

# Improving the tolerance of alfalfa to acidic soils.

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With Acknowledgements for rhizobia research to;

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# Intolerance of alfalfa to acidic soils

- **Poor root growth**
  - Tolerance to low pH
  - Aluminium toxicity
- Poor nodulation
  - **Survival of Rhizobia in soil**
  - **Nodulation potential of plant**



## Selection for improved root growth



Identification of acid tolerant rhizobia



Selection for improved plant nodulation





# 1. The Screening System



pH 4.5  
25-75mMol Aluminum  
Low ionic strength McNights  
solution (minus N)  
2-3 weeks

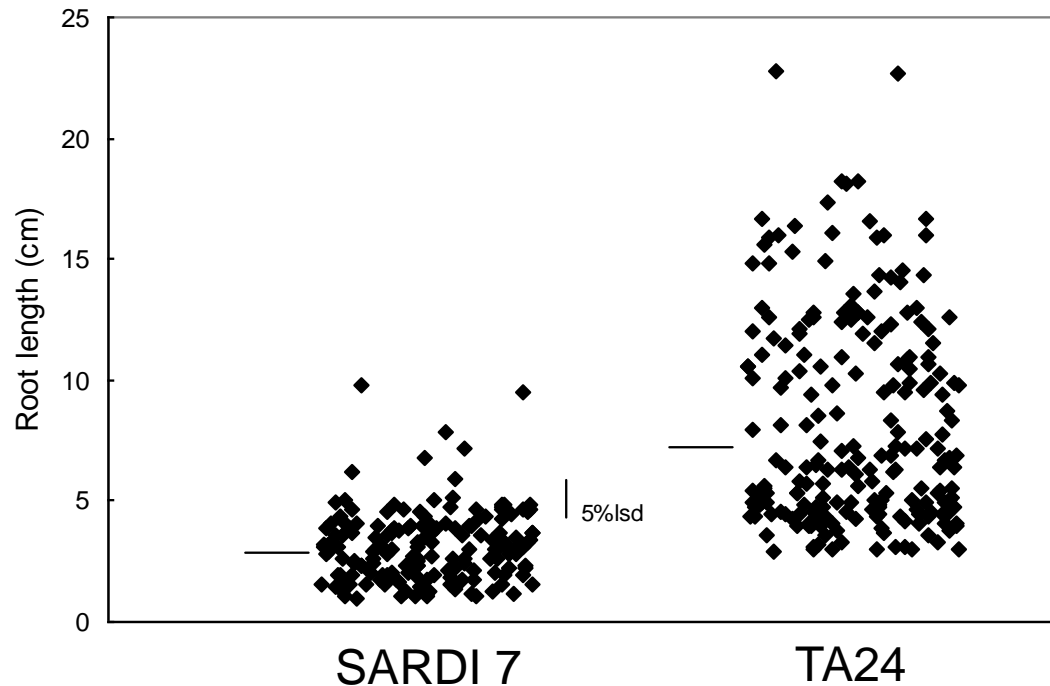
## 2. Selecting the longest roots



SARDI 7

# 3. Cycle 4 versus unselected parent

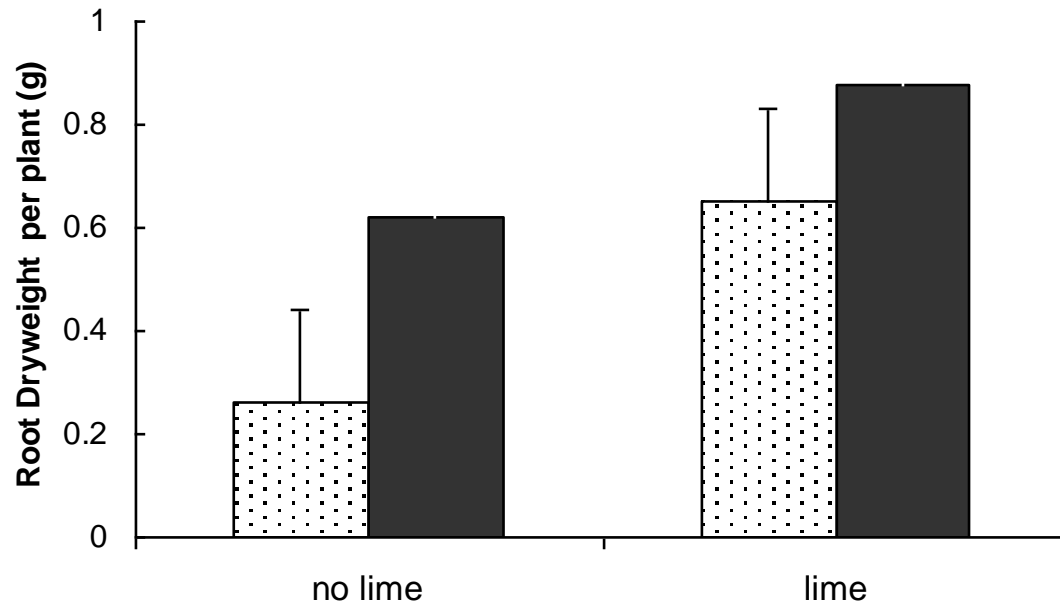
-3uM Al at pH4.5 for 14 days



Combined performance from progeny of 32 half sib families

# 4. Validation of improved performance in Warrnambool soil

- pH 4.5, Aluminium 17% CEC



**Response of root weight in SARDI Seven (dotted) and TA24 (black) to the addition of 1 t/ha lime to an acidic soil from Warrnambool with aluminium toxicity.**



# Warrnambool Soil - Response to Genotype





Selection for improved root growth



## Identification of acid tolerant rhizobia



Selection for improved plant nodulation



# Acid tolerant rhizobia



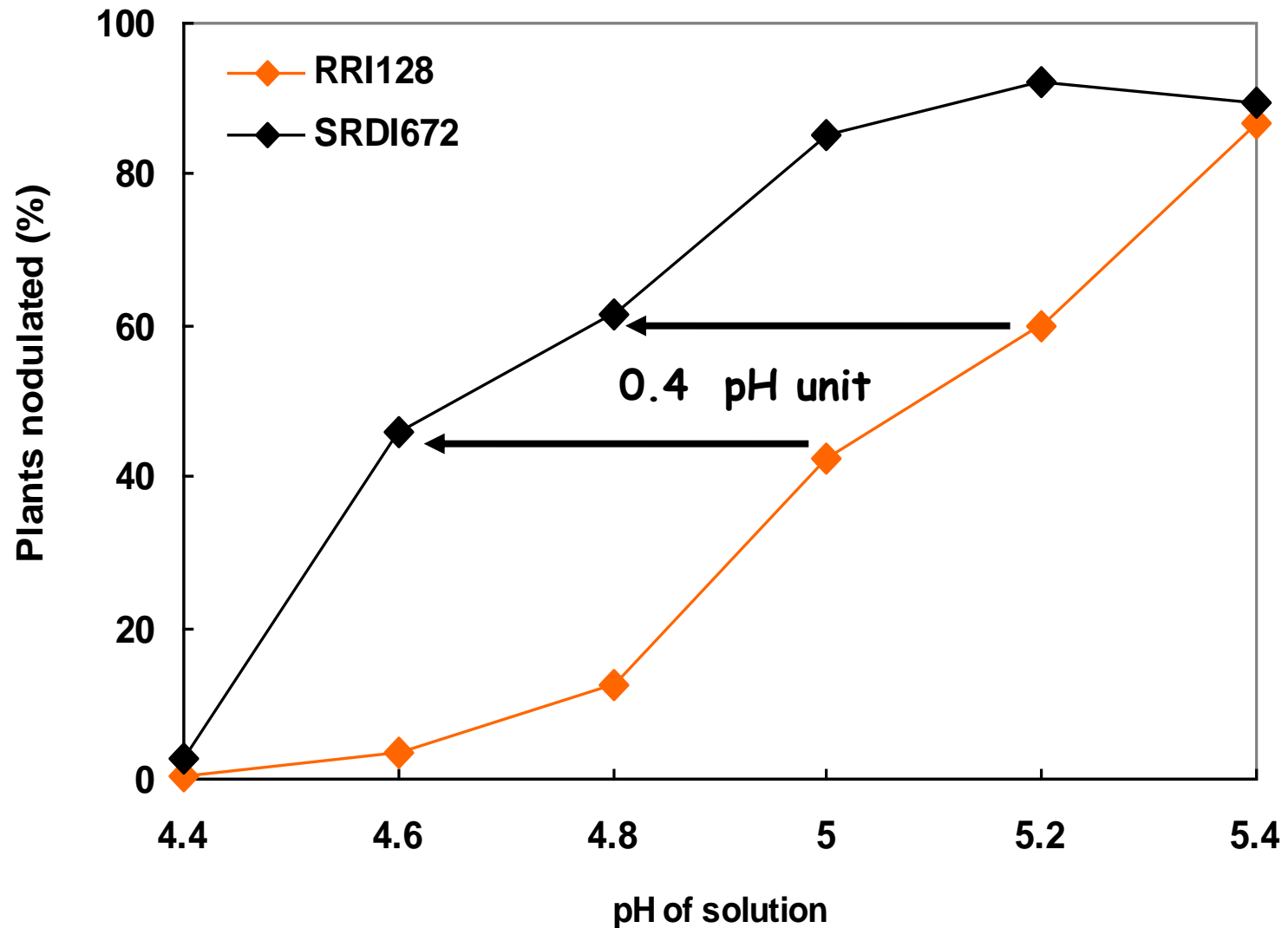
- 228 strains isolated from field environments  
pH<sub>Ca</sub> 4.5-4.8
- Screened for
  - tolerance to low pH in solution culture
  - Effectiveness of N fixation
  - Survival on seed
  - Field performance on low pH soils
    - (plant yield, plant persistence, saprophytic competence, nodulation % and no. nodules per plant on seedlings and mature plants, N fixation N<sup>15</sup> natural abundance, plant genotype x strain interactions).



**Alfalfa seedlings are assessed for nodulation after growing for two weeks in solution cultures maintained at pH 5.0**



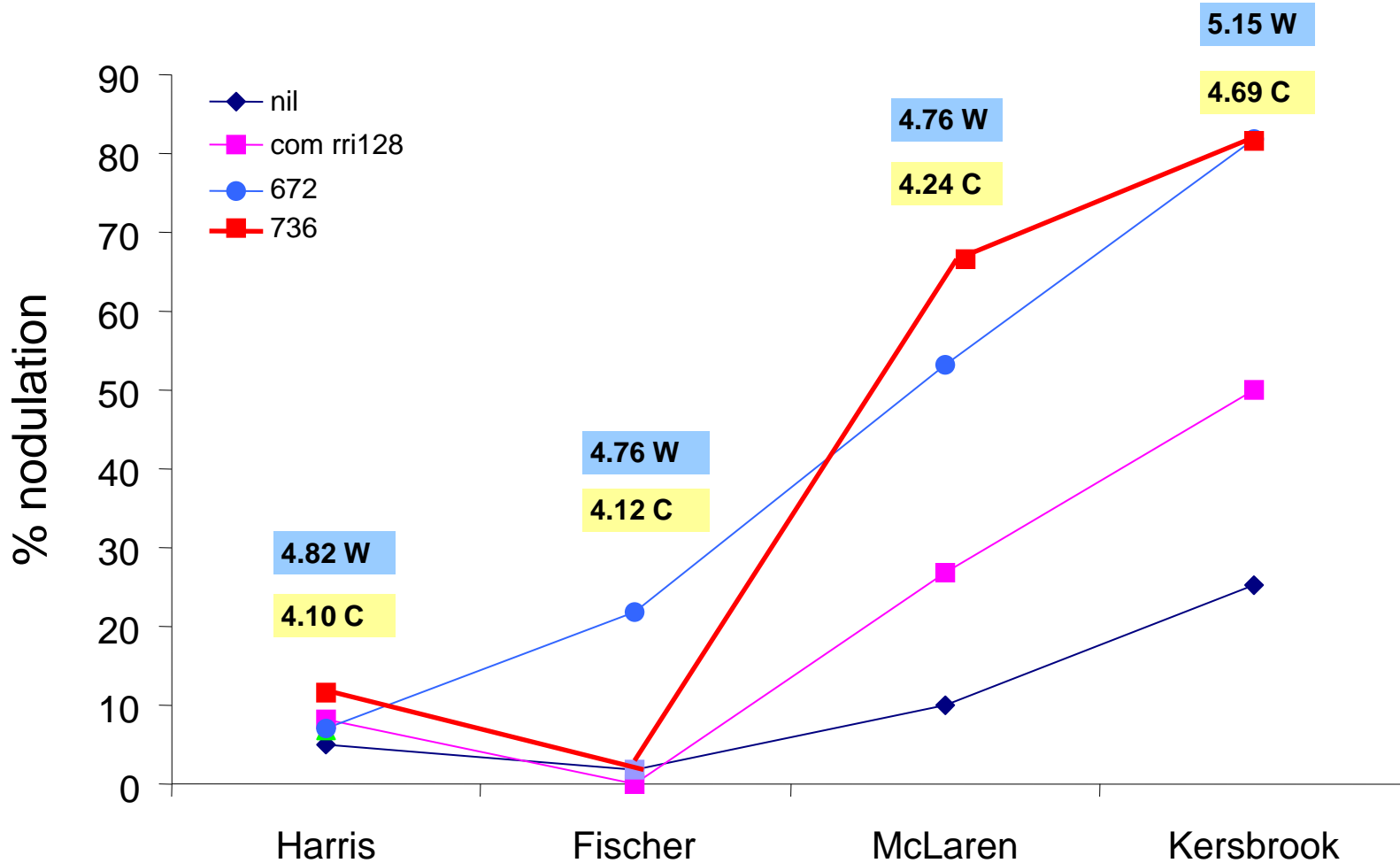
# Effect of pH on alfalfa nodulation by strains RRI128 and SRDI672



# An example of reduced N<sub>2</sub>-fixation capacity of strain SRDI 684



# Nodulation in soil



Soil pH at each site shown in blue (water) and yellow (calcium) boxes



# No. of rhizobia per gram of soil persisting in SA field trials

Table 4. Number of rhizobia per gram of soil, persisting in SA field trials

Inoculation treatment	Kersbrook (pH 4.7)	McLaren Vale (pH 4.2)
NO RHIZOBIA	2,133	0
RRI 128	651	0
RRI 128 + Lime	29,800	20,380
SRDI 672	31,100	1,834
SRDI 722	631	32
SRDI 736	55,630	97,538

The findings are consistent with the percentage nodulation of established seedlings at the two sites ( $R^2=65\%$ ).

# Field performance of rhizobia

- Limitations
- Trials only ran for 2.5 years
  - Takes 2-3 years for alfalfa to completely mop up all the N from soil.
  - Therefore few differences in yield (uninoculated treatments only just starting to decline)
  - Therefore no differences in plant persistence (not enough pressure)
- Limited by performance of plant

Selection for improved root growth



Identification of acid tolerant rhizobia



**Selection for improved plant nodulation**





# multiple trait selection



Nodulated plants with long roots

# Breeding alfalfa for improved root growth and nodulation

- results from solution culture

TA33 has 2 cycle of selection for nodulation

	% nodulation at pH 4.7	NNP* at pH 4.8	Root growth (cm) at pH 4.5*
<b>SARDI Seven</b>	2	1.1	2.3
<b>SARDI TA33</b>	63	2.6	14.3
5% Isd	11	0.6	4.3

NNP = Number of nodules per nodulated plant

\*post aluminium



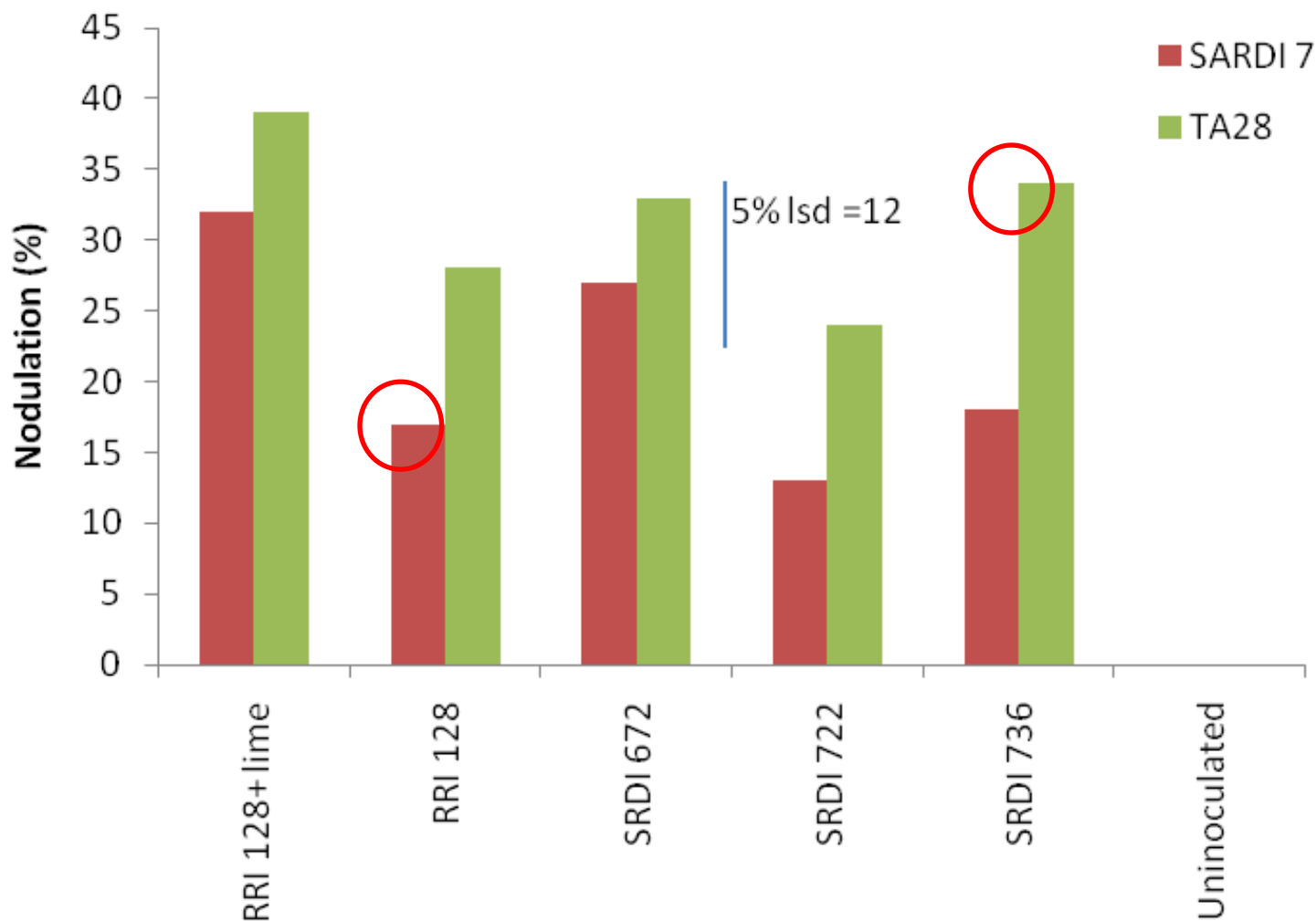


**SARDI 7**  
Average <2% nodulation

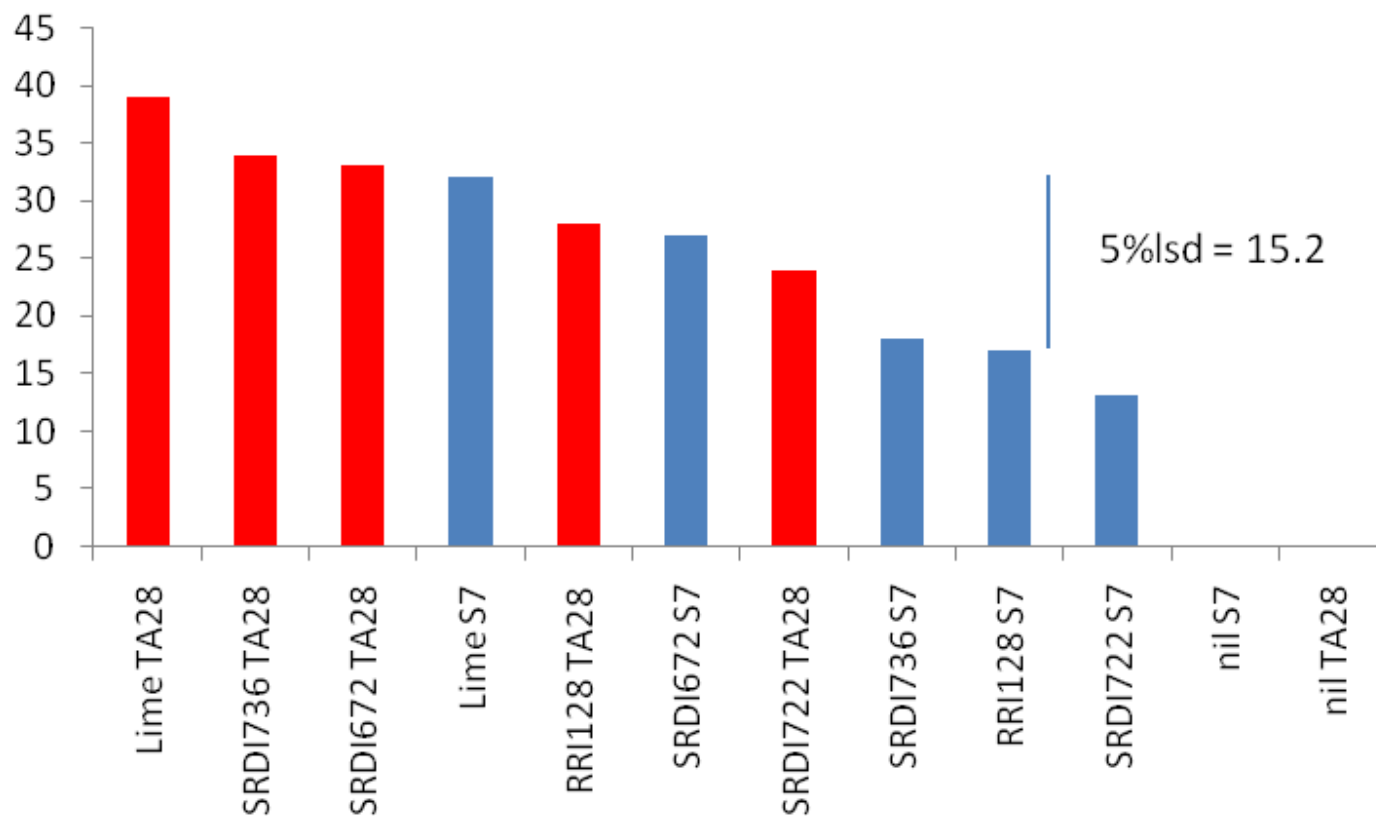
**TA33**  
2 cycles selection for nodulation



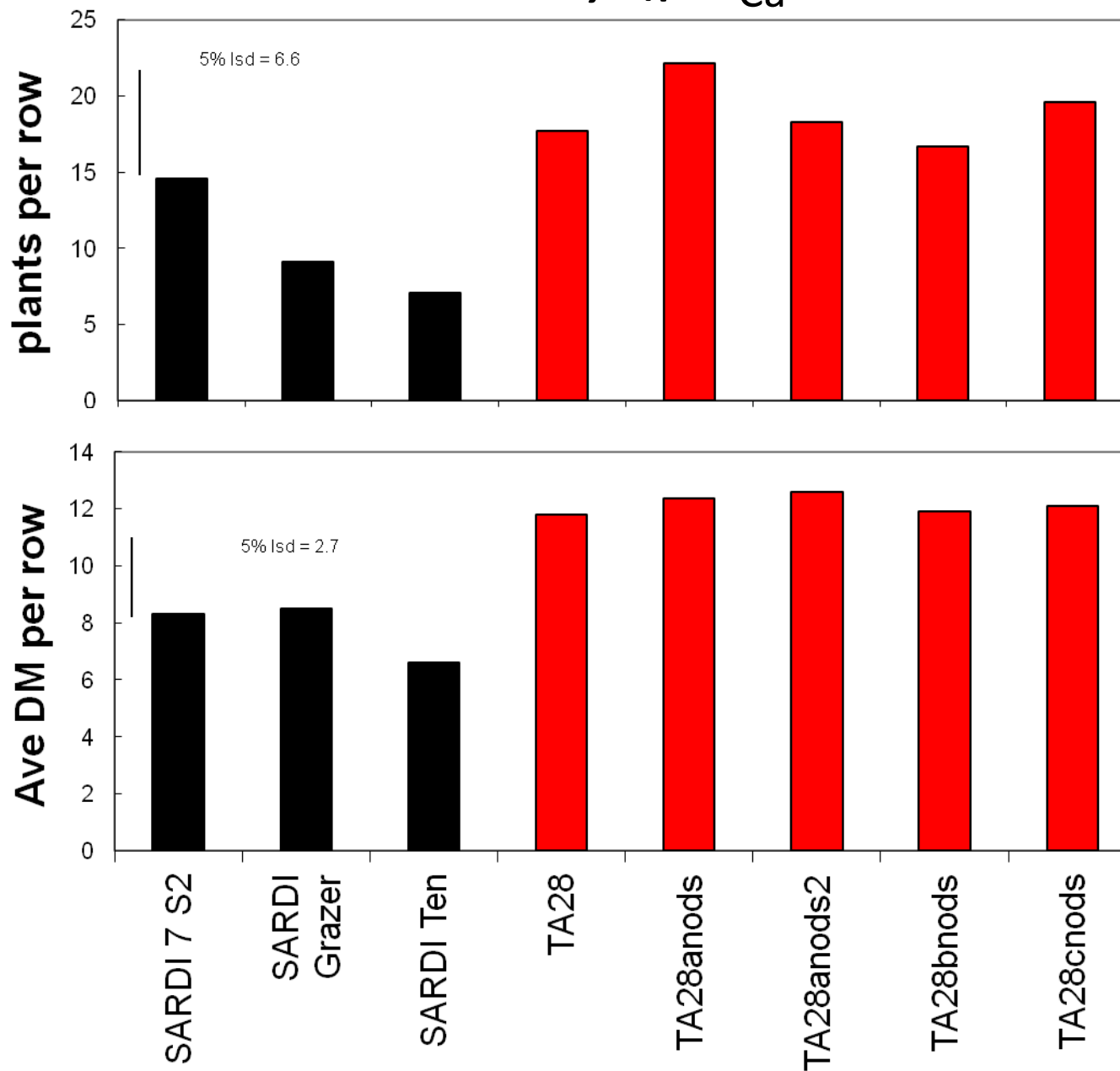
# Nodulation of alfalfa seedlings at Coleraine (pH<sub>Ca</sub> 4.4), low Al



# Nodulation of alfalfa seedlings at Seymour ( $\text{pH}_{\text{Ca}}$ 4.4 17%Al)



# Seymour Row Trial, (pH<sub>Ca</sub> 4.4, Al=17%CEC)



# Conclusions

- 3 traits critical for improvement of alfalfa in acidic soils
  - Al tolerance, nodulation capacity, and rhizobia
    - But there may be others (Manganese toxicity, nutrient efficiency)
    - ‘Field tolerance’ needs to be considered
- Future research work will look at defining the improvement made to date by combining our best plant germplasm with new strain of rhizobia selected for commercialization.



*Thank you*

