

## Management impacts on N fixation of mungbeans and chickpeas.

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### Key words

Nitrogen fixation, nodulation, rhizobia, row spacing, soil nitrate

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### Take home messages

- Changes to agronomy can change N fixation in grain legumes
- In general, increasing row spacing may decrease amount of N fixed by legumes. N fixation in mungbean variety Satin 210 however appears to compensate in N fixation for wider rows.
- Varieties can differ significantly in amount of N fixation and is related to biomass.
- High soil nitrate levels can reduce legume nodulation and N fixation by rhizobia. The addition of N fertiliser does not give any yield advantage in chickpeas or mungbeans and may reduce the amount of N available for the following crop.

### Background

Average amounts of N fixed annually by crop and pasture legumes are around 110 kg N/ha (ranging from close to zero to more than 400kg N/ha). The actual amount fixed depends on the species of legume grown, the site and the seasonal conditions as well as agronomic management of the crop or pasture. The legume crop uses this N for its own growth and may fix significantly more than needed, leaving a positive N balance in the soil for proceeding crops.

Chickpeas were the most widely grown legume crop in Australia in 2013 with about 85 per cent being grown in NSW and Queensland. Mungbeans in the years 2008 - 2010 were up to 70000 t average production after an average of just 40000 t in 2004 -2007, mainly through improved average yields. The vast majority are grown in the northern region of Australia.

The amount of N fixed by a legume increases as legume biomass increases but is reduced by high levels of soil nitrate. In general, legume reliance on N fixation is high when soil nitrate levels are below 50 kg N/ha in the top metre of soil. Above 200 kg N/ha, nitrogen fixation is generally close to zero. The fixed N is used for the growth of the legume itself (saving fertiliser application of the legume crop) as well as potentially leaving residual N for the following cereal or oilseed crop and providing a break from cereal stubble and soil-borne diseases.

Work by Doughton *et al.* (1993) clearly demonstrated the impact of increasing soil nitrate levels on N fixation of chickpeas (see Figure 1), with no yield advantage being gained by applying N. Moreover, chickpea provided a positive soil N balance when fixation rates were high and a negative balance at low fixation rates.

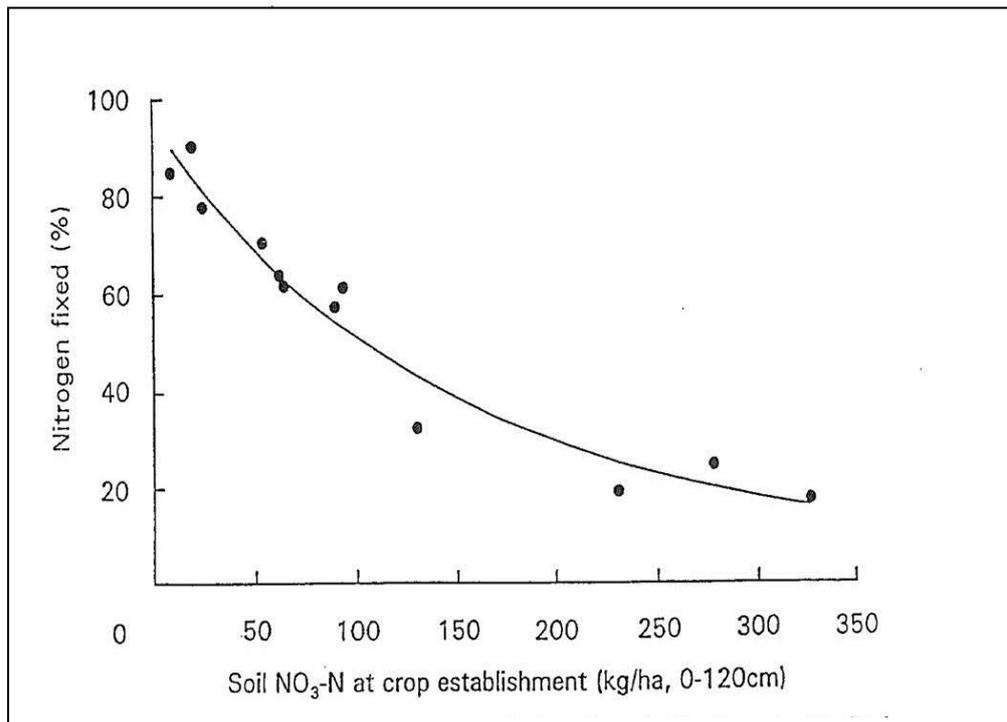


Figure 1. Per cent nitrogen fixed in chickpea (cv. Reselected Tyson) tops 130 days after planting for various levels of soil NO<sub>3</sub>-N at crop establishment. For fitted curve,  $Y = 7.05 + 88.45e^{-0.0070X}$ ,  $R^2 = 0.95$  (from Doughton *et al.* 1993).

Researchers in GRDC project DAQ00181 (Optimising N fixation in grain legumes – northern region) will be working closely with the new Pulse Agronomy projects in Qld and NSW as well as some Grower Solutions projects to identify agronomic practices to optimise legume growth and N fixation without compromising crop yield.

### **Row spacing, plant populations and variety**

Field trials with summer (mungbean) and winter pulses (chickpea) were grown in 2013 in Queensland to examine the effects of varying agronomic factors on the growth, yield and N fixation of the pulses.

#### **Mungbean**

Over the 2012/13 summer, two mungbean trials were conducted at Taabinga and Redvale, near Kingaroy, Qld. Both trials consisted of the factorial combination of the following treatments:

2 row spacings (30 and 90 cm) x 3 plant populations (20, 30 and 40 plants/m<sup>2</sup>) x 3 varieties (Crystal, Satin 2 and Jade-AU). Each had 3 replicates. Yields were not significantly different for any of the treatments at either trial but N fixation analyses showed that variety interacted with row spacing for the %Ndfa (per cent N in the plant shoots that is derived from the atmosphere not from soil nitrate supplies). Both Crystal and Jade-AU had much reduced N fixation as row spacing changed from 30 to 90 cm but Satin II fixed a similar high proportion of N (48 and 49%) for both row spacings (Figure 2).

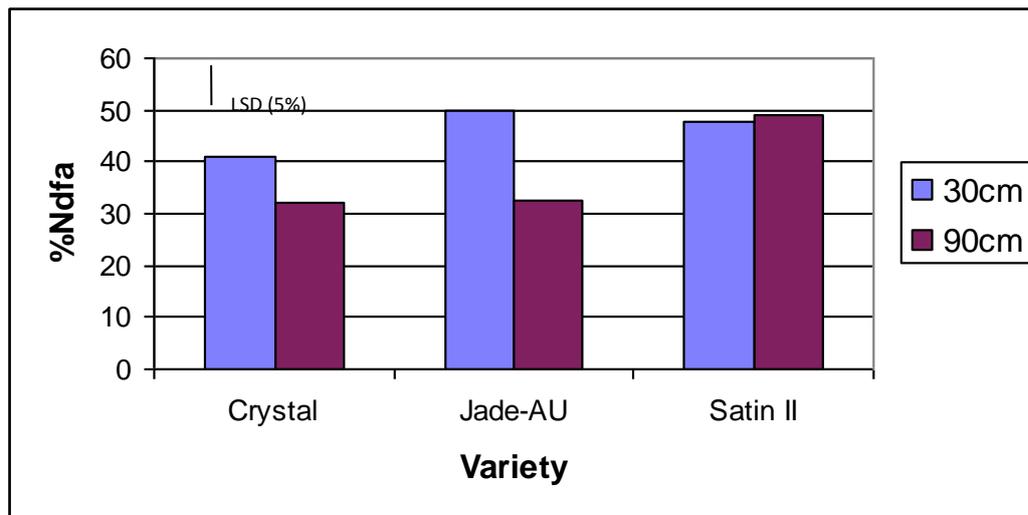


Figure 2. Percent N derived from the atmosphere for 3 mungbean varieties grown at two different row spacings.

### Chickpea

Two chickpea trials were conducted in the new GRDC Qld Pulse Agronomy project in the southern region (near Dalby and Goondiwindi). Each trial had the same design including 3 row spacings (0.25, 0.5 and 1.0 m) x 3 varieties

All 3 chickpea varieties at Dalby and Goondiwindi trials had significantly lower grain and total (grain +shoot) N uptake in kg/ha when grown at 1.0m row spacing. Also PBA HatTrick<sup>®</sup> was significantly lower than Boundary<sup>®</sup> and CICA0912 in N uptake at both sites. The impact of these management practices on N fixation and hence N uptake will be examined in detail following receipt of the <sup>15</sup>N natural abundance data and will be discussed at the Update.

### N fertiliser addition

#### Chickpea

Trials conducted by Northern Grower Alliance in Qld and northern NSW across 6 sites in 2012 and 2 sites in 2013, showed no significant yield response in any individual chickpea trial to the addition of nitrogen fertiliser or the addition of rhizobia. In 2012, residual soil N at planting ranged from <12 to 117 kg N/ha (3 sites had 30 kg N/ha or less). Yields ranged from 1.1 to 2.0 t/ha (only one site >1.6 t/ha). The average yield response to applied N across all 6 sites is shown below in Figure 3. In this same set of trials, there was also no response to the addition of rhizobia inoculum applied as granules with the seed into the planting furrow.

In 2013, yields ranged from 0.75 to 1.3 t/ha with no response to N applied at 10 and 50 kg N/ha.

The lack of response to rhizobia inoculum overall is possibly due to adequate numbers of effective rhizobia already in the soil, however no assessments of nodulation or N fixation and residual soil N were conducted due to the lack of yield response. The seasons were hard and yields were obviously limited primarily by soil water.

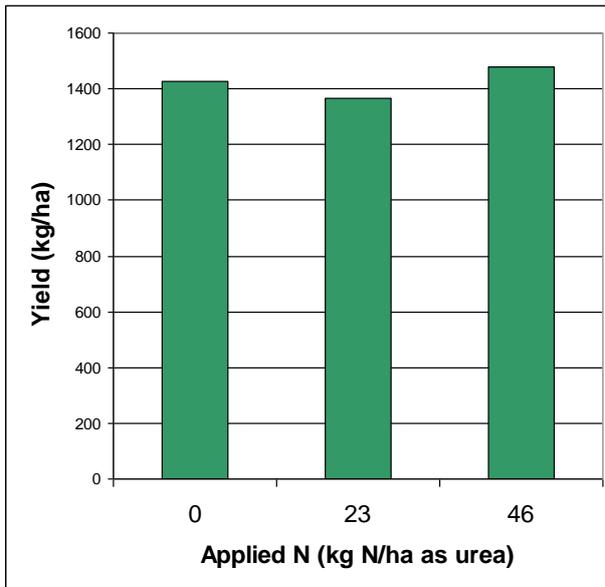


Figure 3. Yield response of chickpea (variety HatTrick) to applied N (no significant differences). Values are averages for 6 trials planted across Qld and northern NSW in 2012 each with 4 replicates.

### Mungbean

Work in Central Queensland in 2010 also indicated that nodulation was suppressed by applications of urea at rates of 10 or more kg N/ha or Triple Super at 5 or 10 kg P/ha (Figure 4). Also, no yield advantage was gained by the addition of fertiliser N (Figure 5). (Seymour *et al.* 2010). Pre-plant soil nitrate levels at this site started at about 80kg N/ha in the top 1m and were increased from there with applied fertilisers. There was also a history of mungbeans at this site contributing to the nodulation of the uninoculated treatments. Despite this, there was a significant yield response to inoculation.

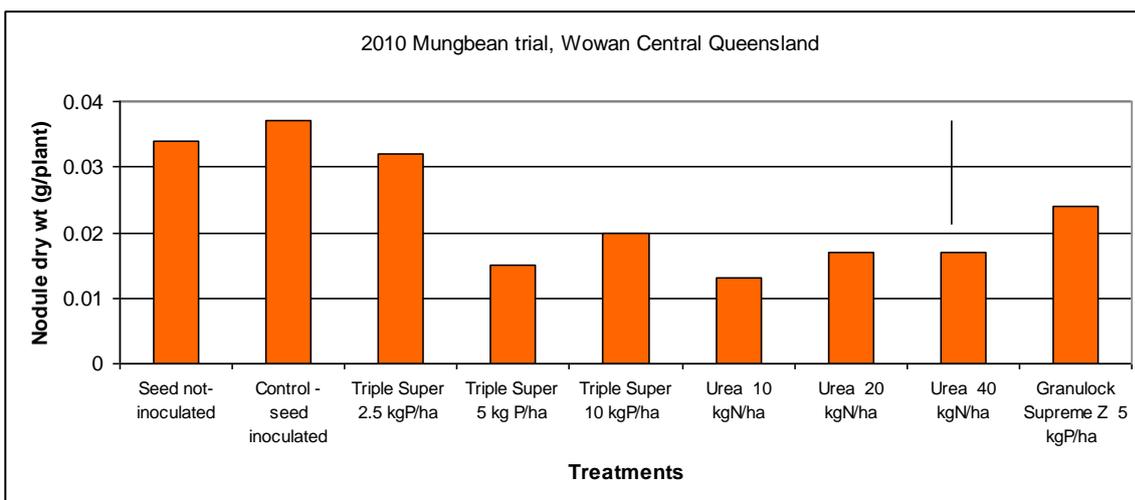


Figure 4. Impact on nodulation of mungbean cv. Crystal from rhizobial inoculation and preplant fertiliser applications.

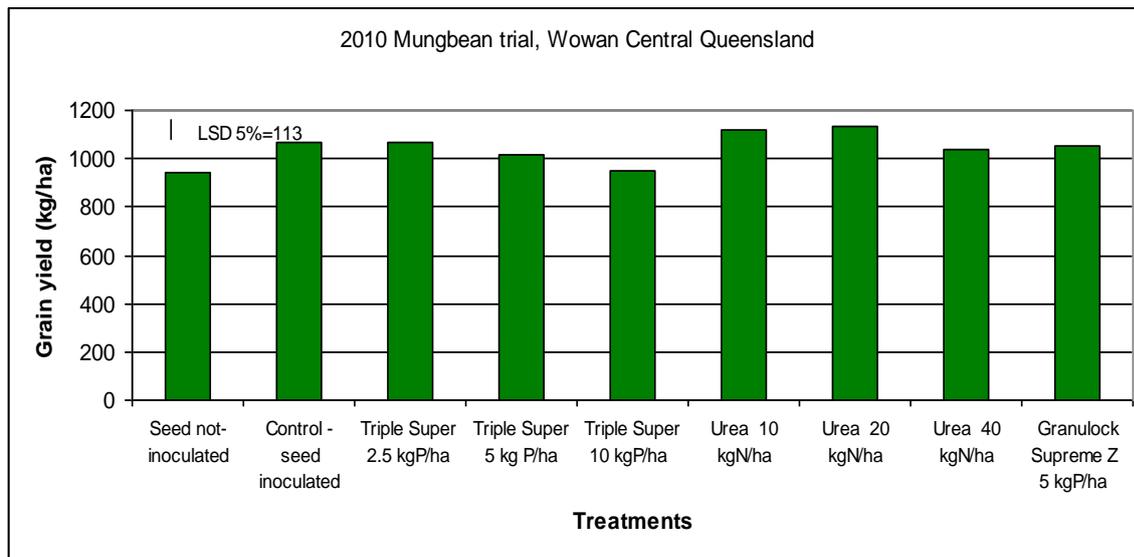


Figure 5. Response of mungbean cv. Crystal to inoculation and preplant fertiliser applications.

### **Acknowledgements**

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### **References**

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- Doughton JA, Vallis I, Saffigna PG (1993) Nitrogen fixation in Chickpea. I. Influence of Prior Cropping or Fallow, Nitrogen Fertilizer and Tillage. Australian Journal of Agricultural Research **44**: 1403 – 13.

### **Recommended reading**

'Inoculating legumes: A practical guide.' Ground Cover Direct

<https://grdc.com.au/GRDC-Booklet-InoculatingLegumes>

Managing legume and fertiliser N for northern grains cropping' Ground Cover Direct.

<https://grdc.com.au/uploads/documents/Managing-N-for-Northern-Grains-Cropping.pdf>

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