Detection of biological nitrification inhibition in canola

Implications for N cycling and soil fertility in rotational cropping.

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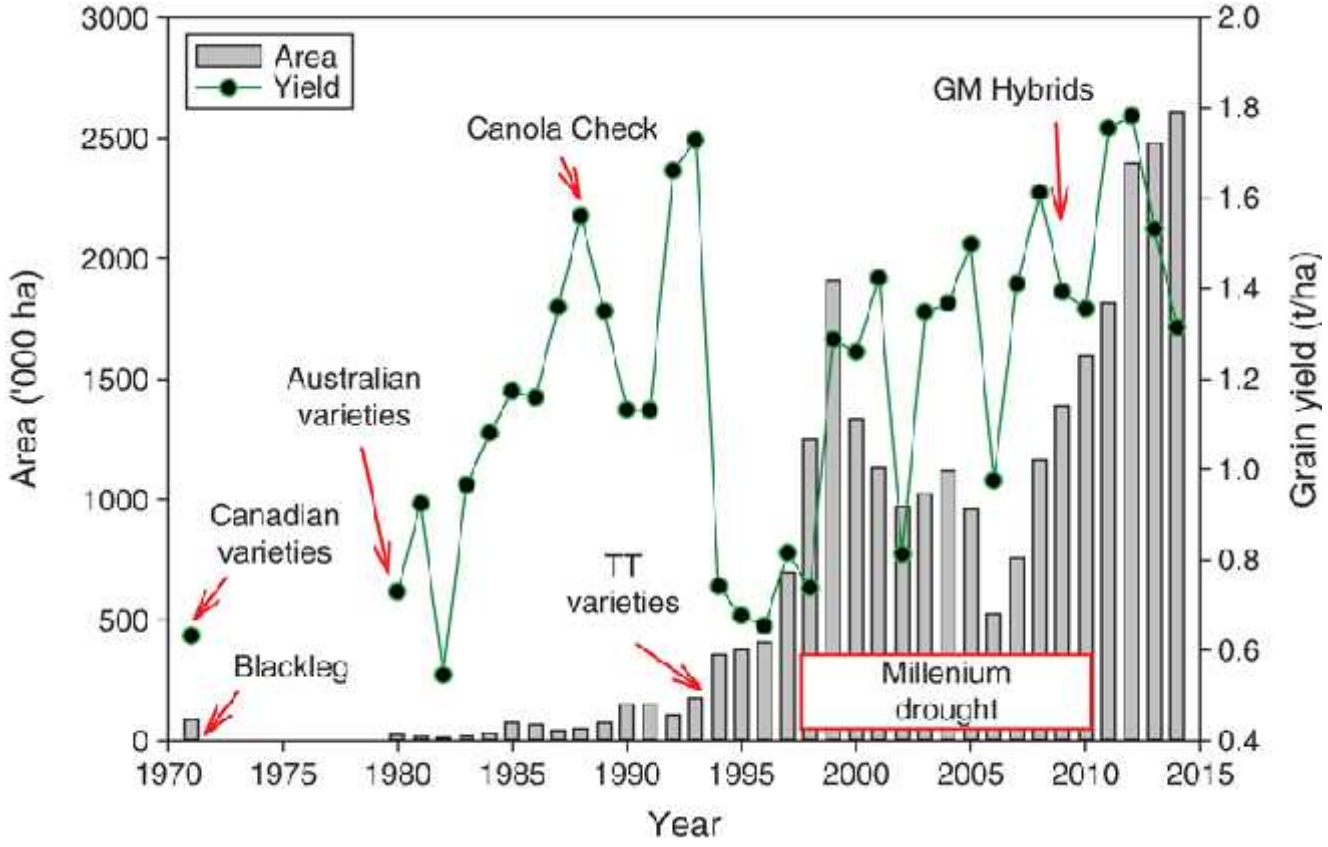
Canola production is increasing in Australia

Growers have several reasons for planting canola

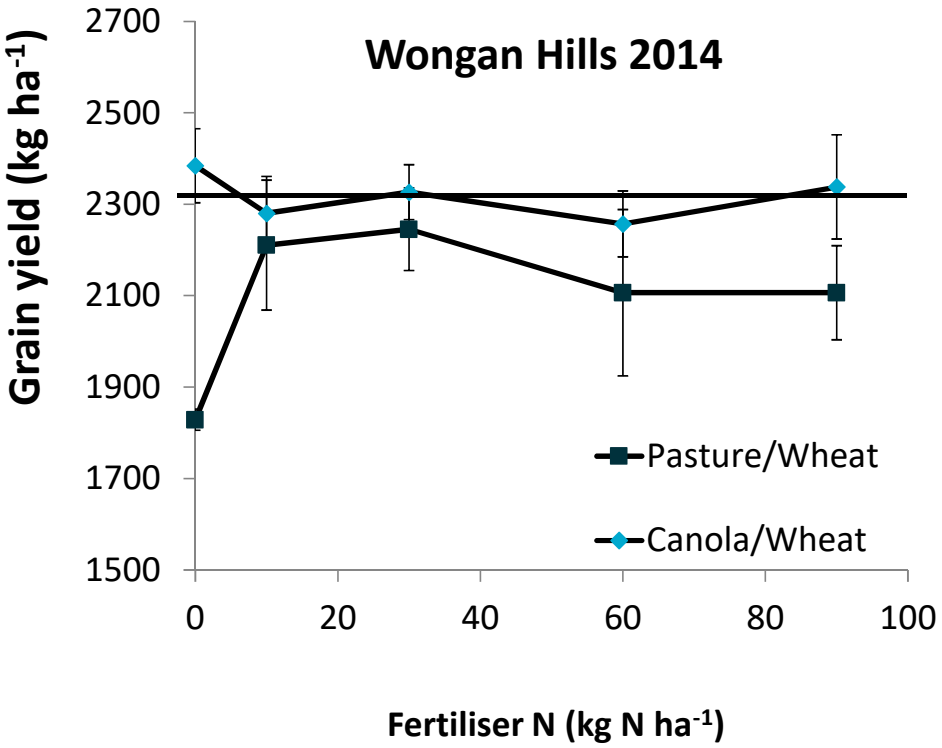
- **Oilseed value**
- **Crop rotation, disease break**
- **Weed management**

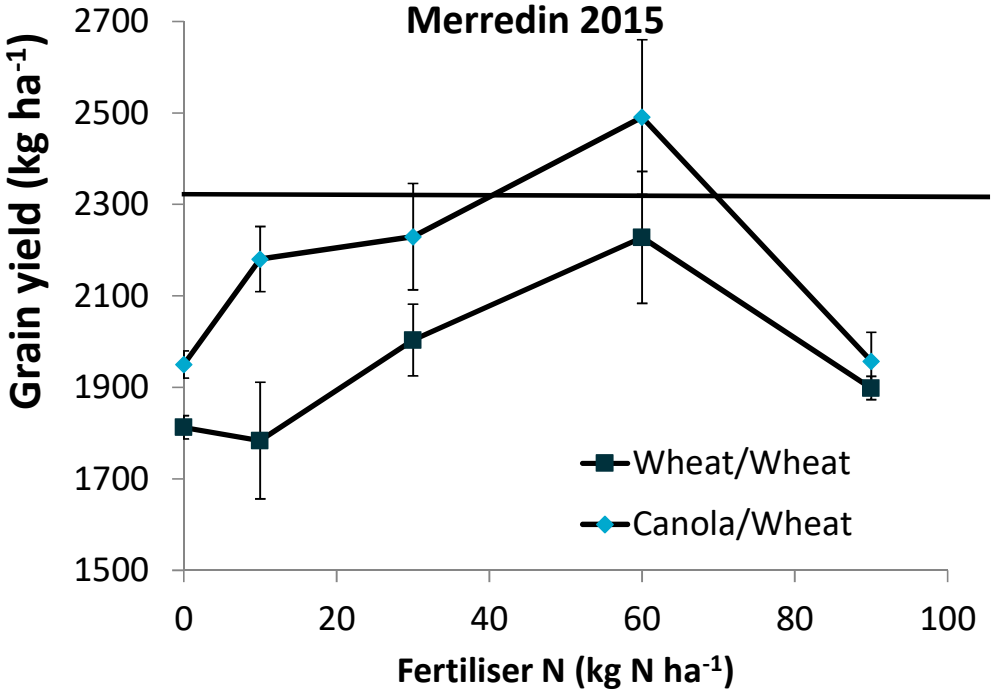


Kirkegaard, J. *et al*. Crop and Pasture Science 2016

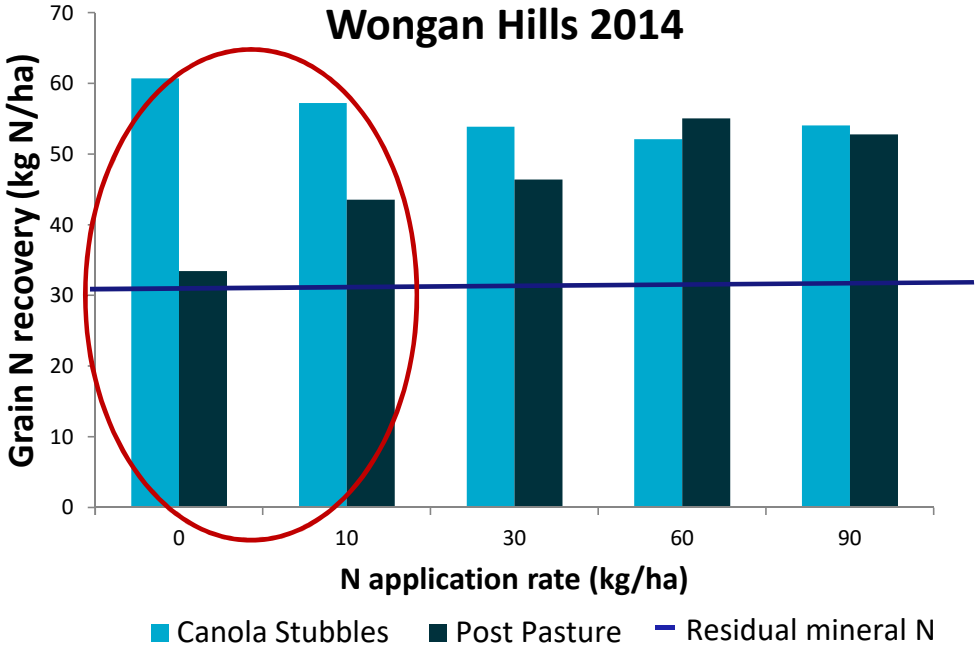
Increased N recovery following canola

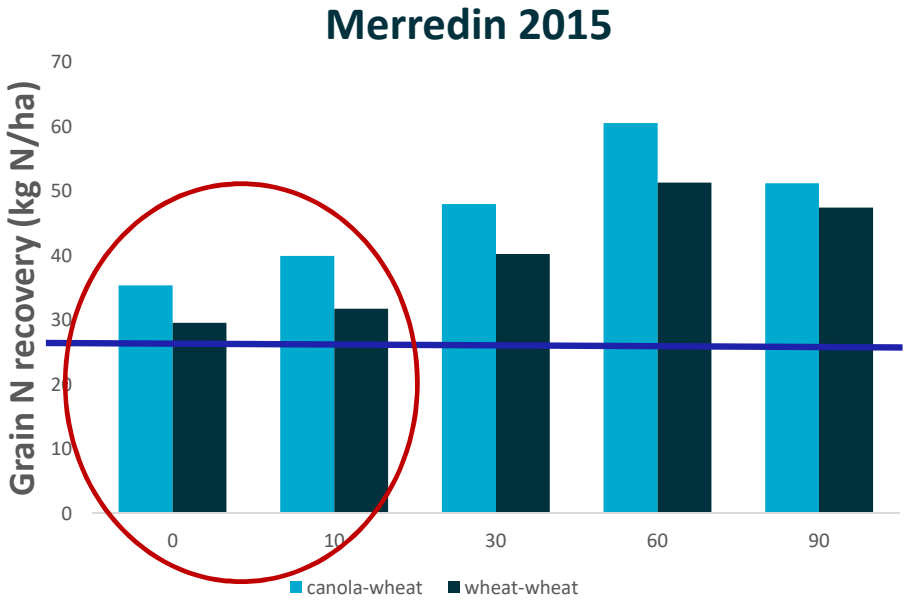
More than just the disease break?





N recovery greater than residual N even without fertiliser





Research questions

Are Brassicas manipulating the N cycling in their rhizosphere?

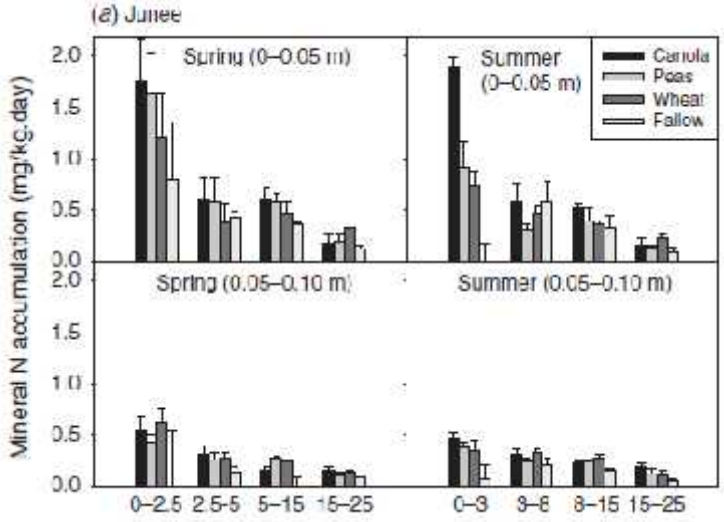
Is there a store of organic N after a canola crop that serves as an N source for the following crop?

- Do brassicas produce root exudates with BNI?
- Does this slow nitrification in soils?
- What are the implications for other N cycling rates?
  - Immobilisation
  - Mineralisation

Evidence of N retention after canola

Mineral N accumulation over the summer fallow **39–49 kg/ha higher** following brassicas compared with wheat at 2 sites

In lab incubations Brassica root tissues initially **immobilised, and later released, mineral N at a greater rate** than wheat root tissues.



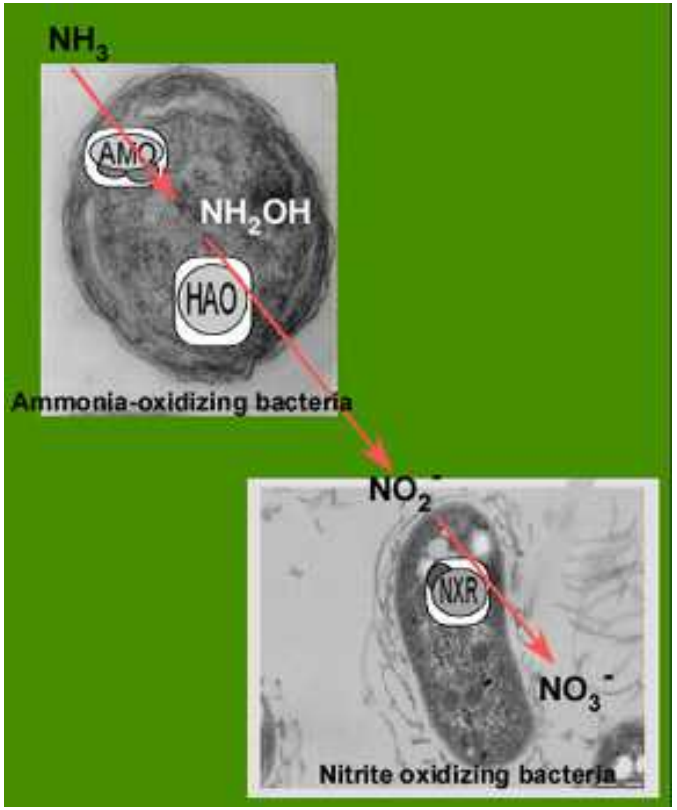
Ryan et al 2006

Accumulation of mineral-N following canola (94 kg/ha), **3 times as much as that following cereals**, and significantly higher than that after the legumes (50 kg/ha)

Sampling position	Previous crop	NH_4^- oxidisers[D]	NO_2^- oxidisers[D]
In row	Wheat	1.67	477
In-row	Canola	0.52	294
		***	n.s.
Between-row	Wheat	2.03	562
Between-row	Canola	0.66	729
		*	n.s.

Kirkegaard et al 1999

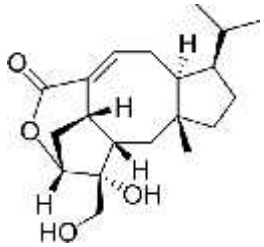
Nitrification inhibition



http://nitrificationnetwork.org/gallery.php

Biological nitrification inhibitors

Brachiaria humidicola



brachialactone

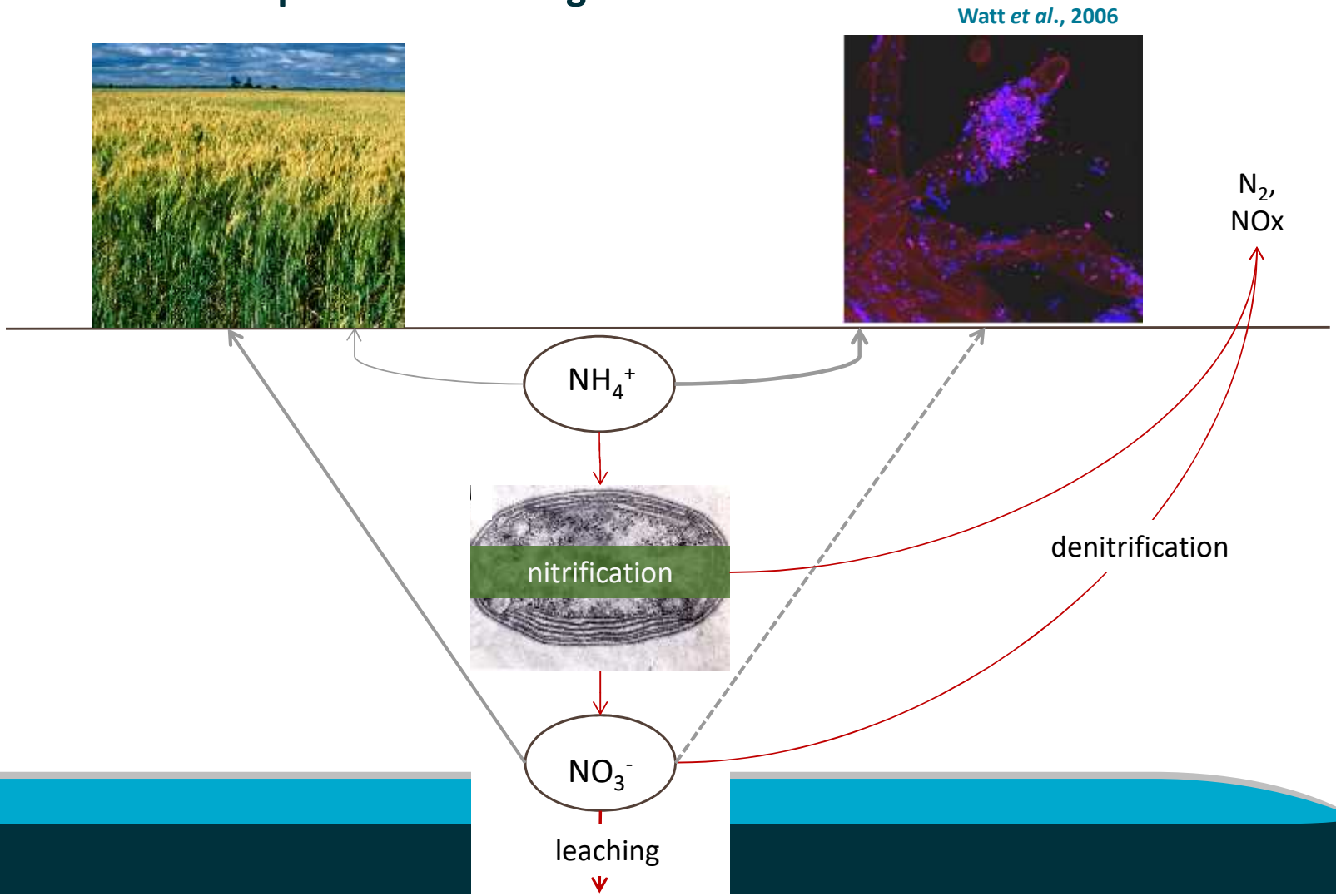
Subbarao et al 2009

- Formed by plant and released at root surface
- Continually replenished
- Found in *Brachiaria*, sorghum, pearl millet, peanut and *Leymus racemosus* (wild relative of wheat)

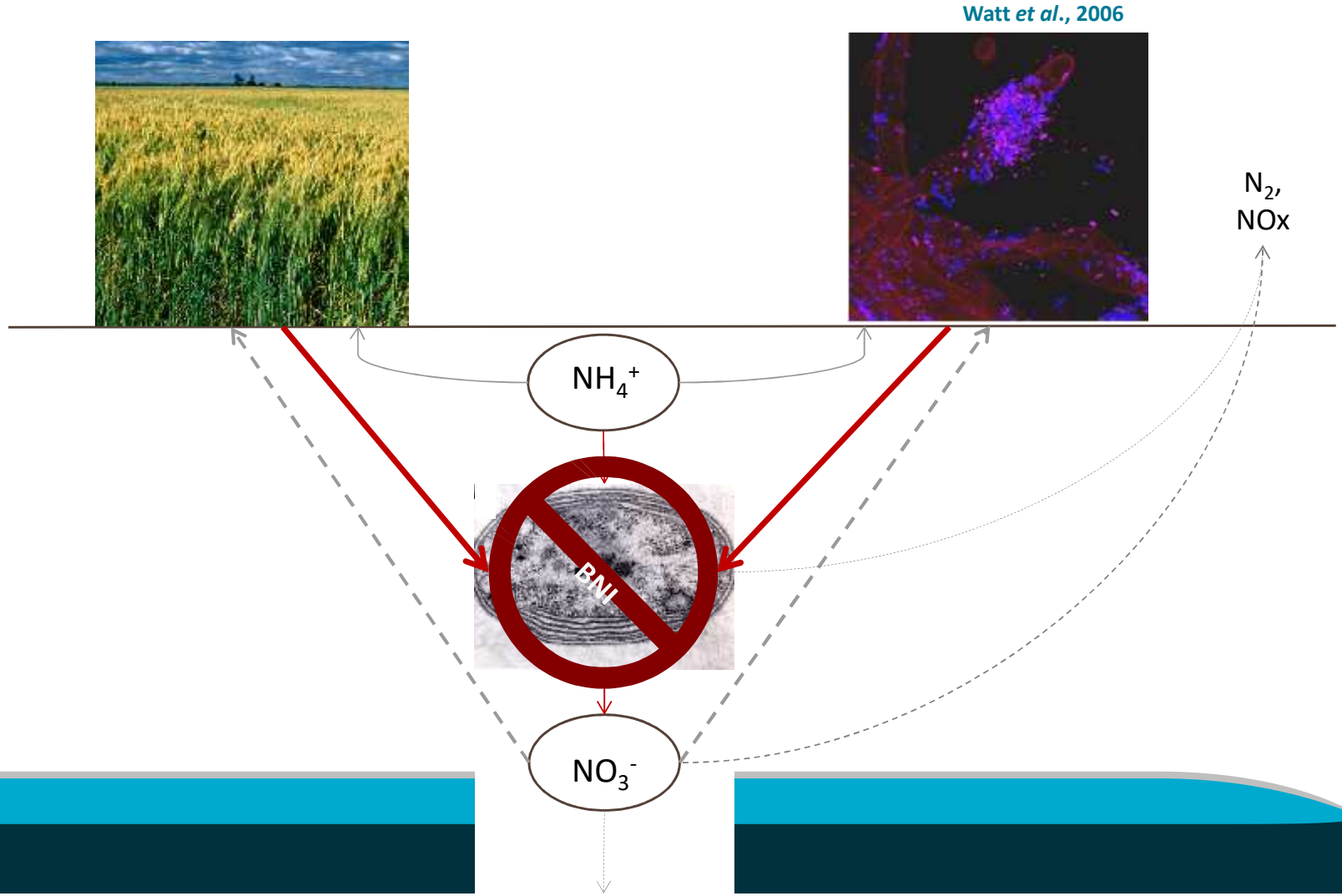
Plants manipulating their microbiome

BNI effects in crops and weeds

NUE improvement vs competitive advantage



BNI effects on crops and microorganisms



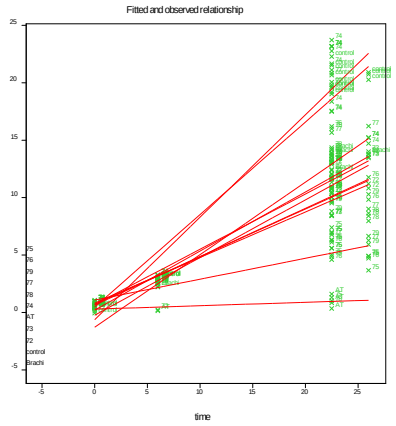
Assay to assess root extracts

Step 1
Grow plants

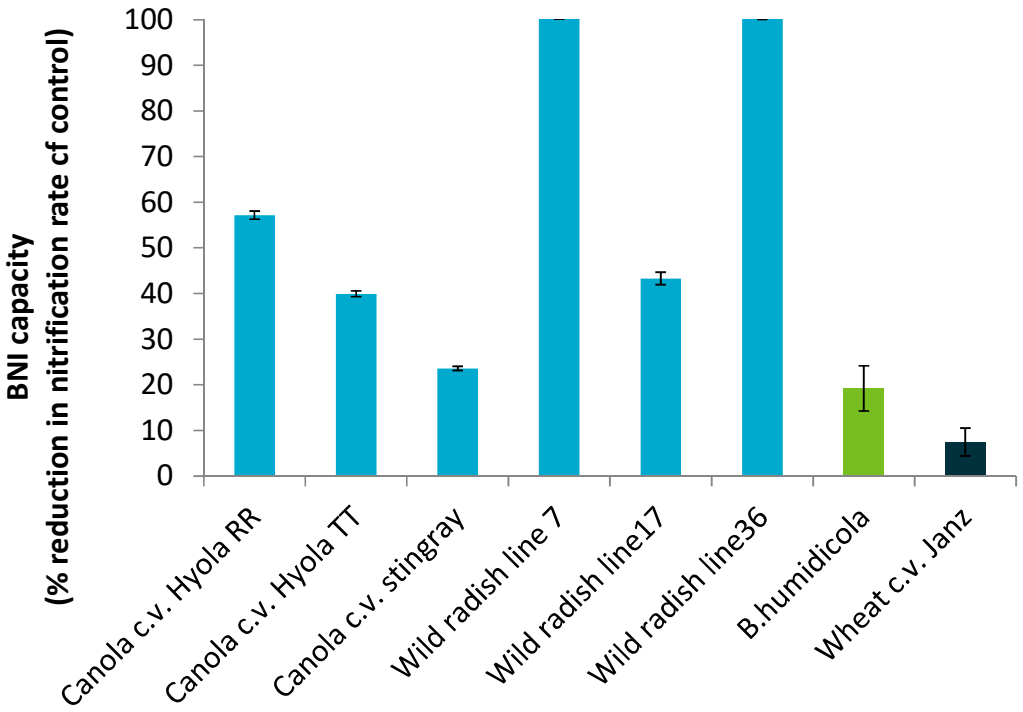
Step 2
Extract compounds from roots

Step 3
Grow pure cultures of *Nitrosomonas* and *Nitrosospira* in presence and absence of root extract

Step 4
Assess nitrification rate against positive control (AT) and negative control (no inhibitor)



BNI in root exudates



- BNI in canola and wild radish significantly higher than in B. humidicola
- First evidence of BNI in non-legume dicot.

Measuring BNI in pots

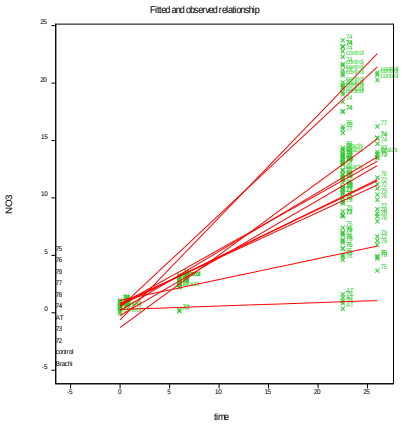
Step 1
Grow plants

Step 2

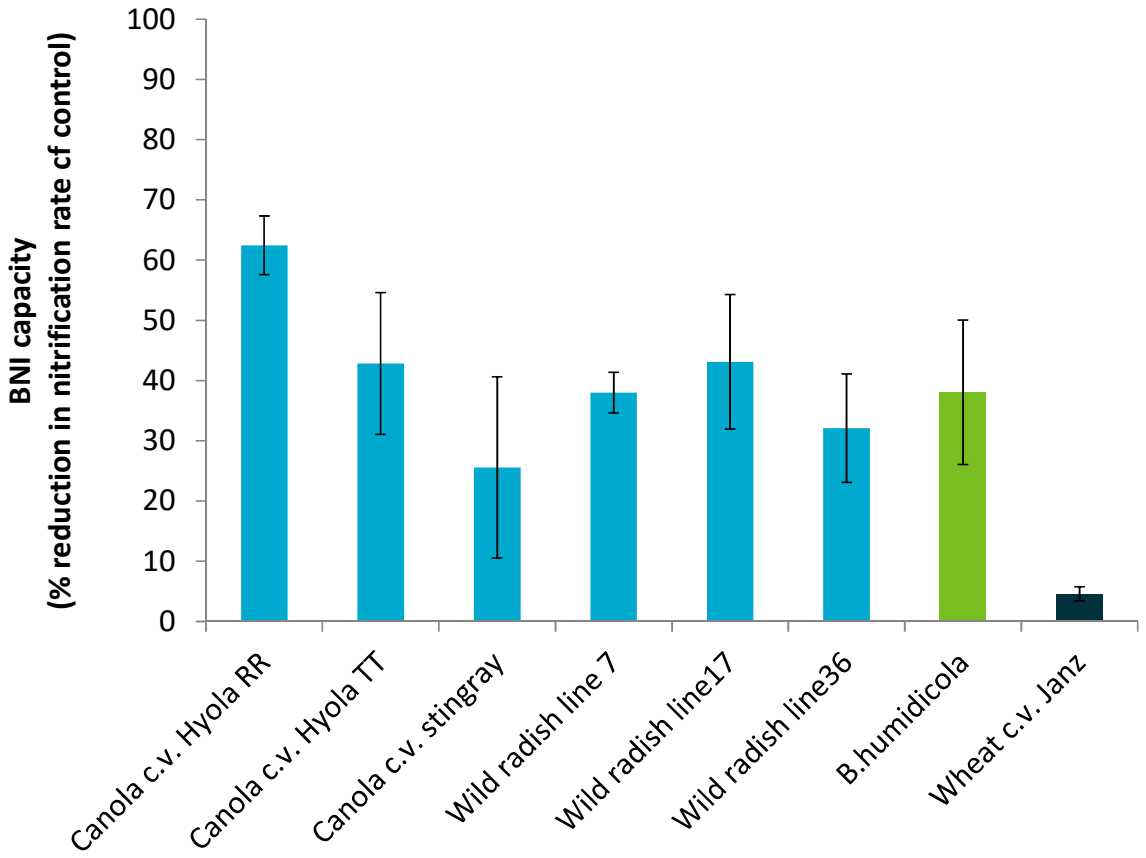
Remove plant and collect soil

Step 3
Incubate soil samples in slurry containing NH_4^+

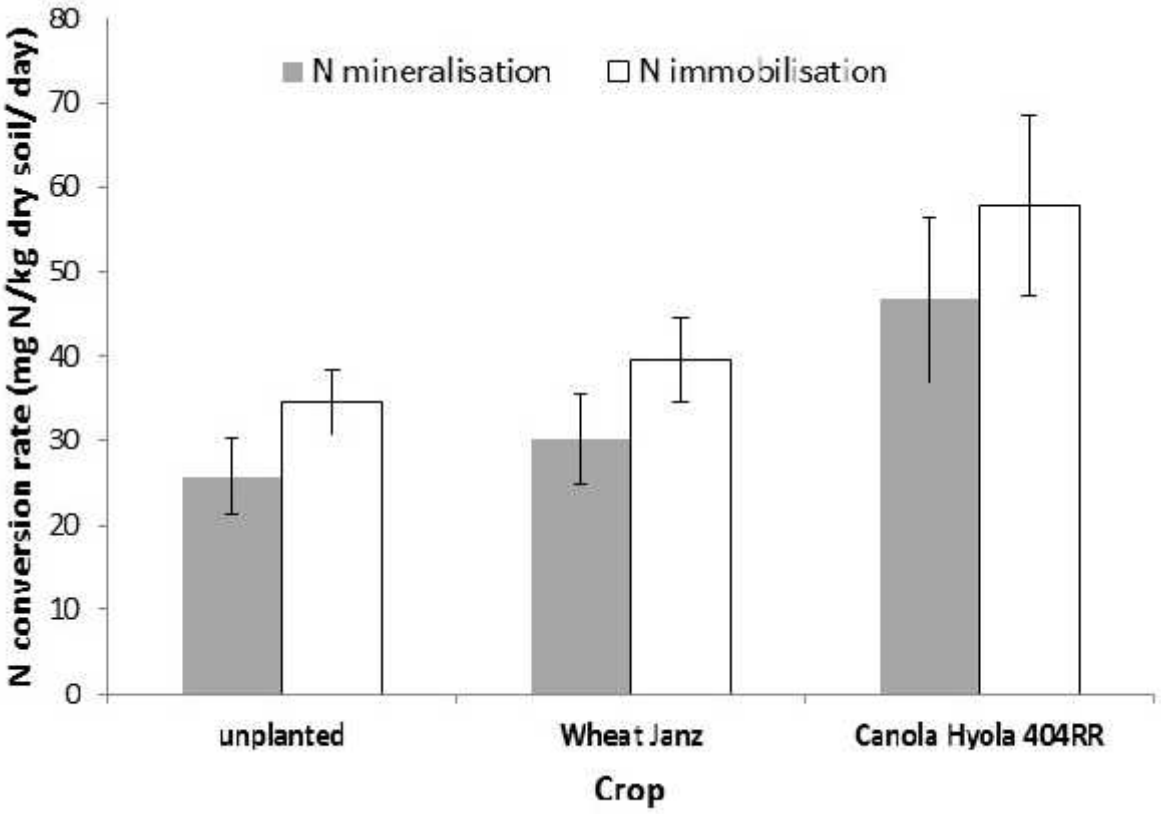
Step 4
Assess nitrification rate against unplanted control



BNI impact in pot assays



15N tracer soil incubations



Net N Immobilisation in fallow following:

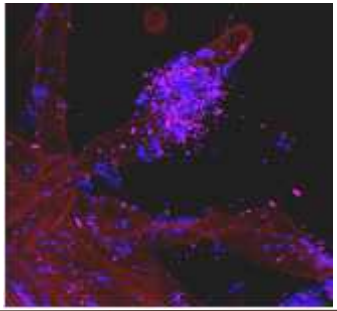
no plant – 8.8 mg N/kg soil.day

wheat - 9.3 mg N/kg soil.day

canola - 11.3 mg N/kg soil.day

Conclusions

Year 1 – canola rotation



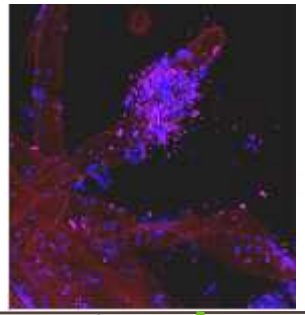
N_2, NOx

NH_4^+

BNI

NO_3^-

Year 2 – wheat rotation



N_2, NOx

NH_4^+

nitrification

denitrification

NO_3^-

leaching

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- DAFWA
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- Project team
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Thank You