



Detection of biological nitrification inhibition in canola

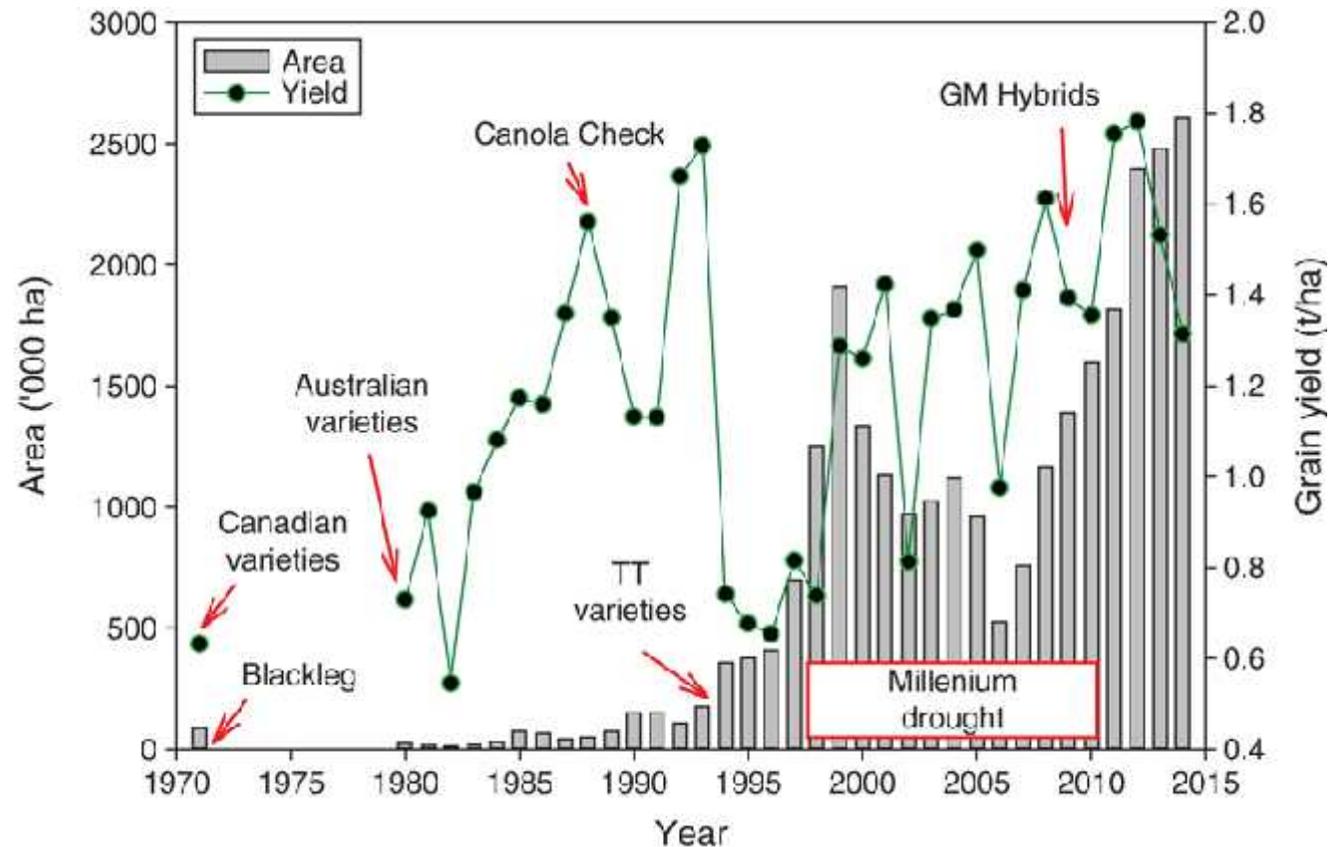
Implications for N cycling and soil fertility in rotational cropping.

Cathryn O'Sullivan, Elliott Duncan, Margaret Roper, Kelley Whisson, Karen Treble, Philip Ward

Canola production is increasing in Australia

Growers have several reasons for planting canola

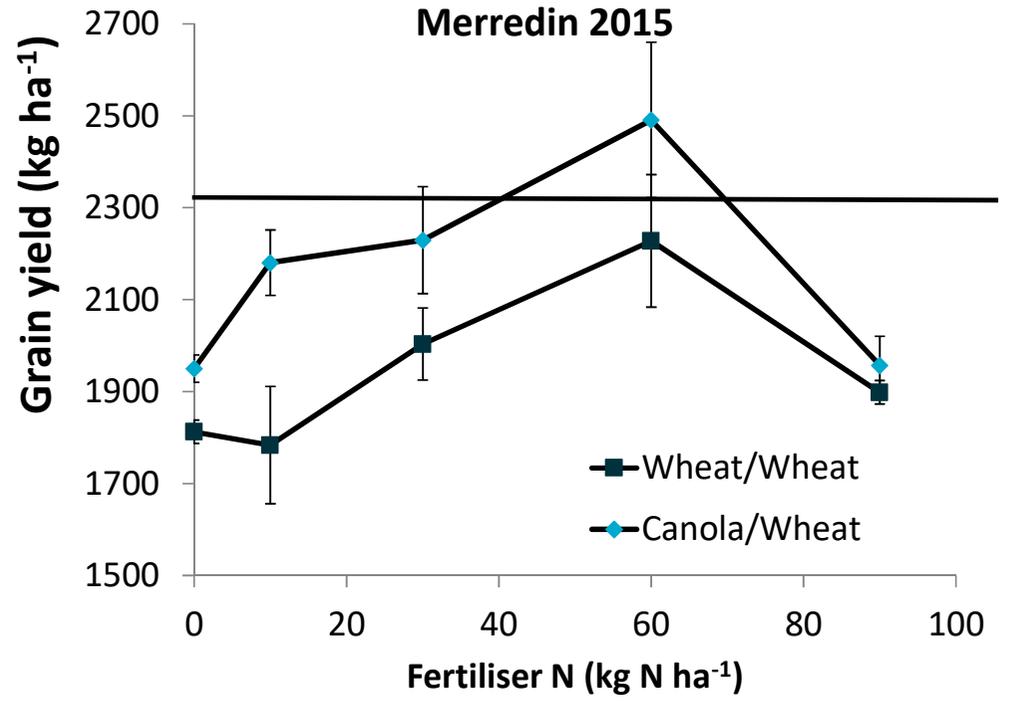
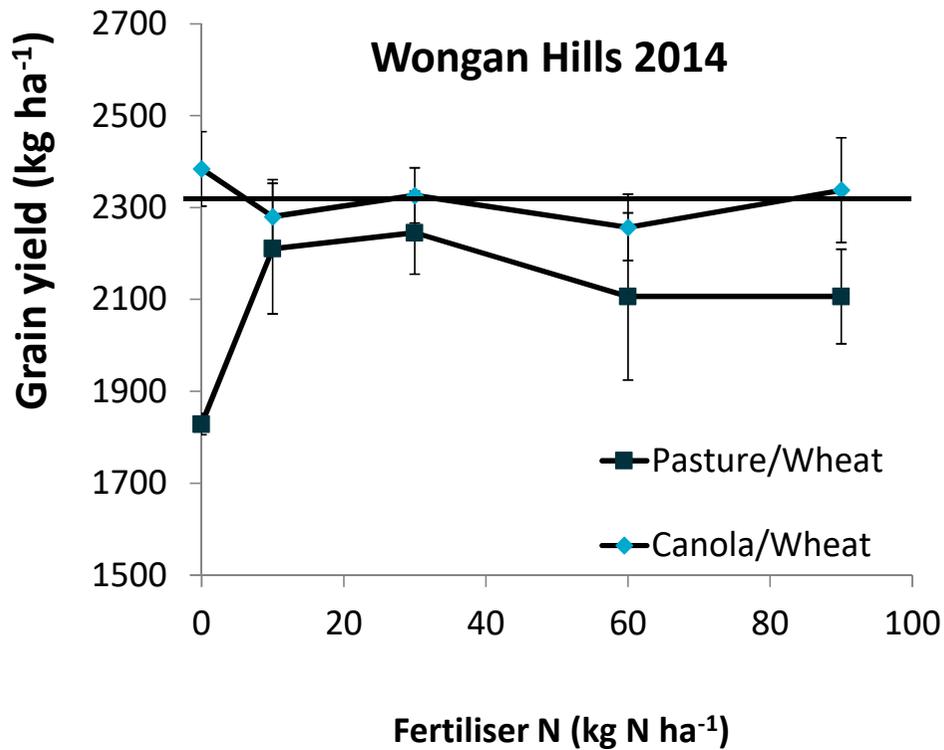
- Oilseed value
- Crop rotation, disease break
- Weed management



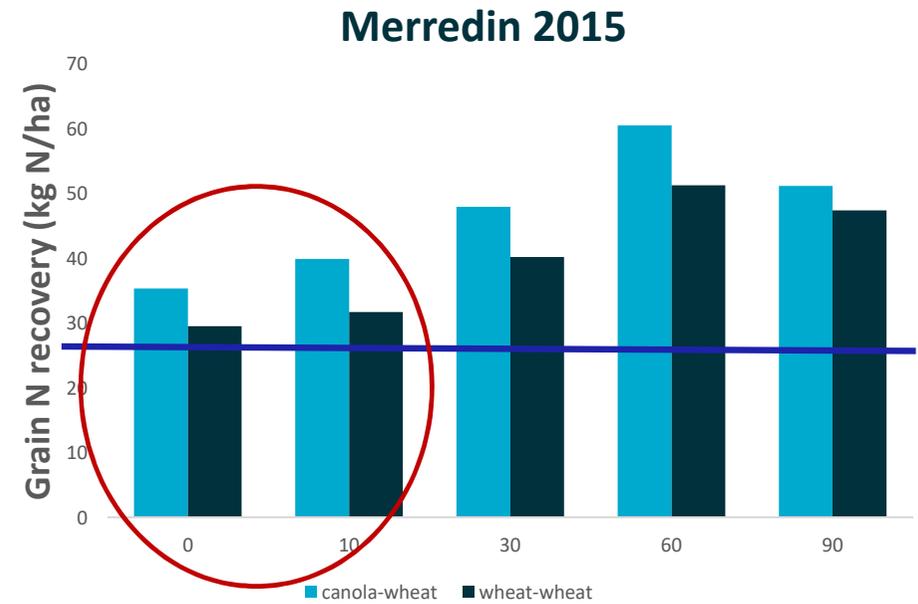
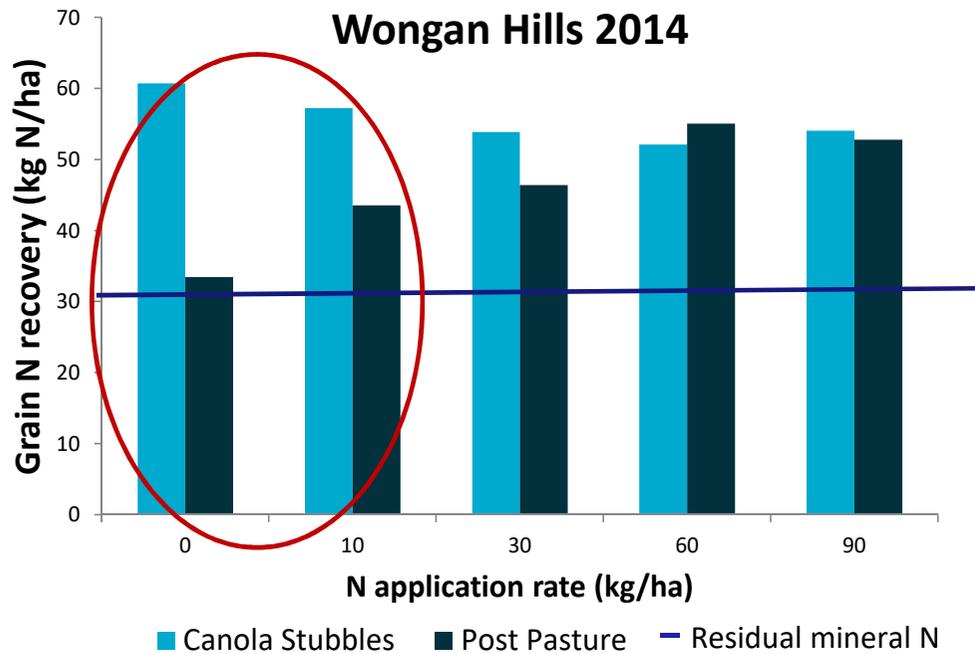
Kirkegaard, J. *et al.* Crop and Pasture Science 2016

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?

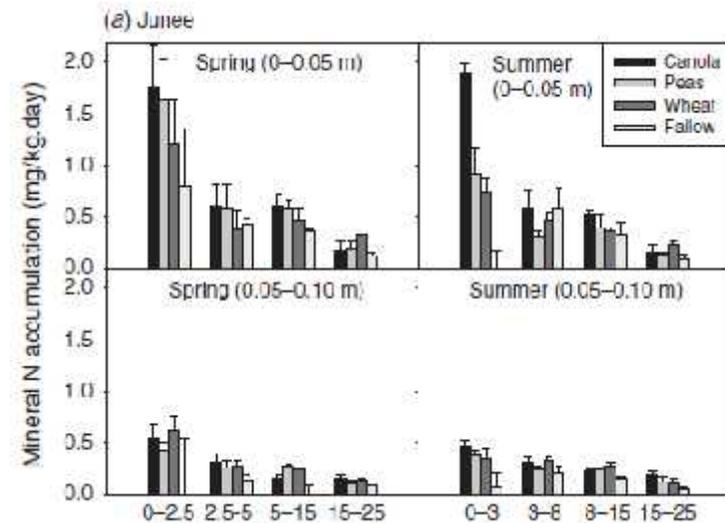
- Do brassicas produce root exudates with BNI?
- Does this slow nitrification in soils?
- What are the implications for other N cycling rates?
 - Immobilisation
 - Mineralisation



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.



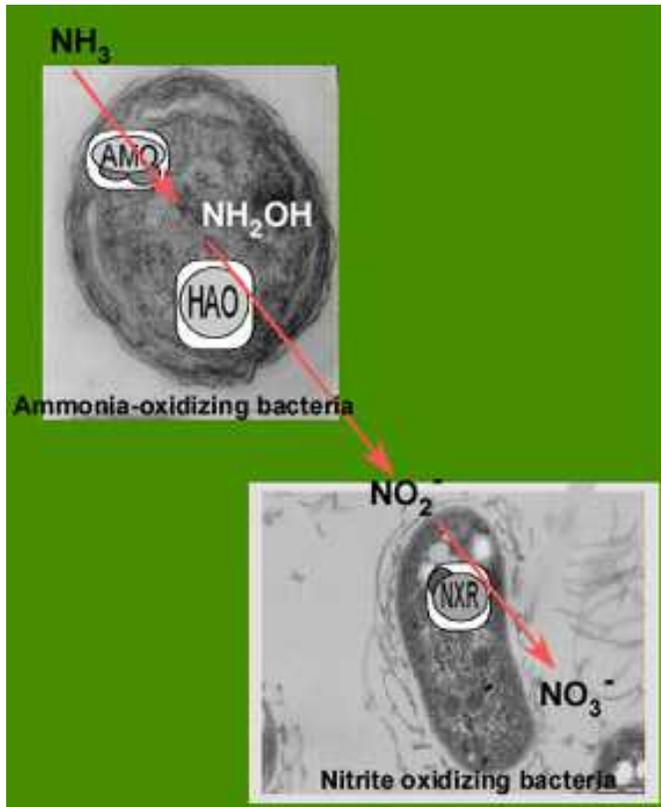
Ryan et al 2006

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 | 7.03 | 167 |
| Between-row | Canola | 0.66 | 729 |
| | | * | n.s. |

Kirkegaard et al 1999

Nitrification inhibition

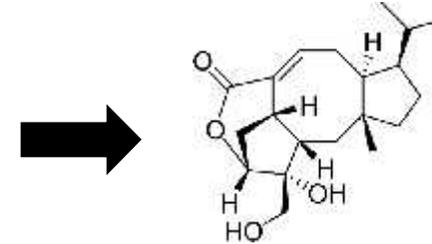


<http://nitrificationnetwork.org/gallery.php>

Biological nitrification inhibitors



Brachiaria humidicola



brachialactone

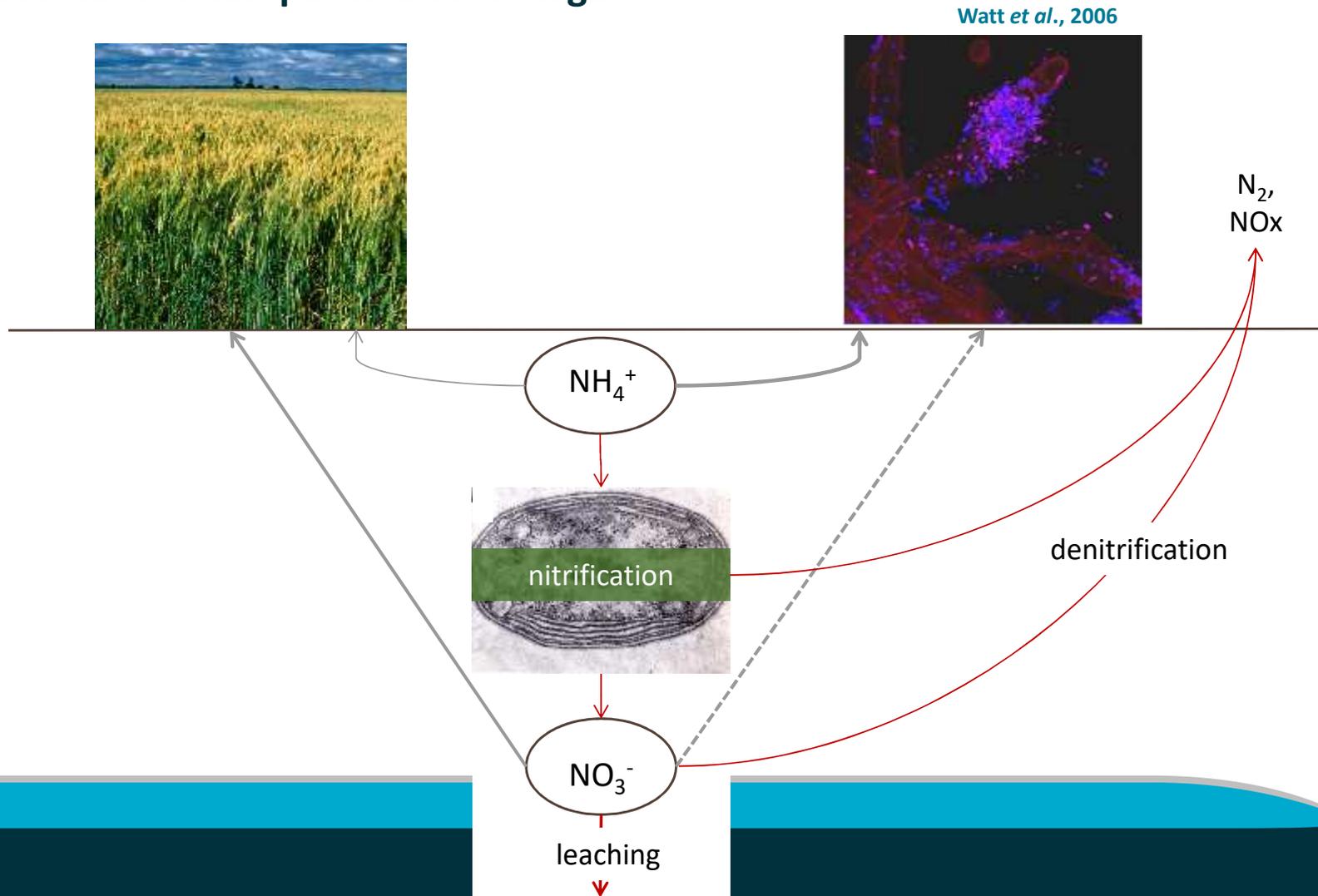
Subbarao et al 2009

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

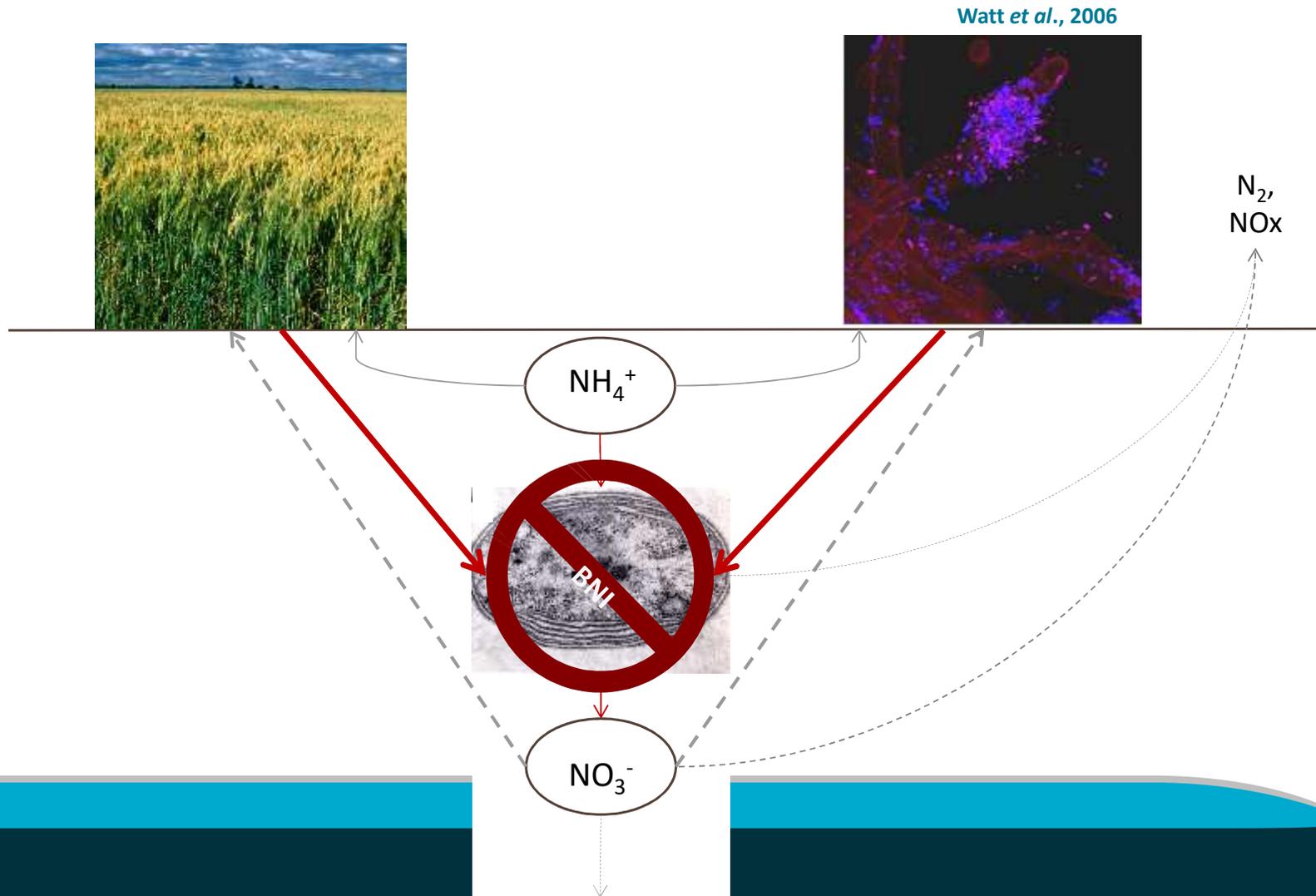
Plants manipulating their microbiome

BNI effects in crops and weeds

NUE improvement vs competitive advantage



BNI effects on crops and microorganisms



Assay to assess root extracts



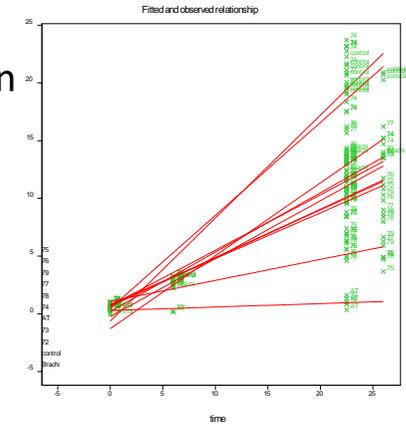
Step 1
Grow plants



Step 2
Extract compounds from roots



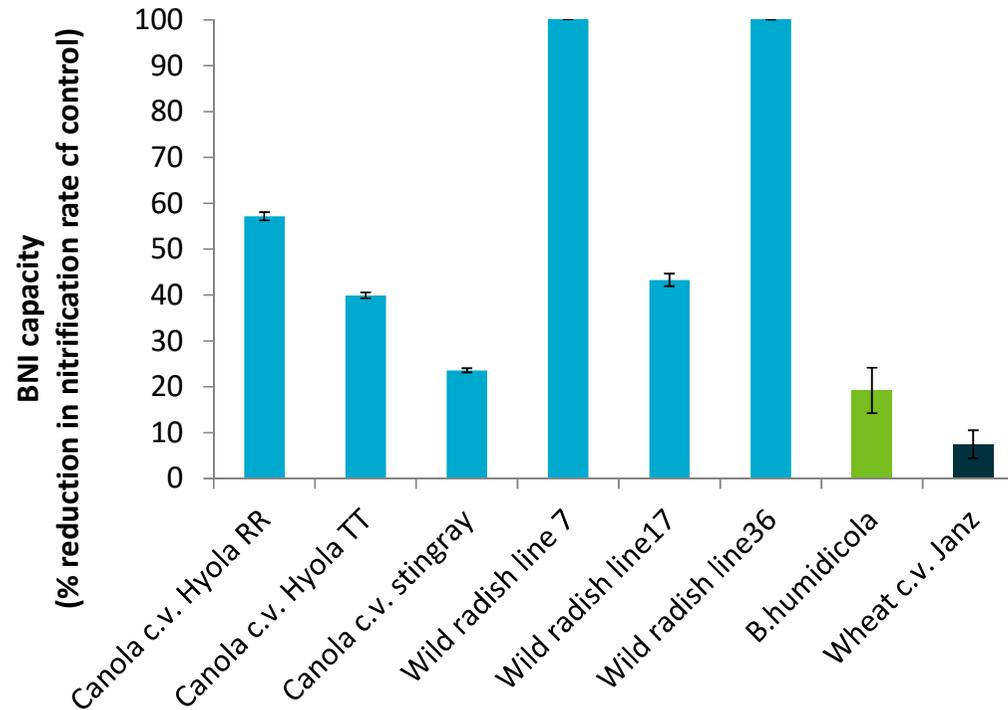
Step 4
Assess nitrification rate against positive control (AT) and negative control (no inhibitor)



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



BNI in root exudates

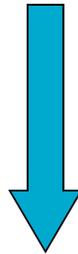


- BNI in canola and wild radish significantly higher than in *B. humicicola*
- First evidence of BNI in non-legume dicot.

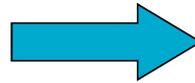
Measuring BNI in pots



Step 1
Grow
plants



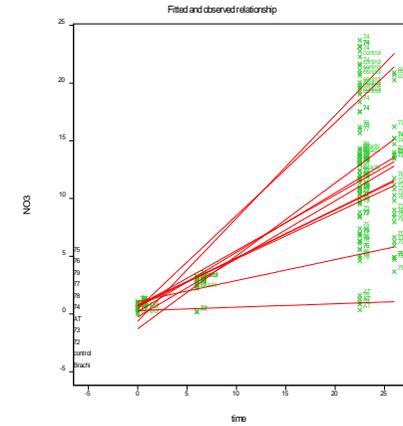
Step 2
Remove plant
and collect
soil



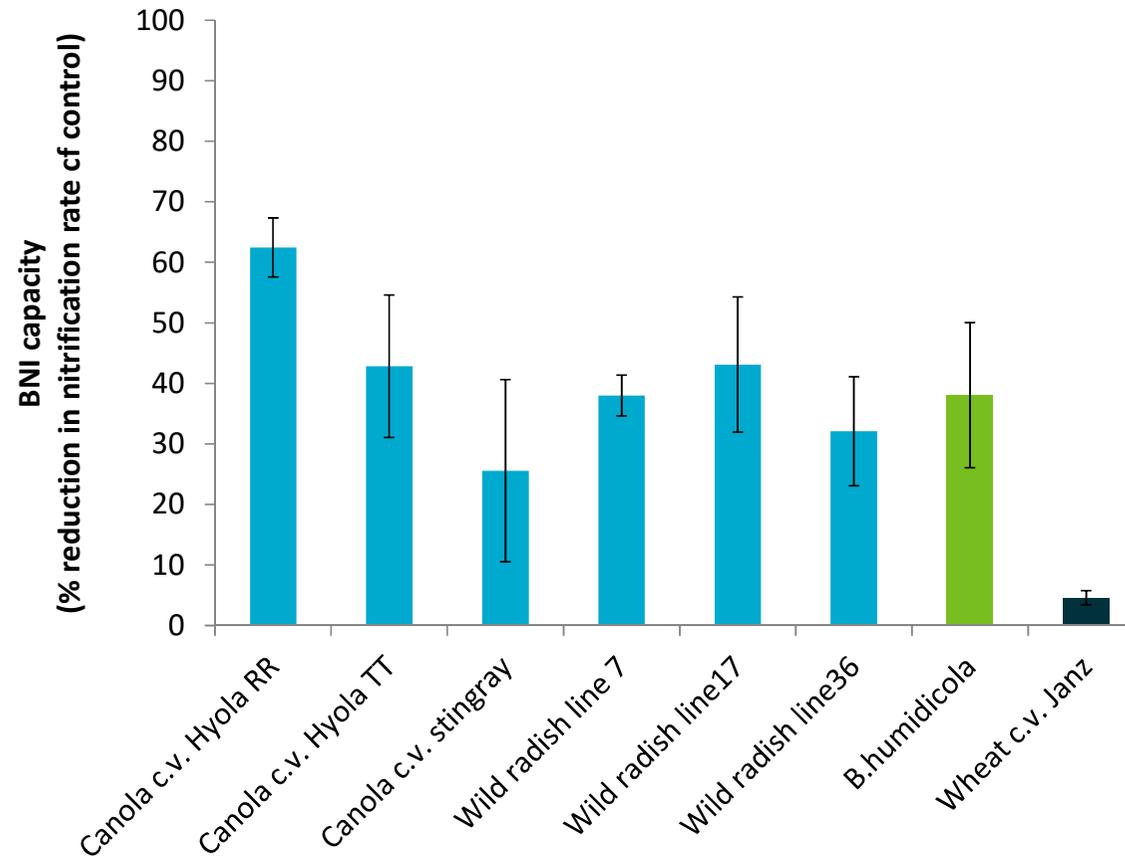
Step 4
Assess
nitrification
rate against
unplanted
control



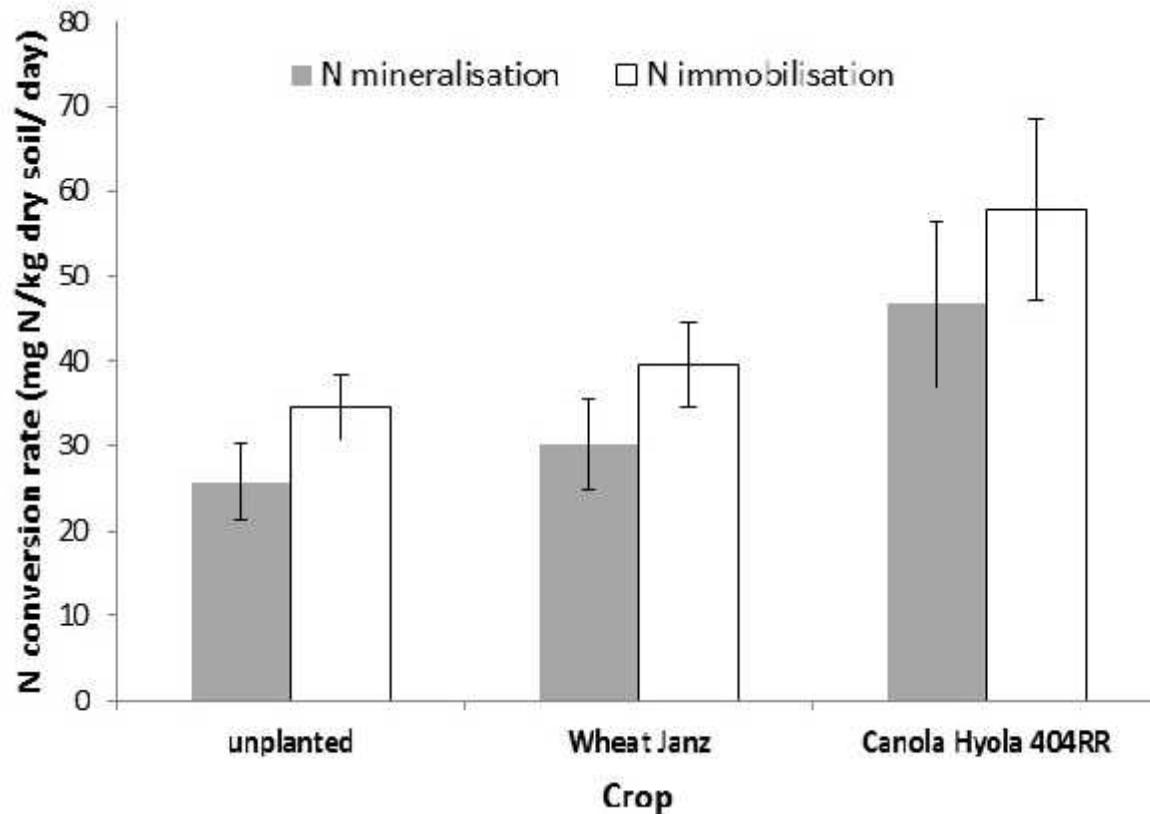
Step 3
Incubate soil
samples in
slurry
containing
 NH_4^+



BNI impact in pot assays



15N tracer soil incubations



Net N Immobilisation in fallow following:

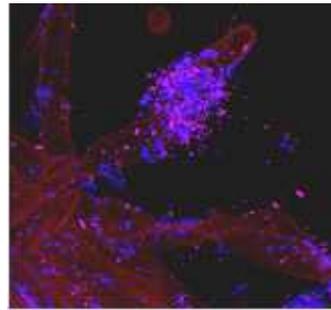
no plant – 8.8 mg N/kg soil.day

wheat - 9.3 mg N/kg soil.day

canola - 11.3 mg N/kg soil.day

Conclusions

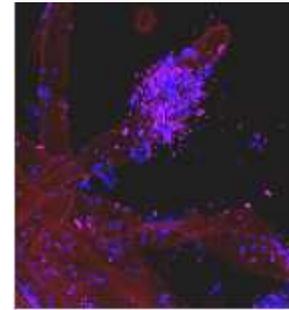
Year 1 – canola rotation



N_2 ,
 NO_x



Year 2 – wheat rotation



N_2 ,
 NO_x



leaching

denitrification

Acknowledgements

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- DAFWA
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 - Elliott Duncan
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 - Phil Ward

Thank You