

Nutrient Uptake and Partitioning by Dry Beans in Manitoba

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Background

Current interest in determining crop nutrient budgets requires crop advisers to rely on standard book values of nutrient uptake and removal. Usually little information exists on micronutrient uptake. This study was initiated to validate current nutrient values for dry beans grown under Manitoba conditions.

Method

Whole plant sampling of navy white beans from a commercial field was done at several times during the 2005 growing season. Harvest time sampling was done in a commercial field of pinto beans in 2004.

Sampling

Plants were sampled on a schedule according to 6 critical growth stages in a RCBD sampling pattern with 3 replicates. Above-ground parts were sampled, partitioned, dried, chopped and ground for nutrient analysis by AgVise Labs.

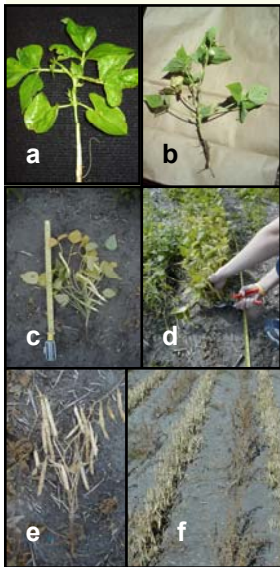


Figure 1. Dry bean sampling in 2005
a – V4, 4-leaf stage on July 5
b – R1 stage, flowering on July 15
c – R7 stage, August 24
d – sampling on August 24
e – R8, September 26 at harvest
f – crop on September 26

Growing season

- 2004 was very cool with only 79% of normal GDD but 99% of normal precipitation
- 2005 was 96% of normal GDD but 113% of normal precipitation with heavy June and July rainfall causing excess water stress

Harvest results

Harvest of the 2004 crop was late but yields were high at 2300 lb seed/ac. Conversely the water stressed 2005 crop yielded only 1250 lb/ac.

Results are reported with "uptake" referring to nutrients contained in the whole plant (stalk, leaves, pod and seed) whereas "removal" refers to nutrients in the seed only.

Dry matter (DM) and Nutrient Partitioning in the 2005 Crop

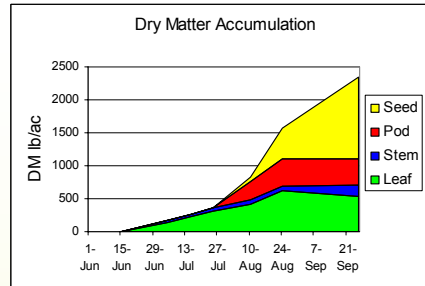


Figure 2. Biomass accumulation in 2005. The excess water stressed 2005 bean crop yielded 1250 lb seed/ac (12.5 cwt/ac).

Surprisingly a considerable amount of biomass continued to accumulate during seed filling in late August and September.

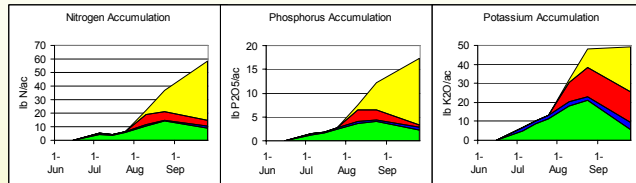


Figure 3. Macronutrient uptake and partitioning. It was apparent that N,P and K are mobile in the plant and were translocated to the seed during seed filling. Seed harvest removes 75-80% of N and P and 50% of K.

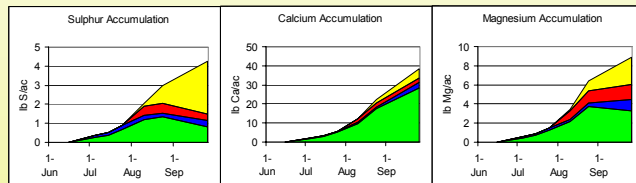


Figure 4. Secondary nutrient uptake and partitioning. S appears to be translocated in the plant and over half is removed in the seed, whereas Ca and Mg largely remain in vegetative tissue.

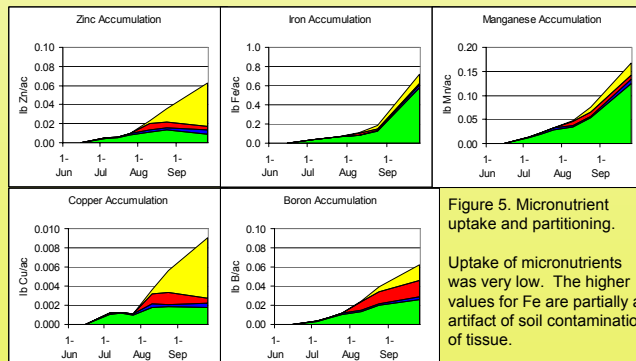


Figure 5. Micronutrient uptake and partitioning.

Uptake of micronutrients was very low. The higher values for Fe are partially an artifact of soil contamination of tissue.

Zn and Cu appear to translocate from vegetative tissue and most is removed in the seed, whereas Fe, Mn and B largely remain in vegetative structures.

Nutrient Uptake and Removal at Harvest

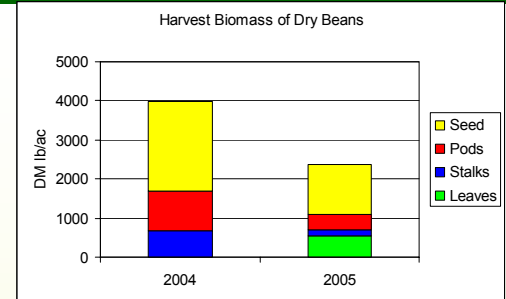


Figure 6. Harvest biomass of the 2004 and 2005 crops. The 2004 crop yielded 2300 lb bean seed/ac and pods and stalk were similarly proportioned more than the 1250 lb seed crop in 2005. In general the amount of nutrient taken up was proportional to the biomass produced¹. Nutrients are reported in Table 1 relative to the seed yield produced and these values are compared to standard values adapted from the Canadian Fertilizer Institute's "Nutrient Uptake and Removal" charts for eastern Canada².

Table 1. Nutrient uptake and removal in pounds per cwt of bean yield.

Nutrient	Manitoba observations		CFI
	Uptake	Removal	Removal
lbs nutrient/cwt seed			
N	3.9-4.7	3.0-3.5	4.2
P ₂ O ₅	1.4-1.6	1.1-1.4	1.4
K ₂ O	3.9-4.1	1.9-2.1	1.4
S	0.28-0.34	0.22	0.28
Ca	0.6-3.0	0.07-0.37	0.11
Mg	0.2-0.5	0.54-0.70	0.11

Potassium and magnesium removal values were greater in this study than the standard range. Nitrogen and sulphur values were slightly less than the standard. Other major nutrient values (P, Ca) generally fall in or close to the published range. The micronutrient values are not shown here but are available in other reports¹.

Summary

Nutrient uptake and removal values for dry beans grown under 2 different growing conditions were similar when scaled according to yield, and were similar to published guidelines.

Acknowledgements

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References

1. Heard, J. 2007. Nutrient uptake and partitioning for dry beans. Manitoba Pulse Growers Assoc. Pulse Beat. Pp. 22-24.
2. Canadian Fertilizer Institute. 1998. Nutrient Uptake and Removal by Field Crops – Eastern Canada 1998.