OACC Organic Agriculture Centre of Canada

Management-induced changes in nitrous oxide emission from organic potato rotations in Eastern Canada

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The Goal

- **Optimize crop yield and quality**
- **Improve profitability of organic farming**
- **Conserve soil nutrient supply**
- **Improve soil health and quality**
- **Use organic residual wastes composts as source of nutrient and organic matter**
- **Minimize nutrient losses to the environment**

The Challenge

- **Synchronize nutrient release from organic sources with crop nutrient requirement**
- **Dropping available soil phosphorus (P) levels in organic production systems**
- **Limited information on use of off-farm organic amendment as source of P and N**
- **Long rotations and less profitability**
- **Weed, pest and disease control**
- **Limited information on GHG emissions**

Objectives

- **To examine the short- and long-term effects of**
  - **green manure type and frequency in different organic rotation sequences**
  - **organic off-farm amendments (e.g. paper mill wastes)**

Objectives

on

- **crop yield and quality**
- **P and N bioavailability**
- **soil health and sustainability indicators**
- **suppression of weed population**
- **Greenhouse gas emissions**

Organic Cropping System field (BEEC site)

Rotation treatments

	Year	1	2	3	4	5
Crop Sequences	C1	Oats u/s RCl	RCl	Potato	Oats u/s RCl	Carrots
	C2	Oats u/s RCl	RCl	Potato	Beans then Buckwh.	Carrots
	C3	Carrots	Oats-Pea -vetch	Potato	Oats u/s RCl	Beans then Buckwh.
	C4	Beans then Buckwh.	Oats-Pea -vetch	Potato	Oats u/s RCl	Carrots

Off-farm organic amendments

Composted municipal food wastes

Composted paper mill wastes

Weed management

Pest management: Potato Colorado Beetle and Late Blight

Entrust

Parasol (copper hydroxide)

In situ Plant Root Simulator

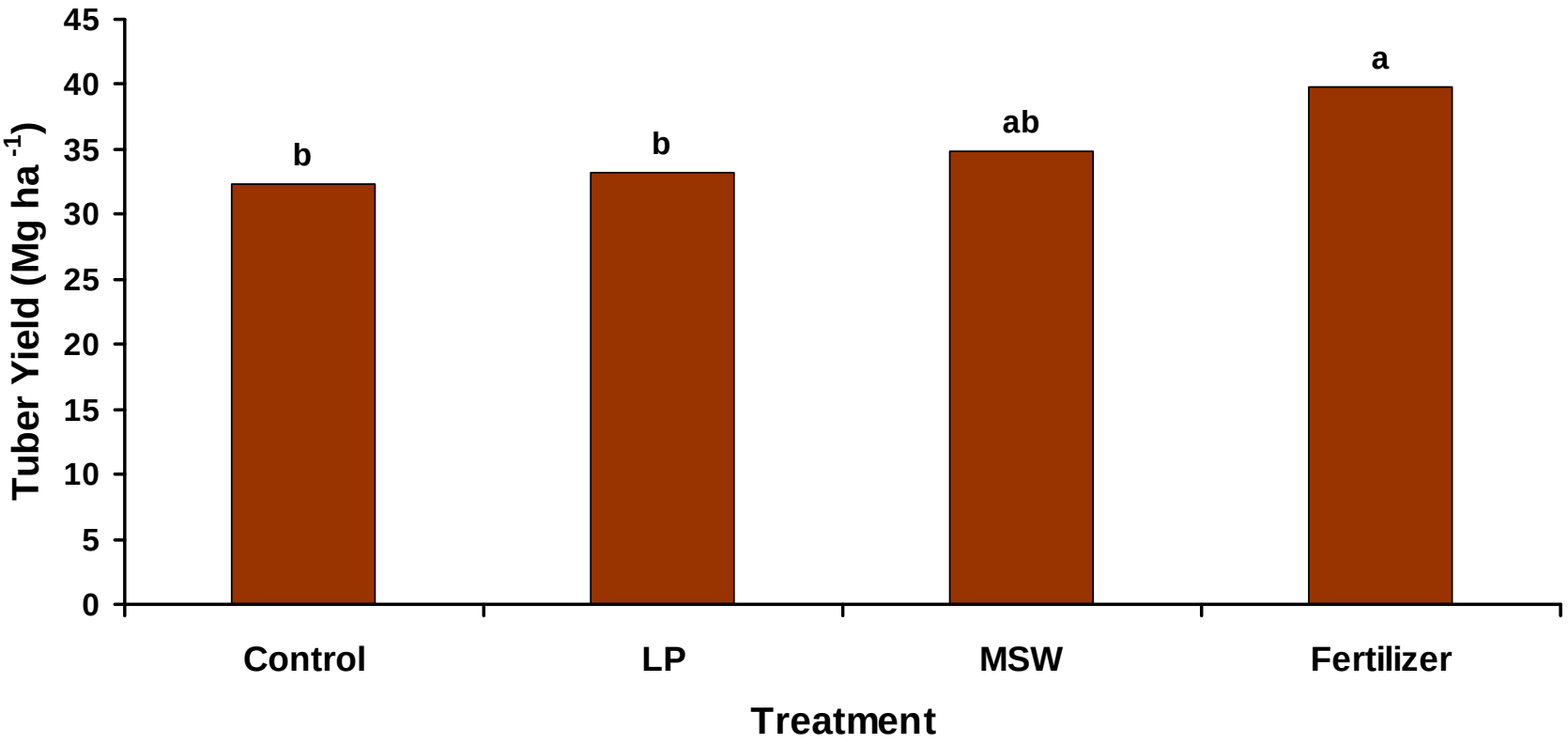
Greenhouse gas sampling

Greenhouse gas sampling

Results

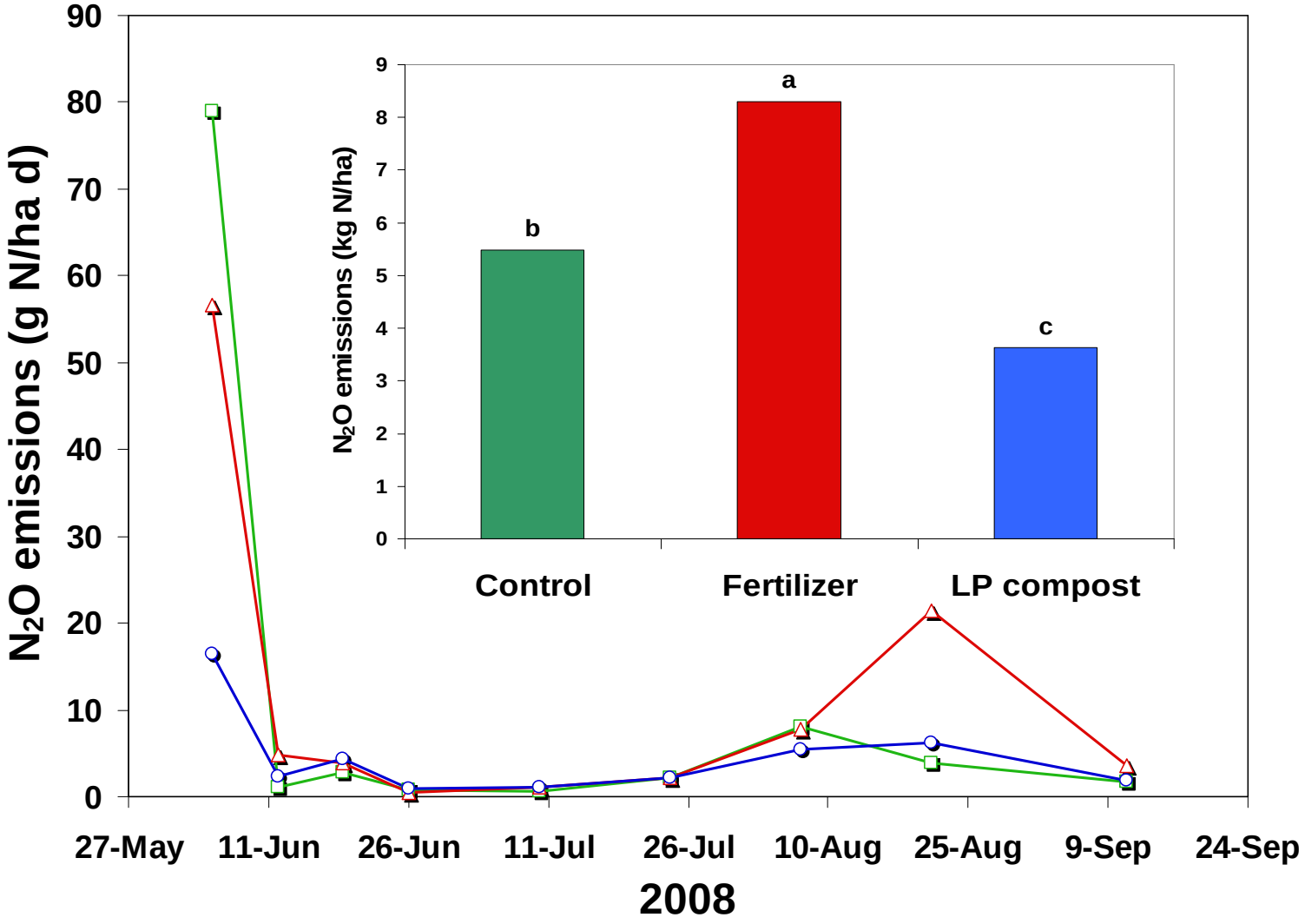
- Yield
- Nitrous oxide emissions
- Nitrogen flux measured by *in situ* placement of Plant Root Simulator probes

Total potato tuber yield

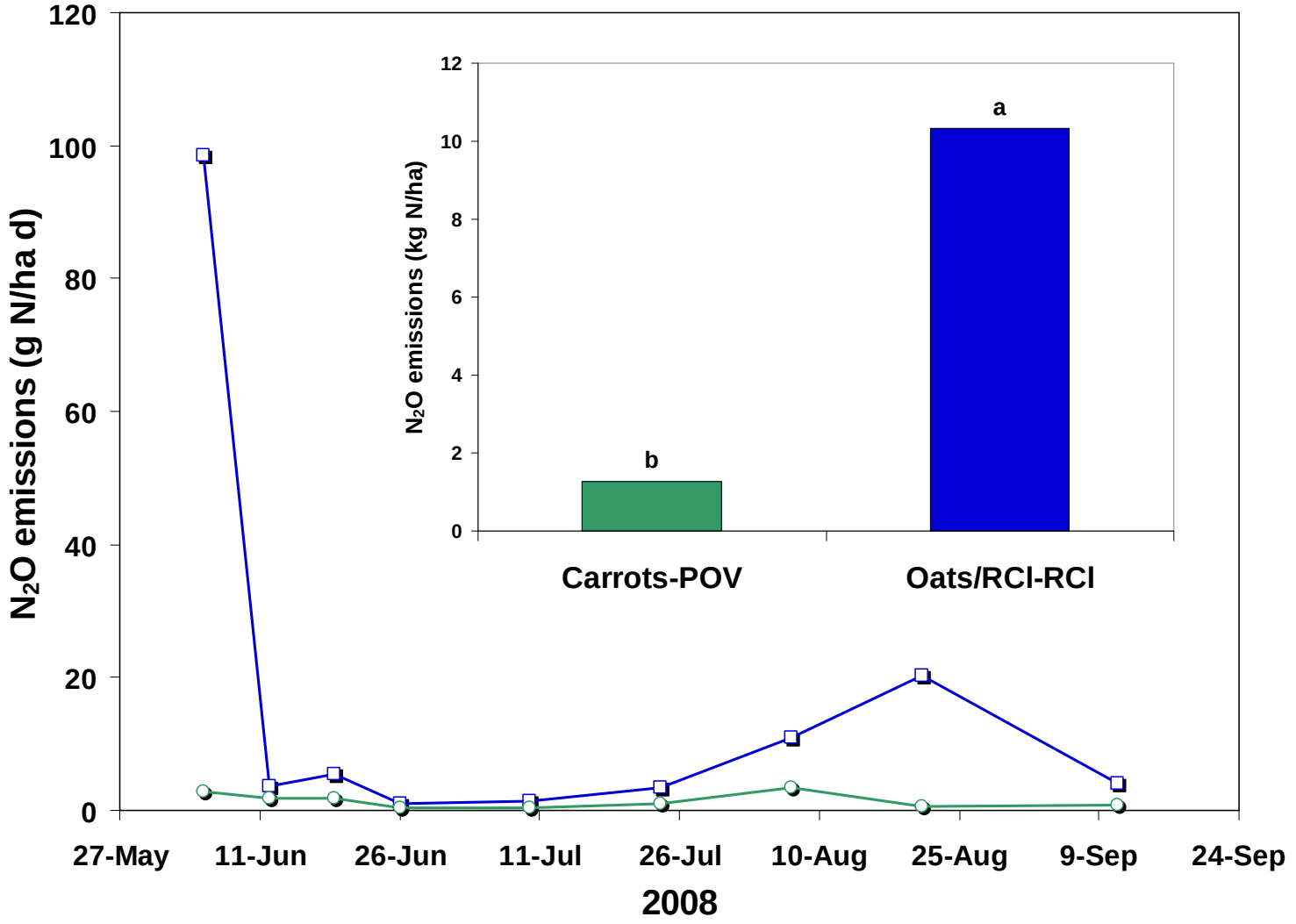


No significant effect of rotation on tuber yield but slightly higher values for RCl compared with POV.

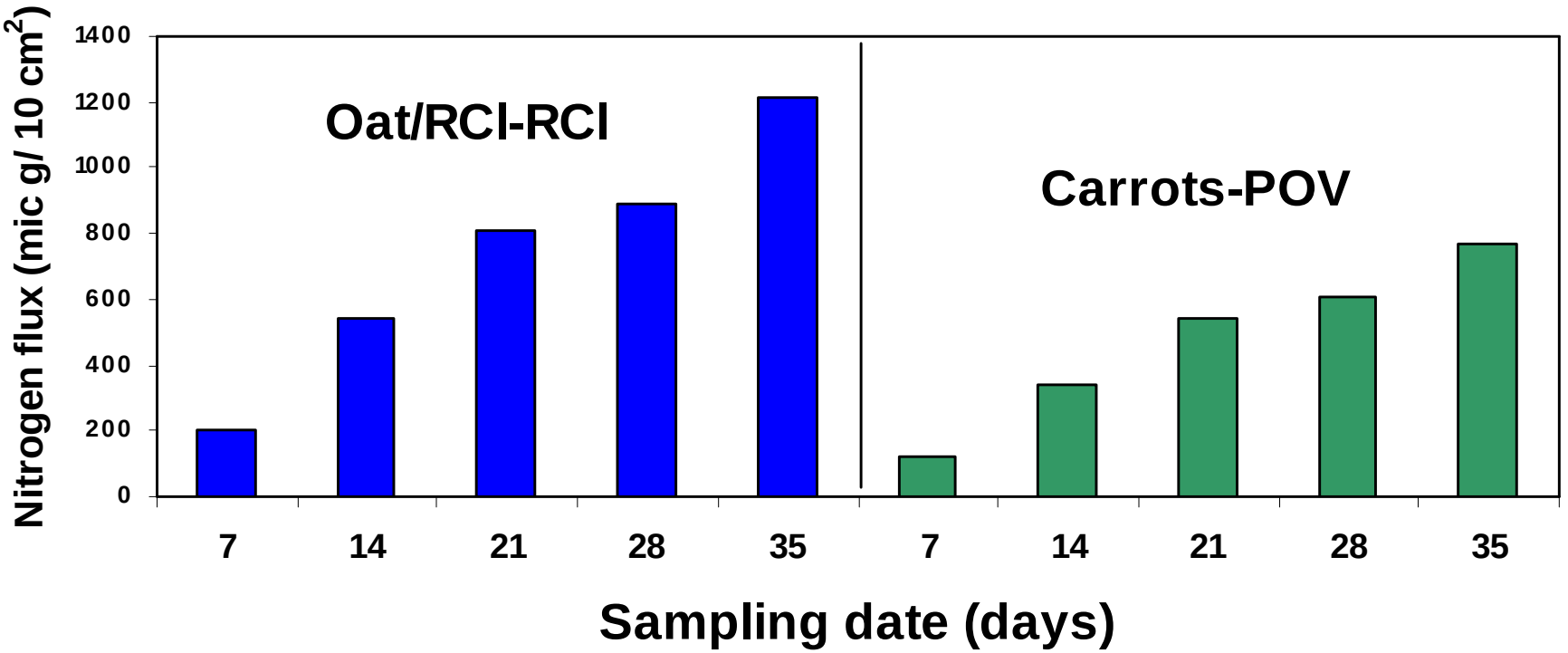
Nitrous oxide emissions in potato crop as affected by N fertilizer/compost



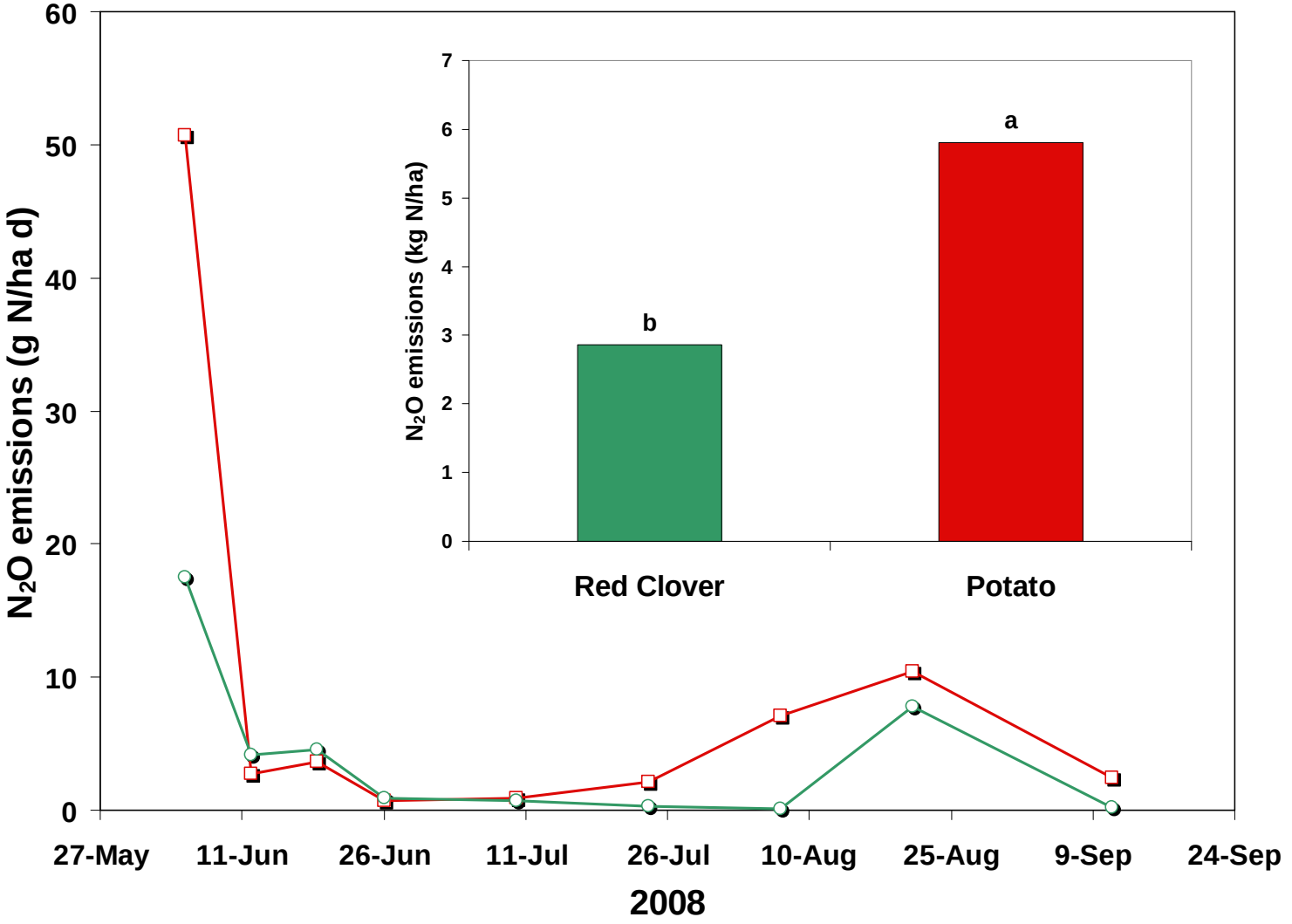
Nitrous oxide emissions in potato crop as affected by preceding crops



Nitrogen flux measured by *in situ* placement of PRS probes as affected by preceding crops



Nitrous oxide emissions in potatoes compared with red clover



Brookside site

Crops: Potato

Timothy

Clover

Management:

(i) Forage plowing date (F/S)

(ii) +/- N fertilizer

Treatments – Brookside site

Potato treatments

Fert rate (kg/N/ha)	Previous crop	Tillage
0	Timothy	Spring
140	Timothy	Spring
0	Timothy	Fall
140	Timothy	Fall
0	Clover	Spring
90	Clover	Spring
0	Clover	Fall
90	Clover	Fall

Forage treatments

Forage	Fert rate (kg/N/ha)
Timothy	0
Timothy	140
Clover	0

Yields and N uptake

Potatoes

Spring plowing increased yields and N uptake

Yields (~7.0 t DM ha^{-1}) and N uptake (127-145 kg N ha^{-1}) highest following clover

Forages

Little difference in N offtake between unfertilized clover (135 kg N ha^{-1}) and fertilized timothy (150 kg N ha^{-1})

Estimated 32% of clover N derived from BNF

Cumulative Nitrous Oxide emissions

Potatoes and Forages

Treatment	N_20 emissions (kg N ha^{-1})
Fertilized	14.3
Non-fertilized	4.0
Potato (clv)	4.9
Potato (tim)	8.1
Clover	3.9
Timothy	14.5

Potatoes

Treatment	N_20 emissions (kg N ha^{-1})
Fertilized	7.7
Non-fert.	5.3
Clover	4.9
Timothy	8.1
Fall plow	6.4
Spring plow	6.5

Summary

- ✓ Nitrous oxide emissions reduced with including green manure in the rotation (37%) and using composted paper mill wastes (57%) compared with N fertilizer while maintaining the comparable yields.
- ✓ The organic system emitted less N_2O (4.4 kg N_2O -N ha^{-1}) while maintaining acceptable yields of forage (4.5 t ha^{-1}) and potato (7.2 t ha^{-1}) crops, compared with emissions of up to 11.6 kg N_2O-N ha^{-1} for conventional (i.e. fertilized) forage and potato management regimes.

Thank you

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