# Chickpea root nodulation and yield response to fertilizer treatments

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## Introduction

Chickpea (*Cicer arietinum)* has become an important pulse crop in the Brown Soil Zone of the Canadian prairies. As with most legumes, chickpea can fix nitrogen from the atmosphere when the plant forms active root nodules. However, best management fertilization for maximizing chickpea production has not yet been determined (SAF 2002). The objective of this study was to evaluate the effect of selected fertilizer treatments on various components of chickpea production.

## Materials and Methods

This study was conducted in conjunction with an existing field trial that evaluated legume inoculant form and fertilization accompanying seeding in lentil, desi chickpea and kabuli chickpea (Gan et al. 2002). For the purposes of our portion of the study, desi (cv. Myles) and kabuli (cv. CDC Xena) chickpea plants were sampled from select fertilizer treatments during the growing season in field trials at two locations, Swift Current and Stewart Valley, in 2001 and 2002. The fertilizer treatments were all side-row banded and are presented in Table 1. The all treatments included granular *Rhizobium* inoculant placed in the seed row. Sampling was done at flowering for root nodule evaluation and aboveground plant biomass. Root nodules were counted and sized. Plot yield was determined at harvest. Weather data was collected at both sites during both years.

All parameters were measured from three replicates. The data was analyzed using ANOVA and means separated using single degree of freedom contrasts (JMP, SAS, Gary NC).

**Table 1.** Fertilizer treatments used in this study. Note that the treatments in ***italics*** were only conducted at Swift Current in 2002.

| **Treatment Code** | **N (lb/ac)** | **$P_2O_5$ (lb/ac)** | **S (lb/ac)** |
|---|---|---|---|
| 0N,0P | 0 | 0 | 0 |
| 0N,15P | 0 | 15 | 0 |
| 15N,15P | 15 | 15 | 0 |
| ***0N,15P,30S*** | ***0*** | ***15*** | ***30*** |
| ***45N,15P*** | ***45*** | ***15*** | ***0*** |

## Results and Discussion

Precipitation in the two crop years was very different with 2001 having the 12th driest June-August (98 mm) in 117 y while 2002 saw the 3rd wettest (319.2 mm) at Swift Current. The weather at Stewart Valley was very similar (data not shown). This lead to nodulation values and yields being 2-4 times greater in 2002 than 2001 overall.

Phosphorus fertilization did not enhance total nodulation, nodule size, biomass at flowering or yield of chickpea except for an increased number of nodules greater than 5 mm in size of kabuli in 2001 (Tables 2 & 3). This lack of response to P fertilization is probably due to the P levels in soil not limiting production for this crop.

The addition of N elicited more responses including reducing total nodule number and increasing biomass in desi in 2001, and reducing large nodules in kabuli in 2001 (Tables 2 & 3). A reduction in nodule function (Chalifour and Nelson 1987) and nodule number (Caba et al. 2000) in response to added N has been found in other legumes. It should be noted that the significant differences were found only in 2001 when the plants were undergoing moisture stress. Starter N (15 lb N/ac) did not significantly enhance yield in either chickpea type however there was a trend apparent for increasing yields in kabuli chickpea with the additional N and P (Table 3).

**Table 2.** Nodulation response of chickpea to N and P fertilization at Swift Current and Stewart Valley, SK.

| **Chickpea Type** | **Treatment** | **Nodules/plant** | | **Nodules >5 mm** | |
|---|---|---|---|---|---|
| | | **2001** | **2002** | **2001** | **2002** |
| **Desi** | 0N,0P | 11.0 | 23.4 | 6.2 | 11.8 |
| | 0N,15P | 13.1 | 21.6 | 7.1 | 13.4 |
| | 15N,15P | 9.0 | 23.7 | 4.9 | 11.7 |
| Contrasts | 0N,0P vs. 0N,15P | ns | ns | ns | ns |
| | 0N,15P vs. 15N,15P | 0.046 | ns | ns | ns |
| **Kabuli** | 0N,0P | 10.2 | 32.2 | 4.5 | 20.2 |
| | 0N,15P | 13.2 | 33.8 | 7.6 | 21.4 |
| | 15N,15P | 9.5 | 31.2 | 4.7 | 20.1 |
| Contrasts | 0N,0P vs. 0N,15P | ns | ns | 0.044 | ns |
| | 0N,15P vs. 15N,15P | ns | ns | 0.045 | ns |

**Table 3.** Response of biomass production at flowering and harvest yield on chickpea to N and P fertilization at Swift Current and Stewart Valley, SK.

| Chickpea Type | Treatment | Biomass ($g/m^2$) 2001 | Biomass ($g/m^2$) 2002 | Yield (kg/ha) 2001 | Yield (kg/ha) 2002 |
|---|---|---|---|---|---|
| **Desi** | 0N,0P | 53.8 | 53.5 | 869 | 2367 |
| | 0N,15P | 60.3 | 47.6 | 697 | 2321 |
| | 15N,15P | 85.9 | 63.7 | 752 | 2421 |
| Contrasts | 0N,0P vs. 0N,15P | ns | ns | ns | ns |
| | 0N,15P vs. 15N,15P | 0.037 | ns | ns | ns |
| **Kabuli** | 0N,0P | 83.7 | 53.6 | 748 | 1635 |
| | 0N,15P | 93.5 | 67.2 | 794 | 1853 |
| | 15N,15P | 100.4 | 85.7 | 874 | 2074 |
| Contrasts | 0N,0P vs. 0N,15P | ns | ns | ns | ns |
| | 0N,15P vs. 15N,15P | ns | ns | ns | ns |

The additional fertilizer treatments (45N,15P and 0N,15P,30S) tested at Swift Current in 2002 did not significantly affect nodulation or yield in Myles desi chickpea (Table 4). This was especially surprising with the 45N,15P treatment not suppressing the number or size of nodules. The high rate of N did result in significantly greater biomass at flowering compared to the 0N,15P treatment.

**Table 4.** Response of Myles desi chickpea nodulation, biomass at flowering and yield to select N, P and S fertilization at Swift Current in 2002.

| Fertilizer Treatment | Nodules per plant | Nod. >5mm per plant | Biomass at flowering ($g/m^2$) | Yield (kg/ha) |
|---|---|---|---|---|
| 0N,0P | 23.7 | 11.9 | 39.0 | 2854 |
| 0N,15P | 28.3 | 16.1 | 42.2 | 2599 |
| 15N,15P | 28.9 | 12.8 | 60.2 | 2627 |
| 0N,15P,30S | 22.2 | 14.6 | 43.8 | 3046 |
| 45N,15P | 31.5 | 16.4 | 97.3 | 2846 |
| Contrasts | | | | |
| 0N,15P vs. 15N,15P | ns | ns | ns | ns |
| 0N,15P vs. 45N,15P | ns | ns | 0.001 | ns |
| 0N,15P vs. 0N,15P,30S | ns | ns | ns | ns |

CDC Xena kabuli chickpea with the high rate of N reduced the total number of root nodules and number of relatively large nodules but this was not significant (Table 5). Biomass was unaffected by higher N. The high rate of N did result in significantly greater yield. The lack of yield response to N in desi chickpea and the positive trends or significant increases in kabuli chickpea may indicate that kabuli derives less of its N requirement from the atmosphere and thus may utilize the added N more readily than desi. Reduced N derived from the atmosphere by kabuli compared to desi was found by Kyei-Boahen (2000) but was not consistent.

**Table 5.** Response of CDC Xena kabuli chickpea nodulation, biomass at flowering and yield to select N, P and S fertilization at Swift Current in 2002.

| **Fertilizer Treatment** | **Nodules per plant** | **Nod. >5mm per plant** | **Biomass at flowering ($g/m^2$)** | **Yield (kg/ha)** |
|---|---|---|---|---|
| 0N,0P | 32.2 | 20.2 | 53.6 | 1635 |
| 0N,15P | 33.8 | 21.4 | 67.2 | 1852 |
| 15N,15P | 31.2 | 20.1 | 85.8 | 2074 |
| 0N,15P,30S | 40.6 | 21.4 | 67.9 | 1610 |
| 45N,15P | 25.8 | 11.8 | 80.0 | 2356 |
| Contrasts | | | | |
| 0N,15P vs. 15N,15P | ns | ns | ns | ns |
| 0N,15P vs. 45N,15P | ns | ns | ns | 0.013 |
| 0N,15P vs. 0N,15P,30S | ns | ns | ns | ns |

With the addition of N at the low or high rate, days to maturity were reduced up to 3-4 days in both chickpea types compared to the treatments without N added (data not shown). This would result in an important benefit to producers to get a quality crop off the field earlier.

The addition of elemental sulfur as a treatment did not result in any significant effects on the chickpea parameters measured. This is consistent with the fact that SW Saskatchewan soils have few sulfur-oxidizing microorganisms and thus the sulfur added would not be available to the crop in this field season (F. Selles, personal communication).

In summary, addition of P did not enhance nodulation consistently or, in turn, increase yield of either chickpea type. Nitrogen was not found to consistently affect nodulation or enhance yield however, kabuli chickpea did show a positive trend for yield increase and a significant increase when the higher rate of N was used.

**Future Work**

This work will be continued for the 2003 field season at both Swift Current and Stewart Valley. Additional fertilizer treatments will be investigated especially to evaluate N responses and for evaluation of S on chickpea production another form will be used.

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**chickpea; nitrogen; phosphorus; yield; root nodules**