4th CASEE Conference
"Food and Biomass Production - Basis for a Sustainable Rural Development"

Nitrate-Nitrogen Content in Soil and Lysimeter Water under Different Nitrogen Fertilization Levels in Biomass Production

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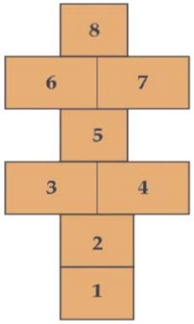
Zagreb, 01.07.2013.

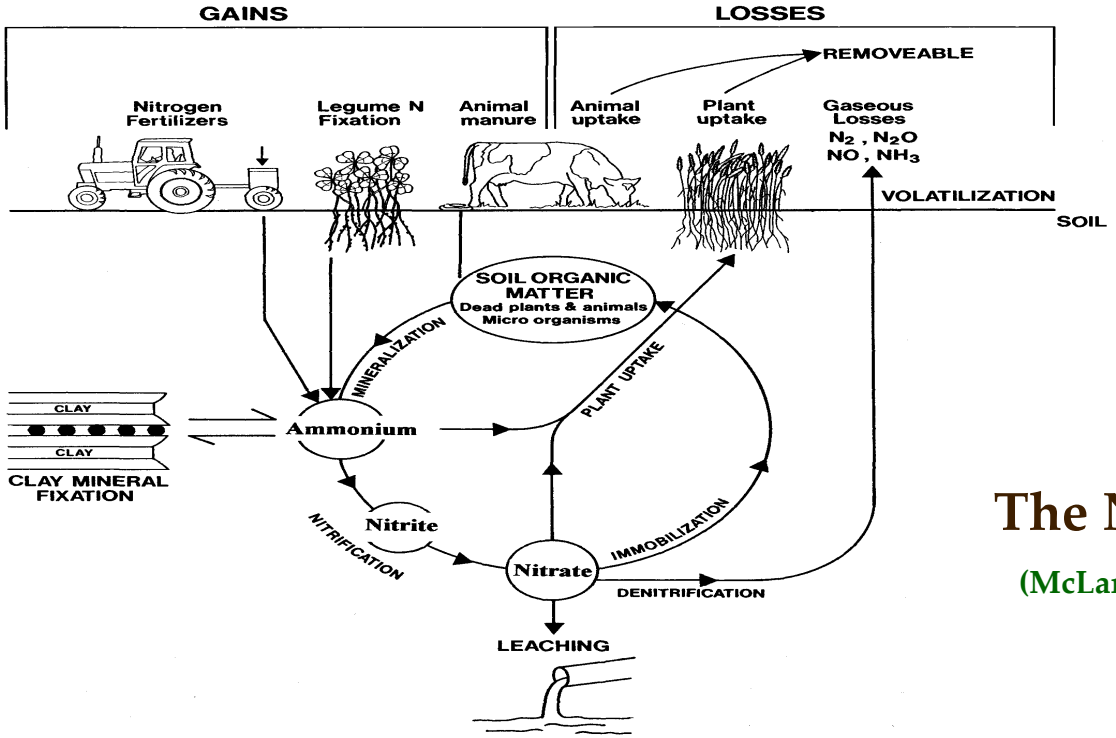
INTRODUCTION



Galloway et al. (1995)
named nitrogen as "hopscotch" (children's game)

- nitrogen moves through the air and water, across political and geographical boundaries around the globe

Reason:

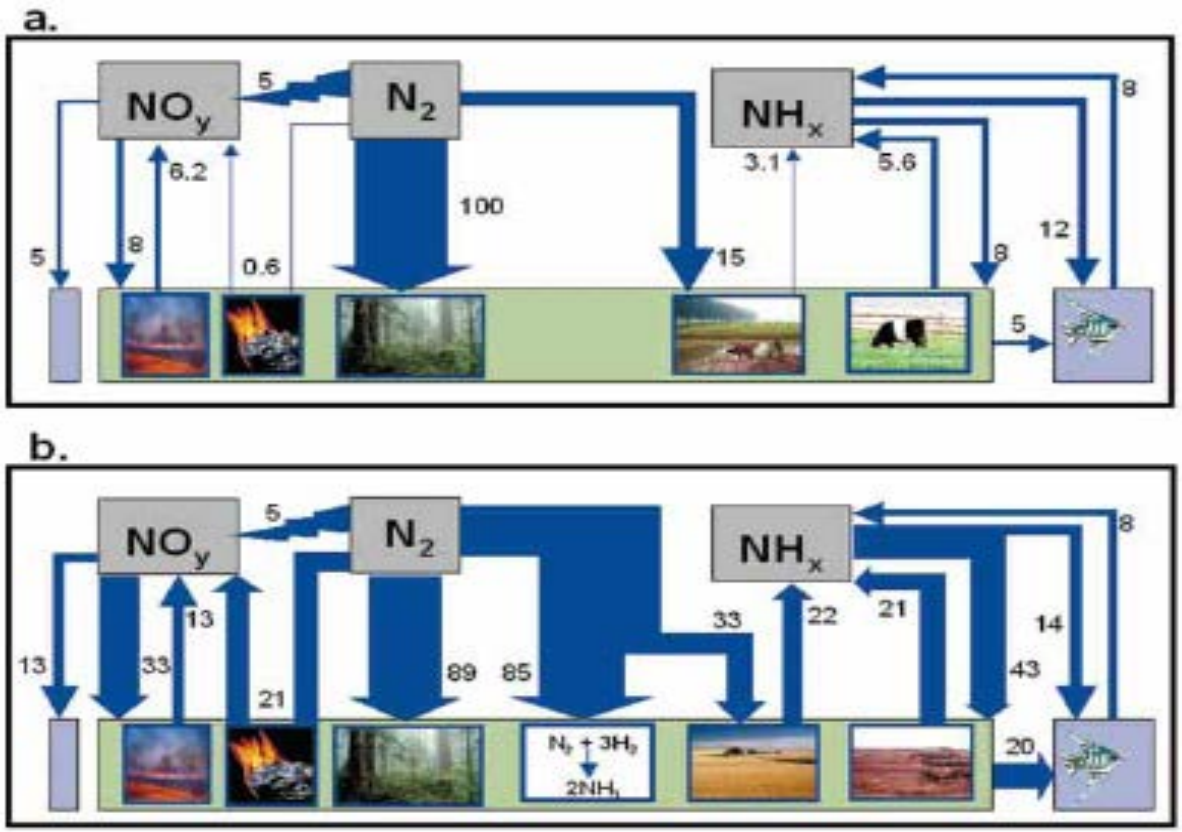


The Nitrogen Cycle

(McLaren and Cameron, 1996)

INTRODUCTION

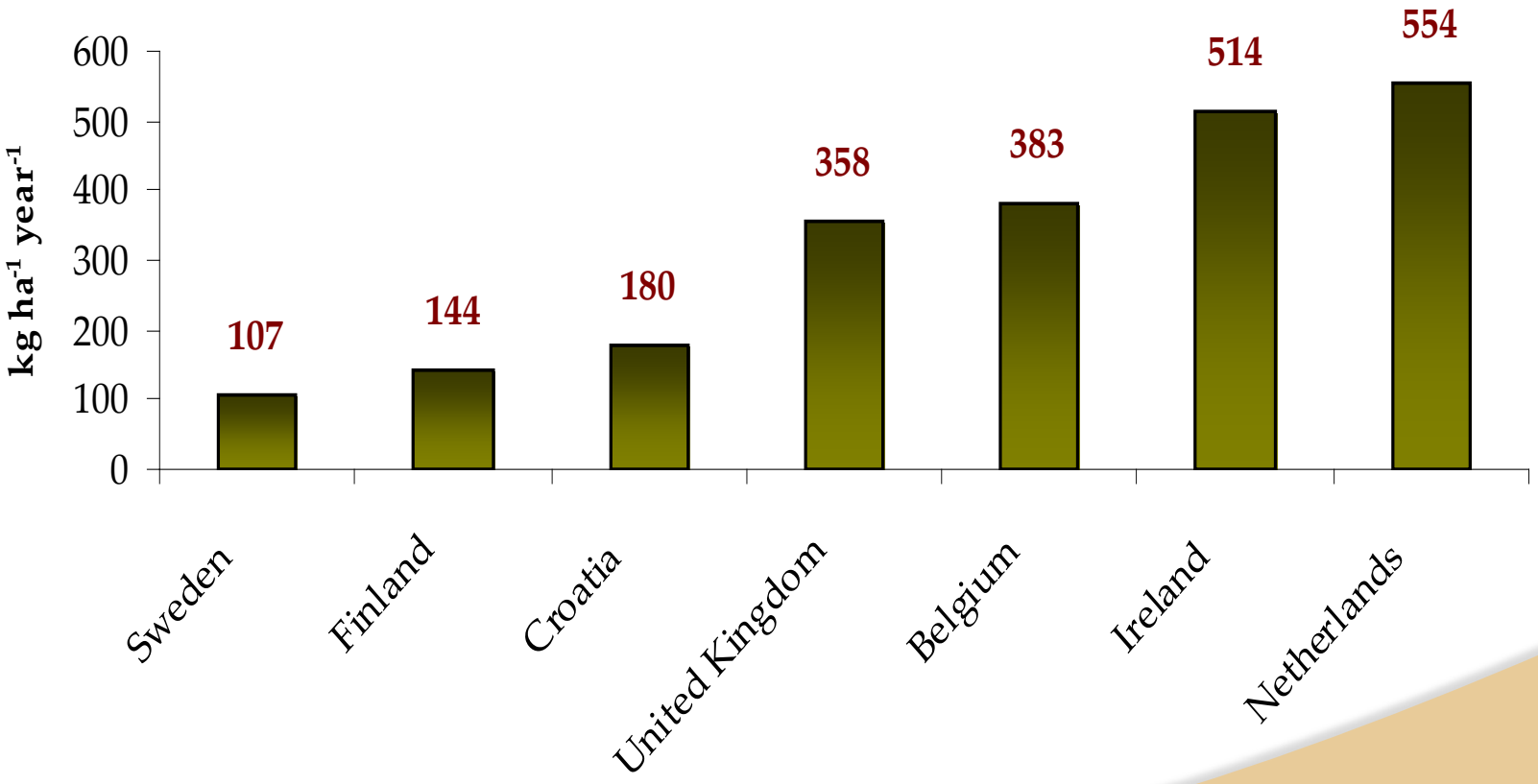
Global nitrogen budget for (a) 1890, and (b) 1990, Tg N yr^{-1}



After Galloway and Cowling, 2002.

INTRODUCTION

The annual consumption of mineral fertilizers



Source: FAOSTAT, 2010

INTRODUCTION

Influence of fertilization on environment

Air

- Agricultural practices in Croatia contributed to direct release of N_2O in the range of 3.2 Gg to 4.5 Gg (Mesic et al., 2006)
- Agriculture as a sector affects the emission of NH_4 with 90%

(Statistical Yearbook, 2010)

Water

- Groundwater pollution by nitrates from agriculture (Nemčić-Jurec, 2010)
- Drainage water pollution by nitrates from agriculture

(Simunic et al., 2002; Bensa et al., 2008; Zovko et al., 2008; Mesic et al., 2012)

- 1.9 mg NO_3^--N L^{-1} up to 319.0 mg NO_3^--N L^{-1}
- Drinking water standards - maximum NO_3^--N concentration - **10 mg L^{-1}** (WHO, 1998)
- EU Nitrate Directive 91/676/ EEC

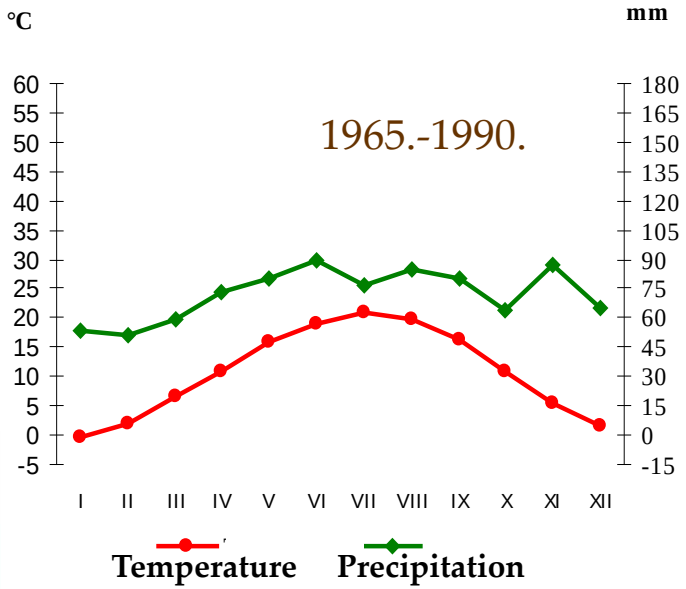
GOAL

1. Determine load of NO_3^--N in soil and NO_3^--N concentrations in lysimeters water regarding the different nitrogen fertilization levels

2. Quantify the effect of nitrogen application rates on NO_3^--N losses via lysimeter outflow

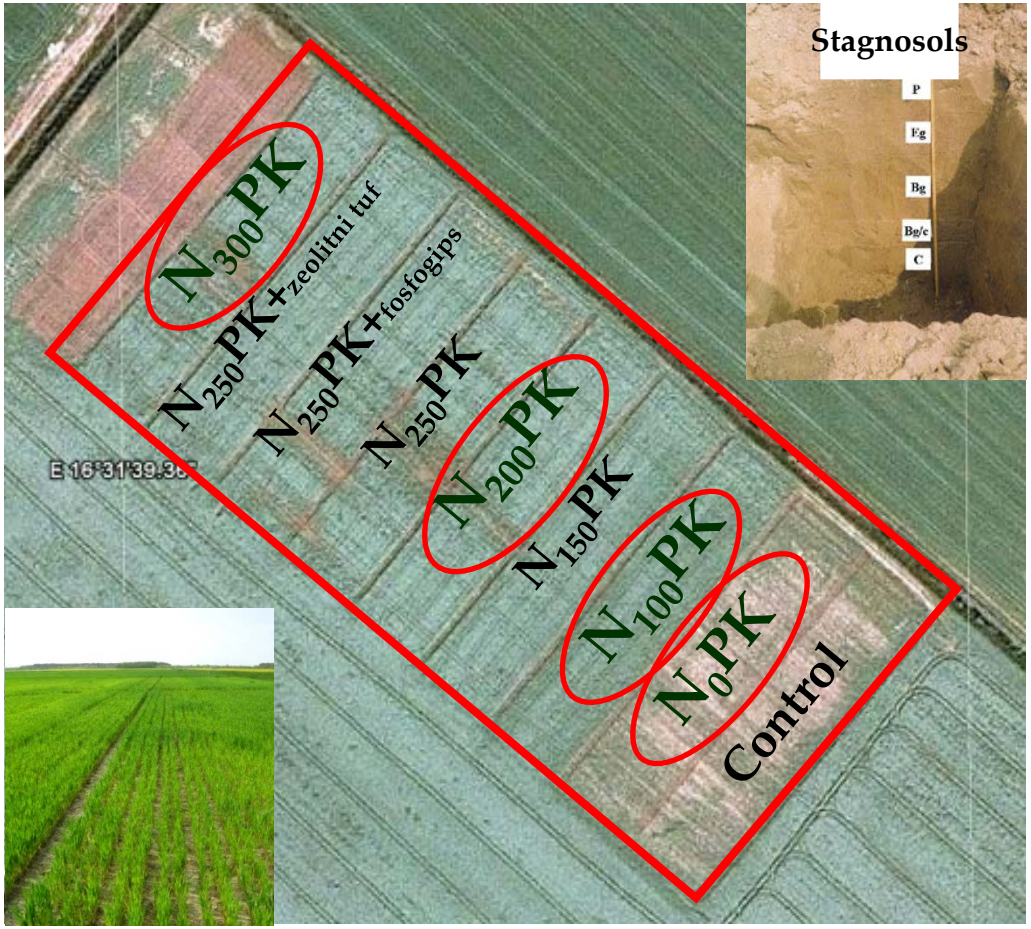
MATERIALS AND METHODS

- Central part of Croatia
- Western Pannonian subregion of Croatia (45°33´N, 16°31´E)
- Soil type: drained Stagnosols
- Annual temperature T=10,7 °C
- Precipitation = 865 mm



MATERIALS AND METHODS

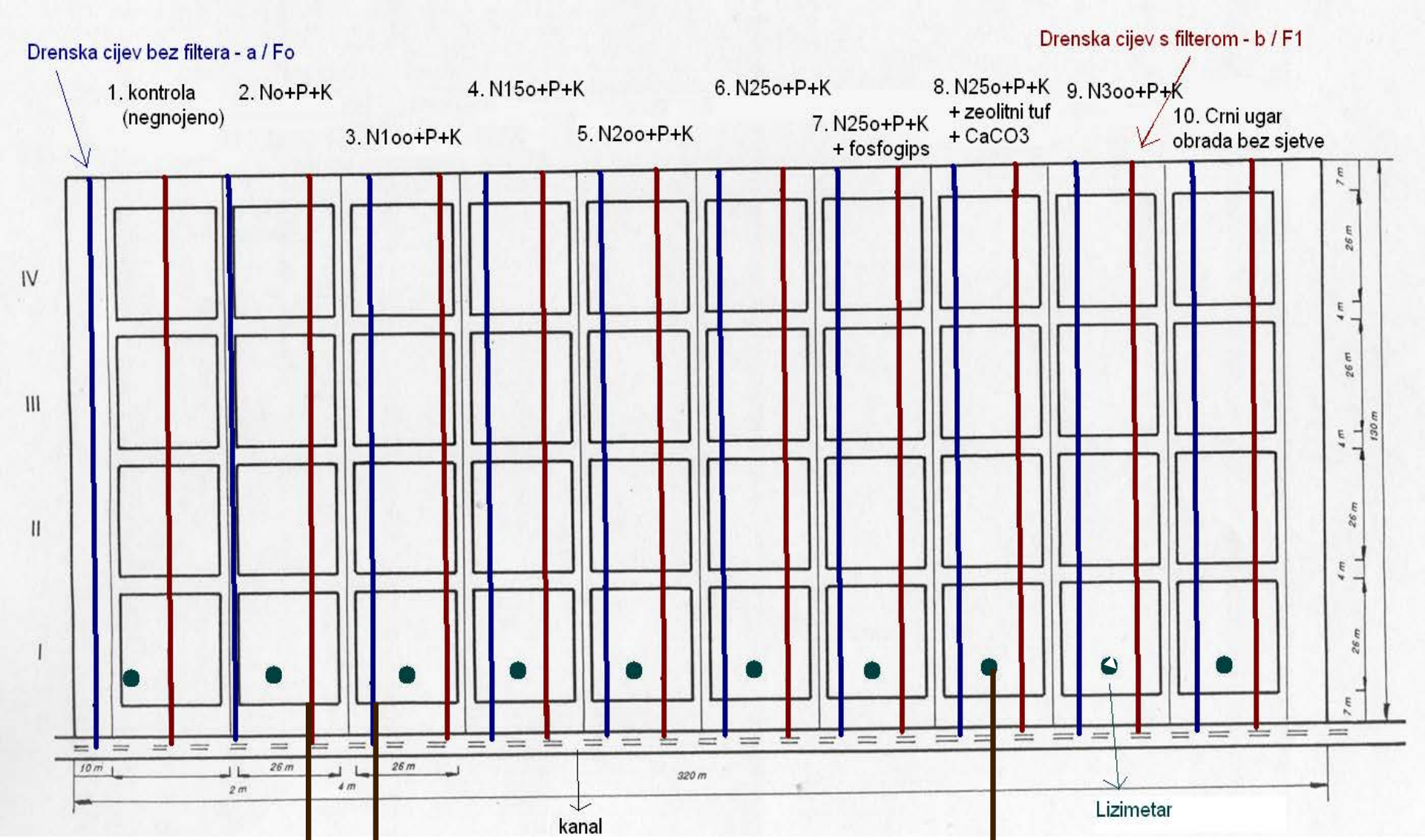
Methodology of experiment



- **4 ha**
- quantities of phosphorus and potassium are constantan on all treatments:
  - ➢120 kg P ha^{-1}
  - ➢180 kg K ha^{-1}
- 4 replications

This investigation includes four treatments:

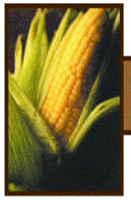
1. **N_0PK**
2. **$N_{100}PK$**
3. **$N_{200}PK$**
4. **$N_{300}PK$ (kg N ha^{-1})**

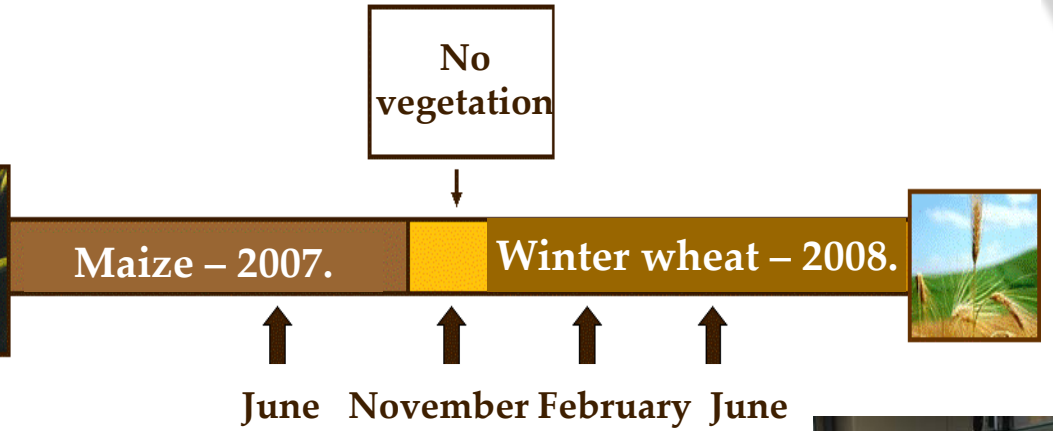

Drenska cijev bez filtera - a / Fo
Drenska cijev s filterom - b / F1
1. kontrola (negnojeno)
2. No+P+K
3. N1oo+P+K
4. N15o+P+K
5. N2oo+P+K
6. N25o+P+K
7. N25o+P+K + fosfogips
8. N25o+P+K + zeolitni tuf + CaCO3
9. N3oo+P+K
10. Crni ugar obrada bez sjetve
IV
III
II
I
10 m
26 m
2 m
4 m
26 m
320 m
kanal
Lizimetar
Drainage pipes
Lysimeter

MATERIALS AND METHODS

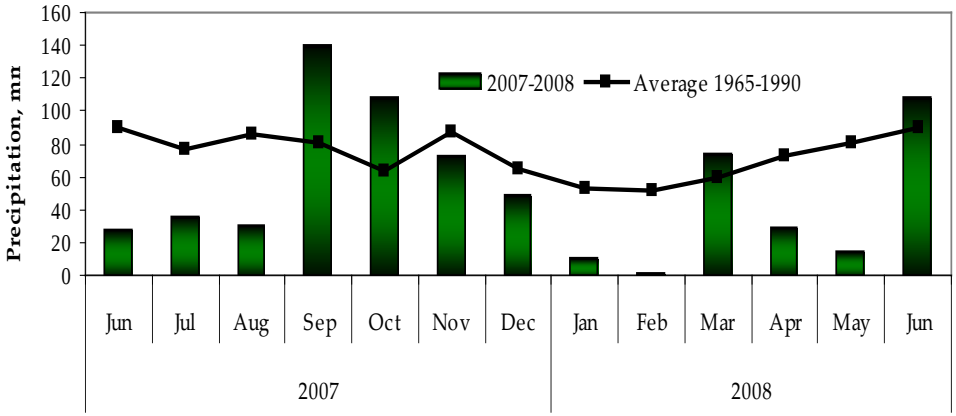
Soil sampling

Depth: 0-25 cm
4 replications



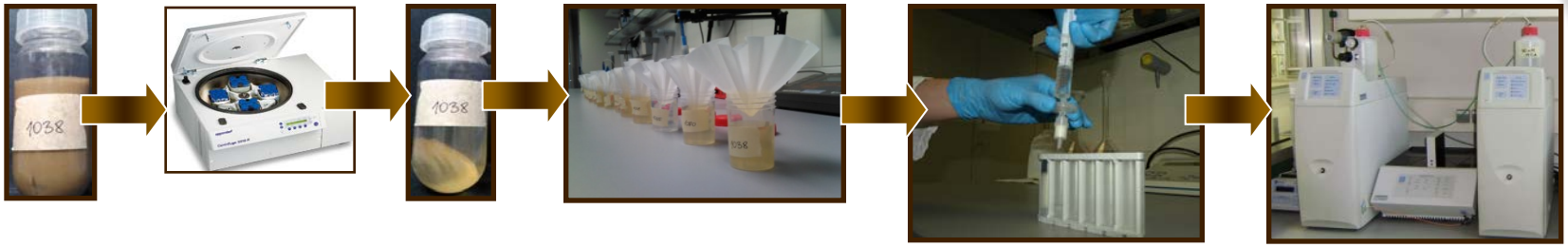


Water sampling



MATERIALS AND METHODS

Laboratory measurements

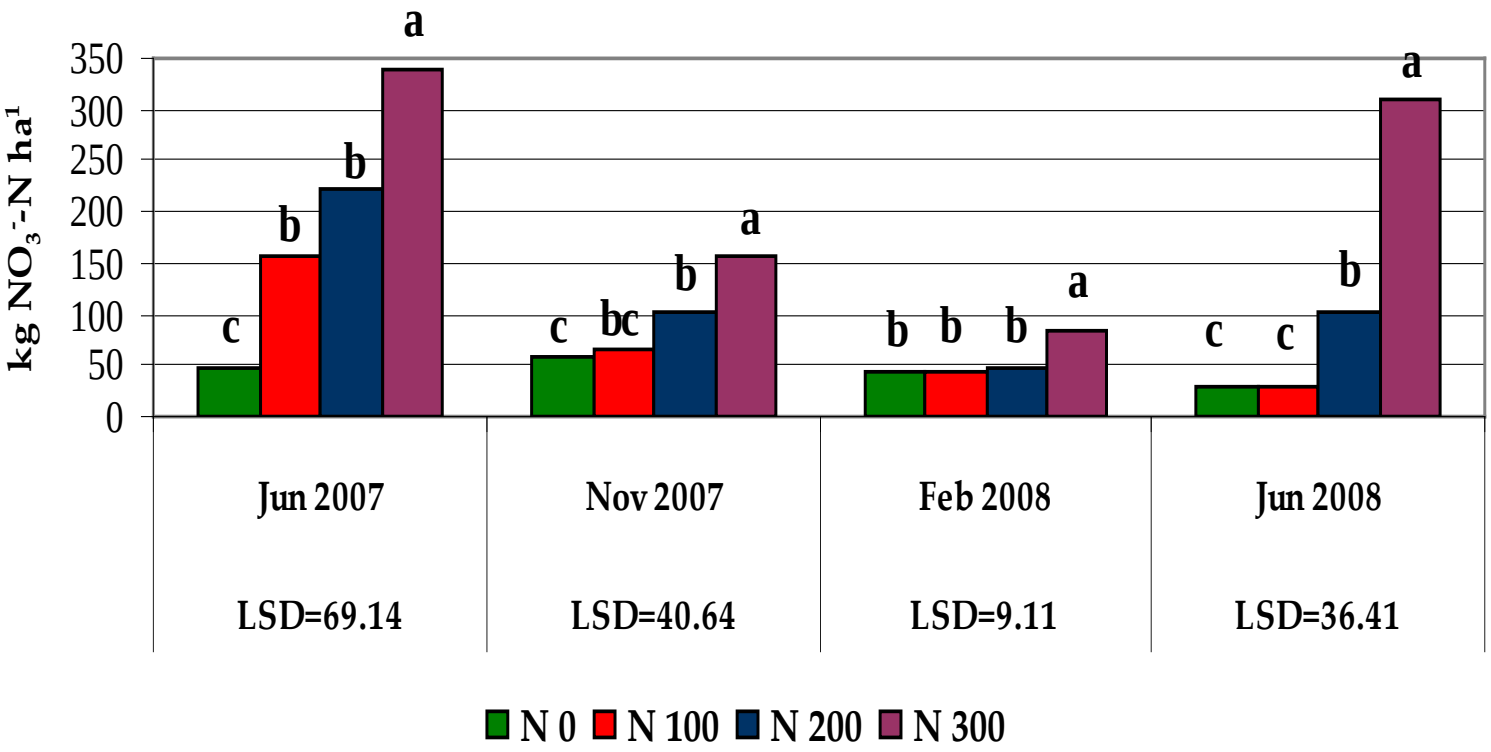


- **Extraction** (1:10 (w/v) in ultra pure water)
- **Centrifuge** (5 min at 12000 rpm) and **filtration**
- $N\text{-}NO_3^-$ determination by **ion-chromatography method**

Statistical analysis

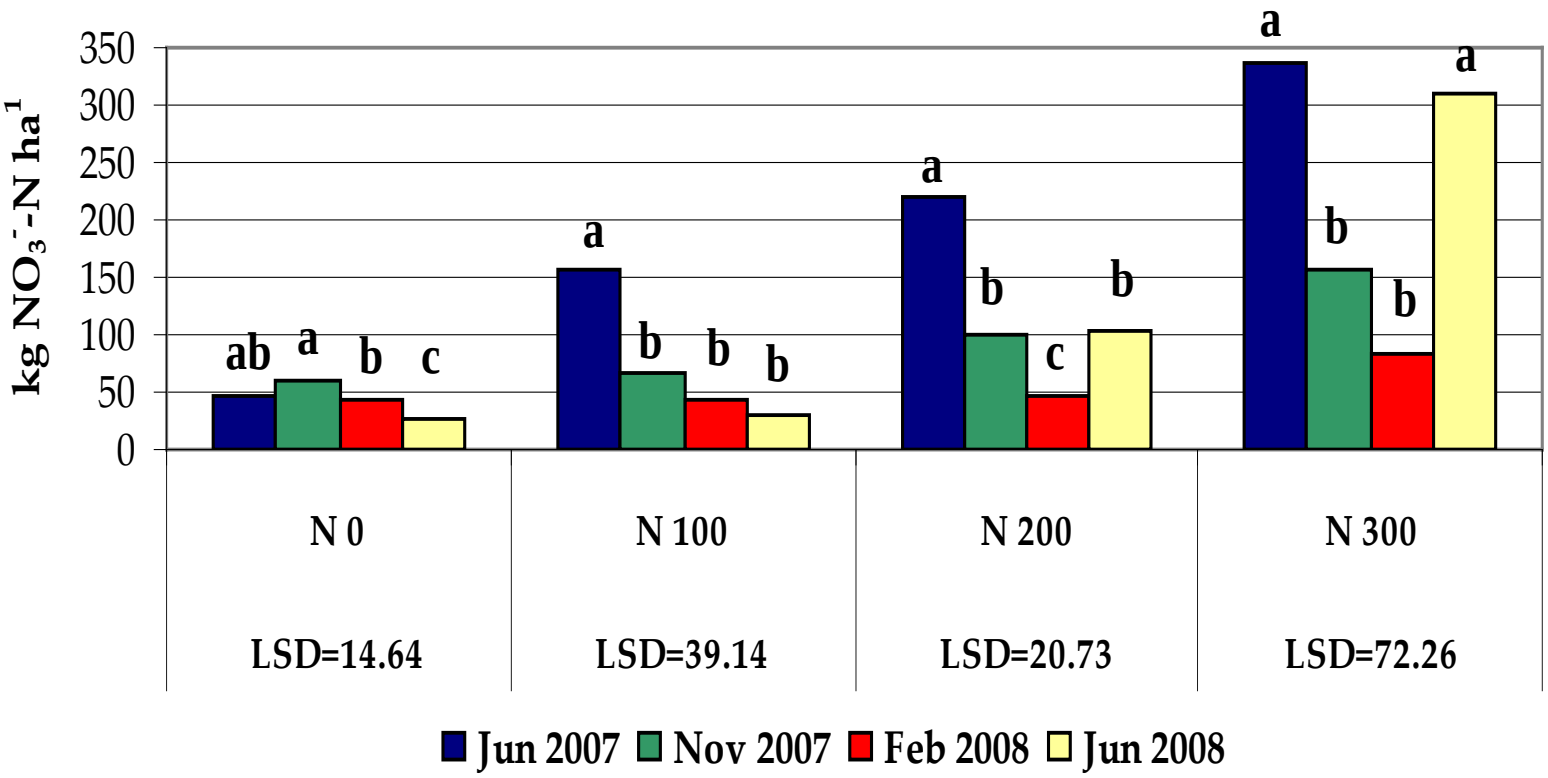
- Differences in soil nitrate-nitrogen content according to fertilization treatments for each sampling time and across sampling dates for each treatment were computed by analysis of variance (ANOVA) (SAS 9.1, SAS Institute Inc., USA).
- The significance test was performed at probability level of $p < 0.05$.
- Fisher's least significant difference procedure

RESULTS - SOIL



Similar findings were reported in research all over the world:
Asia (Guo et al., 2001)
Africa (Ikerra et al., 1999)
America (Nance and Karlen, 2007)
Europe (Kristensen and Thorup Kristensen, 2007; Németh and Kádár, 1999)

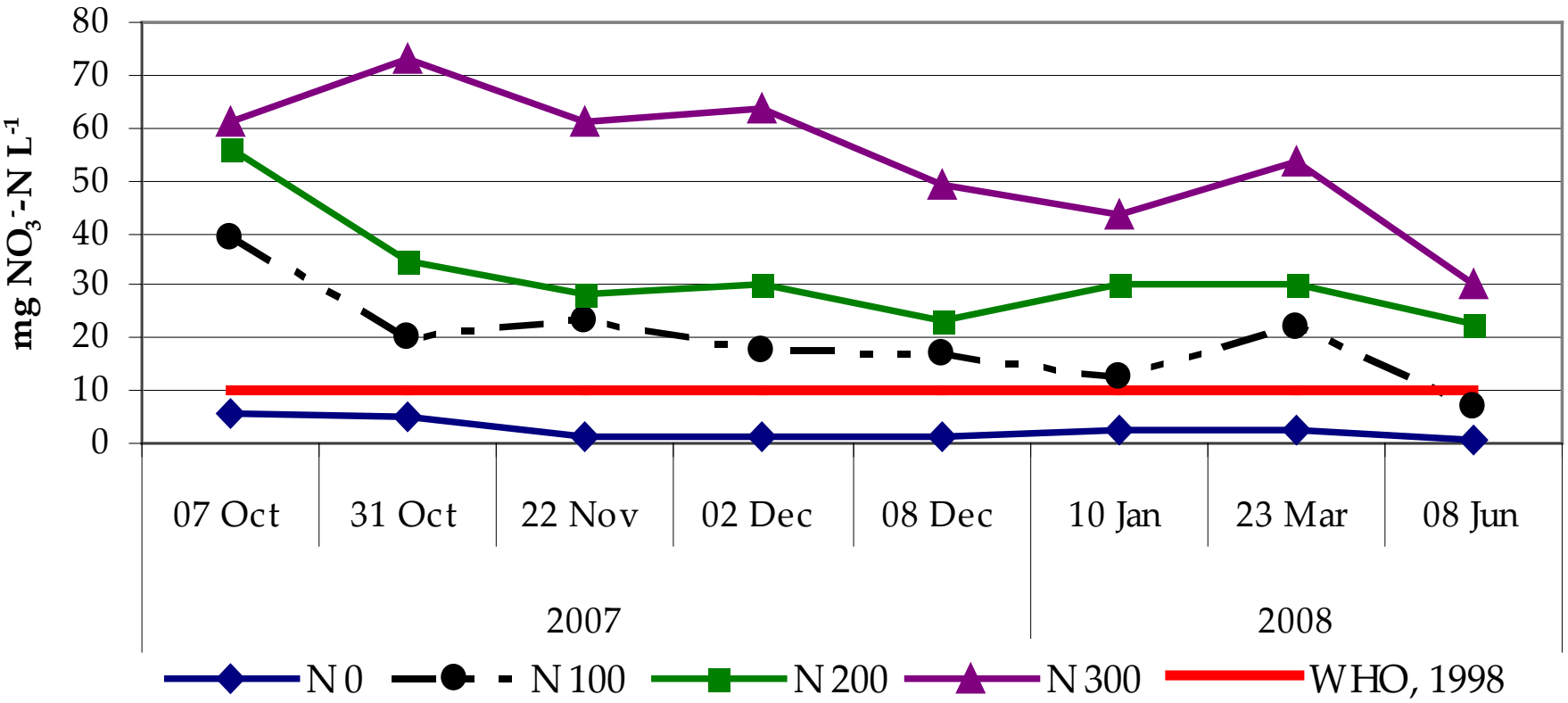
RESULTS - SOIL



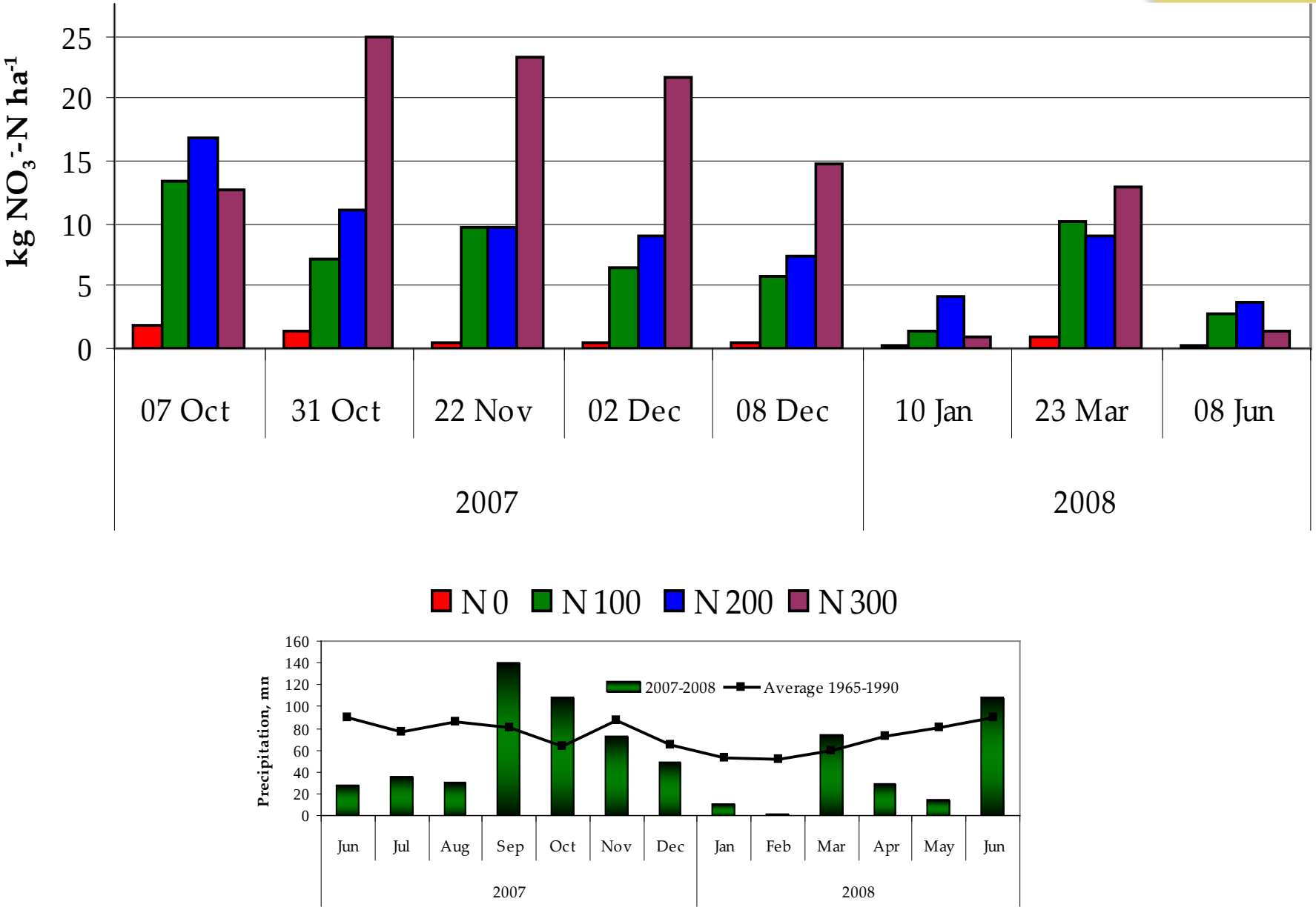
- Nitrification attains its optimum at 26 °C (Beck, 1983)
- Excessive soil moisture inhibits the nitrification process (Sabay, 1969)

- June 2007 - mean monthly temperature was 22.5 °C
  - monthly precipitations were 28.2 mm

RESULTS - WATER



RESULTS - NO_3^--N losses



CONCLUSIONS

- Soil NO_3^--N content significantly varied from 27.3 kg ha^{-1} to 338.2 kg ha^{-1} depending on the treatment and sampling time

- High rates of N fertilizer in the production of maize and winter wheat have resulted in excessive nitrate N (NO_3-N) leaching, with concentrations in lysimeter water frequently exceeding the maximum contaminant level (MCL) of 10 mg/L.

- NO_3^--N losses through lysimeter outflow (0.12 kg ha^{-1} – 24.8 kg ha^{-1}) were influenced by climate conditions, crops grown and their development stages and quantity and time of fertilizers applications.

THANK YOU!

Nitrogenium Azote Nitrogen Dušik Azoto

Stikstof Stickstoff Nitrogênio Nitrógeno Kväve