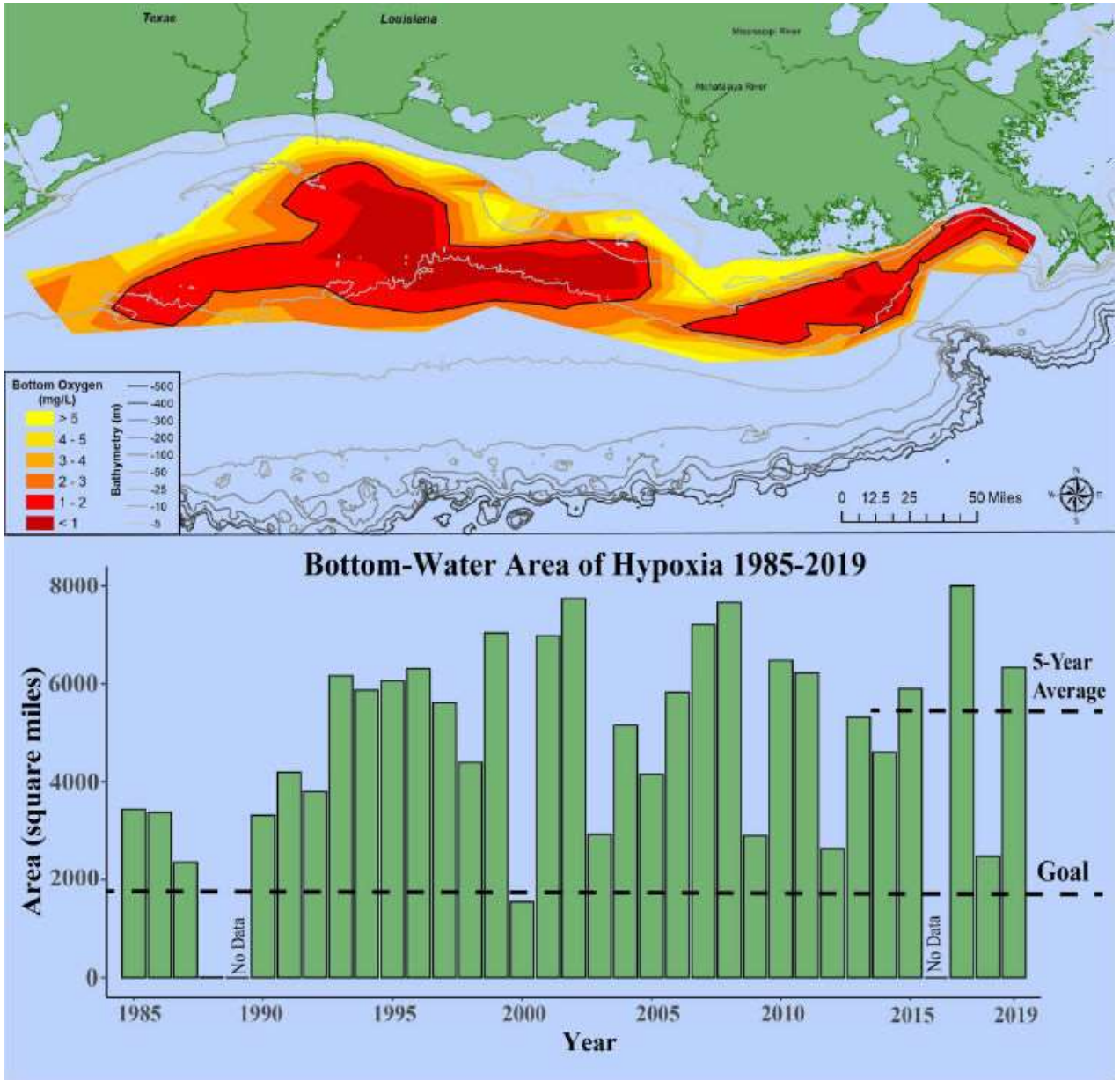


Agricultural Use of Potassium (K_2O) in world 2002-2017



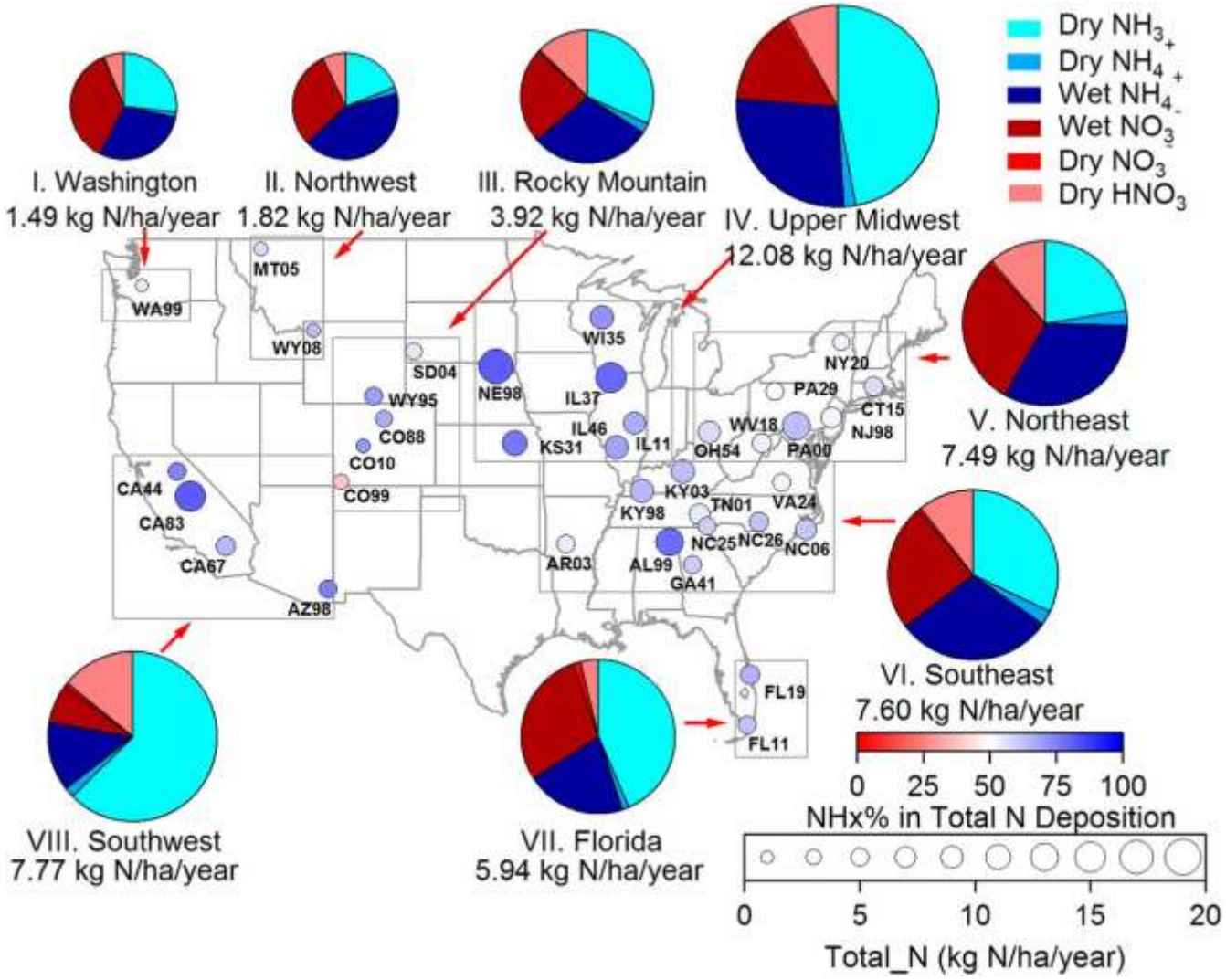
Environmental impact of agriculture

Gulf of Mexico hypoxia (bottom-water)

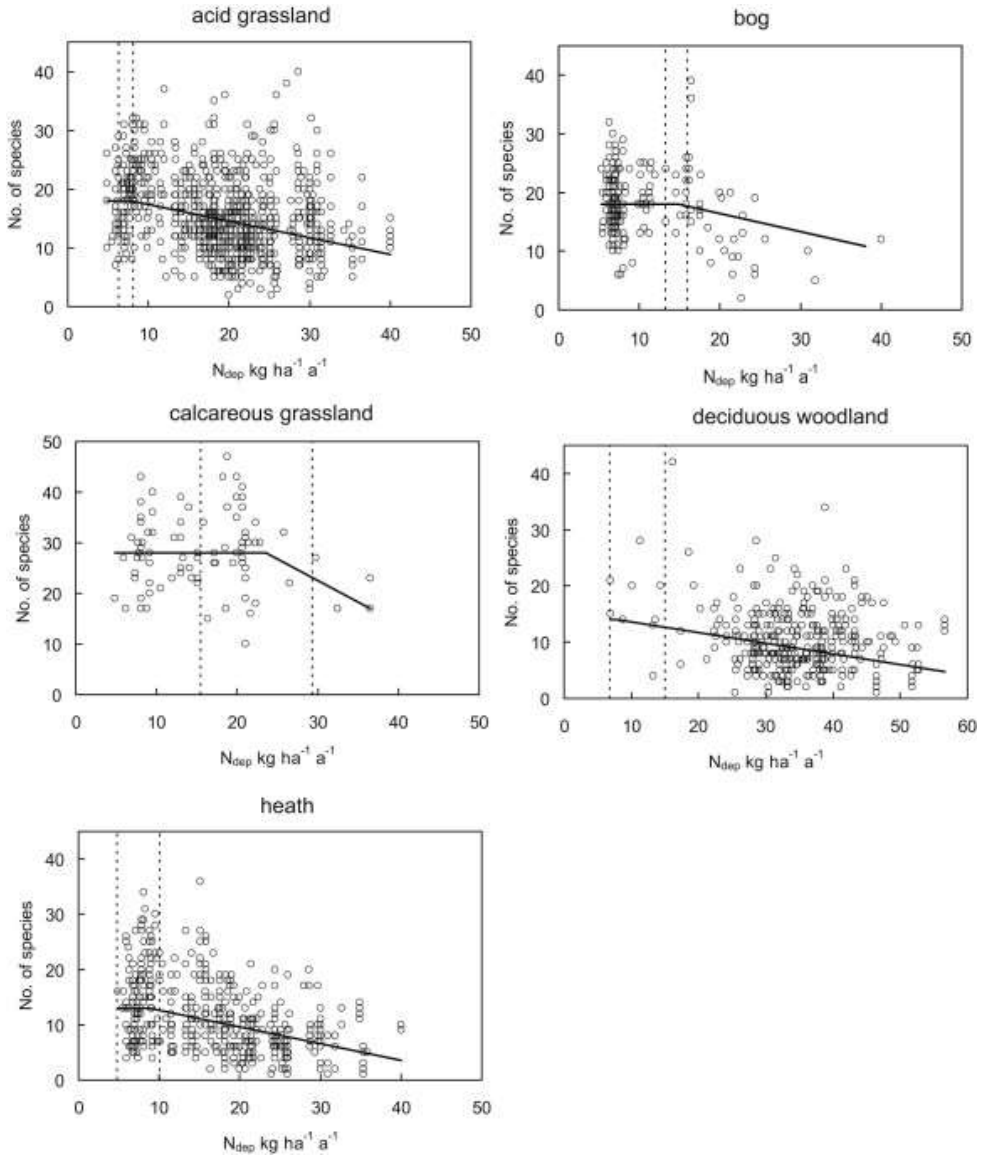


Environmental impact of agriculture

N deposition and N deposition effects

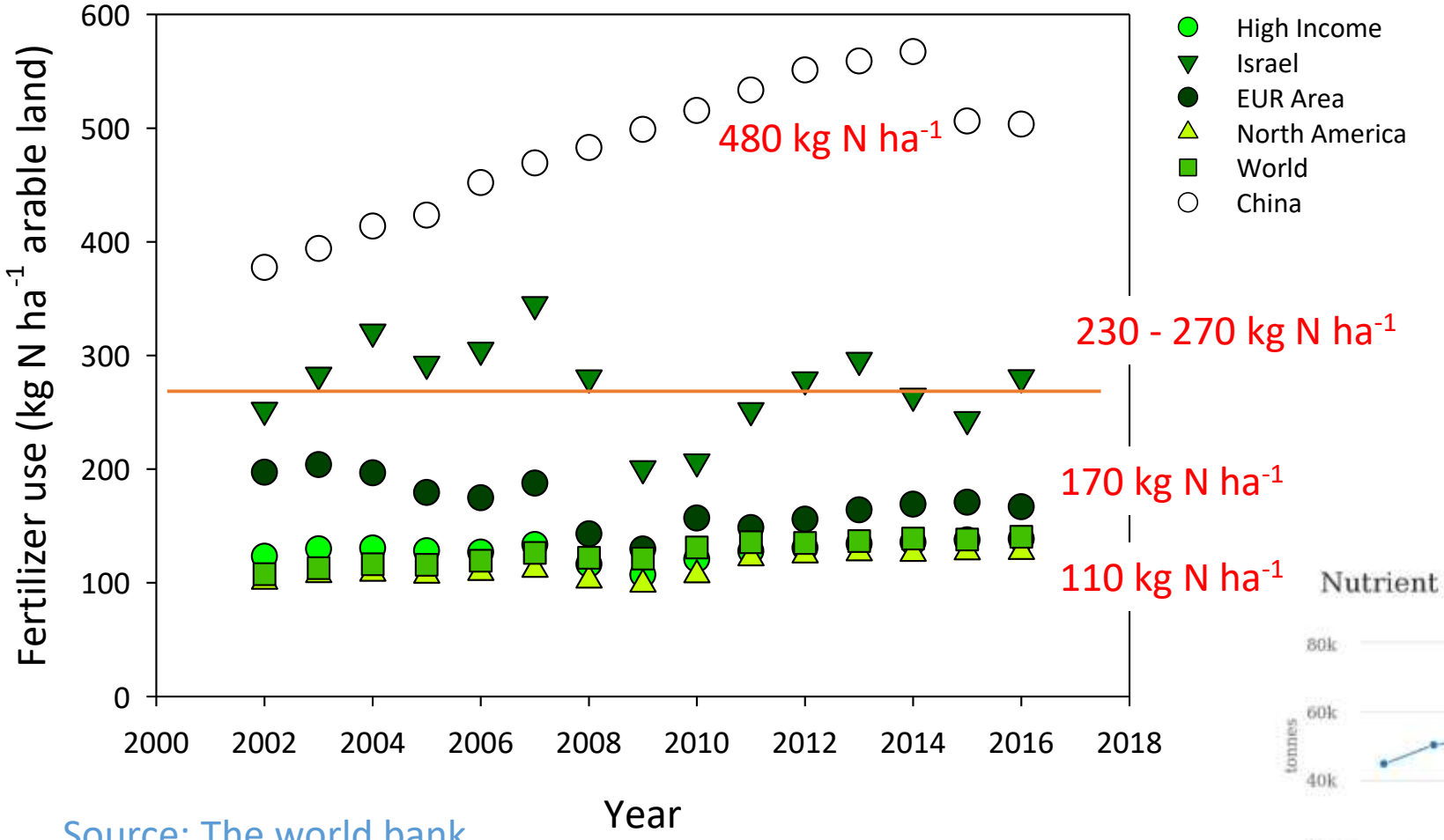


Yi Li et al. PNAS 2016;113:21:5874-5879

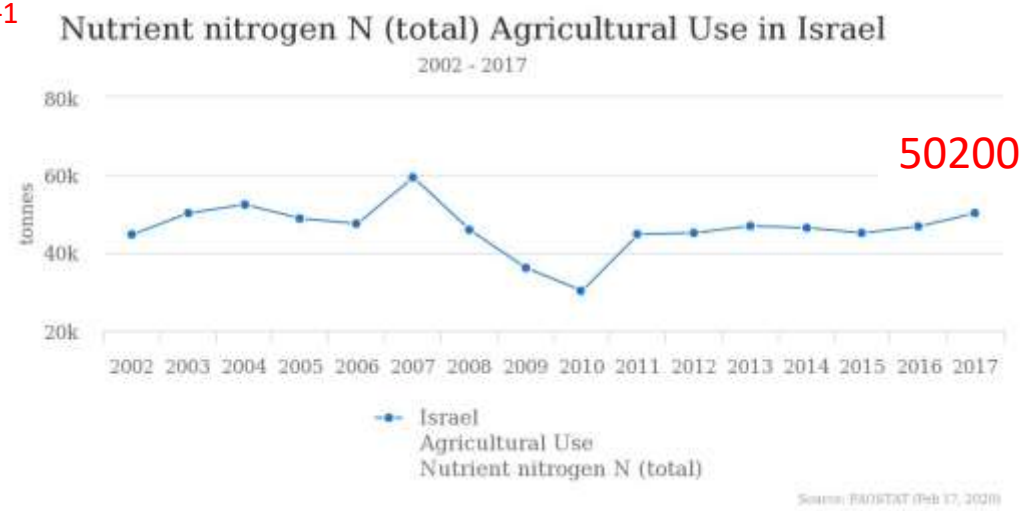


Tipping E, et al 2013; Environmental Pollution179 pp: 218-223

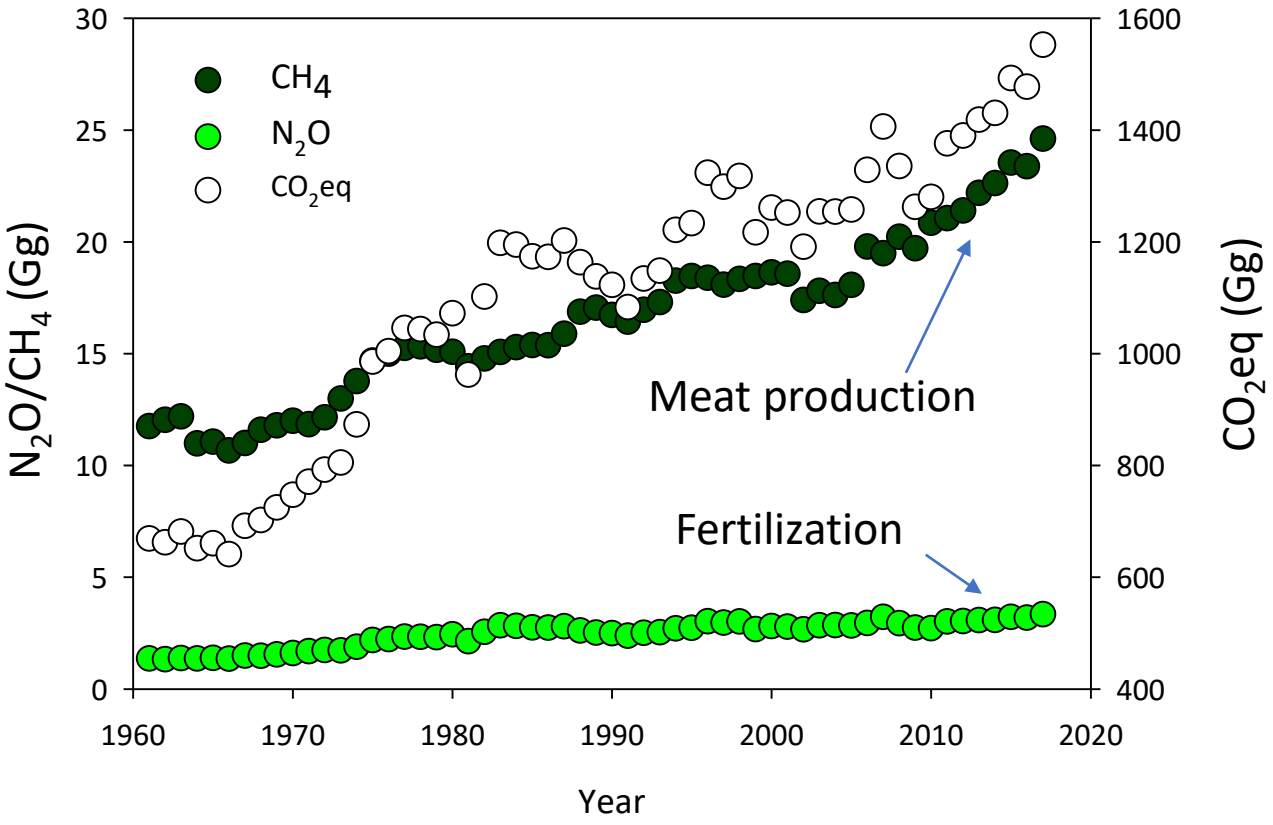
Fertilizer use in Israel



Source: The world bank



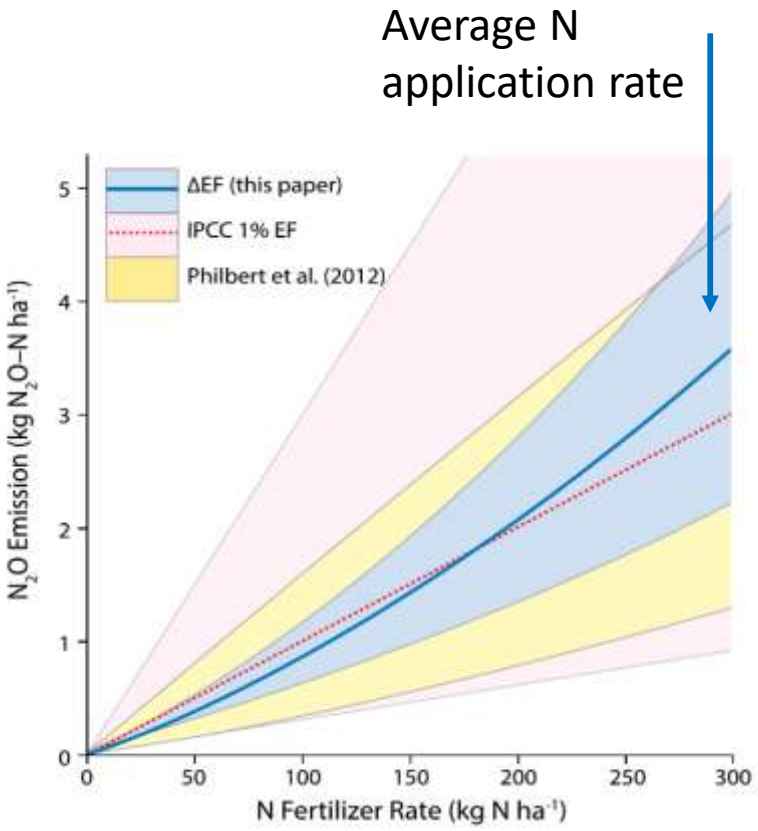
Greenhouse gases emissions from Israeli agriculture

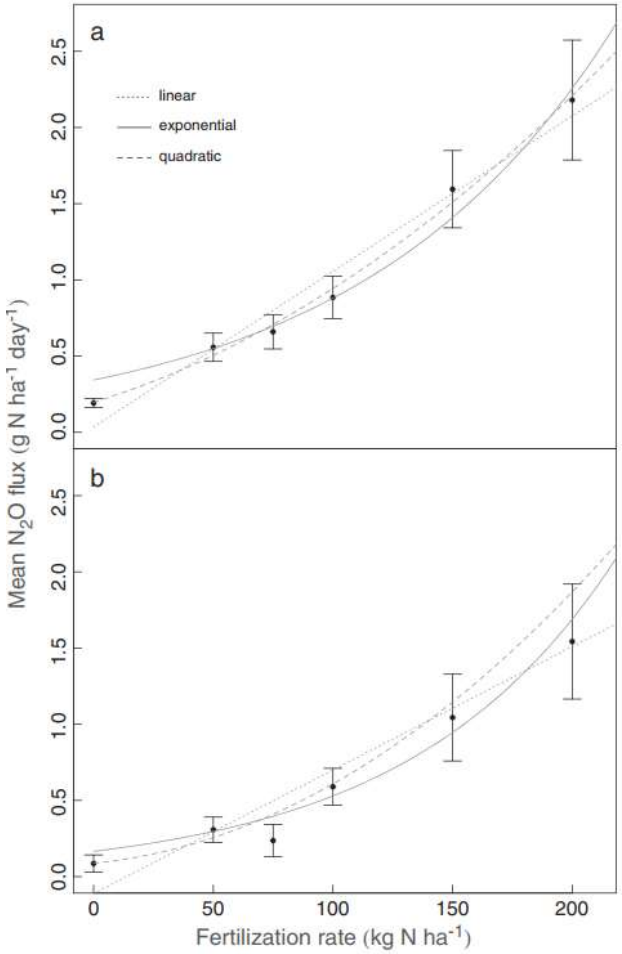


Calculated based on the IPCC tier I approach

FAOSTAT, 2020

Greenhouse gases emissions from Israeli agriculture

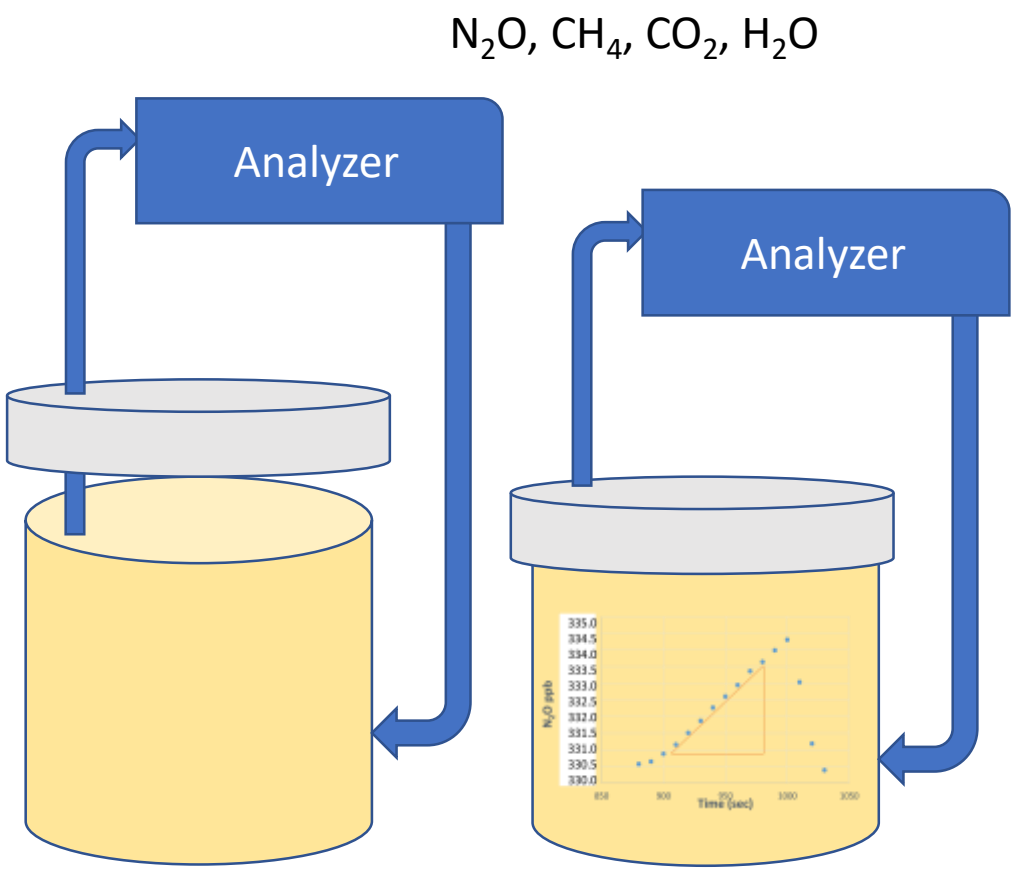


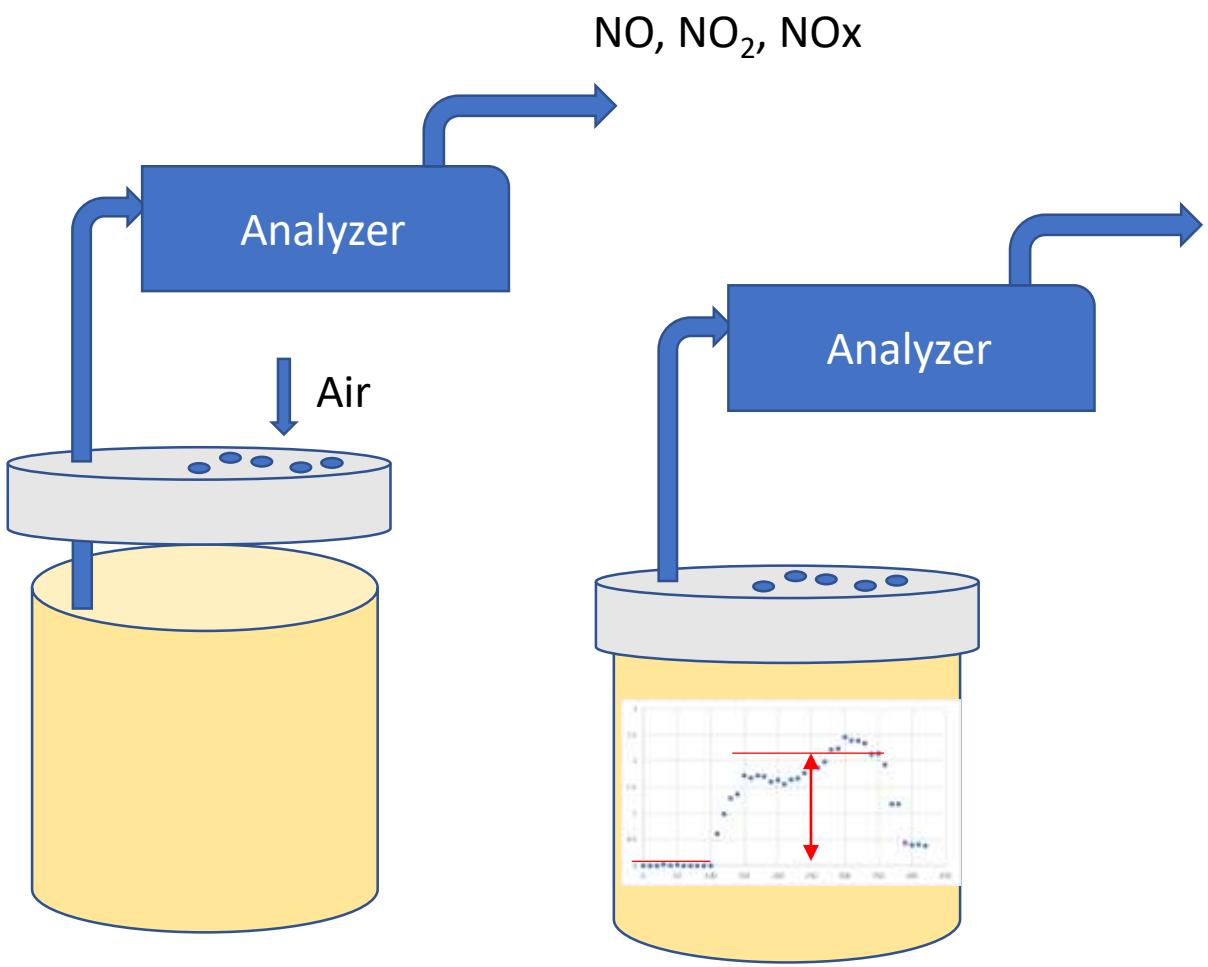


Shcherback et al. 2014,

Methods

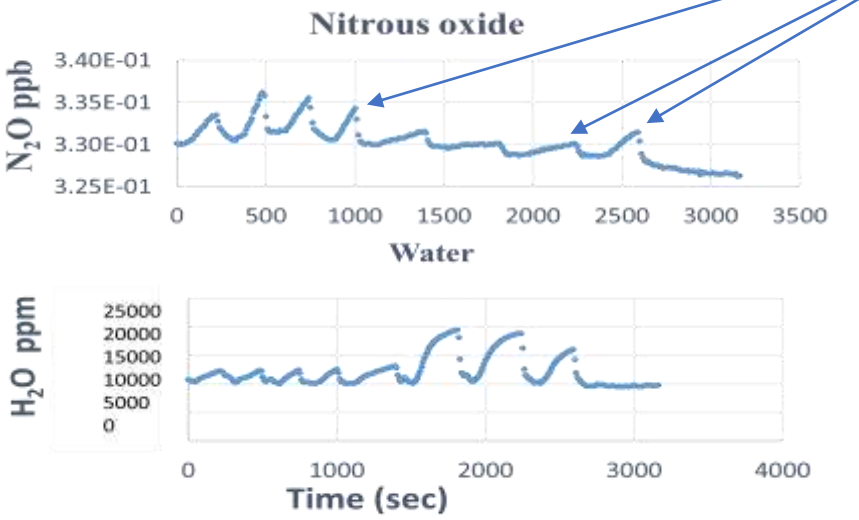
Accumulation and steady-state chambers coupled with:
Quantum cascade laser for N_2O, CH_4, and H_2O analysis,
Chemiluminescence instrument for NOx analysis
IRGA for CO_2 analysis
Measurement time is ~3-5 minutes, sensitivity varies.



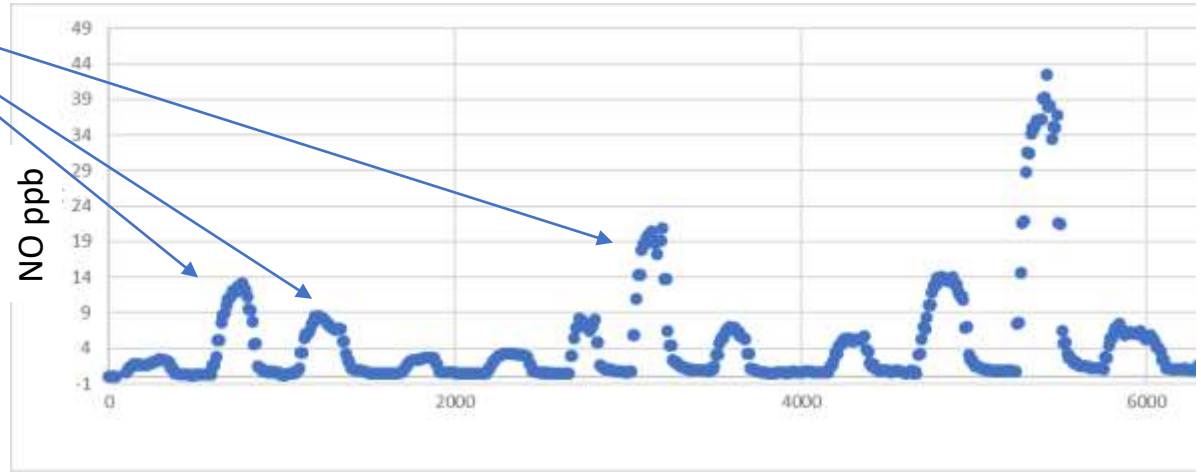


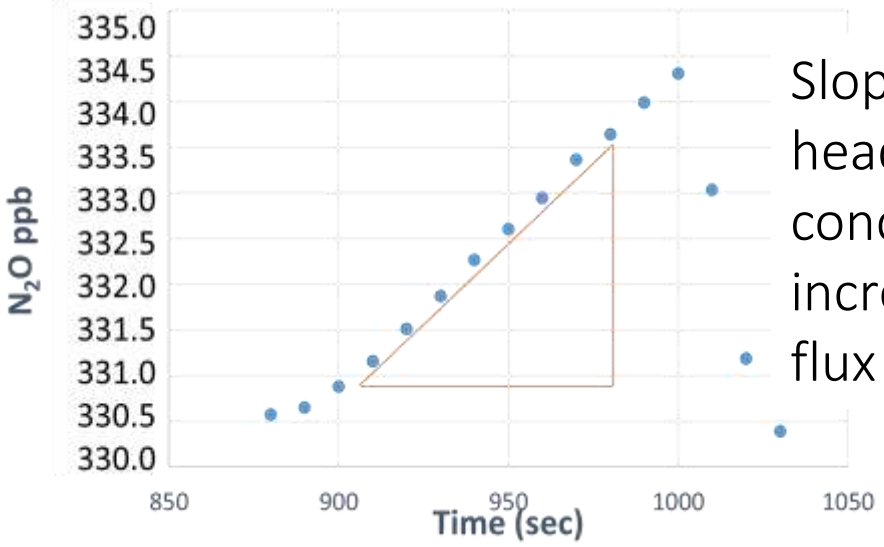
Different positions on the landscape
(i.e. different chambers)

N_2O, CH_4, CO_2, H_2O

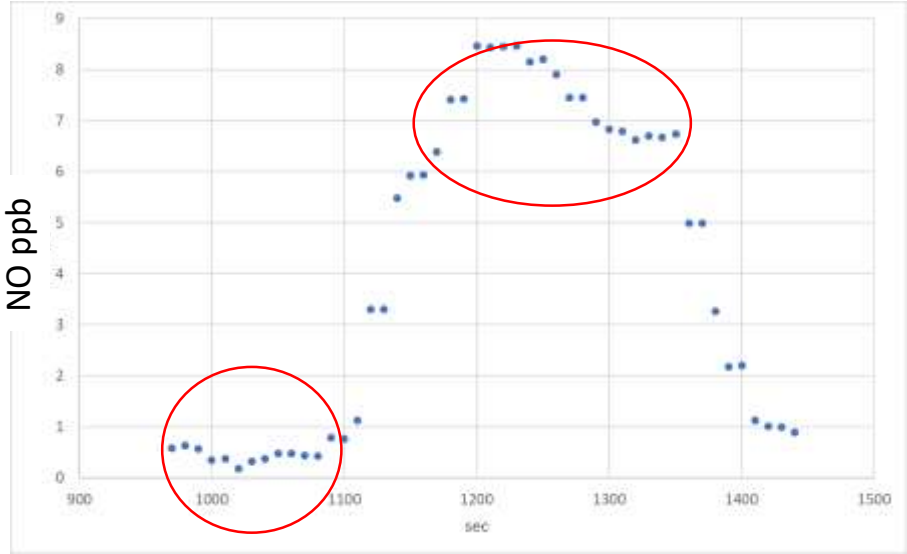


NO, NO_2, NOx





Slope of the headspace concentration increase is the flux



Average of
[NO]out – [NO]in

Date palms experiment: four levels of N application

Agriculture, Ecosystems and Environment

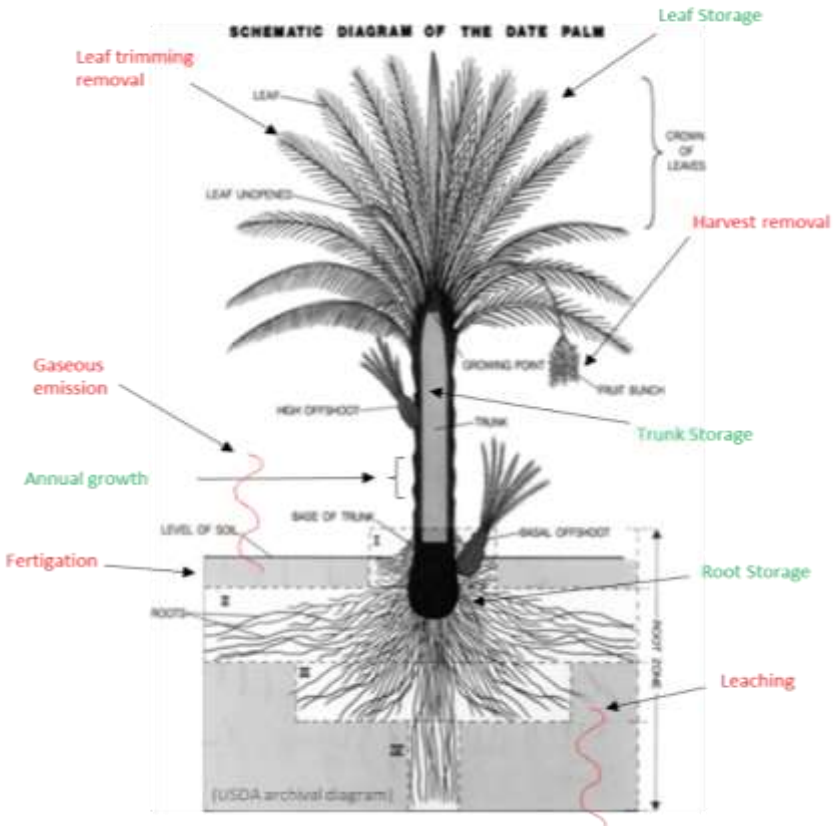
Effect of increasing nitrogen fertilization on soil nitrous oxide emissions and nitrate leaching in a young date palm (*Phoenix dactylifera* L., cv. Medjool) orchard

Daniel Minikaev, Udi Zurgel, Effi Tripler, Ilya Gelfand

Daniel's MS Thesis

Objectives

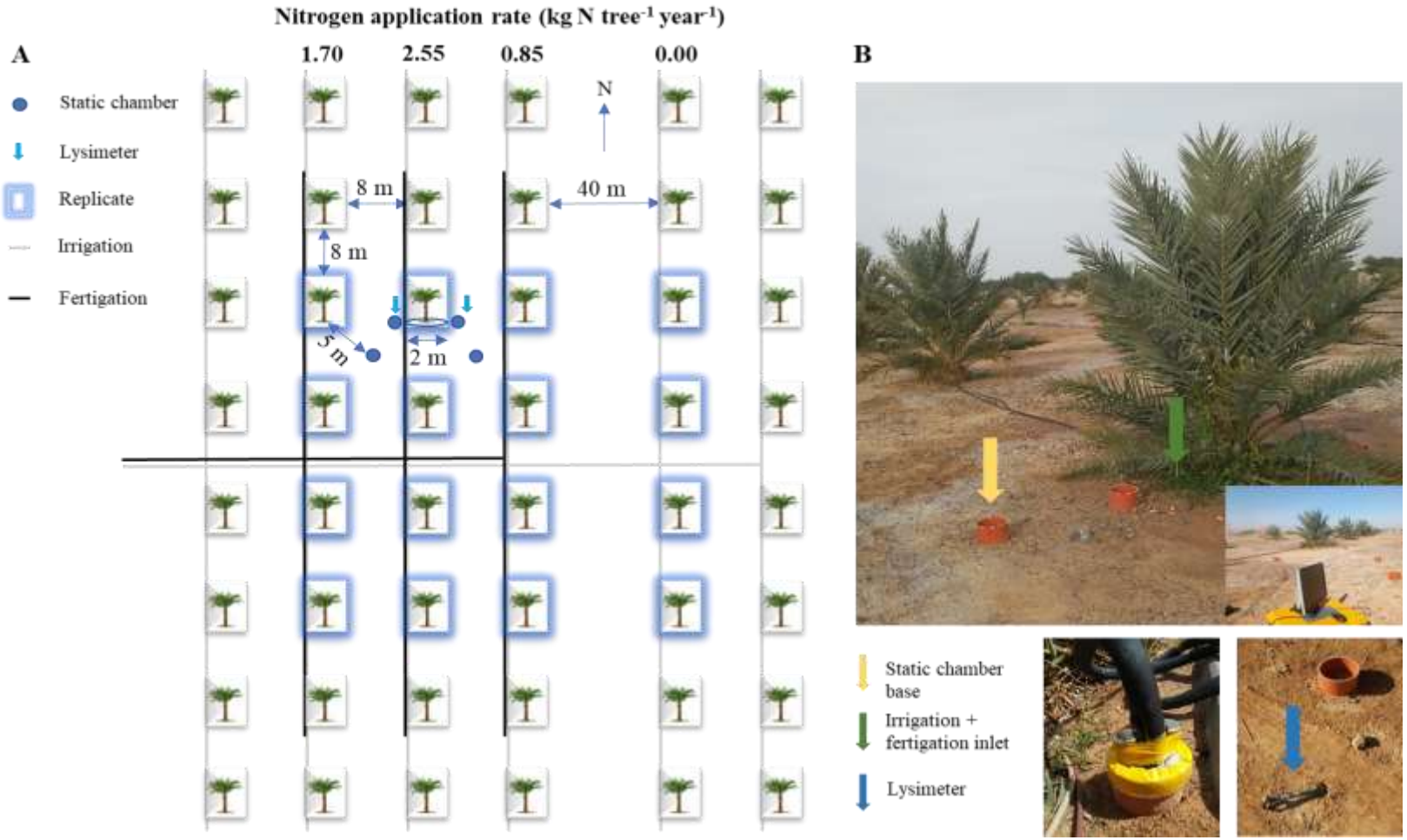
- Describe and quantify the N balance.
- Improve current N fertilization methods, with an attempt to minimize environmental impacts.



Hypothesis

- Exceeding N fertilizer application beyond the plant’s uptake has no benefit to the crop’s productivity and will result in substantial N loss in gaseous and soluble forms.

Experimental Design & Study Site

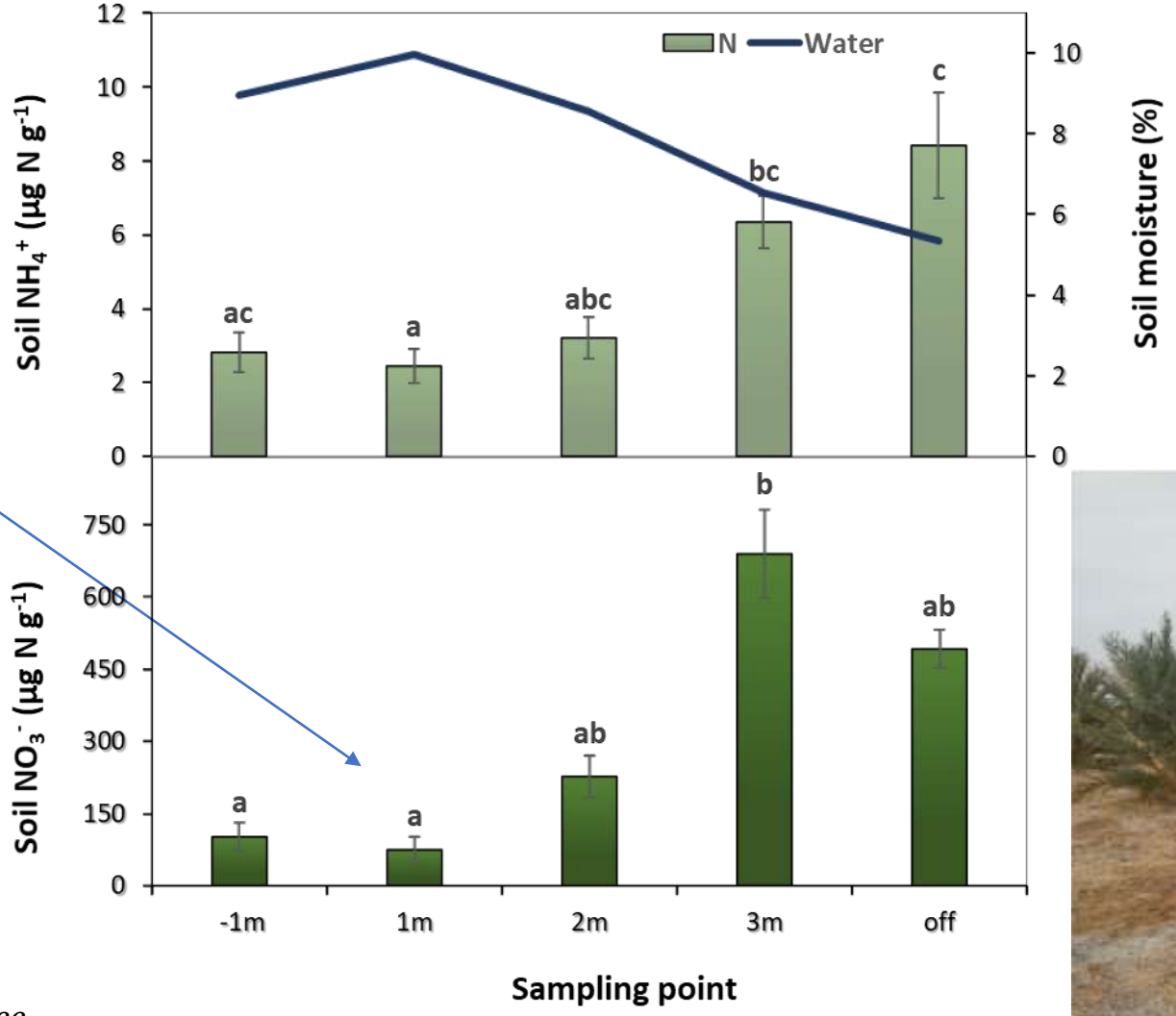


Clay	Silt	Sand	Organic C	Total N	CO_3^{2-}	Bulk Density	Porosity	pH
			%			*kg L⁻¹*		
5.5	31.5	63.0	0.32 ± 0.03	0.046 ± 0.009	58.1 ± 0.5	1.34 ± 0.21	0.5 ± 0.1	8.3

Soil

Soil Inorganic N Pool Across a Wetting-Drying Gradient

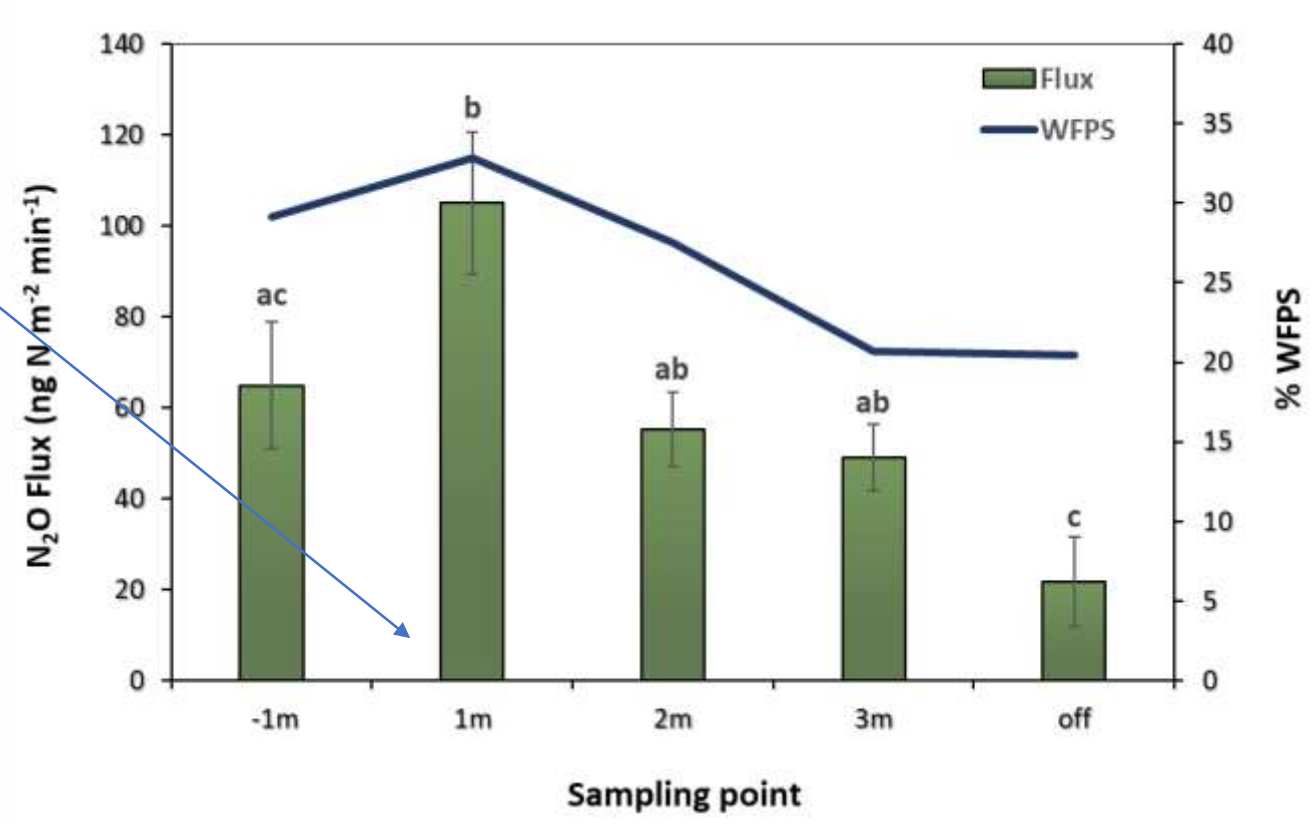
Fertigation inlet



Averaged for all fertilization levels, per tree.

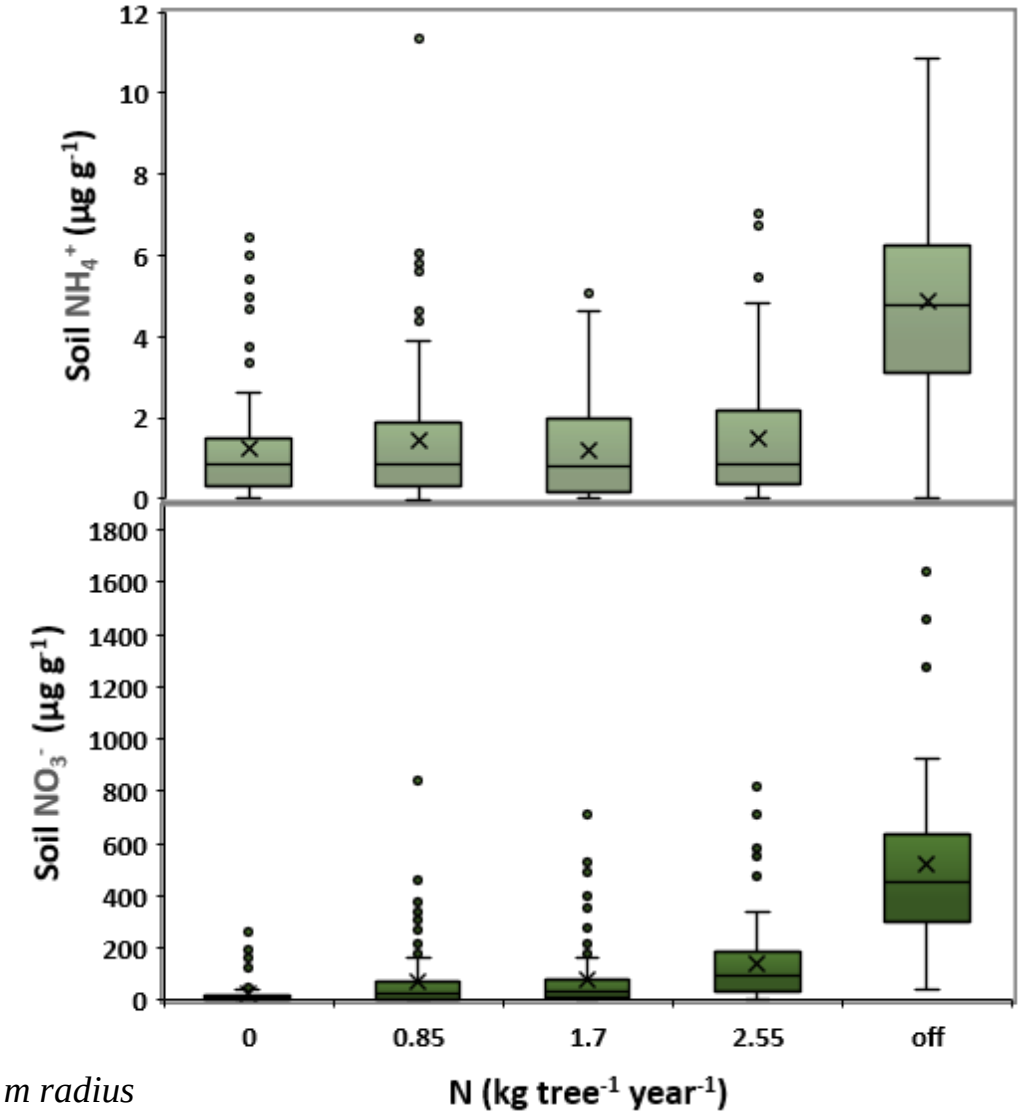
Soil N_2O Emissions Across a Wetting-Drying Gradient

Fertigation inlet



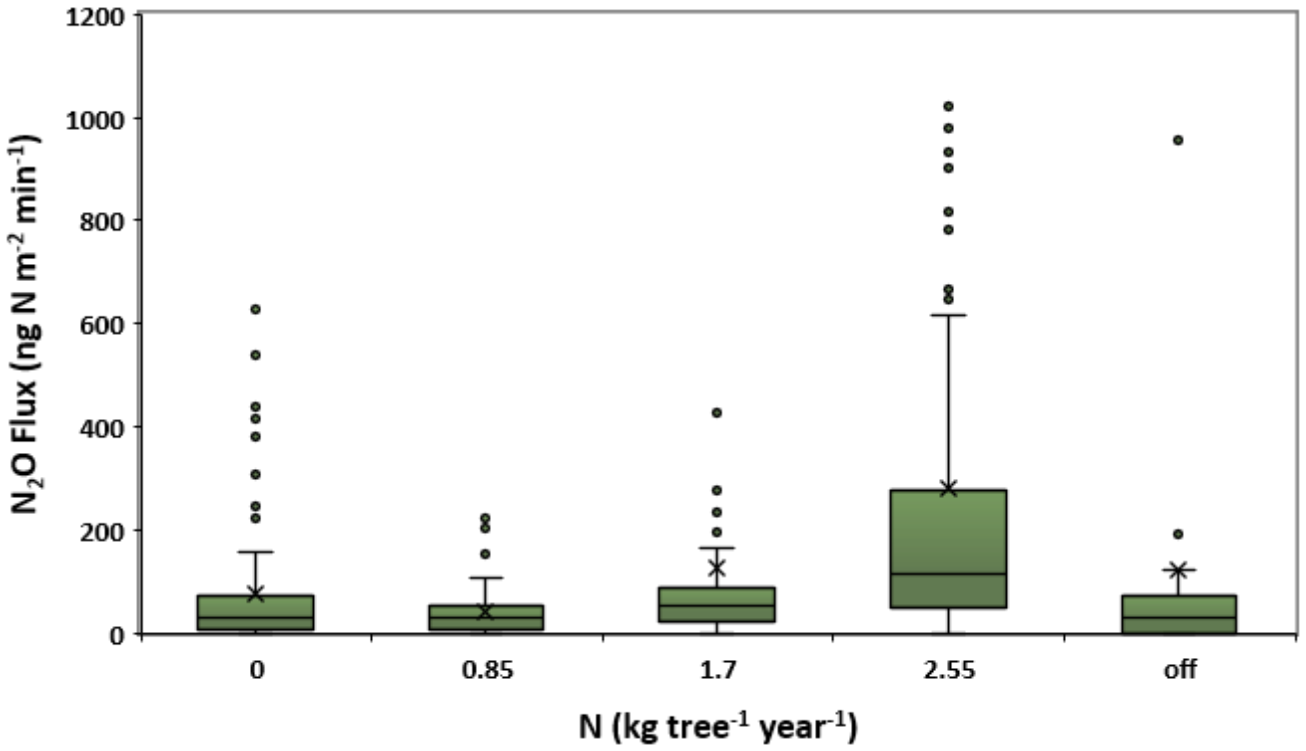
**Averaged for all fertilization levels, per tree.*

Fertilization Effect on Soil Inorganic N pool



**Seasonal average per tree, within a 1 m radius around the tree and off-treatment.*

Fertilization Effect on Soil N_2O Emission Rate

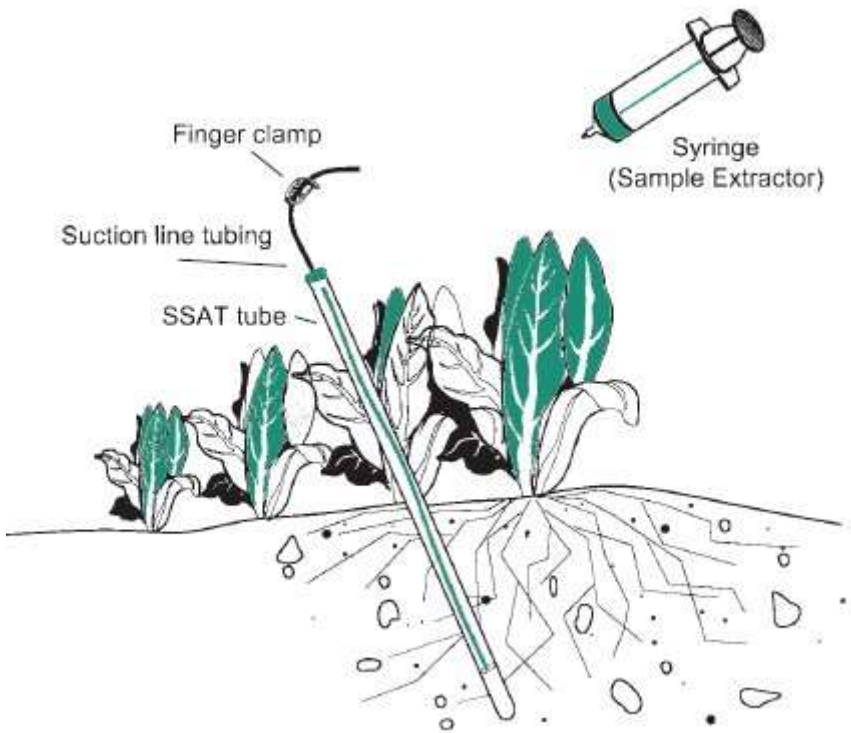


**Seasonal average per tree, within a 1 m radius around the tree and off-treatment.*

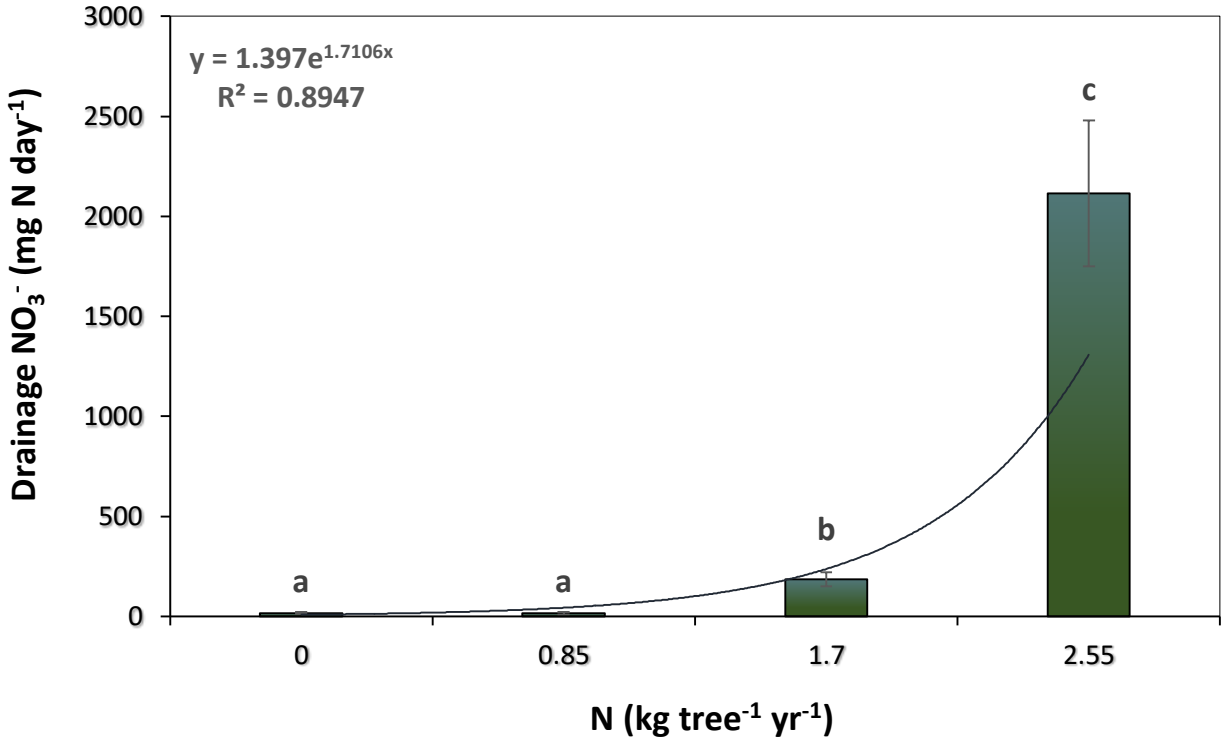
Soil N Dynamics – Summary

- Drier soils are, lower N_2O fluxes and higher inorganic N concentration in soil
- Both, soil N and N_2O were largely increasing with the increasing fertilization rate.

Groundwater

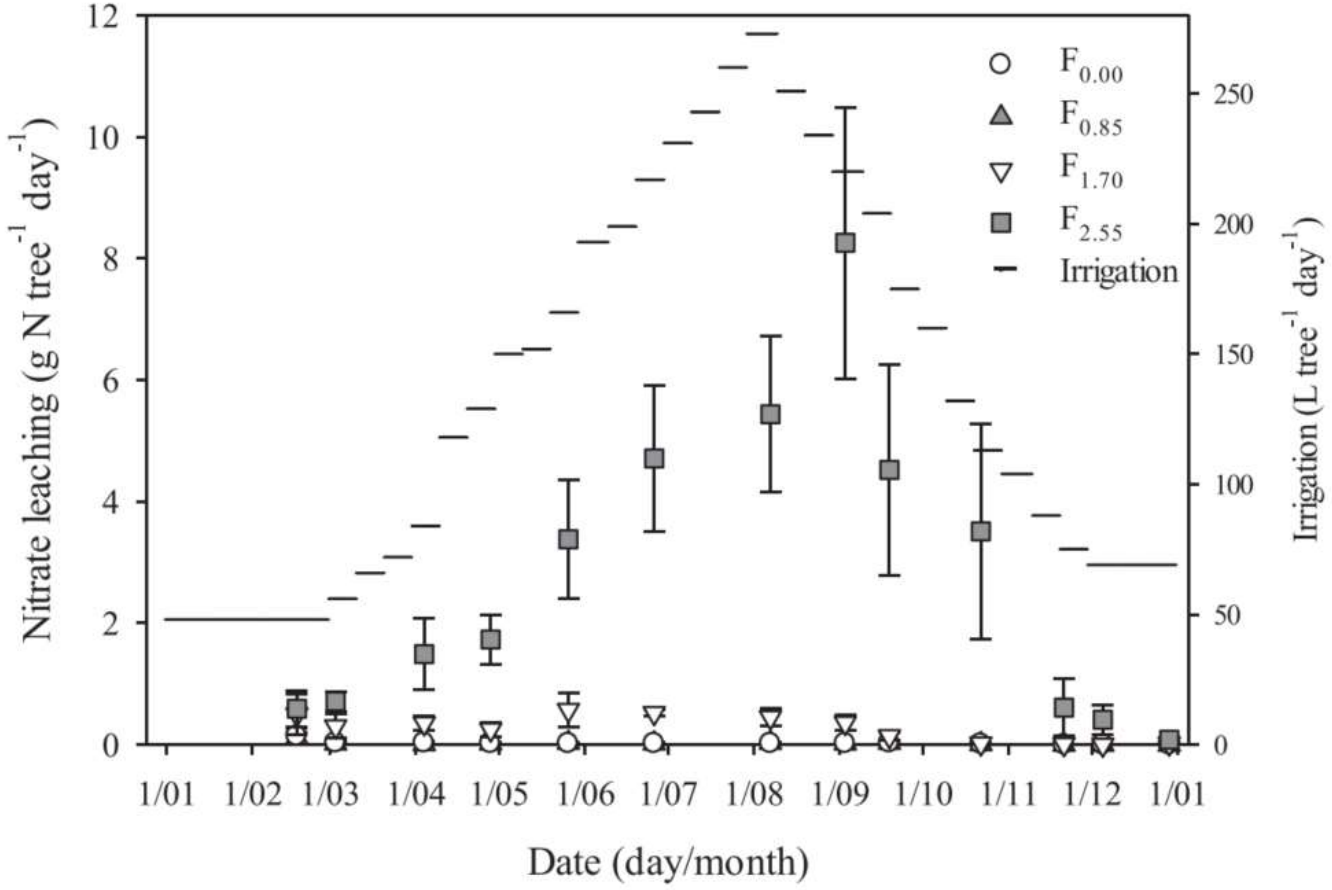


Fertilization Rates Effect on N Leaching



**Seasonal average per tree, measured at 0.5 m and 1 m distances.*

Annual Cycle of Daily N Leaching



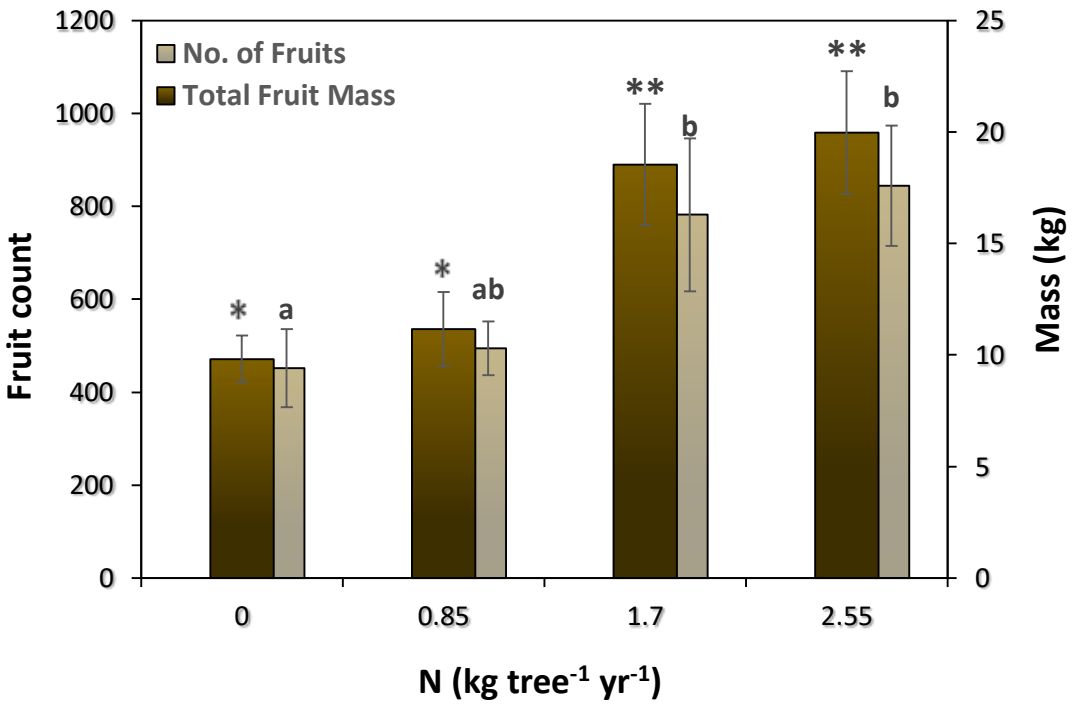
**Average daily drainage per tree.*

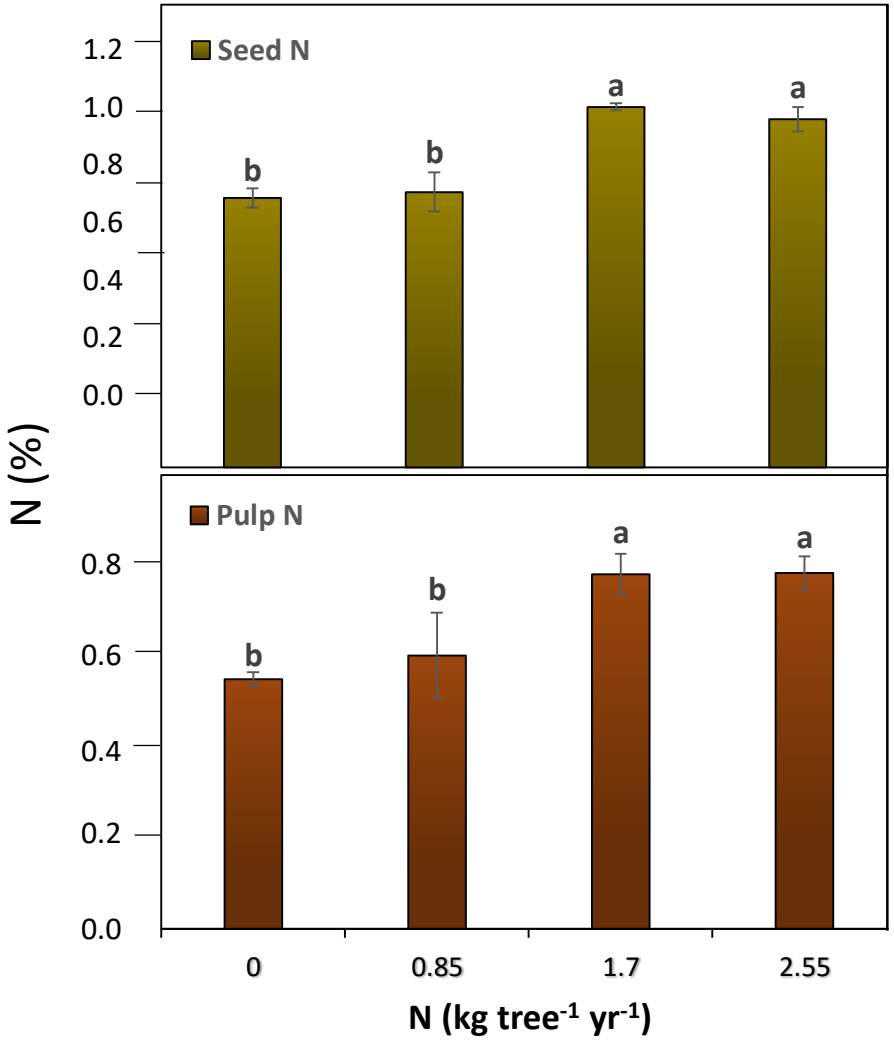
N Leaching – Summary

- N leaching followed an exponential increase with the increasing fertilization rate.
- N leaching was significantly increasing in the summer months, following the increase in irrigation.

Fruit

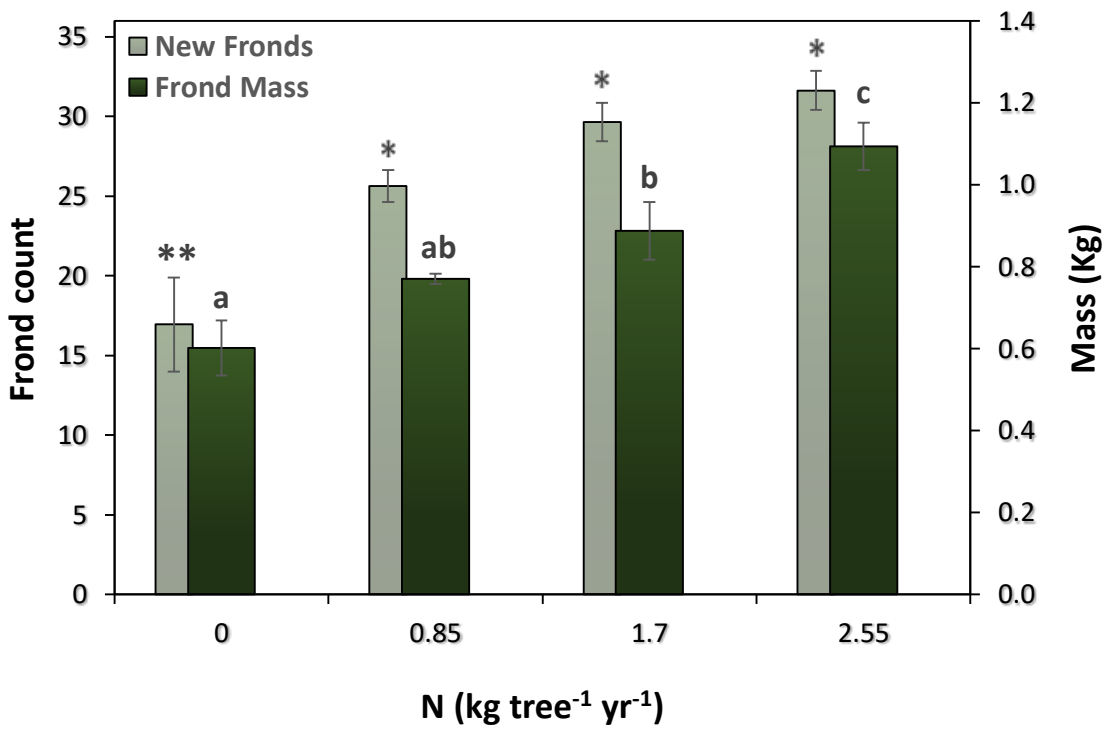
Fruit Yield & C N Analysis

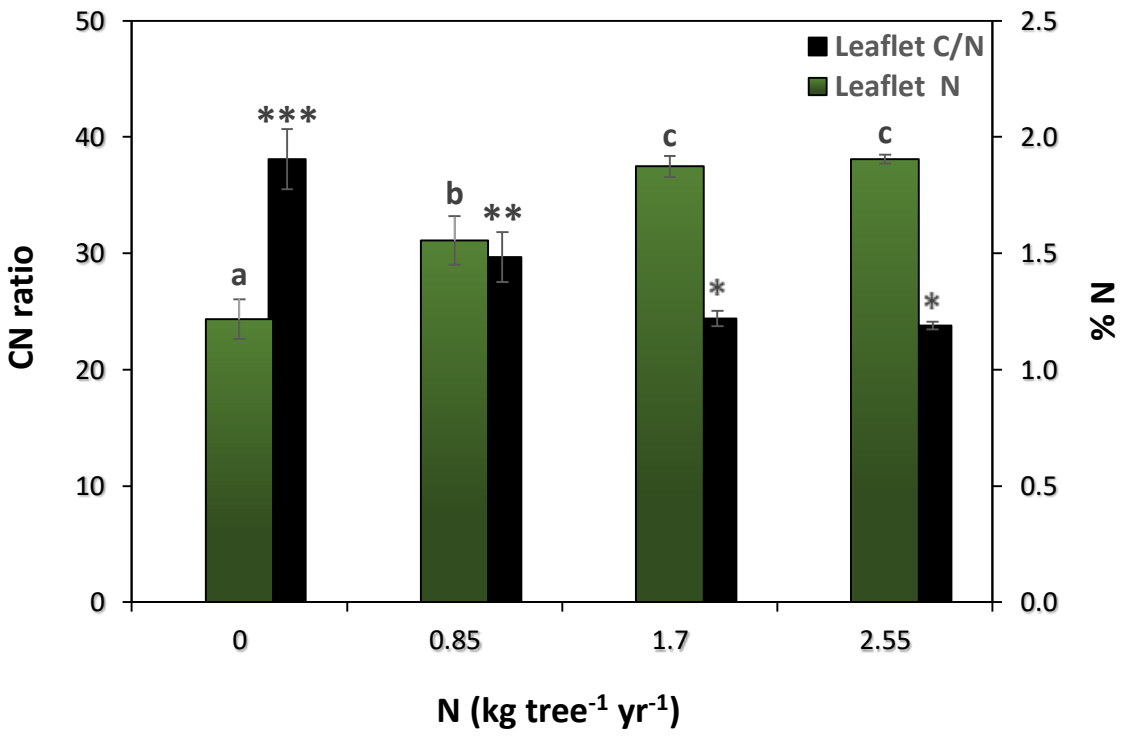




*Average per tree.

Frond Growth & C N Analysis





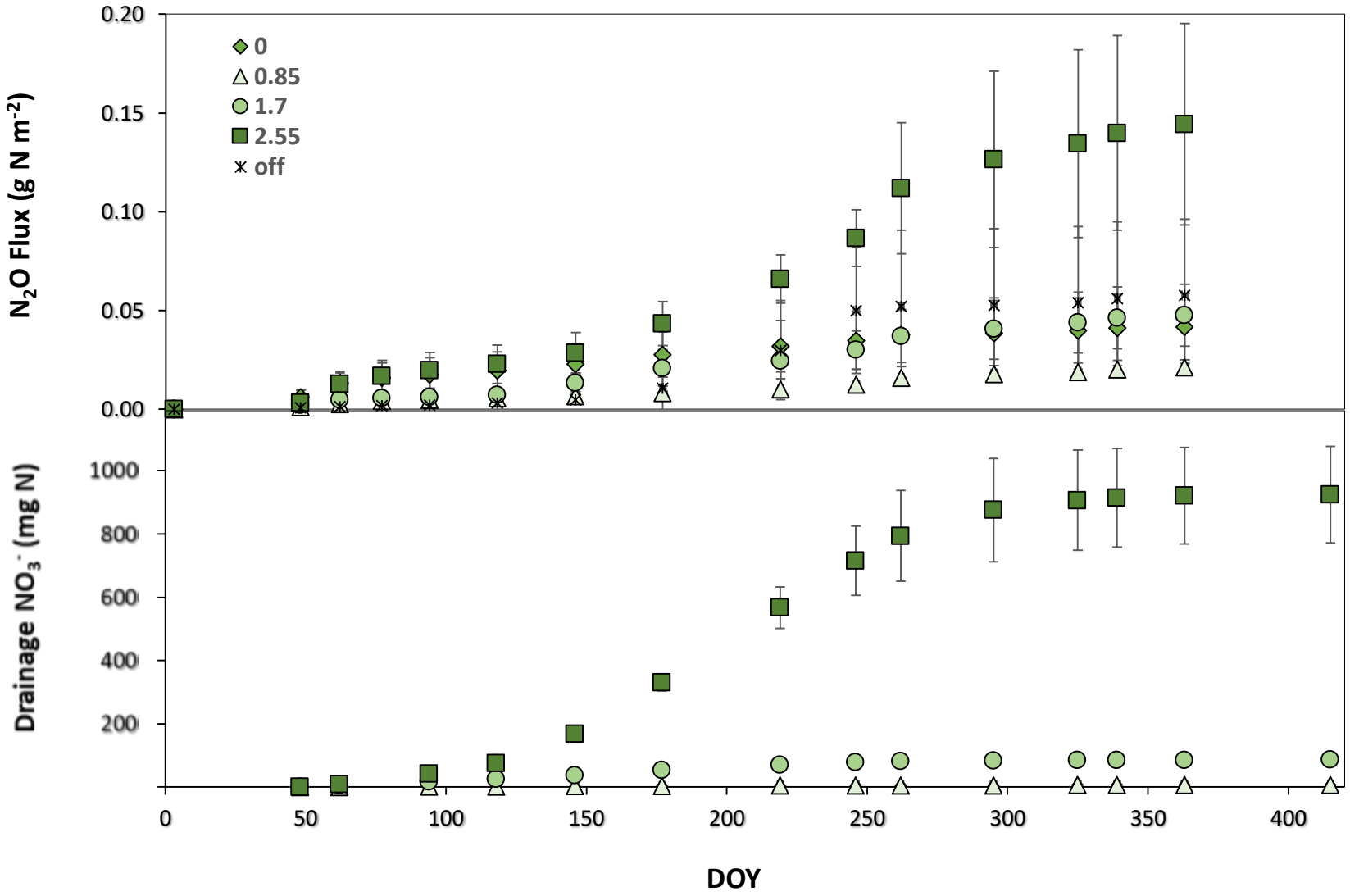
*Average per tree.

Crop Performance – Summary

- Fruit yield and fruit N uptake responded to fertilization and increased from zero to 1.7 kg N without further increase
- Frond growth increased consistently with each increasing fertilization rate. Frond N uptake increased up to 1.7 kg N fertilization level. – Acceleration of vegetative growth.
- N use efficiency increased from 0.85 kg N to 1.7 kg N fertilization levels, and decreased from 1.7 kg N to 2.55 kg N.

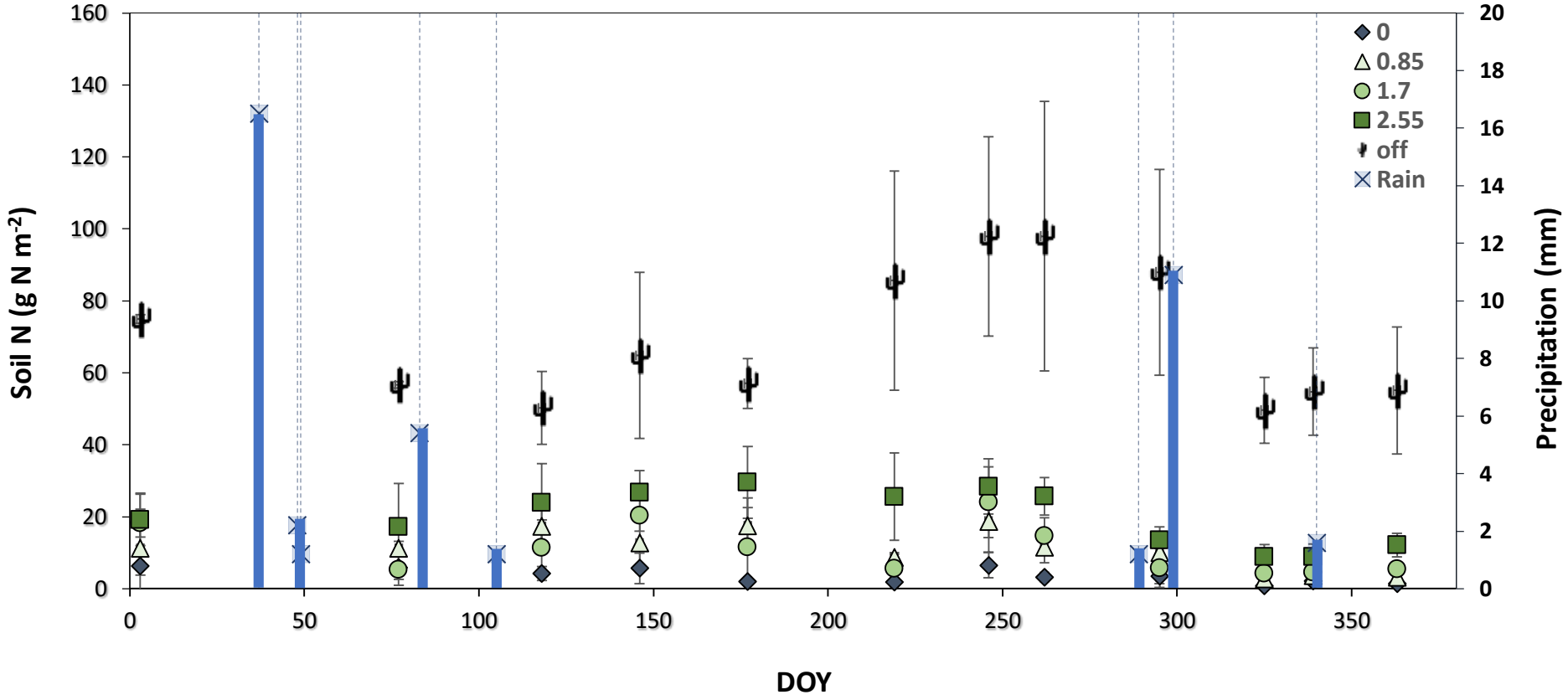
N Budget

Cumulative Annual Gaseous & Groundwater N loss



**Estimated annual cumulative, within a 1 m radius.*

Annual cycle of soil inorganic N pool

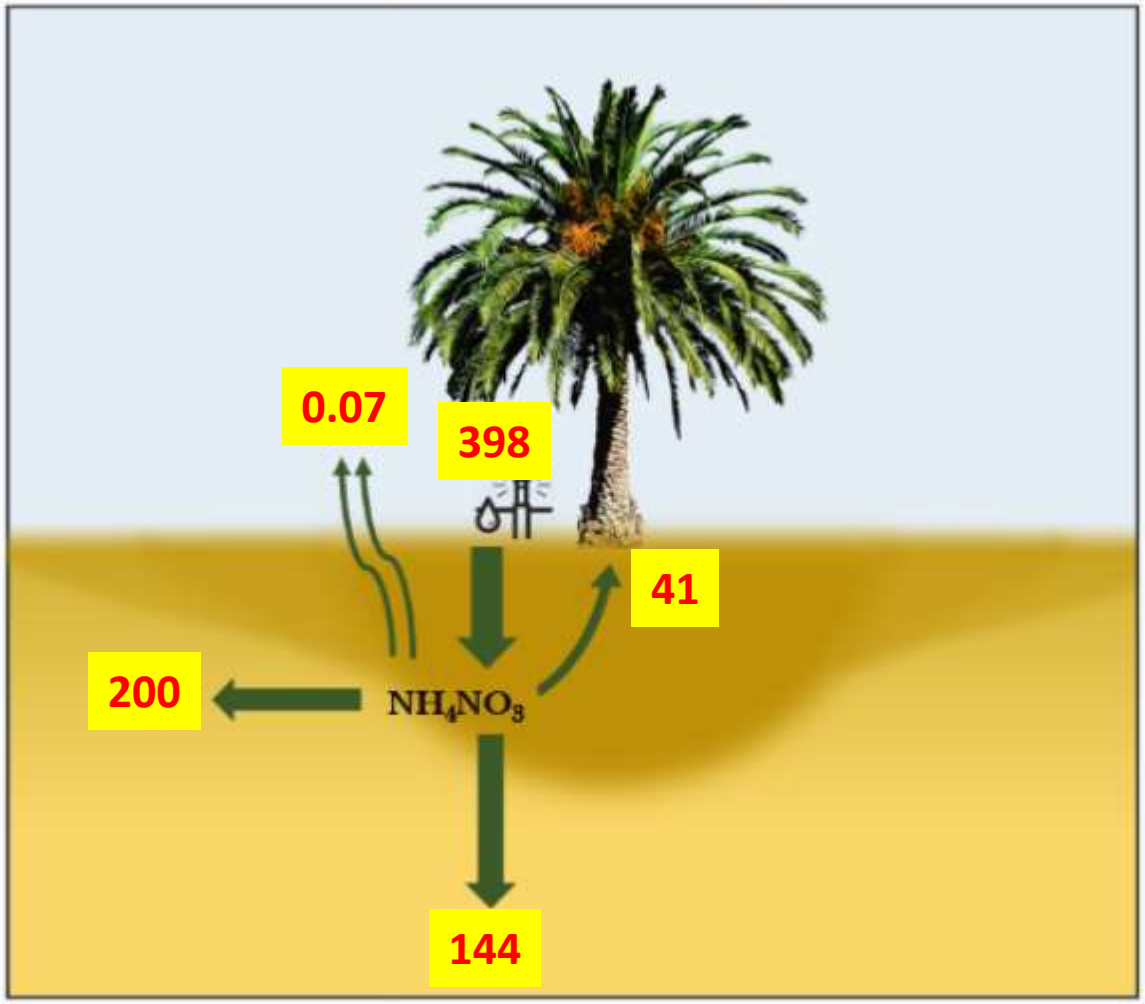


**Total soil inorganic N measured at 0.1 m depth, within a 1 m radius for fertilized trees, and off-treatment dry areas.*

Annual N Budget

Application of
2.55 kg N tree^{-1}

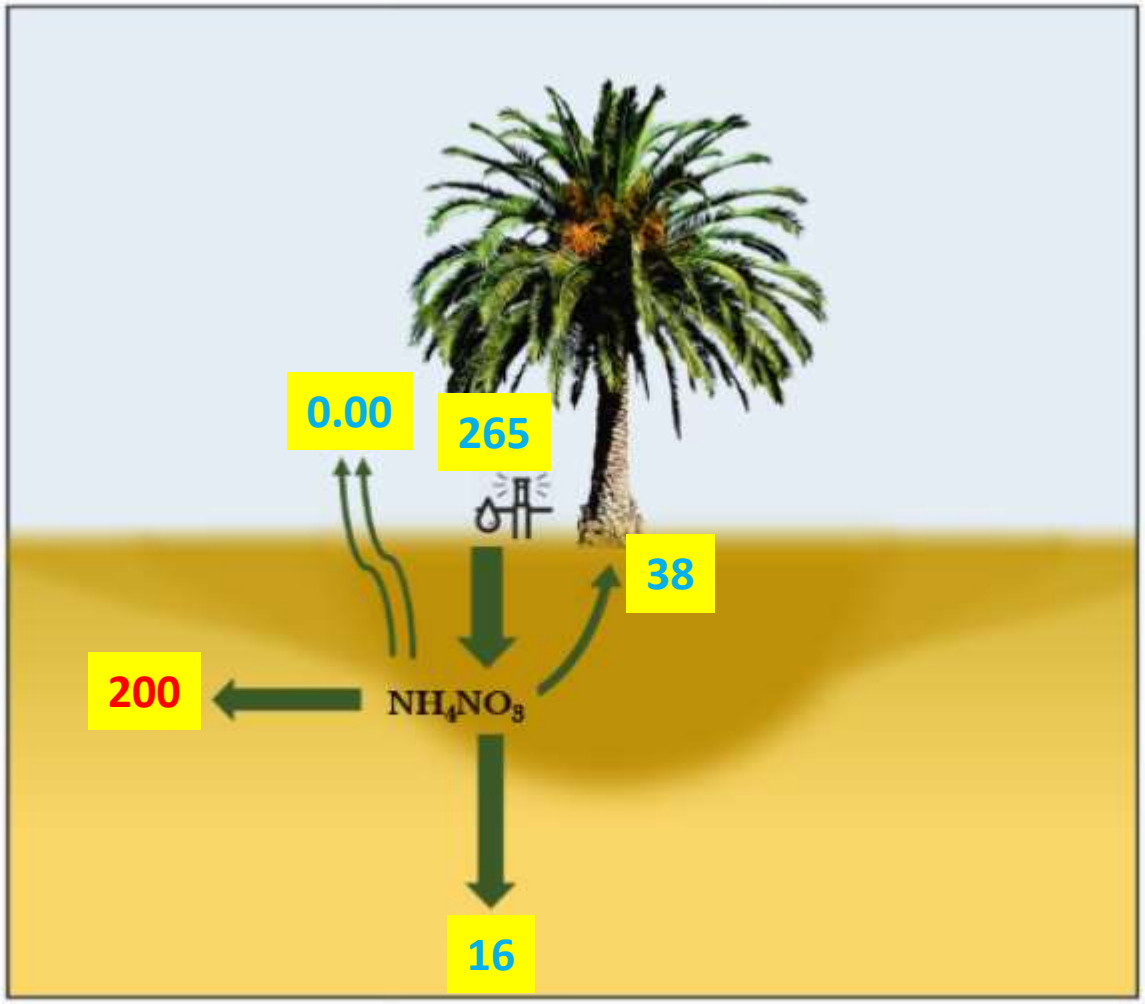
kg N ha^{-1} year^{-1}



Annual N Budget

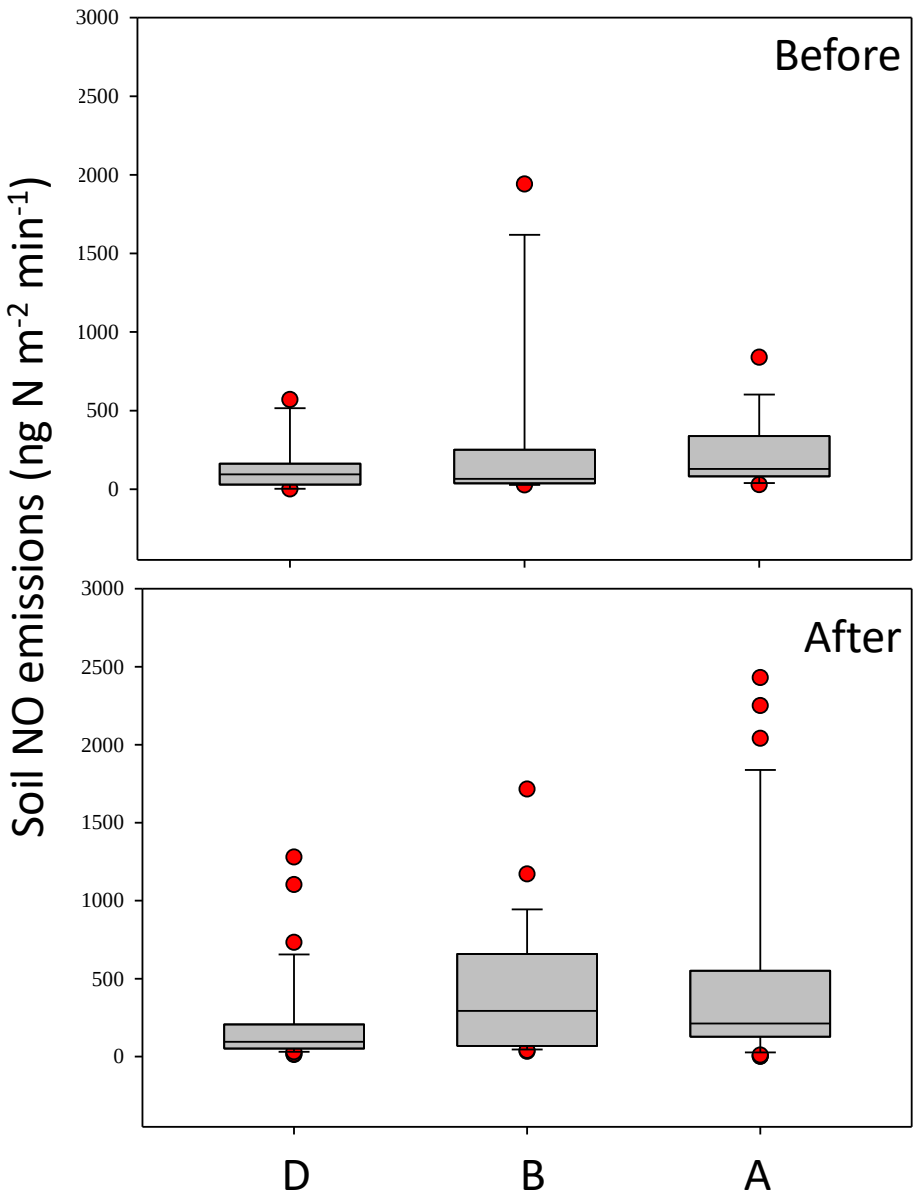
kg N ha^{-1} $year^{-1}$

Application of
1.75 kg N $tree^{-1}$

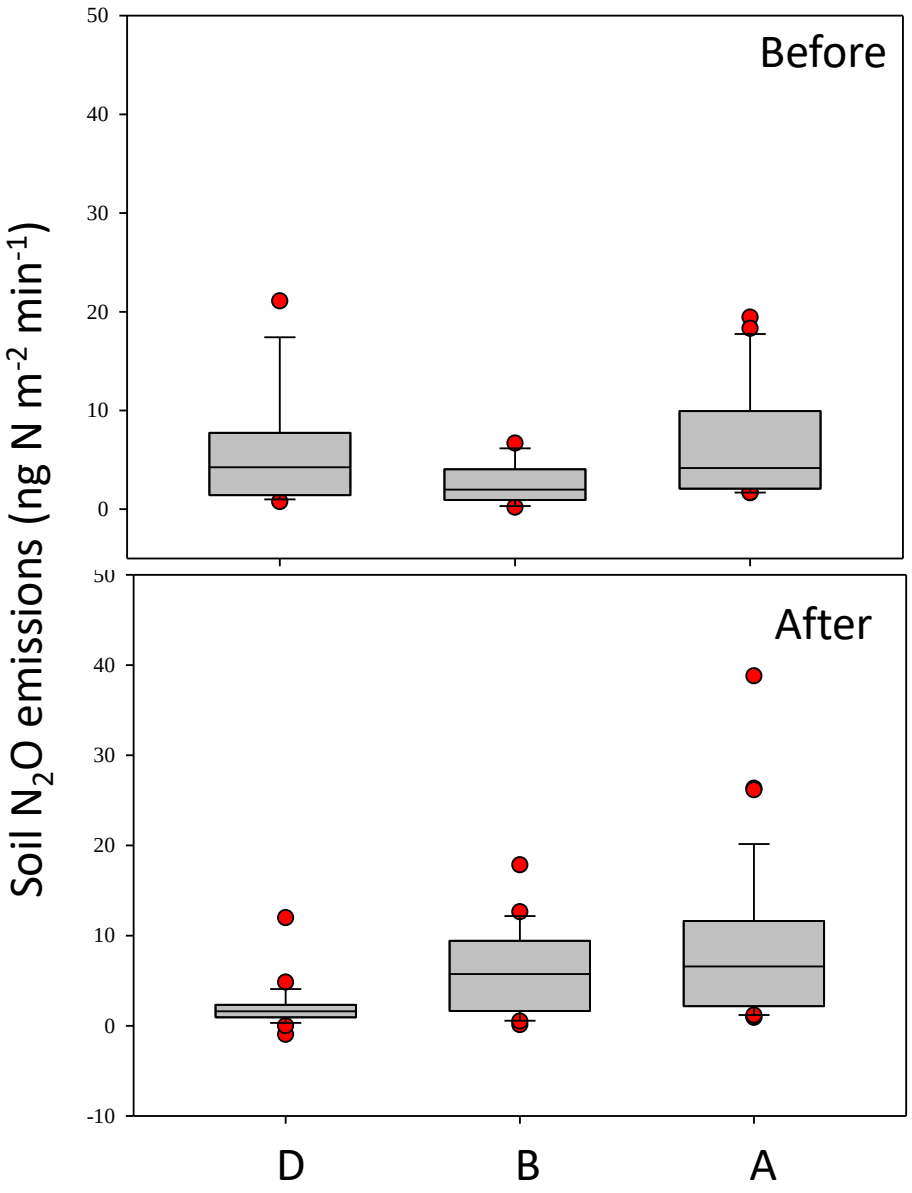


Peppers experiment: can we reduce N oxides emissions by managing fertigation?

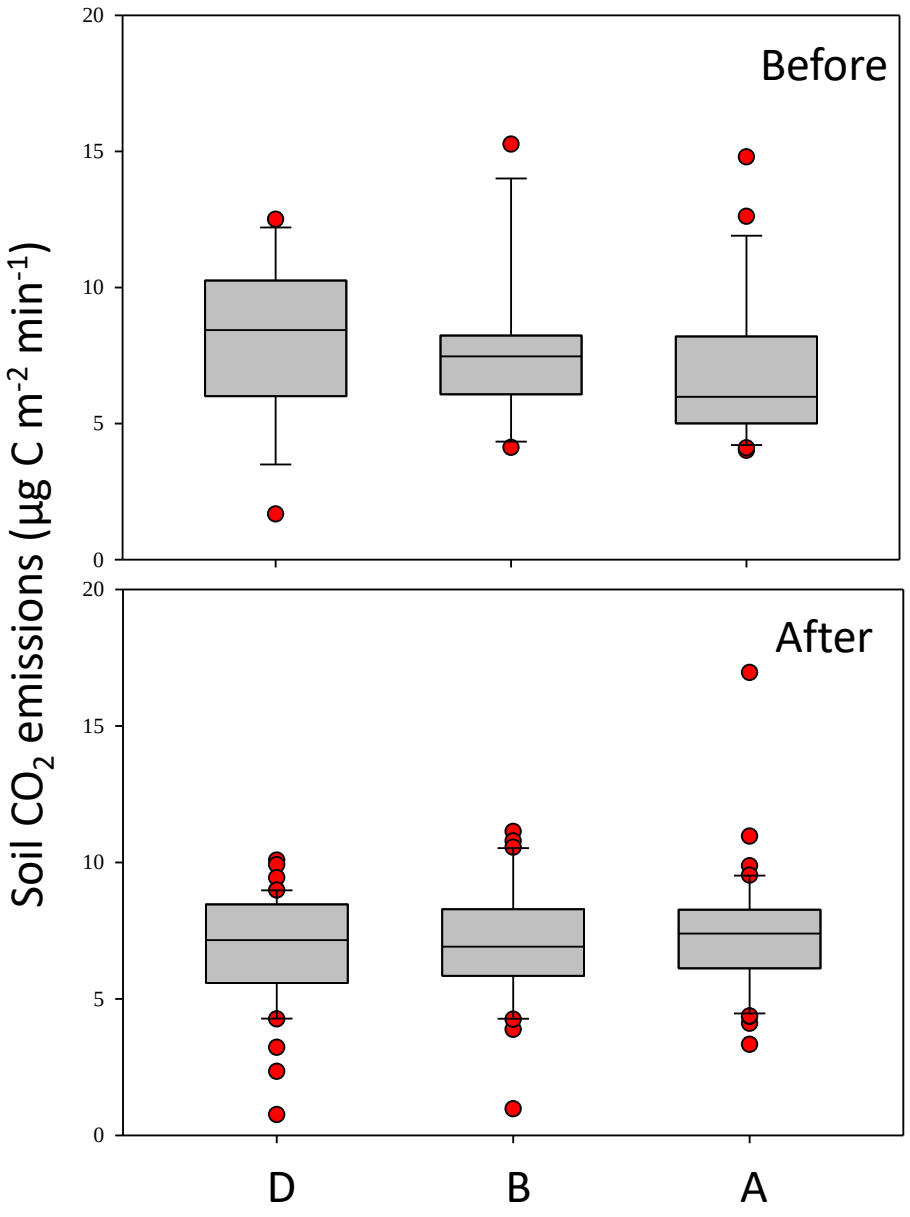
Soil gases emissions



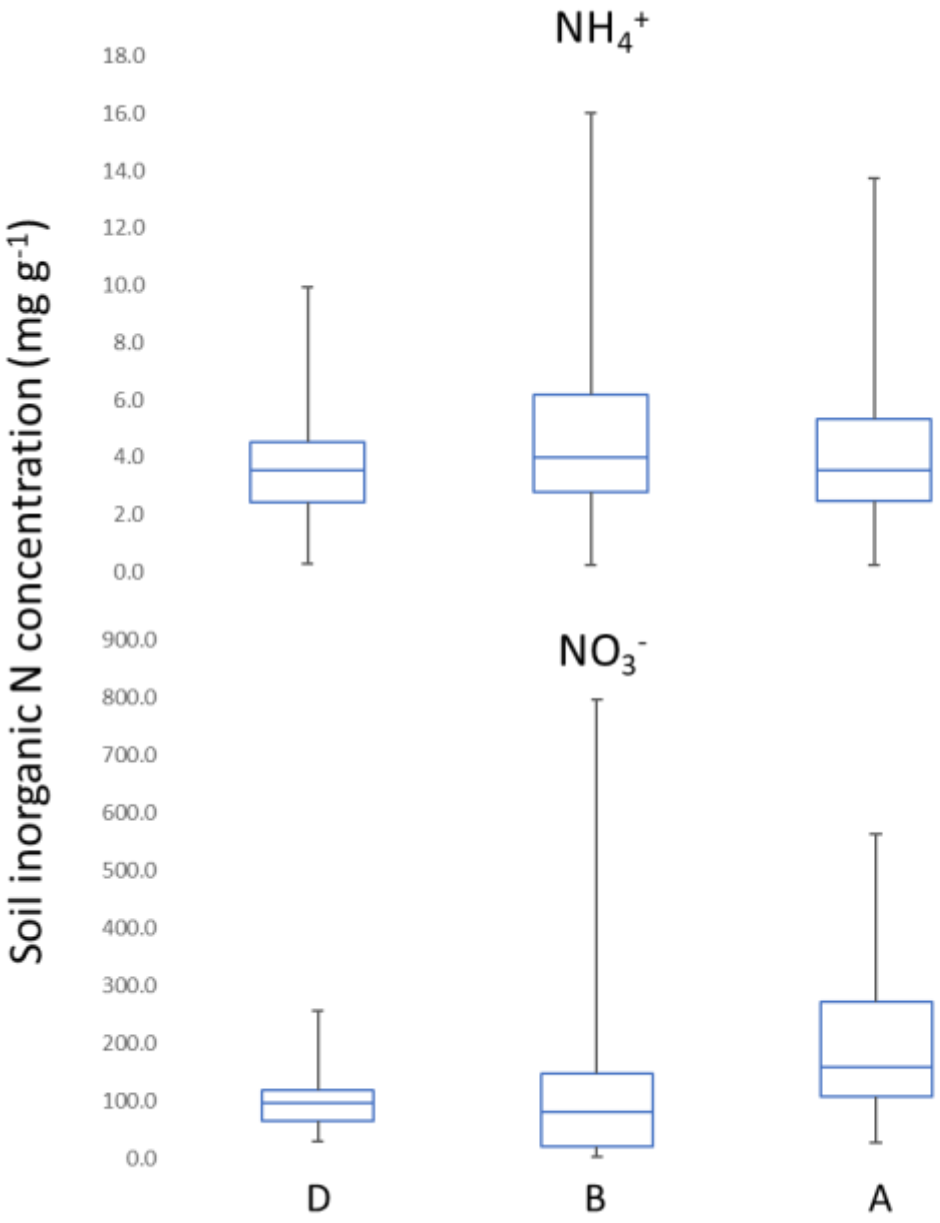
Soil gases emissions



Soil gases emissions



Soil inorganic N (0-10 cm)



Plant C and N content

Treatment	Carbon	Nitrogen
	%	
D	41.5 (0.7)	1.8 (0.1)
B	41.2 (0.5)	1.5 (0.1)
A	42.3 (1.0)	1.7 (0.1)

Carbon	Nitrogen
%	
41.7 (1.3)	1.7 (0.2)