# MALDI

# Getting your legumes to work harder!
## - A Sub clover case study -

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CENTRE FOR RHIZOBIUM STUDIES

Murdoch UNIVERSITY

Problem

How can you maximize Nitrogen fixation?

- **Understand the problem**

1. What do the roots look like?
2. Which rhizobia are in the nodules?
3. What does the soil look like?
4. Which herbicides are used?

- **Solutions:**

1. Nodule scoring system
2. RHIZO-ID using MALDI-ID
3. Soil analysis
4. Re-inoculation

# How to check?

4 - 8

Check roots + Nodule scoring

Healthy?

Not Healthy?

1 - 3

RHIZO ID

Correct inoculant

No inoculant

Soil analysis

- pH
- Phosphorus
- Molybdenum
- Aluminium

Herbicides

NO SU's

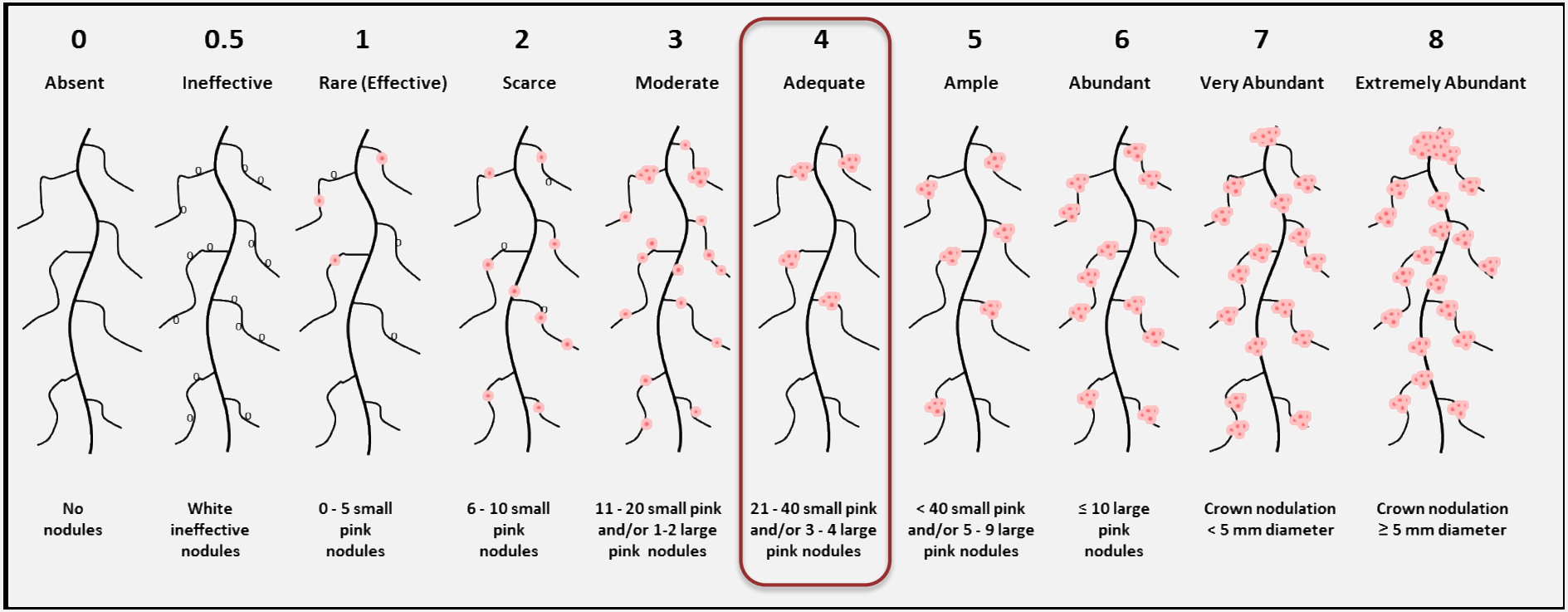
- Change species
- Plant disease control

Inoculate:
- Drill in
- Re-sowing

# Check roots

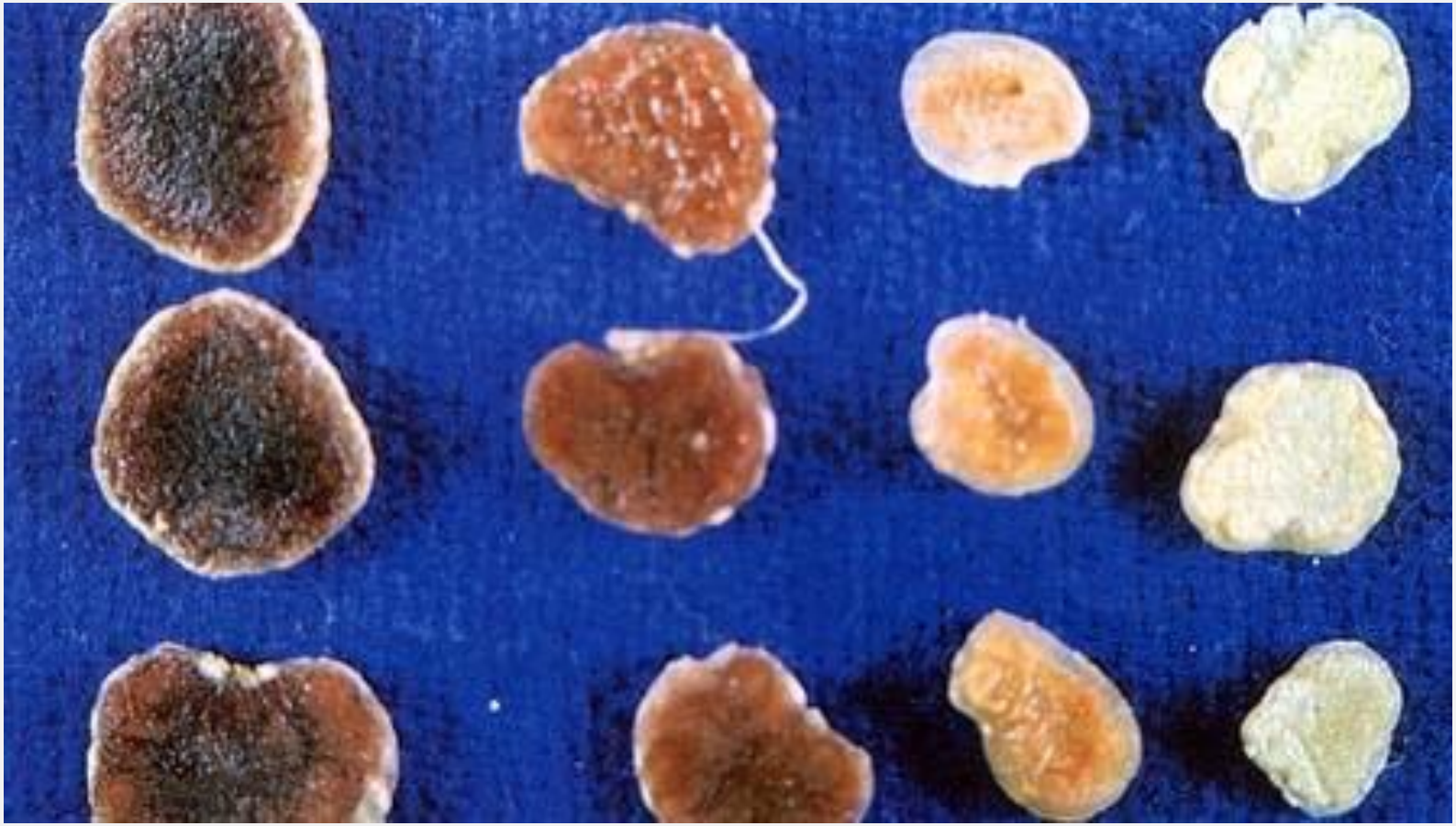

Source: Ron Yates, DPIRD

# Nodule scoring




Source: Yates, R.J., Abaidoo, R., and Howieson, J. 2016. Field experiments with rhizobia. Pages 145-166 in: Working with rhizobia, J. Howieson and M. Dilworth, eds. Australian Centre for International Agricultural Research, Canberra.

# Inside the nodule



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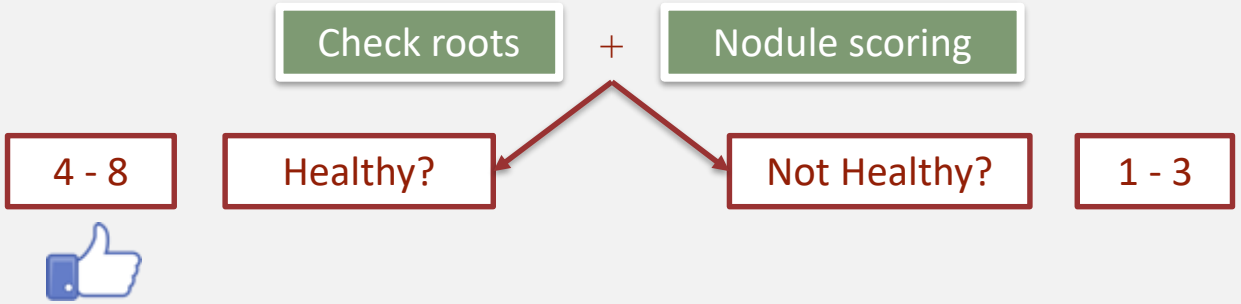


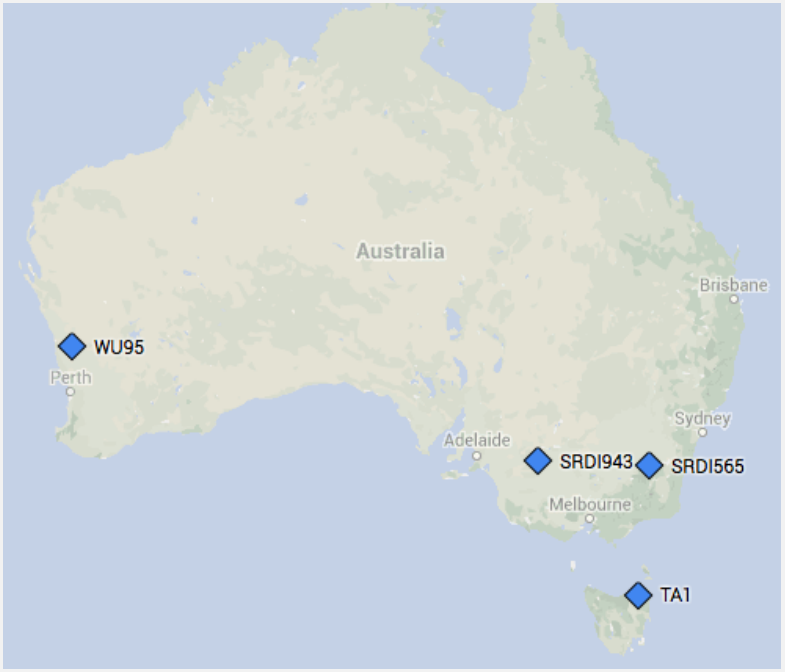

# Why do you need to know which rhizobia are in the nodules?

- Optimal fixing legume can produce 20-30kg Nitrogen/tDM
  → Free Nitrogen Farming
- Slow release fertiliser, available when the plants need it
- Available for subsequent crops

# What does RHIZO-ID tell?

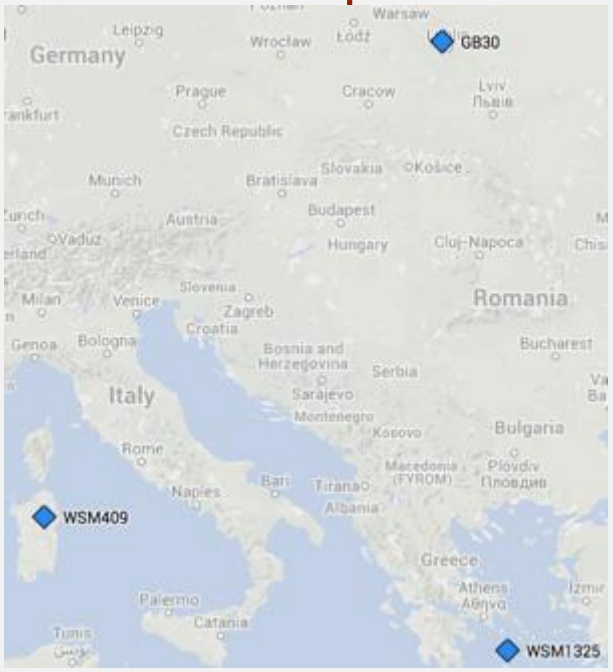
## Sub clover case study

### Australia




Old Group C:
TA1 (’56 - ’70), WU95 (‘68 - ’94), WSM409 (‘94 - 04)

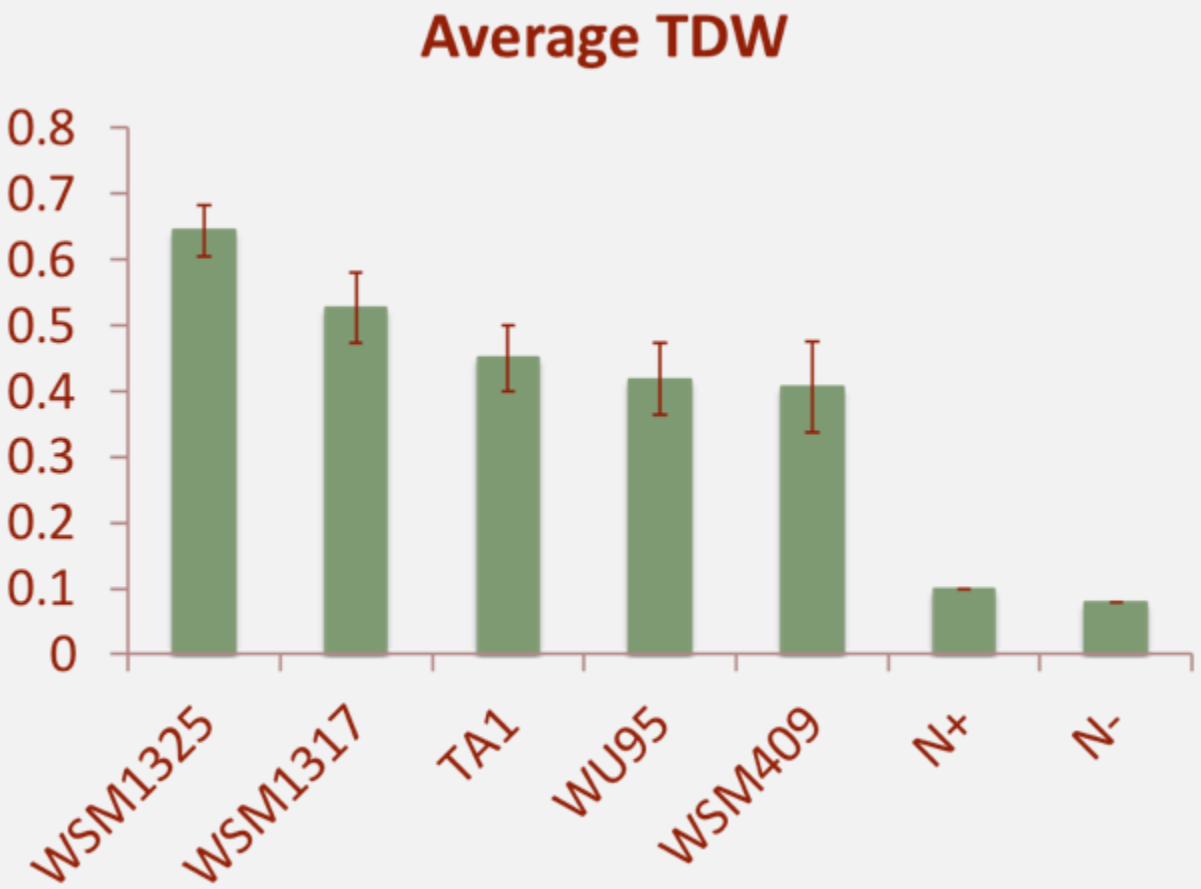
### Europe




Current Group C
WSM1325 (since ’05)

Why WSM1325 for clover?

Better at fixing $N_2$ than old inoculant strains



# Why WSM1325 for clover?

- Competitive against background
- Broad range of clovers: Sub, Arrow, Purple, Gland, Persian, Balansa, Crimson, White and Strawberry

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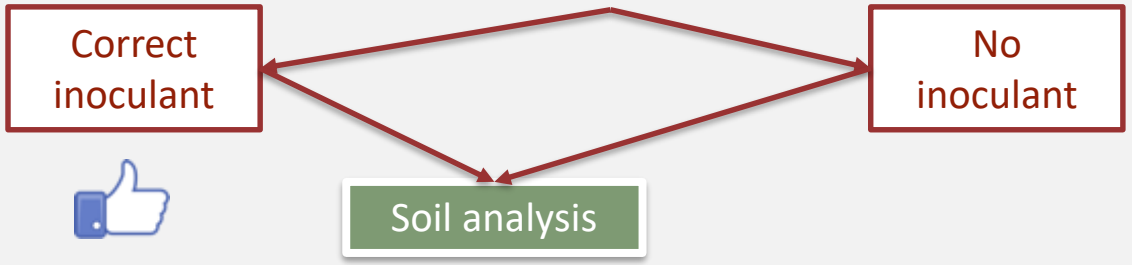
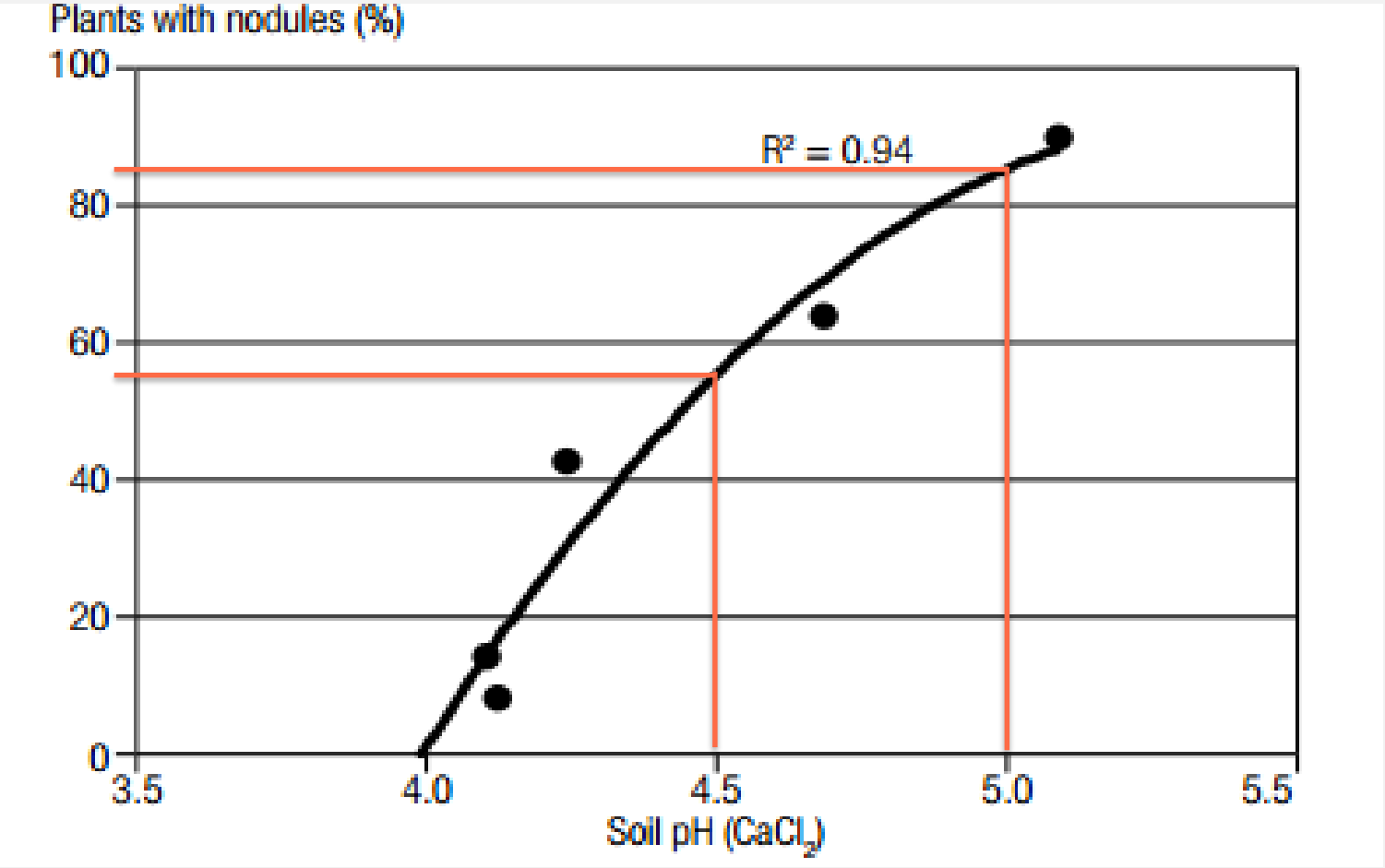
# Soil chemistry - $pH_{Ca}$




| Host legume | pH 4.0 | pH 4.5 | pH 5.0 | pH 5.5 | pH 6.0 | pH 7.0 | pH 8.0 |
|---|---|---|---|---|---|---|---|
| Serradella, lupins | | | | | | | |
| Inoculant Group GS | | | | | | | |
| Clovers | | | | | | | |
| Inoculant Group C | | | | | | | |
| Biserrula | | | | | | | |
| Inoculant Group BS | | | | | | | |
| Medics | | | | | | | |
| Inoculant Group AM/AL | | | | | | | |

Red = low N fixation, Orange = sub-optimal N fixation, Green = optimal N fixation

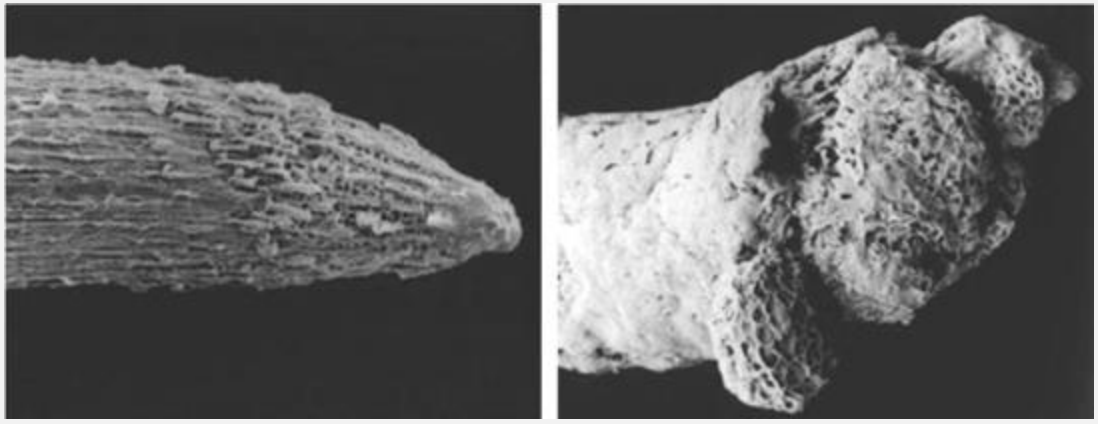
# Soil chemistry - $pH_{Ca}$




Source: Drew et al. 2012

# Soil chemistry - pH

## Aluminium toxicity



Healthy root tip (left) compared to a deformed root tip affected by aluminium toxicity (right).
Photos: CSIRO

Wheat seedlings grown in soil with a range of aluminium concentrations demonstrate restricted root growth at high aluminium concentrations. Photo: S Carr

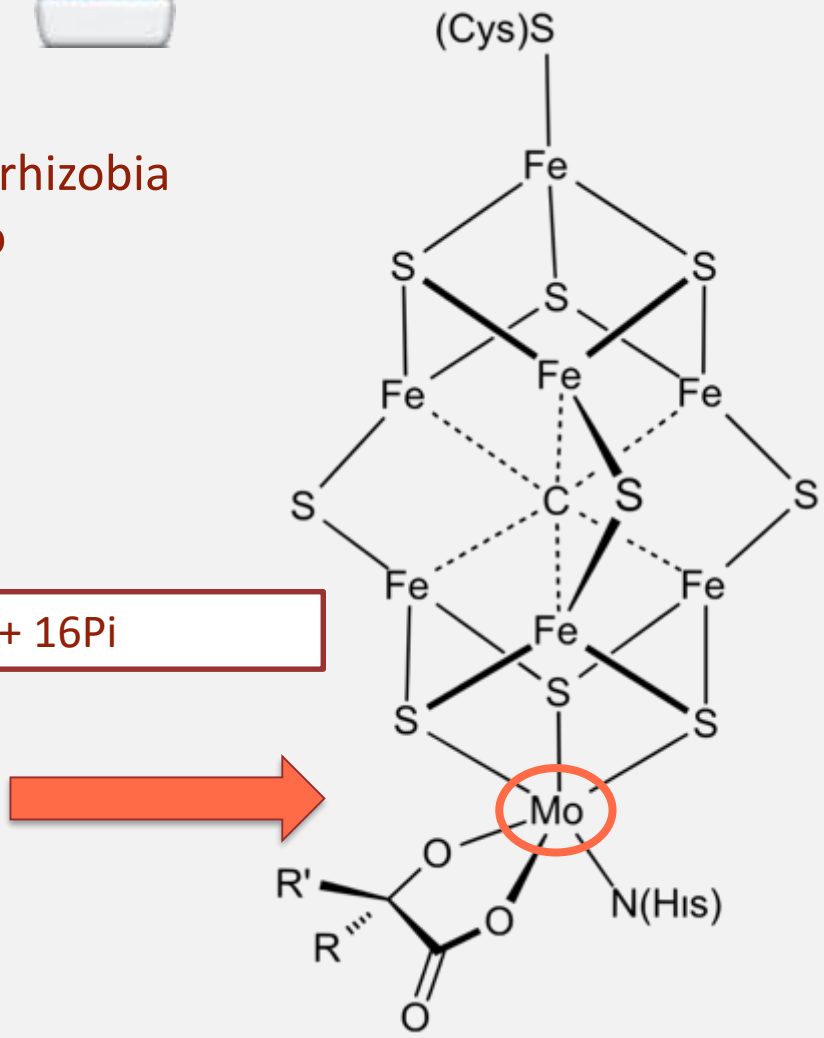
https://www.agric.wa.gov.au/soil-acidity/effects-soil-acidity

# Soil chemistry - Molybdenum


- Required for nitrogen fixation by rhizobia
- Nitrogenase enzyme contains Mo
- Less available if pH is low

## Nitrogen fixation reaction

$N_2 + 8H^+ + 8e^- + 16ATP \rightarrow 2NH_3 + H_2 + 16ADP + 16Pi$



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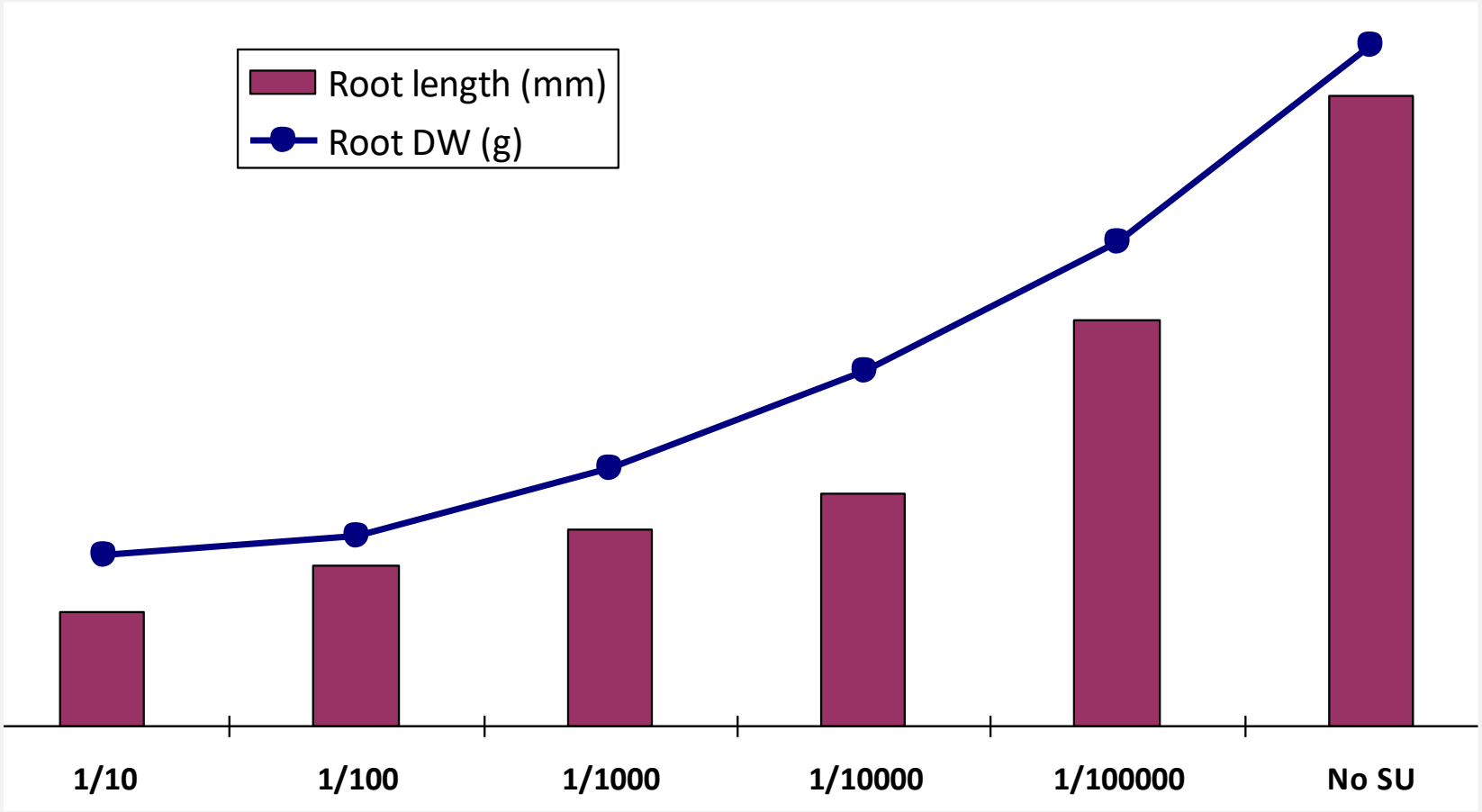
# Soil chemistry - Herbicides

Understanding residual danger of herbicides – Be aware of plant back!

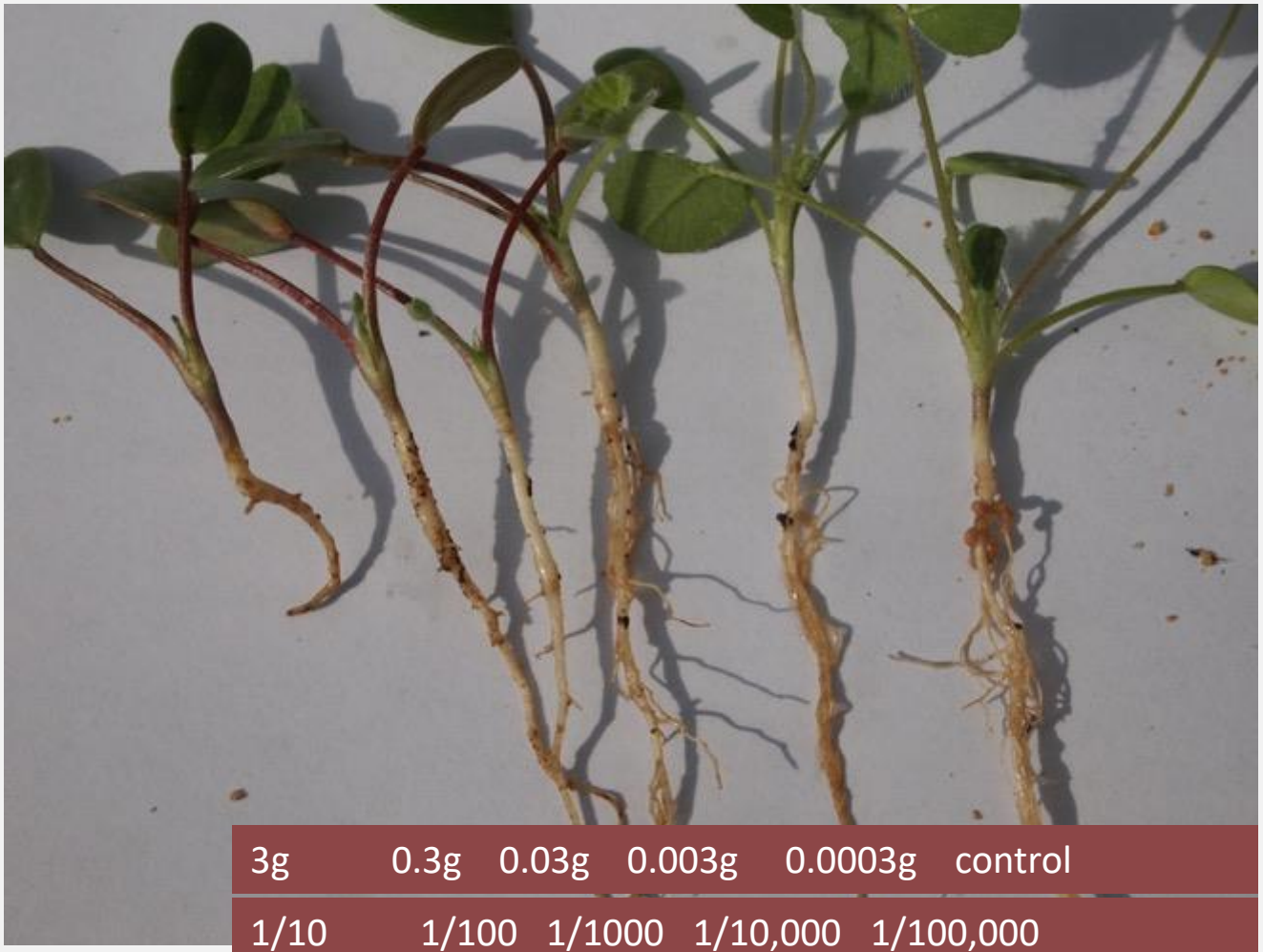



Logran - Triasulfuron

Source: Ron Yates, DPIRD

# Soil chemistry - Herbicides

## Triasulfuron effect on Sub clover (18 days of growth)




Source: Ron Yates, DPIRD

Soil chemistry - Herbicides

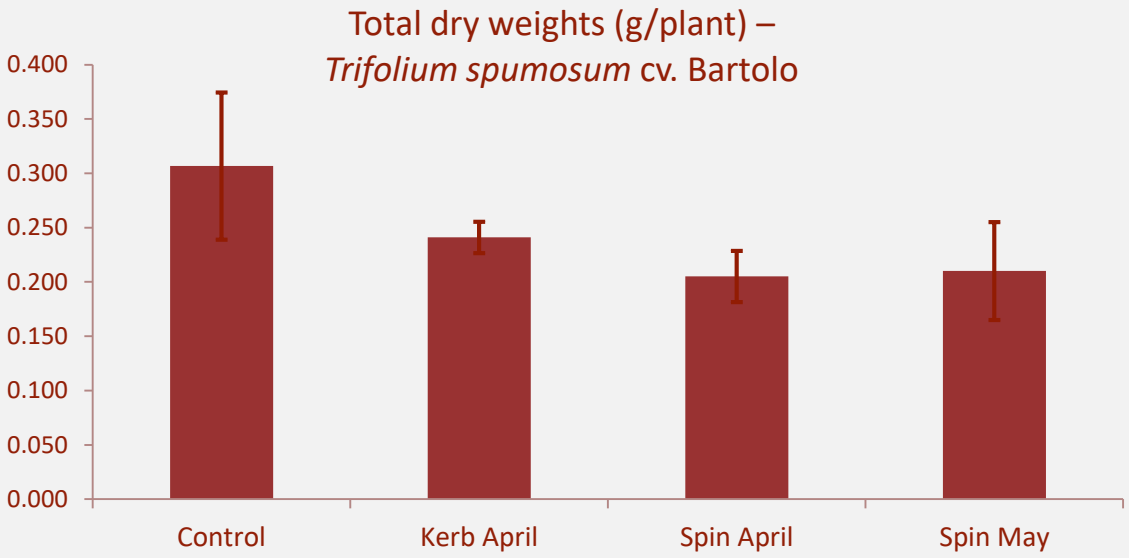
Brookton case study, WA

**Nodule occupancy of commercial inoculant under herbicide pressure**

- Previous oat crop, no previous usage of commercial inoculant
- *Trifolium spumosum* cv. Bartolo inoculated with WSM1325
- 9 treatments:
  - Spinnaker (Group B, Imazethapyr) – February and April
  - Kerb (Group D, Propyzamide) – February and April
  - Spinnaker + Kerb – February and April
  - Spinnaker post emergence
  - Control

# Soil chemistry - Herbicides

## Brookton case study, WA




- Reduced TDW
- Reduced PRL
- Increased # nodules

Control

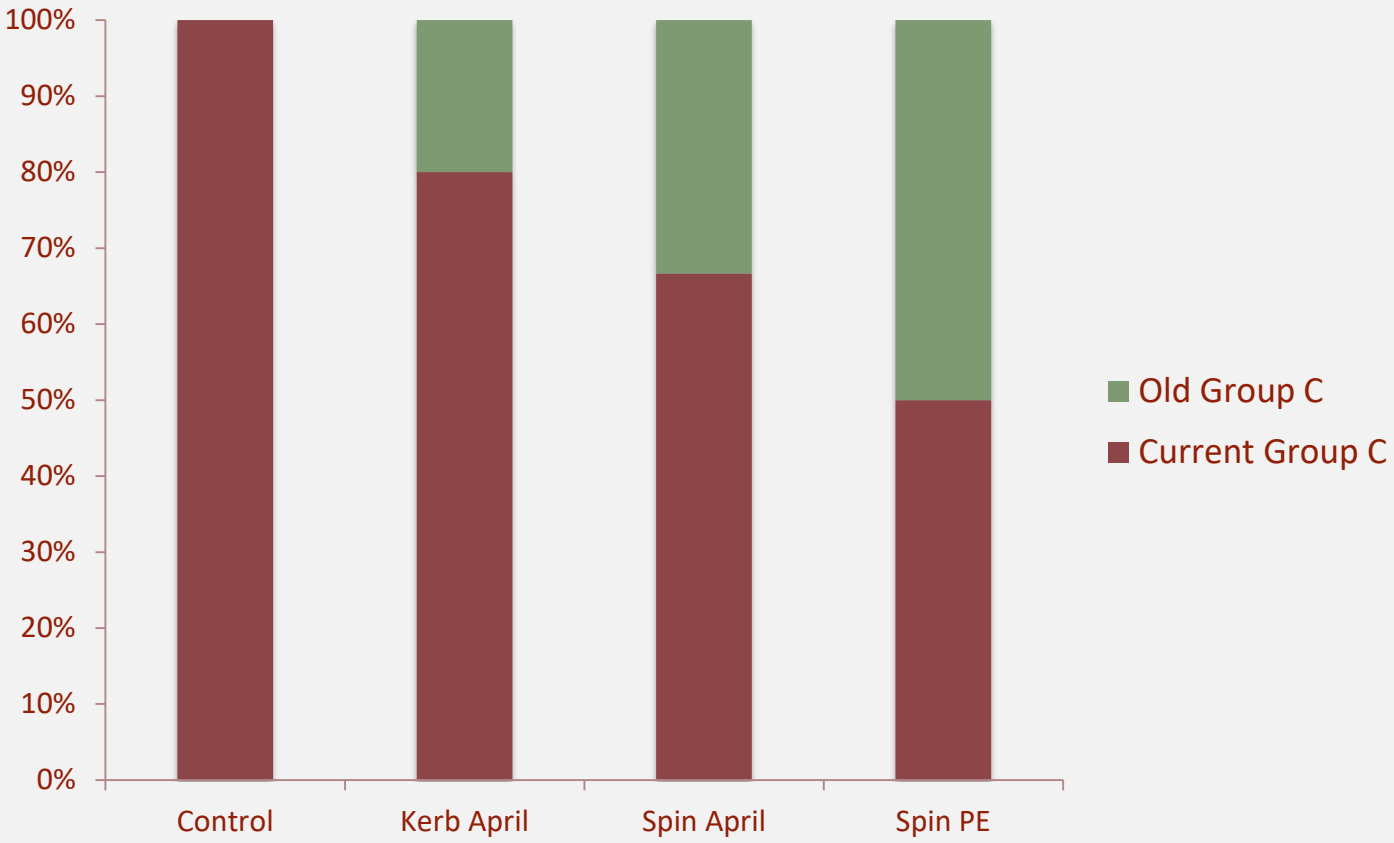
Kerb April

Spinnaker April

Spinnaker post emergence

# Soil chemistry - Herbicides

## Brookton case study, WA




→ **Residual herbicides influence nodule occupancy and subsequent plant performance**

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# Inoculant types

## Granular inoculant

- Reliable
- Dry and wet soil
- Easy storage
- More expensive (10 - 15$ /ha)
- Less user friendly for mixtures

## Peat inoculant

- Cheap (4 - 6$/ha)
- Reliable
- Store in fridge
- Wet soils
- Quick usage after opening

## Pre-coated seed

- Easy use
- Added fungicides
- Expensive (20 – 30$/ha)
- Variable results with clover
- Short shelf life

Inoculant types

## Guidelines for paddock renovations

- Lack of legume density → re-sowing:
  - Peat: Cheapest option
  - Pre-coated seed: Shortly after coating and controlled storage
- Existing paddock with good legume density
  - Drill/scratch in granules
  - Sow peat inoculated grazing oats @ one peat pack (250g) for 50kg and sow at 25kg/ha
- Paddock after crop rotation
  - Add granules when sowing crop year before pasture phase

# Diagnosis pathway

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# MALDI ID

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