

# Nutrient Uptake and Partitioning by Soybeans in Manitoba

John Heard, CCA. Manitoba Agriculture, Food and Rural Initiatives [jheard@gov.mb.ca](mailto:jheard@gov.mb.ca)



## Background

Current interest in determining crop nutrient budgets requires crop advisers to rely on standard book values of nutrient uptake and removal. Soybean values are often based on studies with greater yield potential than that in northern, shorter season areas (1). This study was initiated to validate current nutrient values for Manitoba conditions.

Of additional interest is the surprisingly small nitrogen benefit of soybeans to following crops in Manitoba. A closer look at nitrogen (N) and carbon (C) content of the plant may offer an explanation.

## Method

### Site

A commercial soybean field in south central Manitoba near Carman was selected for the study. The soil was a moderately well drained Reinfeld clay loam with 5.7% organic matter.

### Production

OAC Prudence soybeans were seeded in 8" rows on May 22, 2005. Seed was inoculated and fertilizer applied to supply 40 lb N/ac, 20 lb  $P_2O_5$ /ac and 20 lb/ac  $K_2O$ /ac. Weeds were controlled with Pursuit Ultra herbicide.

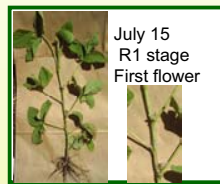
### Sampling

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

Soil was sampled before seeding and after harvest.



July 6  
V4 stage  
4<sup>th</sup> trifoliolate



July 15  
R1 stage  
First flower



July 25  
R3 stage -Early  
pod formation



August 5  
R4 stage  
Full pod, >3/4  
long pods



August 17  
R6 stage  
Full seed size



Sept. 28  
R8 stage  
Harvest

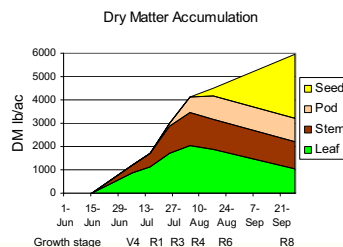
### Growing season

•Accumulated corn heat units were 2453 CHU which equals the normal (30-yr average).

•In-season rainfall was 10.5" or 93% of normal. Much of this rain occurred in July and caused excess moisture stress.

Combine harvest of the entire field averaged 32 bu/ac.

## Dry matter (DM) accumulation



Total biomass was 5959 lb/ac

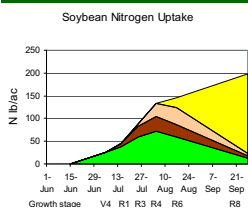
•Final grain yield was 45.5 bu/ac with a harvest index of 46%.

•Greatest rate of DM accumulation was between R1-R3 at 129 lb/ac/day

•DM partitioning to seed was mainly from the leaves

•During seed fill the seed accumulated 57 lb or 1 bu/ac/day

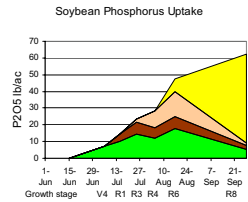
## Primary nutrient uptake



Total nitrogen (N) uptake was 199 lb/ac with 88% in the grain.

•Maximum rate of N uptake was 4.3 lb N/ac/day between R1-R4.

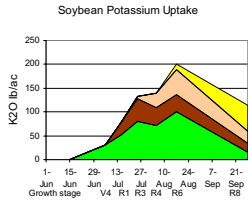
•N was translocated from leaves, stem and pod during grain fill with seed accumulating 3.7 lb N/ac/day between R6-R8.



Total phosphorus (P) uptake was 62 lb  $P_2O_5$ /ac with 86% in the grain.

•Rate of P uptake was 0.96 lb  $P_2O_5$ /ac/day between V4-R6 and accumulated in grain at 1.1 lb  $P_2O_5$ /ac/day.

•Seed removed 1.15 lb  $P_2O_5$ /bu

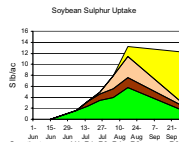


Greatest potassium (K) uptake measured was 202 lb  $K_2O$ /ac at the R6 stage but by harvest, much K had been lost from senescing leaves

•55 lb  $K_2O$ /ac or 1.2 lb  $K_2O$ /bu was removed in the seed, which is considerably greater than most other prairie grain crops.

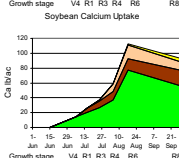
•Rate of K uptake exceeded 4 lb  $K_2O$ /ac/day between V4-R6

## Secondary nutrient uptake



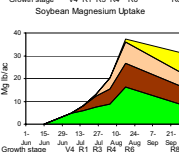
Total sulphur (S) uptake was 13 lb S/ac with 72% in the grain.

•S appeared to be moved from leaves to the grain.



Calcium (Ca) uptake was greater than expected

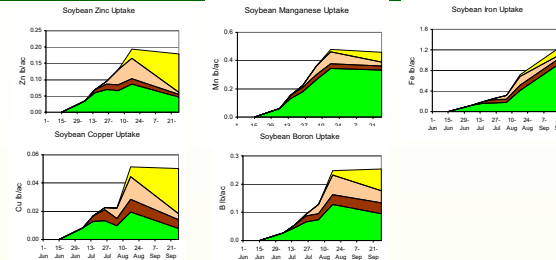
•Most Ca was present in leaves (60%), stem (22%) and pod (12%) with little accumulation in the seed.



Greatest magnesium (Mg) uptake was 38 lb Mg/ac with 27% in the grain.

•At harvest Mg was similarly distributed among leaf, stem, pod and seed.

## Micronutrient uptake



Micronutrient uptake was small with Fe >Mn>B>Zn>Cu.

•Iron (Fe) appeared to increase through grain fill but is likely a result of soil contamination on fallen leaves

•Zn and Cu appeared to translocate from vegetative tissue and accumulate in the seed, whereas Mn, Fe and B remained in vegetative tissue.

## Discussion

Uptake values from this study were compared to those published by the Canadian Fertilizer Institute (CFI) for Eastern Canada (2) in Table 1.

Phosphorus uptake and removal values (in bold) were greater in this study than the standard range. Other major nutrient values (N, K) generally fall in or close to the published range.

Table 1. Uptake and removal values for soybeans (lb/bu seed produced)

	Uptake lb/bu		Removal lb/bu	
	Study	CFI	Study	CFI
N	4.3	4.6-5.8	3.8	3.7-4.0
$P_2O_5$	1.4	0.8-1.0	1.15	0.8-0.88
$K_2O$	4.4	2.4-4.4	1.2	1.4
S	0.26	0.34	0.2	0.1
Ca	2.0	0.5-0.6	0.11	0.18-0.22
Mg	0.67	0.4-0.5	0.2	0.14-0.18

Although some of the secondary nutrients had values outside of the standard range, these are of less concern in nutrient management planning. Published standards are generally acceptable for nutrient budgeting purposes, but some verification of P uptake/removal is warranted.

If this study were repeated, it would have been beneficial to do additional sampling at R7 before leaf drop and to capture leaves before they contacted the soil.

## Nitrogen Credits from Soybeans?

Previous Manitoba research has shown little N benefit of soybeans to the following cereal crop (3), and for this yield of 45.5 bu/ac would offer a credit of only 5 lb N/ac.

•Only 23 lb N/ac remained in the crop residue, and C/N ratio at harvest was 37:1 for leaf, 112:1 for stem, 86:1 for pod and 8:1 for seed.

•Soil nitrate levels in the 0-24" depth decreased from 37 lb N/ac in May to 27 lb N/ac following harvest.

These observations tend to support our very modest N credits.

## Acknowledgements

MB Pulse Growers Association  
University of Manitoba  
Greenhouse Gas Mitigation Program

AgVise Laboratories, Northwood, ND  
MB Zero Till Research Assn

## References

1. Hanway, J.J. and C.R. Weber. 1971. Accumulation of N, P, K by Soybean (*Glycine max* (L.) Merrill) Plants. Agron. J. 63:406-408.
2. Canadian Fertilizer Institute. 1998. Nutrient Uptake and Removal by Field Crops – Eastern Canada 1998.
3. Przednowek, D.W.A., M.H. Entz, B. Irvine, D.N. Flaten and J.R. Thiessen Martens. 2004. Rotational yield and apparent N benefits of grain legumes in southern Manitoba. Can. J. Plant Sci. 84:1093-1096.