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Crop Recovery of Labelled-^{15}N Urinary-N Following Simulated Winter Forage Grazing

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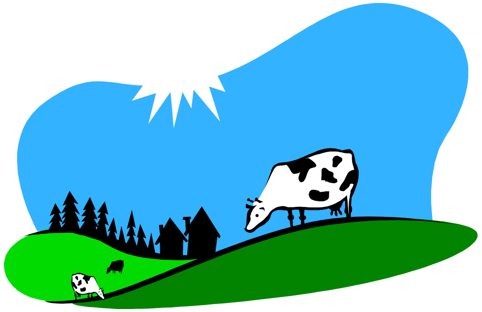

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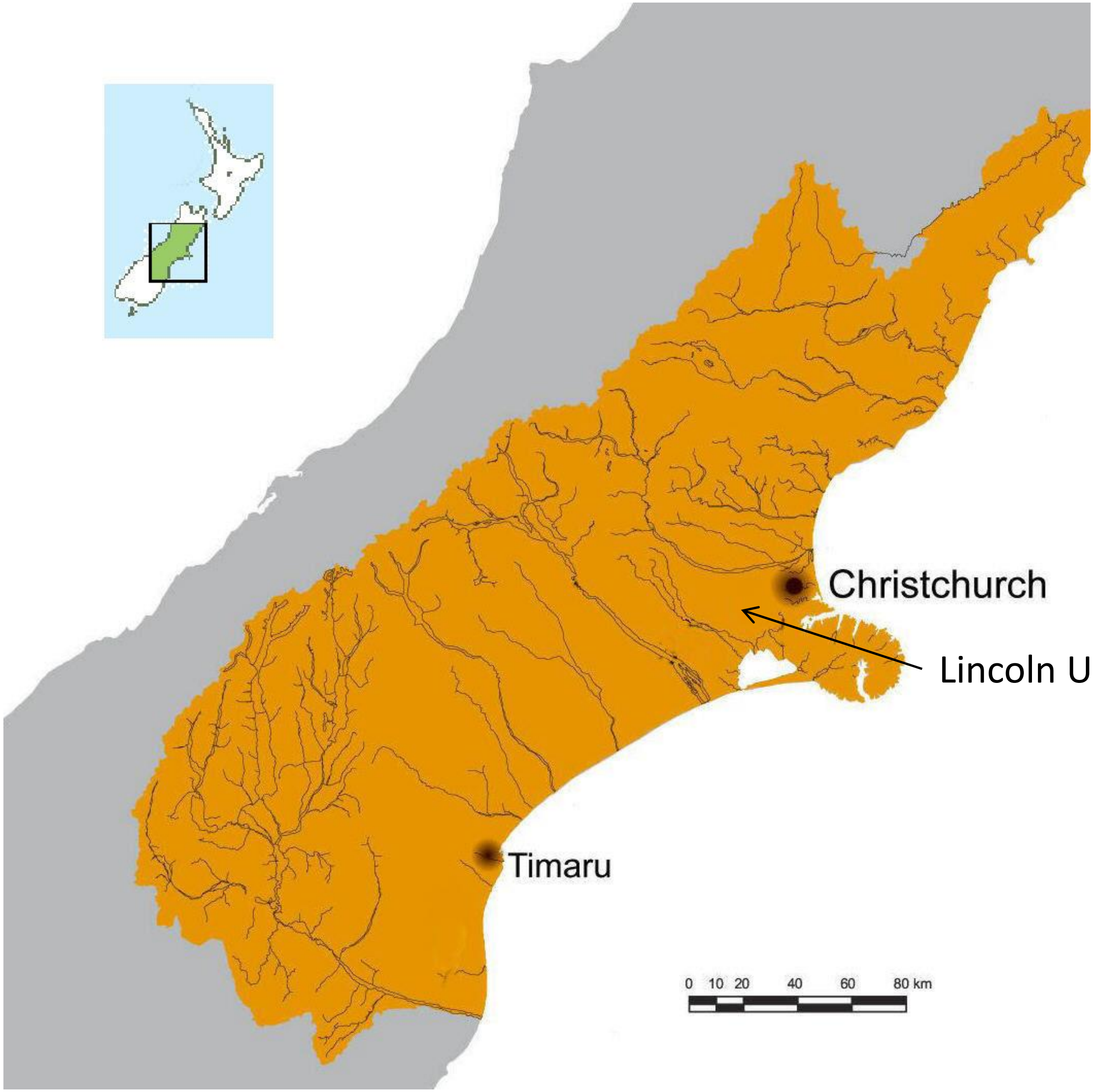
Introduction

- In the NZ dairy industry winter forage grazing (WFG) is a common winter feed management option to build body condition of dairy cows prior to calving.
- Stock graze winter forage crops (WFG) outside
  - forage brassicas: kale, turnips, swedes, etc.
  - crops are grazed over the main winter months (June & July)
- However, this also coincides with higher rainfall & minimum evapotranspiration
  - max. drainage = max. potential for nitrate leaching.
  - Nitrates in ground and surface water are an environmental concern

Introduction (cont’d)

- Monaghan et al. (2007) identified that 45% of a NZ catchment’s N leaching losses can occur from dairy feed wintering systems occupying just 10% of the catchment area.
- Losses of nitrate-N (and N_2O) are potentially high: ~80-150 kg N/ha (Shepherd et al. 2012; Smith et al. 2012)
- New strategies are needed to reduce these N losses if these low cost feed systems are to continue.
- Could the use of a catch crop, with or without a nitrification inhibitor (DCD), help lower these losses?



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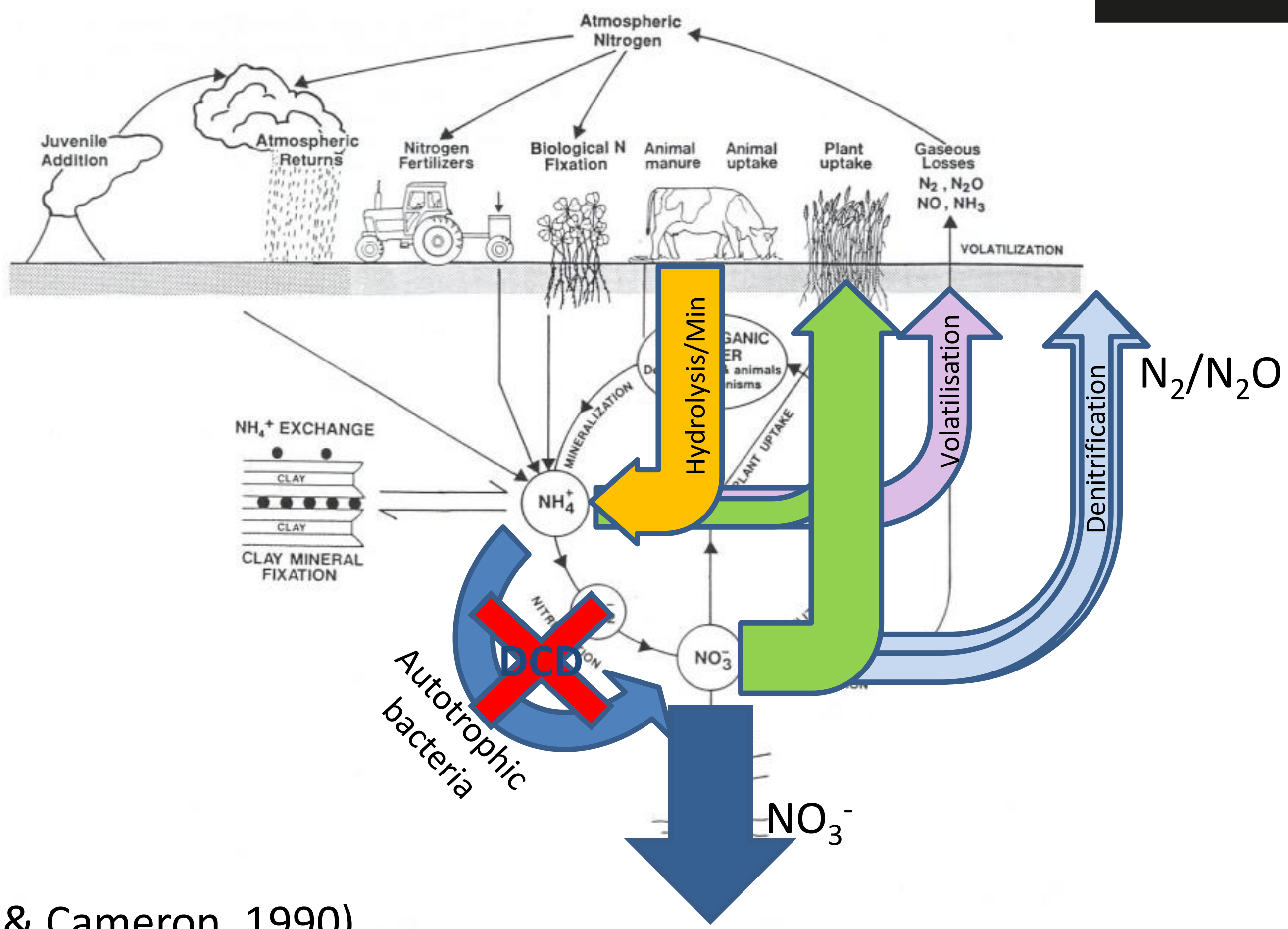
Nitrogen cycle



(McLaren & Cameron, 1990)

Objectives

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1. To quantify the effect of single and double urination events on N leaching losses on a stony, free-draining Canterbury soil following winter forage grazing and mitigation potential by two spring-sown catch crop species.
2. Quantify the synergistic effect of applying a nitrification inhibitor in combination with a spring-sown catch crop to further reduce N leaching losses.

Hypothesis

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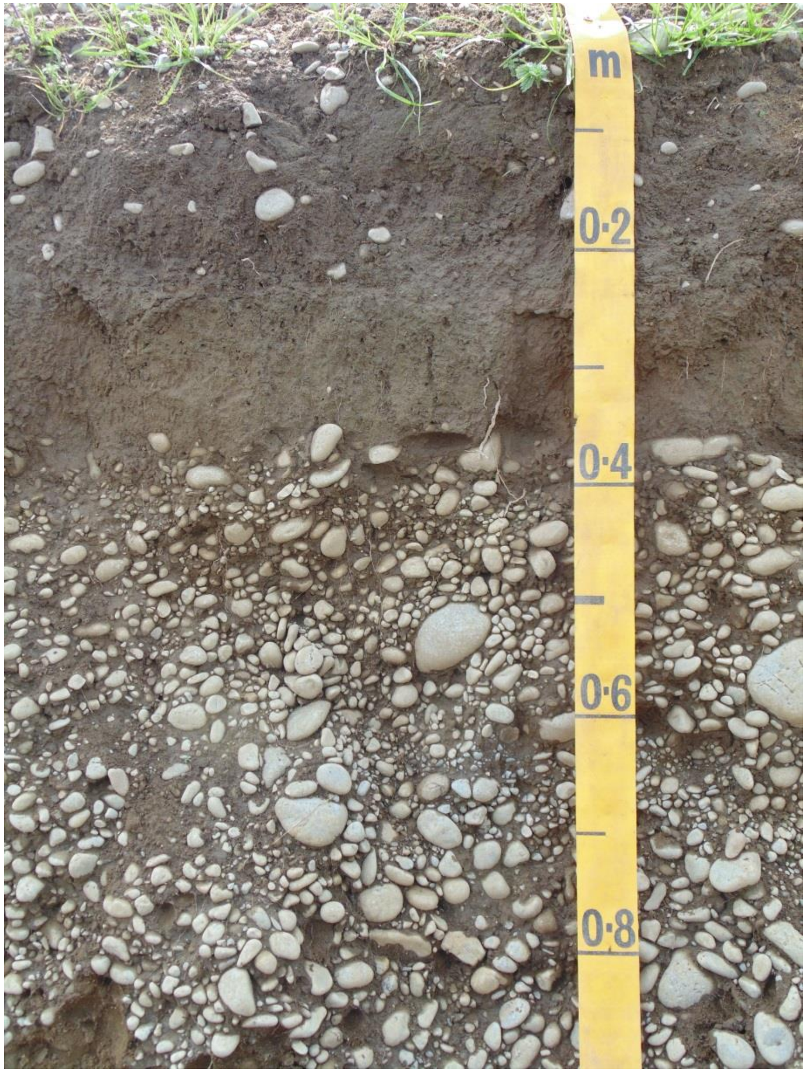
That sowing a catch crop and application of a nitrification inhibitor after winter forage grazing can reduce nitrate leaching from urinary-N deposition.

Methodology
Lysimeter collection and installation

Balmoral silt loam



Balmoral soil properties

NZSC: Acidic Orthic Brown

Mod. stony ~50% (30 cm)

pH	6.0
Olsen-P	33
cmol Ca/kg	9
cmol Mg/kg	0.6
cmol K/kg	0.5
CEC	16
BS%	58
C%	4.2
N%	0.38
C/N ratio	11.1

Experimental design

- 32 lysimeters; kale- 8 trts x 4 reps
- 2 catch crops – Oats (*Avena sativa*)
  or Italian ryegrass (*Lolium multiflorum*).
- Urine applied at 0, 350 & 700 kg N/ha
- 2 DCD rates- 0 & 20 kg/ha; 350 trt. only (t-test)
- Urine labelled with 98% ^{15}N-urea/glycine (90:10)
  (~9% enriched; control received 35 kg 98% ^{15}N/ha)

Urine-N rate (kg N/ha)	0	350	350+DCD	700 (2 app.)
Oats	4	4	4	4
Italian ryegrass	4	4	4	4

Experimental protocol

Order of operations

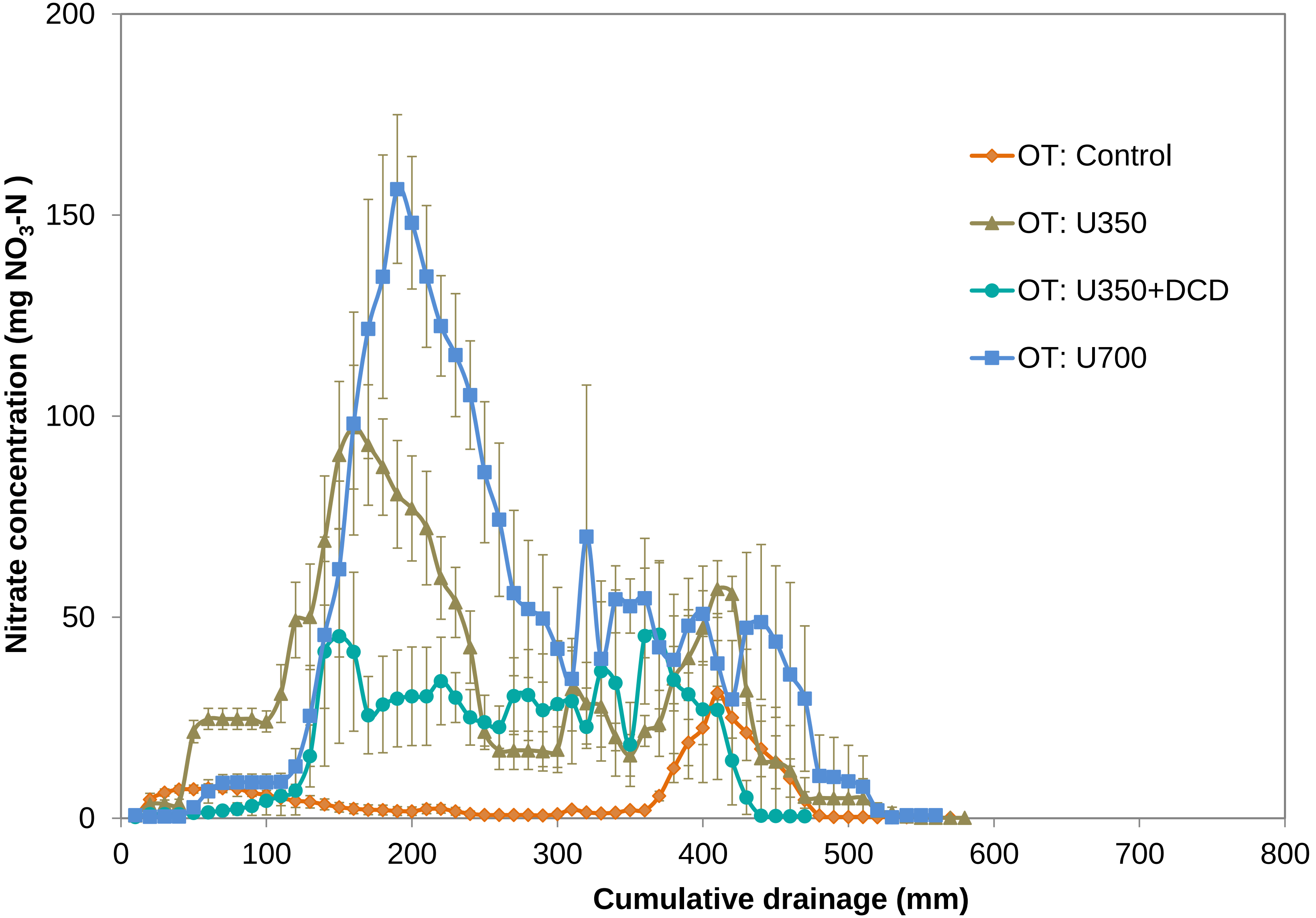
- Kale transplanted in Nov 2012
  (basal fertiliser applied & 2x 25 kg N/ha)
- "Grazed" late June 2013, pugged surface with artificial hoof
- Labelled urine applied (2 L/lys);
  DCD applied 1 day later -10 mm irrigation
- Oats sown August and Italian RG in Sep/Oct
- Rainfall set at 75th percentile –irrig. deficit >20 mm
- Oats harvested Nov., Kale re-sown early Dec.
  Ryegrass harvested at ~2500 kg DM/ha, residual 1500.

Measurements

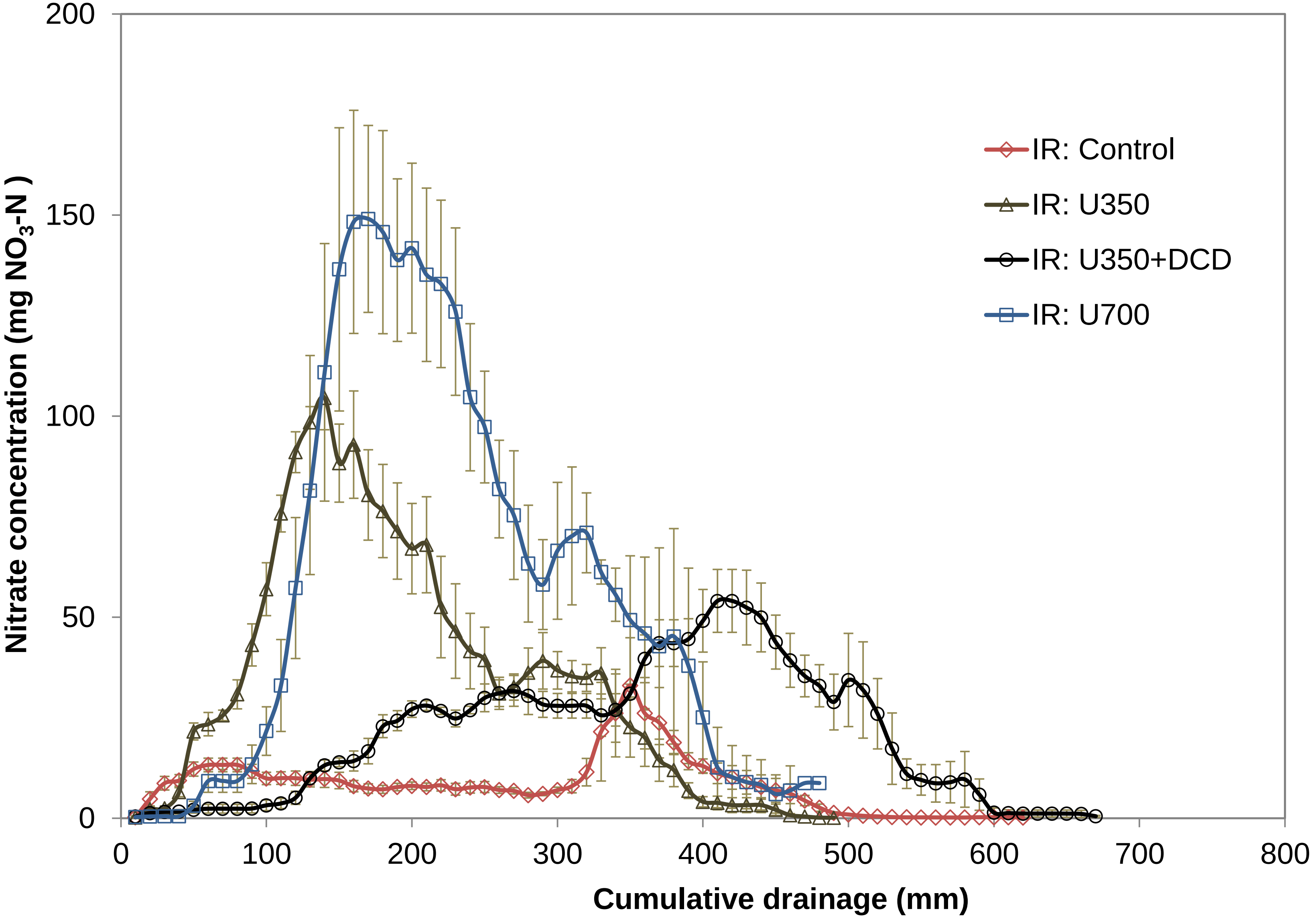
- Full N balance- gas/leachate/DM/soil
- Ammonia volatilisation – airflow trap method (Black et al. 1985)
- Nitrous oxide/N_2 emissions- enclosure method (Di et al. 2007)
- N leaching- leachate collected 1-2/week-FIA analysis ^{15}N diffusion method (Brookes et al. 1989)
- Destructive soil and root sampling- ^{15}N balance (Fraser 1992; Silva 1999)
- Total-N and ^{15}N analysis of soil & plant material using Elementar Vario-Max instrument and mass spectrometer, respectively.

Results

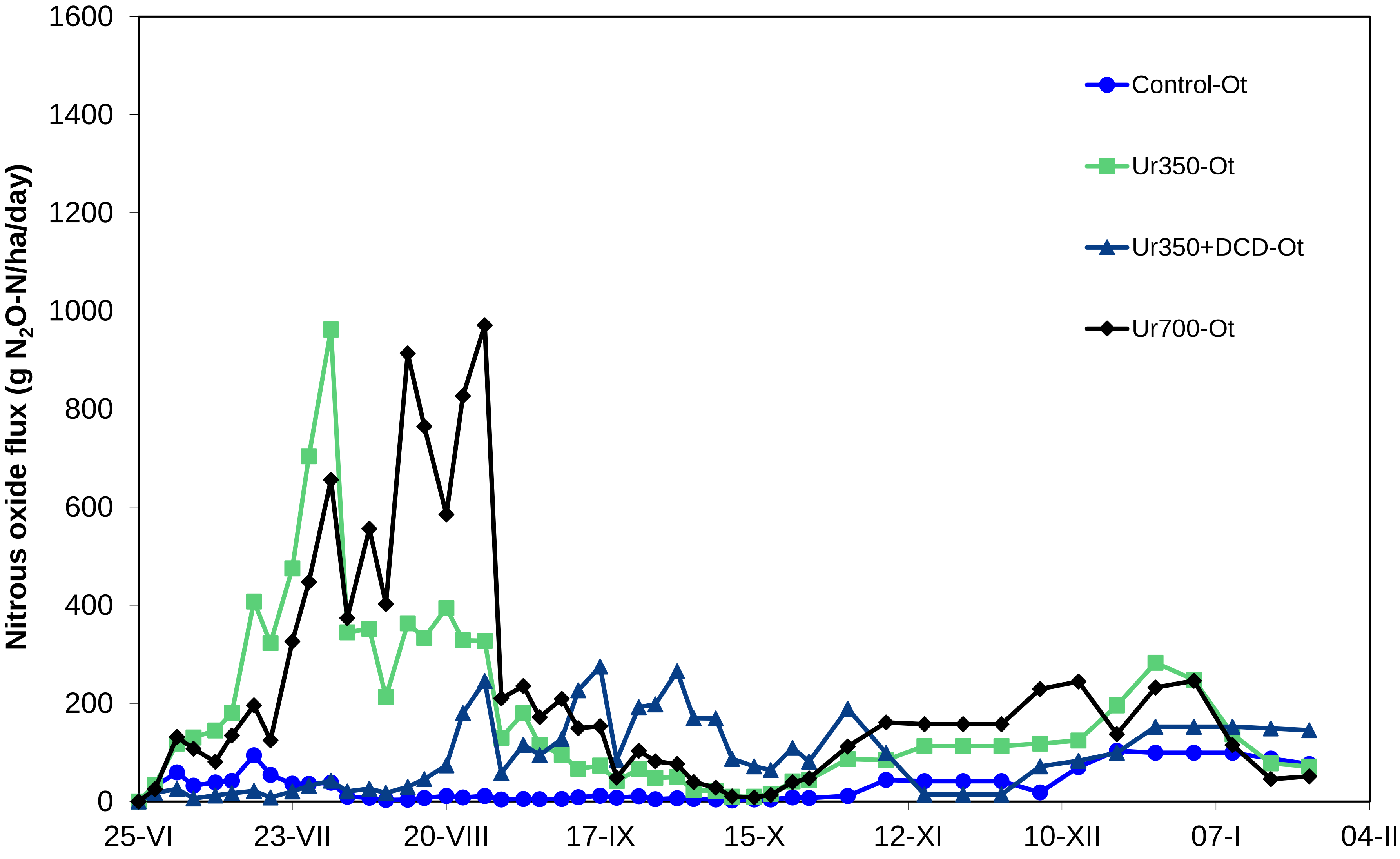
Nitrate leaching-Oats



Nitrate leaching-Italian RG

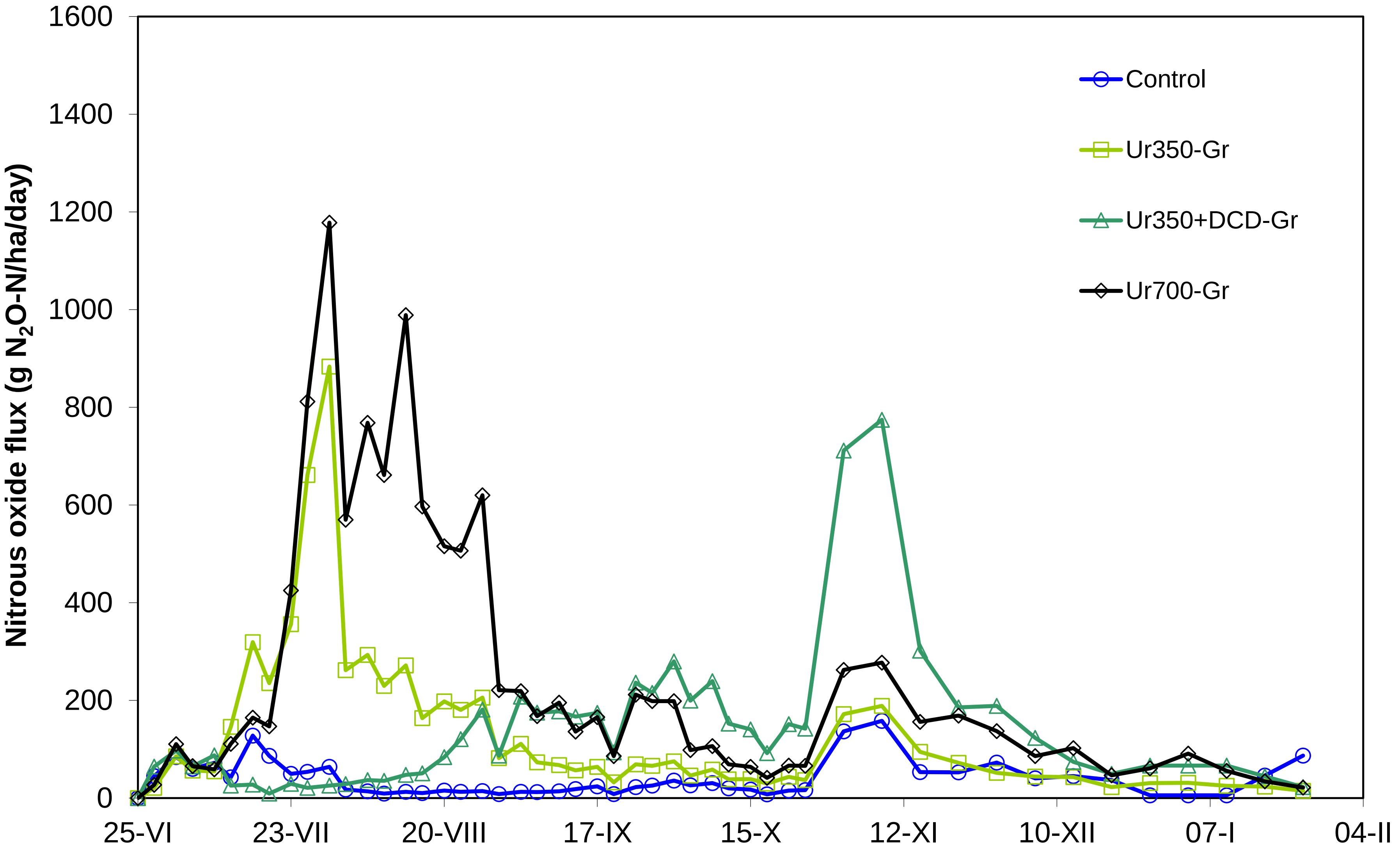


N_2O flux



1600
1400
1200
1000
800
600
400
200
0
Nitrous oxide flux (g N2O-N/ha/day)
25-VI
23-VII
20-VIII
17-IX
15-X
12-XI
10-XII
07-I
04-II
Control-Ot
Ur350-Ot
Ur350+DCD-Ot
Ur700-Ot

N_2O flux



Nitrous oxide flux (g N2O-N/ha/day)
1600
1400
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1000
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600
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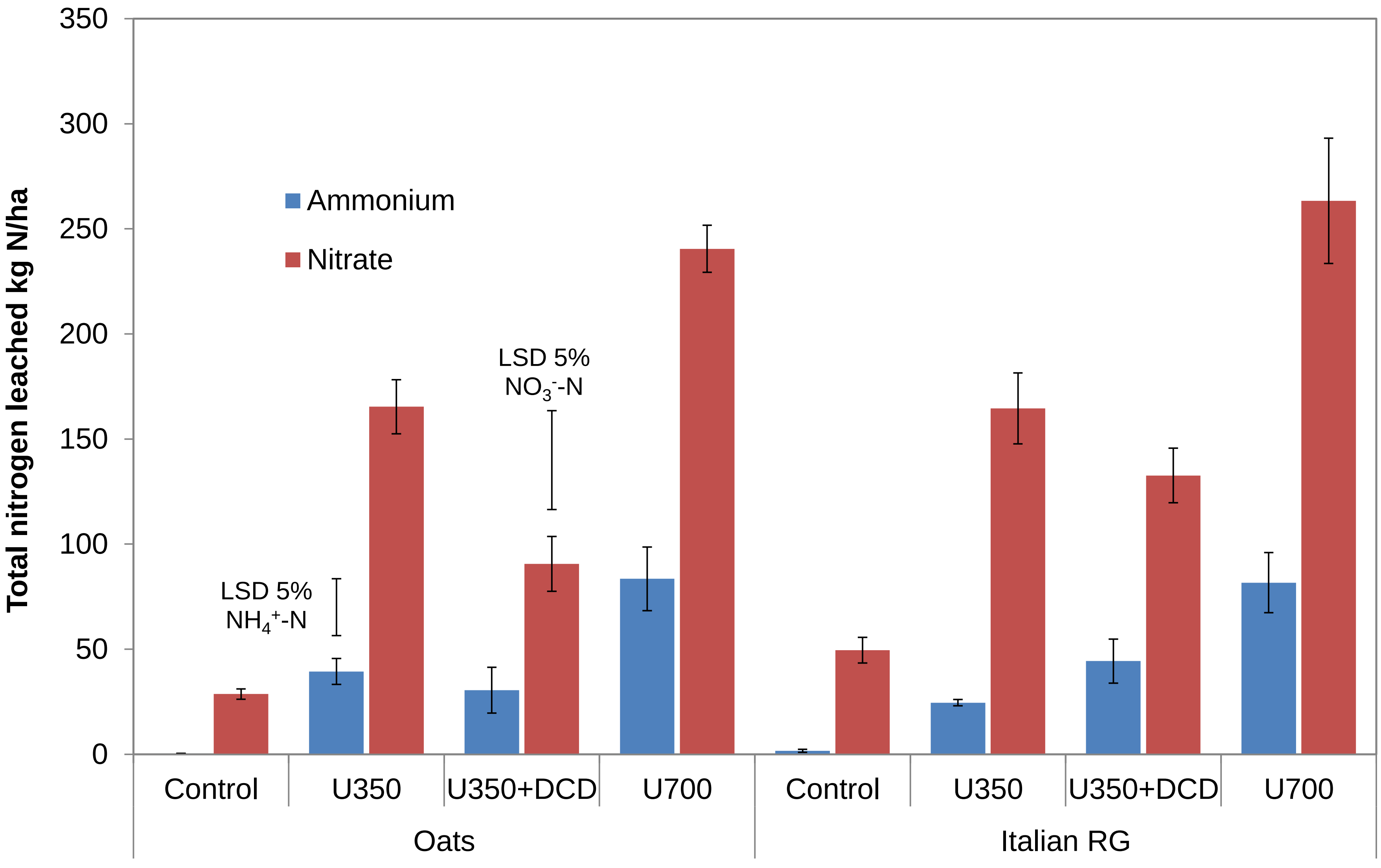
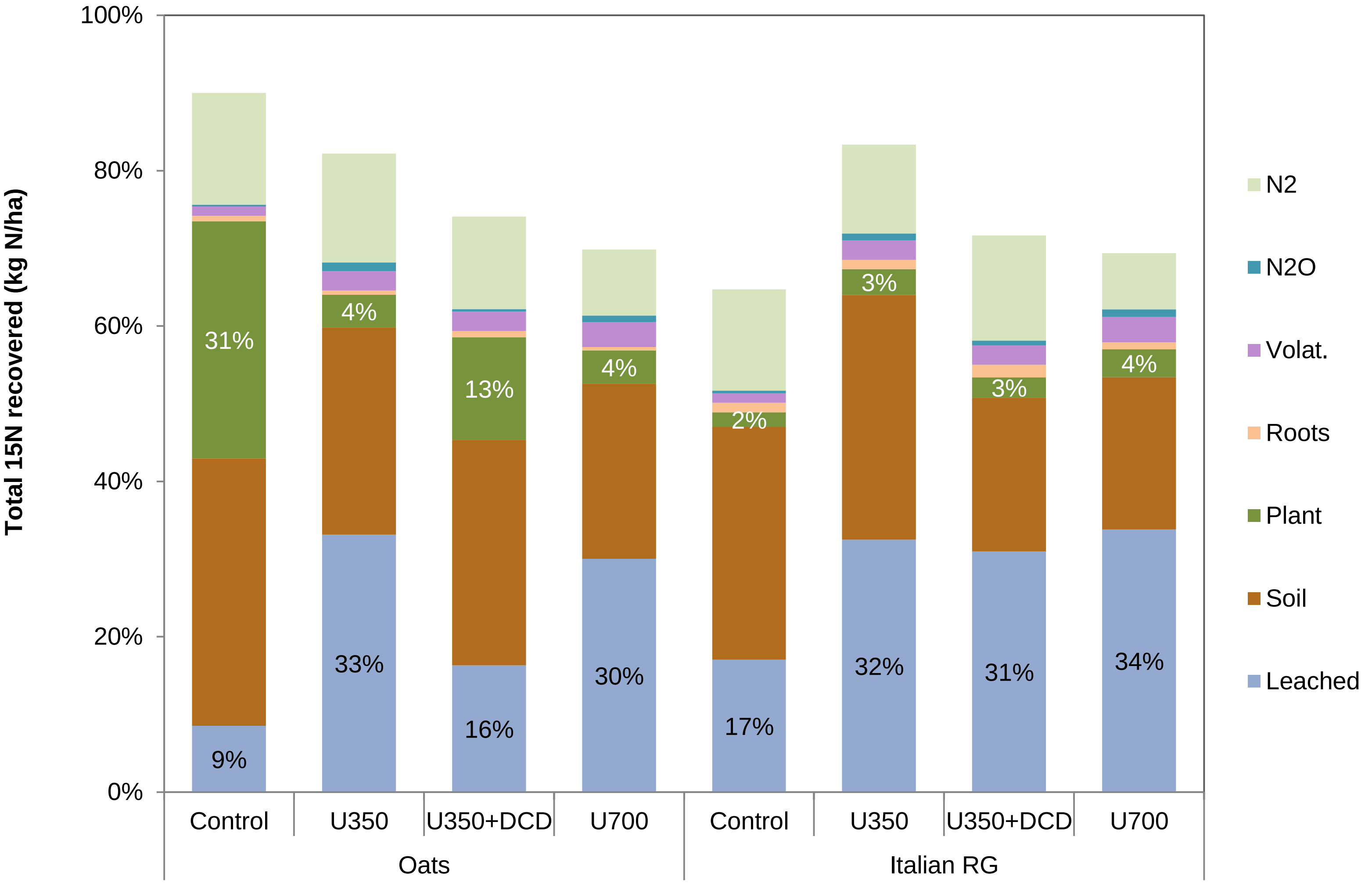
25-VI
23-VII
20-VIII
17-IX
15-X
12-XI
10-XII
07-I
04-II
Control
Ur350-Gr
Ur350+DCD-Gr
Ur700-Gr

Inorganic-N leaching



^{15}N recovery



Conclusions

- Planting a catch crop (oats) in conjunction with application of DCD reduced peak nitrate leaching concentrations and total N losses by ~40%
- Application of DCD increased plant-N uptake in the oats catch crop (13% of applied urinary-N) but only 3-4% of the applied urine-N was captured in the 350 & 700 N treatments.
- There was no significant difference in N leaching losses between the oats and Italian ryegrass catch crops but there is potential for earlier planting of the oats crop to increase N uptake.

Acknowlegements

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