

# Nutrient Uptake and Partitioning by Grain Corn in Manitoba

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## Background

Current interest in determining crop nutrient balance requires crop advisers to rely on standard book values of nutrient uptake and removal. Grain corn values are often based on studies with greater yield potential than that in northern shorter season areas.

This study was initiated to validate current nutrient values for Manitoba conditions and to assess the extent of nutrient uptake from the soil.

## Method

### Site

In 2003 a commercially seeded block of corn was selected on the Hyland Research farm near Carman, in south-central Manitoba. The soil was a well drained Neuenberg loam with good moisture holding capacity and 5.1% OM.

The field composite soil test indicated 172 lb nitrate-N/ac (0-24" depth), 64 ppm Olsen-P (VH), 306 ppm K (H), 3.4 ppm Zn and 1.3 ppm Cu.

### Production

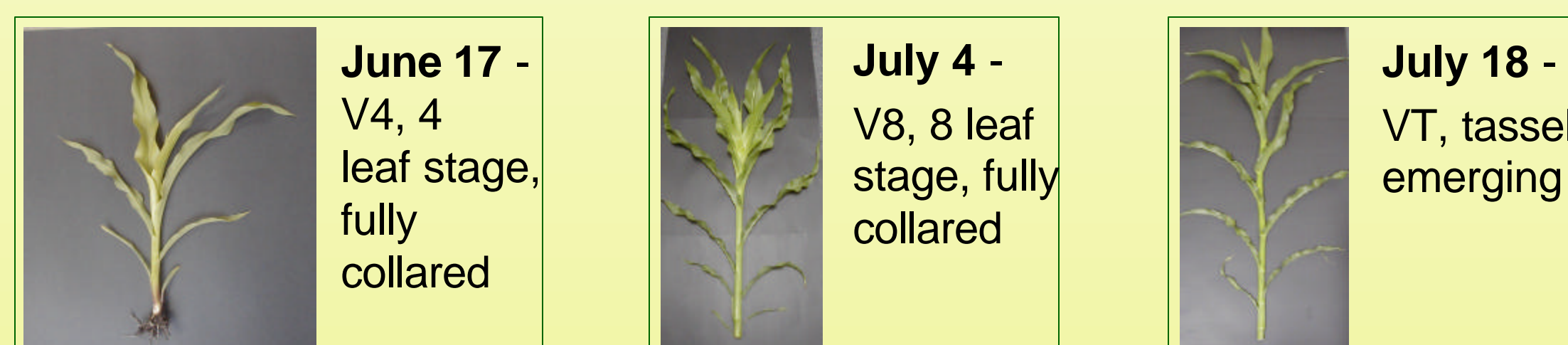
Hybrid HL 2093 was seeded May 7 with no fertilizer. N status was reassessed in mid June via SPAD meter and pre-side-dress N soil test prompting side-dressing with 60 lb N/ac on June 25.

Commercial harvest of field on Oct 21 yielded 119-128 bu/ac.

### Sampling

Plants were sampled on a schedule according to 7 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.

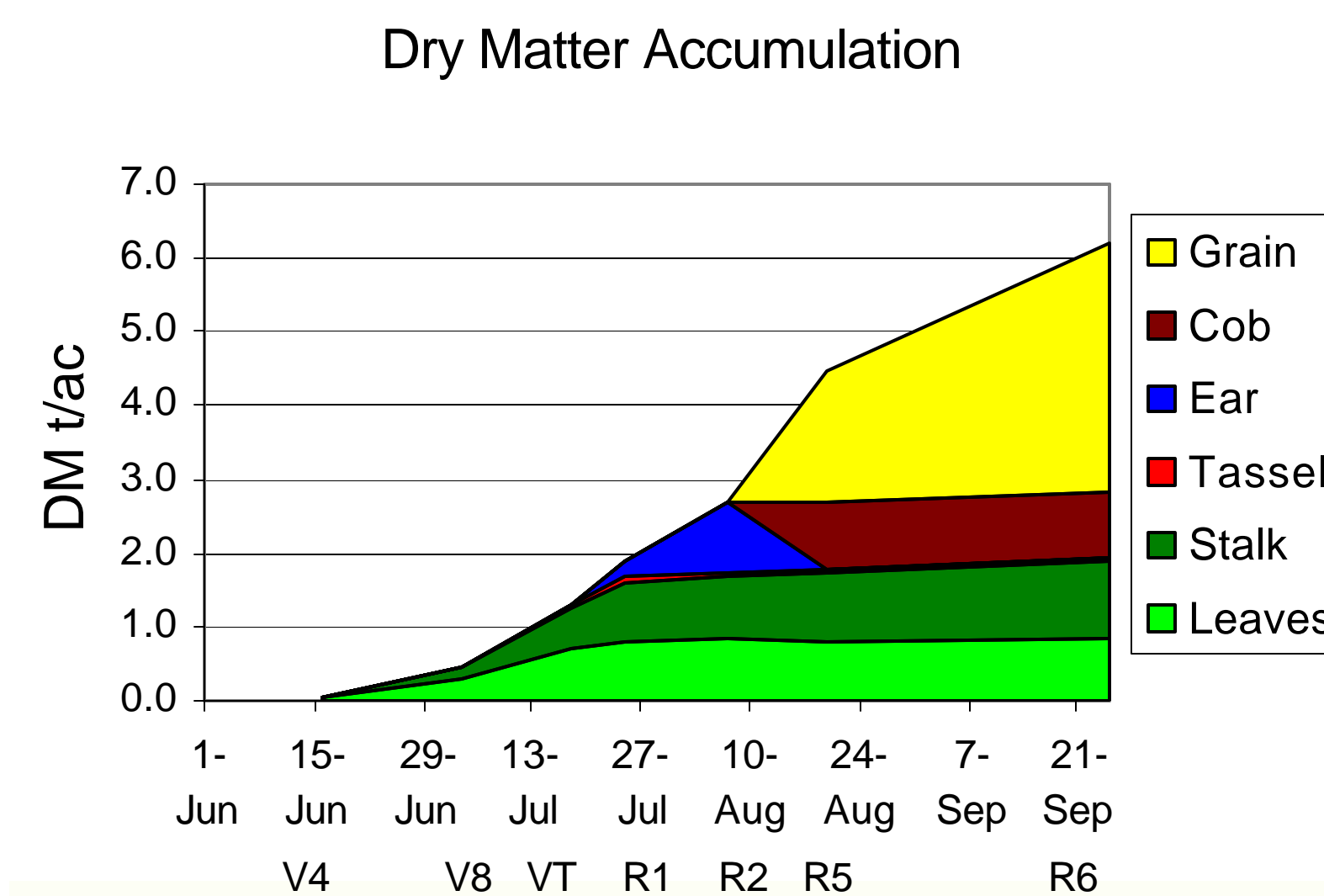
Soil was sampled at monthly intervals for nitrate-N content.



### Growing season

- Accumulated corn heat units were 2694 CHU or 10% greater than normal.
  - In-season rainfall was 12" or 97% of normal
- This combination of heat, rain and stored soil moisture produced higher than average corn yields in 2003.

## Dry matter (DM) accumulation



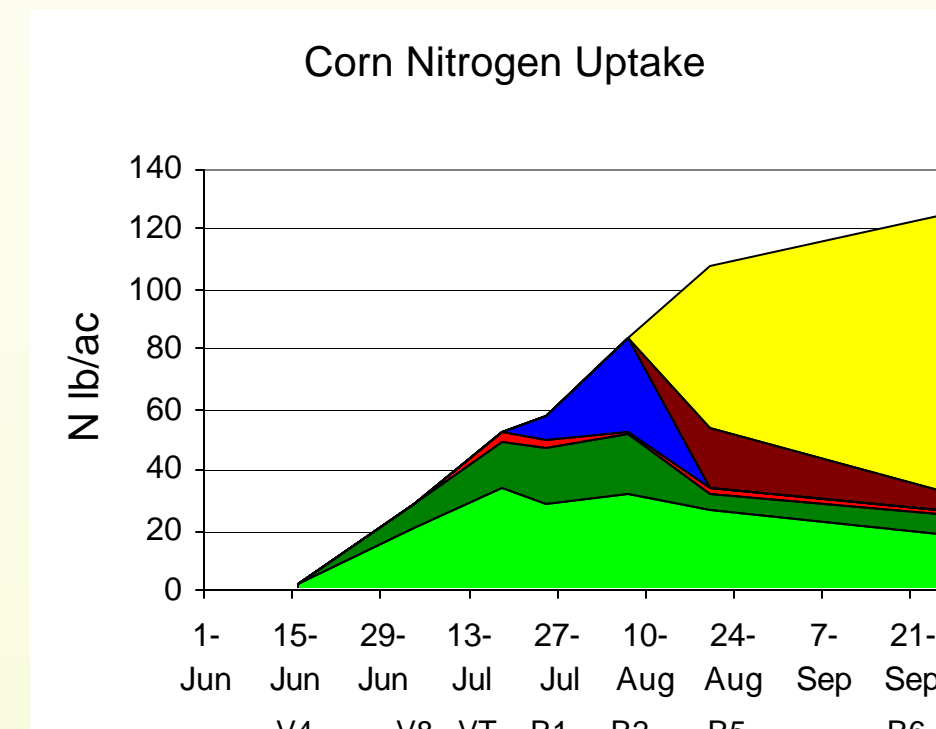
•Final grain yield was 156 bu/ac with a harvest index of 54%.

•The highest rate of DM accumulation was during early grain fill (R2-R5) at 308 lb/ac/day or 6.5 bu/ac/day.

•DM accumulation was greatest for leaves between V8-VT.

•The ear was separated into grain and cob plus husk at R5.

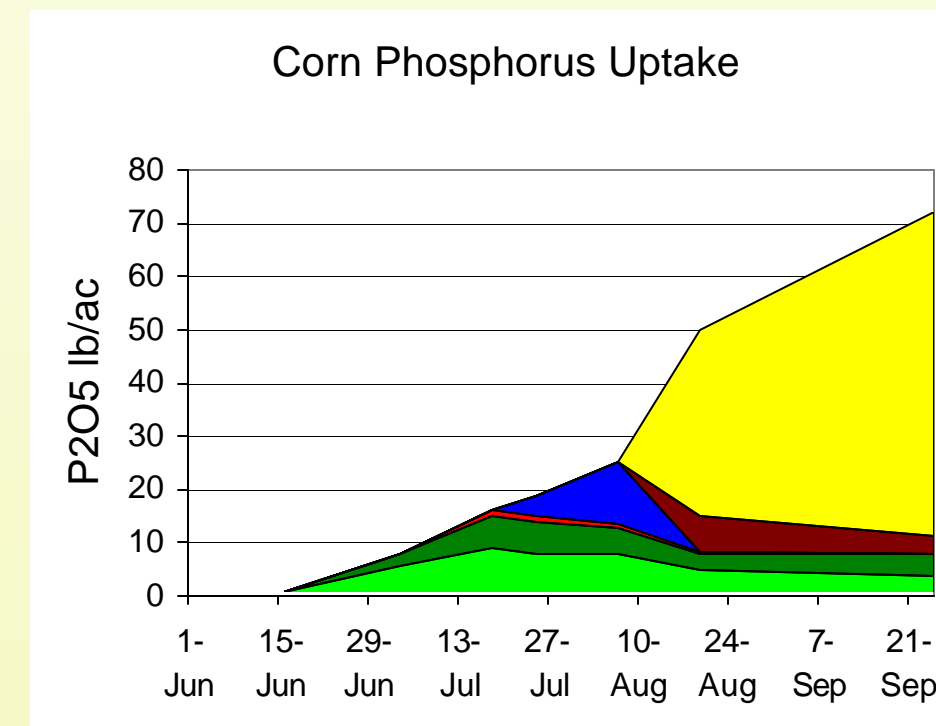
## Primary nutrient uptake



•Total N uptake was 125 lb/ac with 73% in the grain.

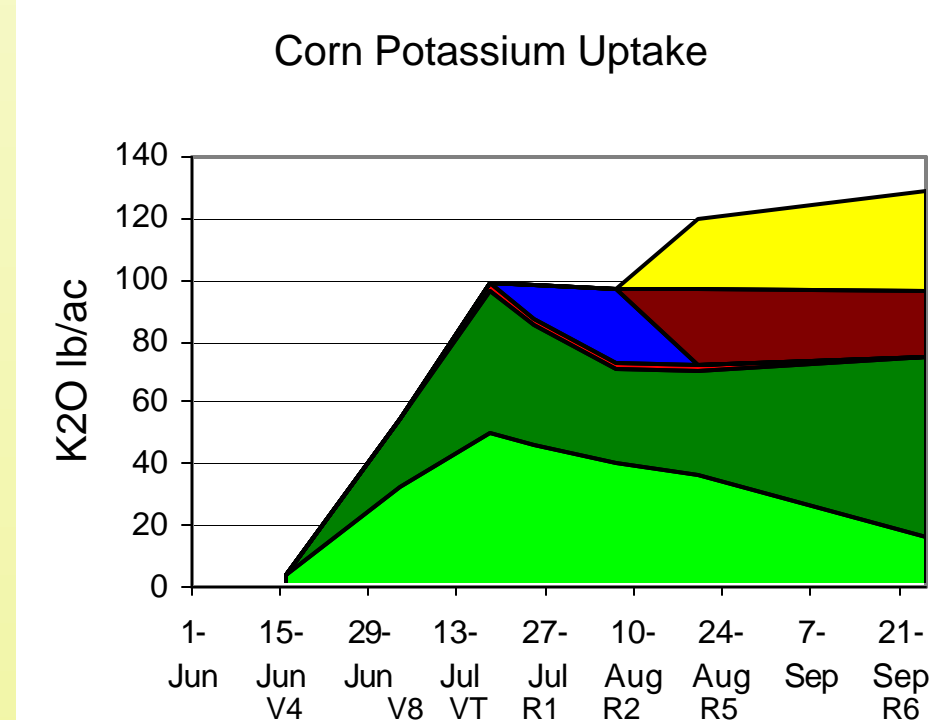
•Max rate of N uptake was 1.8-1.9 lb N/ac/day between V8-VT and R1-R5.

•N was translocated from leaves and stalk during grain fill with grain accumulating 4.2 lb N/ac/day between R2-R5.



•Total P uptake was 72 lb P<sub>2</sub>O<sub>5</sub>/ac with 85% in the grain.

•Max rate of P uptake was 1.9 lb P<sub>2</sub>O<sub>5</sub>/ac/day during grain fill (R2-R5) and moved from leaves and stalk to accumulate in grain at 2.7 lb P<sub>2</sub>O<sub>5</sub>/ac/day.

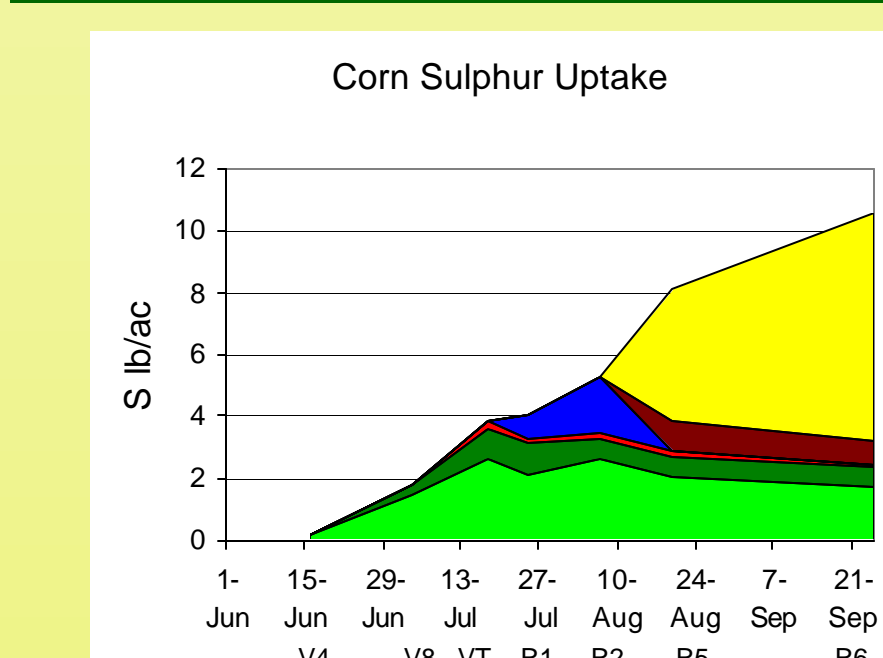


•Total K uptake was 129 lb K<sub>2</sub>O/ac with only 25% in grain but 45% in the stalk.

•75% of K was taken up during vegetative growth (V4-VT) at the rate of 2.8 to 3.1 lb K<sub>2</sub>O/ac/day.

•During reproductive stages, K content of leaves declined while the stalk maintained and increased K content.

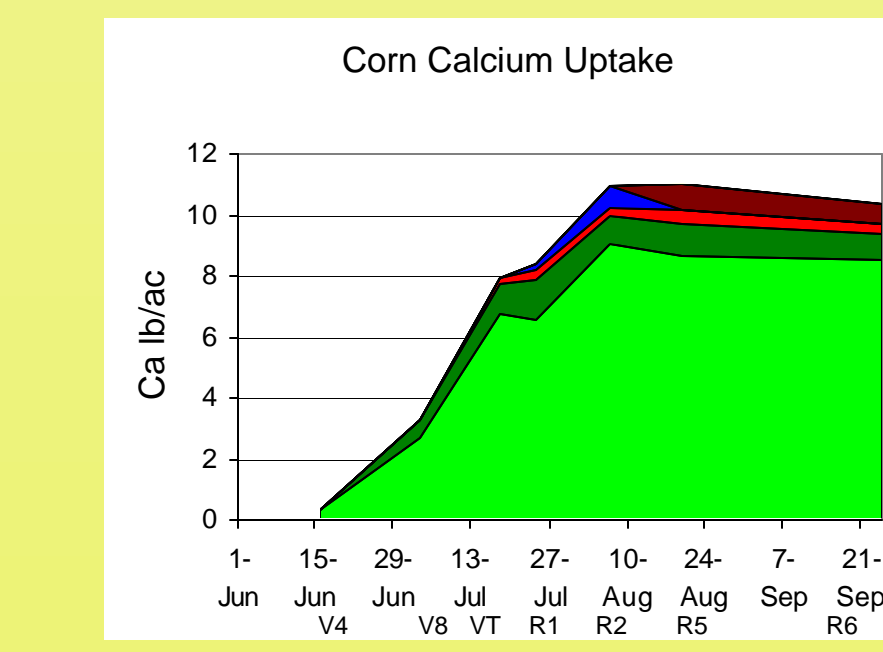
## Secondary nutrient uptake



•Total S uptake was 10.5 lb S/ac with 70% in the grain.

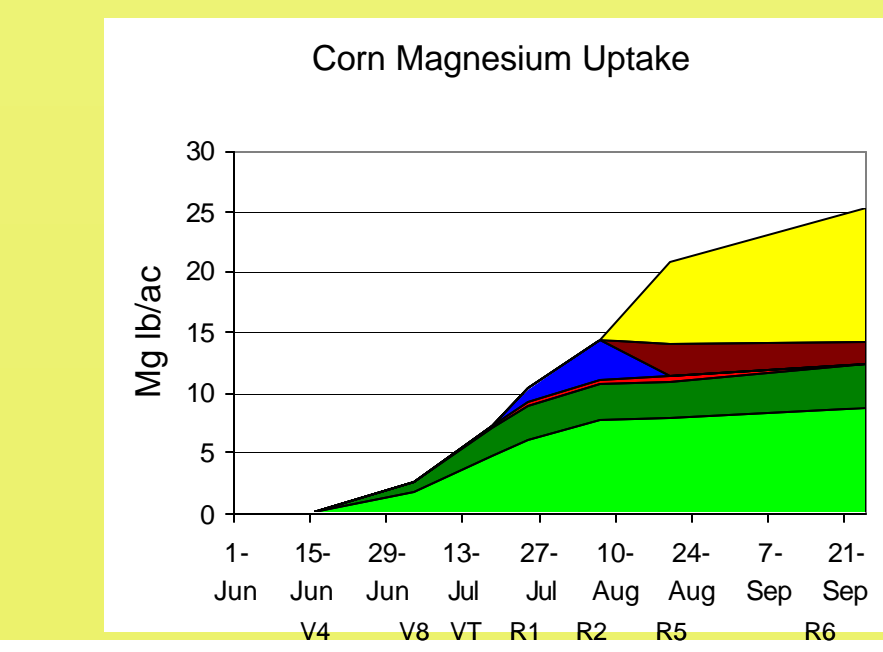
•S uptake rate was uniform through the season.

•Little S was moved from leaves to the grain.



•Ca uptake amount was similar to S, but occurred entirely during vegetative and early reproductive stages (V4-R2)

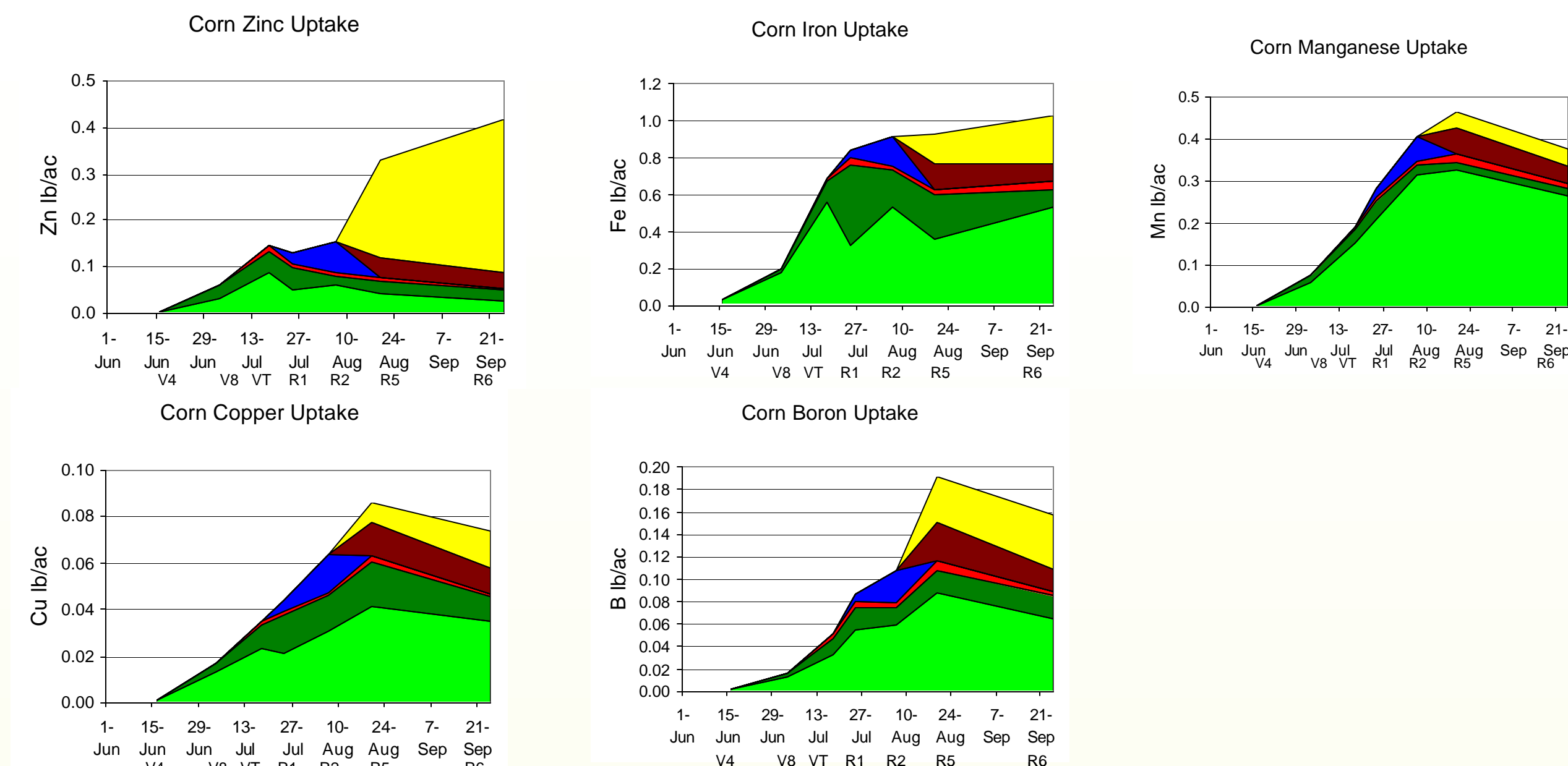
•Most Ca was present in leaves (82%), stalk and tassel (12%) and cob and husk (6%) with no translocation to grain.



•Total Mg uptake was 25 lb Mg/ac with 45% in the grain.

•Mg uptake was rather constant through the season with very little moving from leaves and stalk to grain.

## Micronutrient uptake

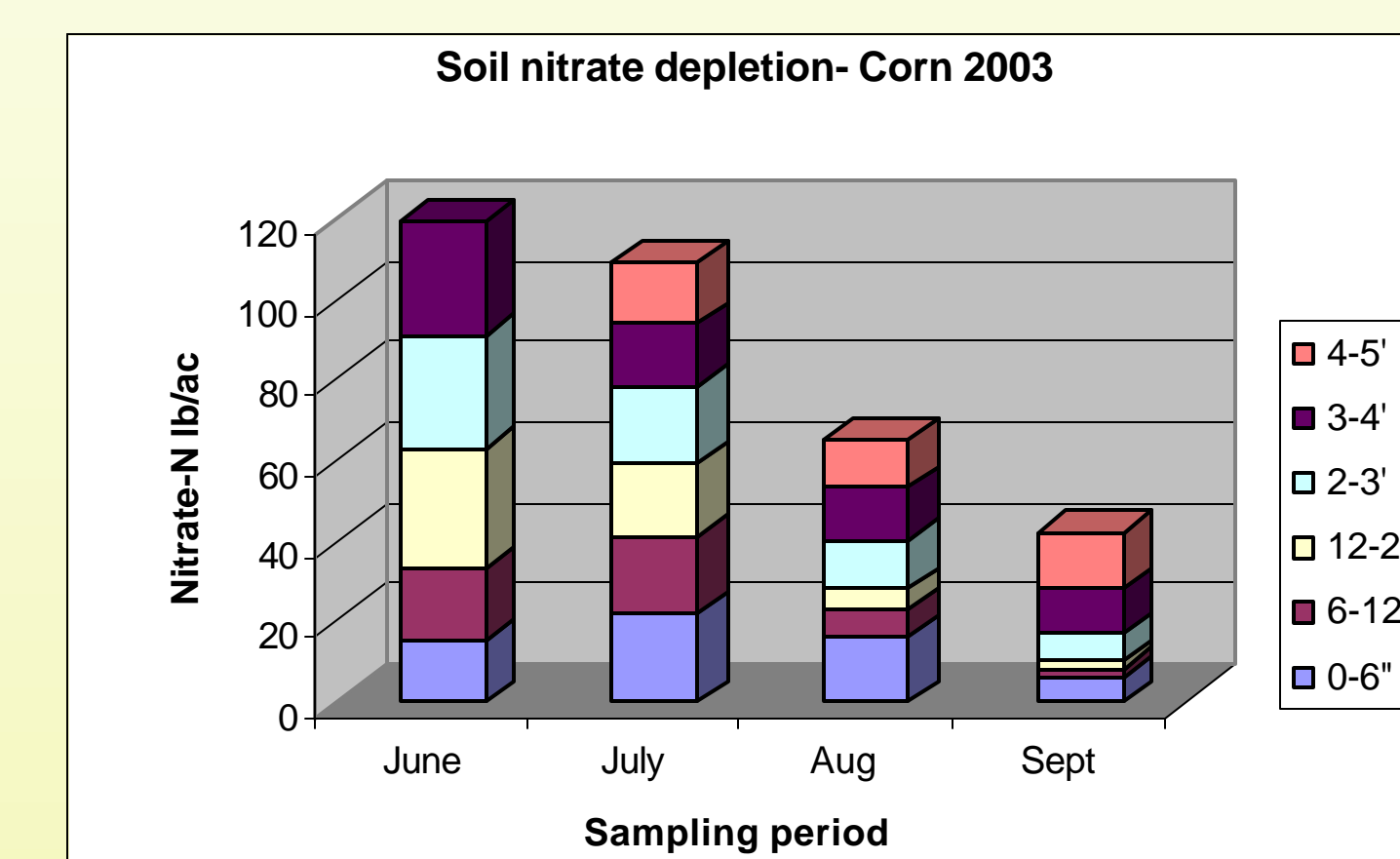


•Micronutrient uptake was small with Fe > Zn = Mn > B > Cu.

•75% of the Zn was present in the grain, whereas other micronutrients remained predominantly in leaf and stalk tissue.

•Zn uptake occurred chiefly at grain filling whereas others were largely accumulated prior to grain fill with apparent decline in Mn, Cu and B.

## Soil N depletion



•Monthly measurements showed a steady decline in soil nitrate-N.

•By harvest, nitrate levels were very low (<10 lb N/ac) in 0-24".

•Nitrate-N was depleted to the 4' depth but unchanged at the 4-5' depth.

## Discussion

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

- The study N, P, K and Ca uptake values (in bold) were less than these and other reported values (Karlen et al., 1988), perhaps due to our conservative use of fertilizer.

Table 1. Comparison to standard nutrient values for corn (150 bu/ac)

	Uptake lb/ac		Removal lb/ac	
	Study	CFI	Study	CFI
N	<b>125</b>	170-240	<b>91</b>	100-150
P <sub>2</sub> O <sub>5</sub>	<b>72</b>	75-110	<b>62</b>	55-66
K <sub>2</sub> O	<b>129</b>	130-240	<b>32</b>	39-44
S	11	11-13	<b>7</b>	10-11
Ca	<b>11</b>	25-50	<1	1
Mg	25	18-30	<b>12</b>	13

Book values may be established from high input studies where nutrients are taken up in luxury amounts.

Partitioning of nutrients within the corn plant agreed with other studies (Karlen et al., 1988) except for the apparent disappearance of leaf Cu, B and Mn at maturity.

High yielding corn with modest N fertilizer can extract N to 4' depths.

## Acknowledgements

MB Corn Growers Association  
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AgVise Labs  
University of Manitoba  
MB Zero Till Research Assn

## References

- Canadian Fertilizer Institute. 1998. Nutrient Uptake and Removal by Field Crops – Eastern Canada 1998.
- Karlen, D.L., R.L. Flannery and E.J. Sadler. 1988. Aerial accumulation and partitioning of nutrients by corn. Agron. J. 80:232-242.