

# Nutrient Uptake and Partitioning by Potatoes in Manitoba

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## Background

Current interest in determining nutrient balance requires crop advisers to rely on book values to calculate nutrient uptake and removal. Potato nutrient values are often based on studies with greater yield potential than northern growing regions.

This study was initiated to validate the use of such book values and to assess the extent of nutrient uptake from the soil.

## Method

### Site

In 2003 a commercially seeded field of potatoes was selected at the Manitoba Crop Diversification Centre at Carberry in central Manitoba. The soil was a Ramada clay loam.

The fall 2002 soil test indicated 46 lb nitrate-N/ac (0-24" depth), 78 lb N/ac in 2-5' depth, 10 ppm Olsen-P = (M), 228 ppm K = (VH), 86 lb S/ac.

### Production

Ranger Russet potatoes were seeded May 13.

Fertilizer was banded at seeding to supply 60 lb N/ac, 70 lb P<sub>2</sub>O<sub>5</sub>/ac and 30 lb K<sub>2</sub>O/ac with an additional 70 lb N/ac broadcast prior to hilling on June 24.

The crop was irrigated as needed and harvested Oct 7, with a commercial field yield of 288 cwt/ac.

### Sampling

Plants were sampled 5 times according to critical growth stages (see figures below) in a RCBD sampling pattern with 3 replicates.

Above and below-ground parts were sampled, partitioned, dried, chopped and ground for nutrient analysis by AgVise Labs.

Soil was sampled at 3 occasions to a 3' depth for nitrate-N content.



**June 23**  
Growth stage 2, vegetative



**July 7** -  
Growth stage 3, Tuber Initiation



**July 23** -  
Growth stage 4, Tuber Bulking, <2" diameter



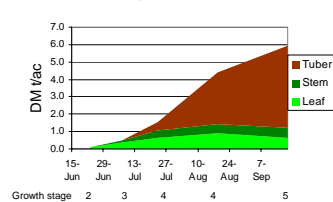
**August 18**  
Growth stage 4, Tuber Bulking, >2" diameter



**September 18**  
Growth stage 5, maturity

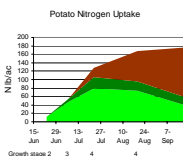
## Dry matter (DM) accumulation

Potato Dry Matter Accumulation



- At maturity, DM accumulation was near 6 t/ac.
- 80% of DM was present in tubers: 72% as maingrade marketable tubers and 8% as undersize tubers (<2" diameter).
- Maingrade tuber yield was 376 cwt/ac.
- During late tuber bulking, leaves started to senesce and DM content declined at 19 lb/ac/day while tuber DM increased at 123 lb/ac/day or 5 cwt/ac/day

## Primary nutrient uptake



Total N uptake was 177 lb N/ac with 67% in tubers.

- Max rate of N uptake was 4.6 lb N/ac/day between tuber initiation and early bulking.
- N content of potato tops peaked on July 23 at 106 lb N/ac and declined throughout the bulking period at 0.4 - 1.2 lb N/ac/day while tubers accumulated N at 1.5-1.9 lb N/ac/day.

Total P uptake was 69 lb P<sub>2</sub>O<sub>5</sub>/ac with 86% in tubers.

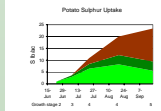
- Between GS 3-4, plants took up P at a rate of 1.2 lb P<sub>2</sub>O<sub>5</sub>/ac/day.
- During late bulking, leaves declined in P content while tubers accumulated P at 0.8-0.9 lb P<sub>2</sub>O<sub>5</sub>/ac/day

Total K uptake was 330 lb K<sub>2</sub>O/ac with 69% in tubers.

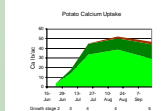
- Between tuber initiation and early bulking, plants accumulated K at 4.6 lb K<sub>2</sub>O/ac/day.
- During late bulking leaf tissue declined in K content and tubers accumulated 3.2 lb K<sub>2</sub>O/ac/day.

Uptake of P and K occurred at a fairly uniform rate until harvest, indicating requirement for good supply throughout the season.

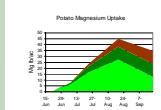
## Secondary nutrient uptake



- S uptake was 23 lb s/ac with 63% in tubers.
- S accumulated throughout the season with movement from leaves to tubers during late bulking.

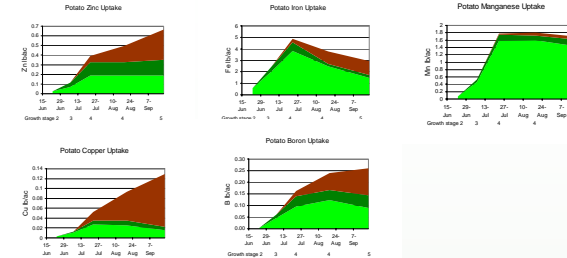


- Maximum Ca uptake was 53 lb Ca/ac and was almost exclusively in leaves (62%) and stem (32%).



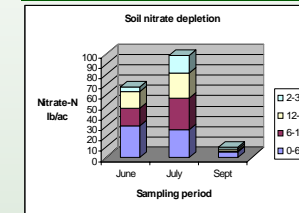
- Mg uptake and distribution pattern was similar to Ca, at a maximum uptake of 45 lb Mg/ac with 62% present in leaves and 24% in stems.

## Micronutrient uptake



- Micronutrient uptake was small with Fe>Mn>Zn>B/Cu.
- Mn and Fe uptake occurred during vegetative growth and remained predominantly in leaf tissue ( high Fe levels on July 23 may be due to soil contamination of plant material).
- Zn, B and Cu uptake continued until harvest with Zn and B equally present in leaf, stem and tubers, and Cu most prevalent in tubers (75%).

## Soil N depletion



Elevated July nitrate levels reflect the late June N application.

By harvest soil nitrate levels in 0-3' were depleted to < 10 lb N/ac.

## Discussion

Uptake values were compared to those published by the Canadian Fertilizer institute (CFI) in Table 1.

N uptake values were slightly less than CFI values whereas K, S and Ca uptake and P removal were slightly greater.

In general the published tables are suitable for use by field agronomists.

Table 1. Comparison to standard nutrient values

Nutrient	Uptake lb/ac		Removal lb/ac	
	Study	CFI-West 400cwt/ac	Study *	CFI-West 400cwt/ac
N	177	205-251	107-119	115-141
P <sub>2</sub> O <sub>5</sub>	69	60-73	53-60	33-40
K <sub>2</sub> O	330	268-327	206-227	194-238
S	23	16-20	12-14	11-13
Ca	47	20**	2-3	5**
Mg	36	40**	10-11	10**

\*376 cwt/ac Maingrade yield and 416 cwt/ac total yield  
\*\* CFI-East values

High yielding potatoes extracted N to depths of 3', while returning 60 lb N/ac in leaf and stem tissue after harvest.

## Acknowledgements

Greenhouse Gas Mitigation Program MB Zero Till Research Assn  
AgVise Labs MCDRC Research Station  
AAFC-Brandon Research Station

## References

Canadian Fertilizer Institute. 1998. Nutrient Uptake and Removal by Field Crops - Eastern Canada, Western Canada.