BACKGROUND

- Soybeans are capable of fixing their own nitrogen via root nodulation.
- Previous research has investigated this subject, but apparently not all aspects.
- Schmidt et al. (2001) studied response of soybean cultivars to manure in Minnesota.
- seed yield was generally improved or unaffected by manure.
- sites with low soil N in mid June produced higher yields.
- effect on quality (protein and oil content) was not reported.
- Wallace et al. (1991) examined timing of fertilization effect on soybean cultivars.
- Preliminary work conducted near Beausejour, MB on N-responsive field (Table 1).
- Effect on quality (seed protein and oil content) is rarely reported.
- Generally, research has shown inconsistent yield response to applied N.

OBJECTIVE

- Assess impact of soil N levels on soybean seed yield and protein.

METHODS

A 2-factor RCBD experiment was designed with:
- A) 4 levels of initial soil N levels, created with:
  - T1 = Commercial P, K, S (soil test recommended rates)
  - T1 + Manure
  - T1 + Inoculant
  - T1 + Manure + Inoculant
- B) 2 levels of Rhizobium inoculant:
  - non-inoculated (raw seed) on virgin soybean land
  - inoculated with granular Rhizobium inoculant at 18 lb/acre
- Starter fertilizer (MAP) to supply 30 lb/ac P2O5 was applied to all treatments.

SITE DESCRIPTION

Study site located at U of M research farm outside Carman, MB.
- Soil type and properties (Soil Survey Special Report 93-1 and AgVise Laboratory analysis in Spring 2002).
- Denham sandy clay loam (Orthic Black Chernozem).
- Moderately well to well drained, upper position of very gentle slopes.
- Moderate to moderately slow permeability varying slowly permeable clay
- pH = 6.5-7.0
- Non-saline
- CEC = 19
- Organic matter = 4.7%

FIELD ACTIVITIES

- Planting soybean plots in mid-May
- Application of N fertilizer or manure on soybean land is an inefficient use of this resource.
- Reduced root nodulation
- post-harvest soil testing to determine residual N.

OBSERVATIONS (Photo 2)

- Non-inoculated soybeans ripened pre-maturely compared to inoculated plots.
- High soil N soybean plots showed:
  - Reduced root nodulation.
  - Taller plants at mid-season.
- Urea & fall manure treatments > no N or spring applied manure, regardless of inoculant status.
- SPAD readings (where higher indices indicate greener colour and more chlorophyll
- raw seed & fall manure declined with time relative to other treatments.
- spring manure increased with time relative to other treatments.
- inoculated check was consistently higher than the raw seed check.

DISCUSSION

- Inoculant promoted formation of root nodules, enabling the crop to fix its own N throughout the growing season, leading to high yield and quality at harvest.
- In non-inoculated treatments, it is apparent that 100 lbs N/ac as fertilizer or manure is insufficient to meet soybean needs, since crops ripened pre-maturely, and produced lower yield and seed protein.
- Where seeds were inoculated, high soil N may have inhibited nodulation by the root, leaving the crop dependent on soil N supply to meet needs throughout the growing season.
- It is suspected that NO3-N in early spring is the N form that inhibits root nodulation.
- Despite inhibition of nodulation, sufficient N was still available at mid-season to fuel vegetative growth (higher tissue N) and some lodging.
- but the application rate was insufficient to adequately supply N through maturation, with slightly (but not significantly) lower yields and lower protein of harvested seed.
- Within the inoculated plots, nodulation was found wherever urea was applied just before seeding.
- insufficient time for N transformation to nitrate form before bacteria infected soybean roots, partly explaining level of nodulation found within all plots.
- Heavy rainfall after initial root infection and as shoots were emerging may have caused some denitrification losses of N in manured plots, again possibly lowering the Nitrate in soil to such a level as to allow some nodules to form.
- Visual assessment of N sufficiency of the soybean plant may be misleading, since early season N, and late season chlorophyll content led to lower yield and protein in high N plots than the unfertilized, but inoculated seed.
- Low residual soil N in all treatments indicated full use of applied or residual N in all treatments.

CONCLUSION

- Preliminary work and first year of full study suggest that high levels of soil N reduce soybean yield and quality.
- High soil N from fertilization tended to cause:
  - increased vegetative growth.
  - increased lodging.
  - lower yield and protein content.
- Effects are likely due to reduced root nodulation which is required for full season N, and late season chlorophyll content led to lower yield and protein in high N plots than the unfertilized, but inoculated seed.
- Low residual soil N in all treatments indicated full use of applied or residual N in all treatments.

ACKNOWLEDGEMENTS

- University of Manitoba - Carman Research Farm - A. Iverson, T. Van Dijk, L. Quinn.
- AgVise Laboratories - J. Lee.
- Manitoba Agriculture and Food staff - A. Mintenko, C. Fraser, T. Laycock, D. Fatheringham.
- Manitoba Pulse Growers Association.
- Agricultural Research and Development Initiative (ARDI).