POTASSIUM IN CORN STARTER FERTILIZERS REVISITED

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Abstract

Despite the importance of potassium in crop nutrition, there has been relatively little assessment of potassium in starter fertilizers, and particularly where sufficient preplant broadcast K has been applied to meet the needs of the crop. Initial results from the first year of a multi-year study in Southern Ontario showed that corn yields were increased by about 0.4 t ha^{-1} by the inclusion of potassium in a starter fertilizer on low P and K testing soils, above the response to added P. Further work is needed to refine the optimum rates of potassium in starter fertilizers for corn.

Introduction

The role of potassium in plant nutrition is well known, with documented functions including osmoregulation, enzyme activation, stomatal opening, phototropism, and sugar transport in the phloem (Marschner, 1995). Despite the importance of potassium to crop nutrition, relatively little work has been done on potassium placement, or more specifically on the importance of potassium in starter fertilizers. For many years, potassium has been the least expensive macronutrient in the fertilizer blend, and inclusion of K in a starter blend often played the role of diluting the more expensive ingredients rather than intentionally for its role in crop nutrition. Balancing this has been the risk of salt injury, or “fertilizer burn” from the application of too much K near the seed. Ontario has set maximum safe rates of fertilizer, where the risk of salt injury is minimal, to be 90 kg ha^{-1} of (N + K_2O) where the fertilizer is applied 5 cm to the side and 5 cm below the seed, and 10 kg ha^{-1} of (N + K_2O) where the fertilizer is applied with the seed (Reid et al. 2006).

Roth et al. (2003) compared the response of grain corn grown on high P soils to various starter fertilizers, including one that included K, in Pennsylvania. One out of four site years showed a statistically significant increase in yield over the check when a starter that included K was applied at planting. The soil test of the responsive site was 101 ppm K, while the non-responsive sites all had K soil tests >140 ppm.

Osborne (2005) found a corn yield increase with starter fertilizer that contained both P and K, compared to no starter fertilizer in a South Dakota study. This study did not include a comparison of high P starter fertilizers with and without K, so it is impossible to tell how much of the yield response was due to each nutrient. Neither of these studies included previous broadcast applications of K. The yield responses recorded may be due to a “starter effect”, where placement at planting will have a significant impact on results, or if the response is simply to providing adequate K to meet the needs of the crop.

In contrast, a study in Kansas (Gordon and Pierzynski, 2005) found no incremental yield response when K was added to starter fertilizers for corn, although there was a yield increase from the addition of starter fertilizers relative to the check.

Vyn and Janovicek (2001) compared the response of grain corn to banded K in the starter band in various tillage systems and with different rates of fall applied K fertilizer. They found positive yield responses to starter K on a silt loam and a loam site where K tests were below 100 ppm, but not on a silty clay loam site with K tests >150 ppm. Fields under no-till management tended to have larger and more consistent responses than fields under conventional tillage. There were no significant interactions between fall K rates and yield responses to starter K in this study, but the rates of fall K were relatively modest (42 or 84 kg K ha^{-1}).

Materials and Methods

Field plots were established in the fall of 2007 on the Elora Research Station and on a farmer's field near Ancaster, Ontario. Soil tests in these fields were low enough for P and K that responses to these nutrients were likely. Both of these fields were conventionally tilled, which on the Elora site consisted of spring cultivation prior to planting, and on the Ancaster site consisted of fall mouldboard plowing followed by spring cultivation. The Elora site was planted to Pioneer 38N87 (Roundup Ready®) on May 7, while the Ancaster site was planted on May 8 to Hyland B282 (non-RR). Target population at both sites was 30,000 plants per acre. Roundup® herbicide was applied to the Elora plots at the 3-leaf and 8-leaf stage. Weed control at Ancaster was the same program as the farmer applied to the balance of the corn field surrounding the plots.

Experimental design was a split-plot RCBD, replicated three times, with the split between pre-plant and side-dress nitrogen. Various starter treatments were imposed on each of the split plots (Table 1).

Table 1. Treatments applied to plots

N timing	Starter Fertilizer	Placement	N	P_2O_5	K_2O
			kg ha^{-1}		
Pre-plant	Check	-	0	0	0
Pre-plant	10 Gal. 28-0-0	2x2	33.5	0	0
Pre-plant	7.5 Gal. 6-24-6	in-furrow	5.6	22.4	5.6
Pre-plant	5 Gal. APP	in-furrow	6.5	22.1	0
Pre-plant	5 Gal. APP	2x2	6.5	22.1	0
Pre-plant	10 Gal. APP	2x2	13	44.2	0
Pre-plant	5 APP +10 28-0-0	2X2	40	22.1	0
Pre-plant	75 MAP	2x2	9.2	43.7	0
Pre-plant	150 MAP	2x2	18.4	87.4	0
Pre-plant	75 MAP+10 28-0-0	2x2	42.7	43.7	0
Pre-plant	75 MAP + 3 28-0-0		19.2	43.7	0
Pre-plant	75 MAP+ 5 APP	in-furrow 2x2	15.7	65.8	0
Pre-plant	122 lb ac^{-1} 8-32-16	2x2	10.9	43.7	21.9
Pre-plant	200 lb ac^{-1} 5-20-20*	2x2	11.2	44.8	44.8
Side-dress	Check	-	0	0	0
Side-dress	10 Gal. 28-0-0	2x2	33.5	0	0
Side-dress	7.5 Gal. 6-24-6	in-furrow	5.6	22.4	5.6
Side-dress	5 Gal. APP	in-furrow	6.5	22.1	0
Side-dress	5 Gal. APP	2x2	6.5	22.1	0
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Side-dress	75 MAP + 5 APP	in-furrow 2x2	15.7	65.8	0
Side-dress	122 lb ac^{-1} 8-32-16	2x2	10.9	43.7	21.9
Side-dress	200 lb ac^{-1} 5-20-20*	2x2	11.2	44.8	44.8

*At Ancaster, this treatment was replaced with 175 lb ac^{-1} 13-23-21, which provided 25.5-45.1-41.2 kg ha^{-1} of N-P_2O_5-K_2O respectively.

All plots received 224 kg ha^{-1} of Muriate of Potash (0-0-60.5) as a broadcast application in the fall of 2007, as well as 165 kg ha^{-1} of N as Urea-Ammonium Nitrate solution (28-0-0) either preplant or side-dress, in addition to the starter fertilizer treatments.

Soil samples were collected and analyzed prior to any fertilizer applications (Table 2). Muriate of potash (0-0-60.5) was broadcast all of the plots at a rate of 200 pounds per acre in the fall of 2007. Urea-Ammonium Nitrate solution (28-0-0) was applied to provide 150 lb ac^{-1} of actual N, as either a pre-plant or side-dress application.

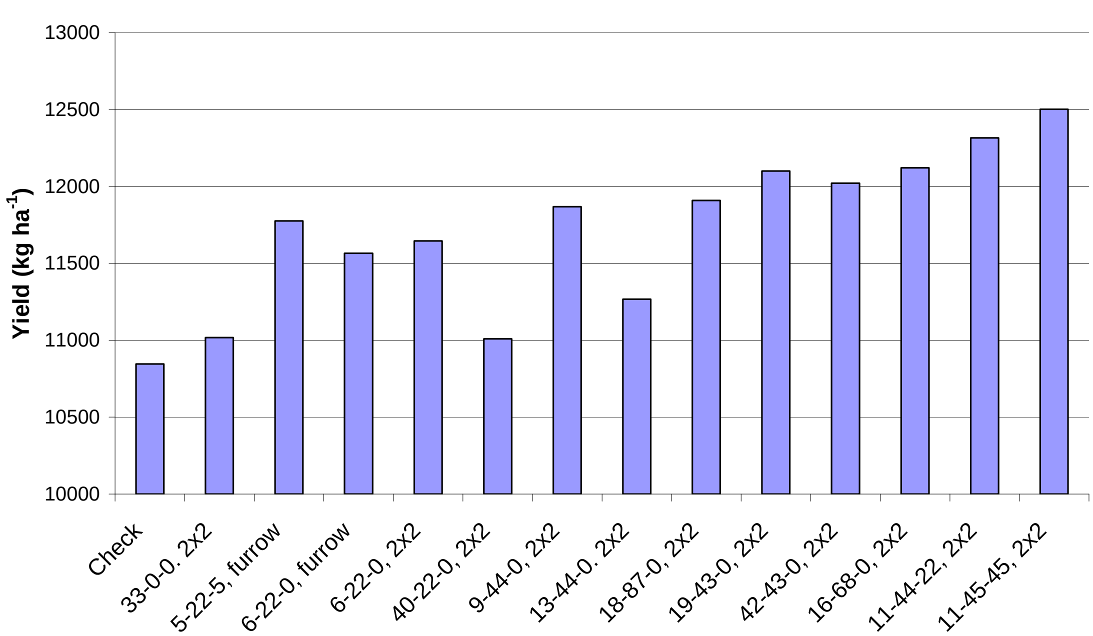
Table 2. Initial soil test results

	Elora	Ancaster
Soil pH	7.66	5.86
Olsen P (ppm)	11.3	13.8
Ammonium Acetate K (ppm)	62	57
Ammonium Acetate Mg (ppm)	347	195
Ammonium Acetate Ca (ppm)	2960	1961
Soil Organic Matter	3.6	n/a

Results and Discussion

Yield results from the plots in Elora and Ancaster are shown in Figure 1. The expectation was that the fall application of potash fertilizer would provide enough potassium to meet the needs of the crop, so the response to potassium in the starter fertilizer would be small to nil. It was surprising, therefore, to note that the highest yields in the plots were from the treatments that included significant amounts of K in the starter fertilizer. This was in addition to the yield response to added phosphate. Individual responses to phosphorus and potassium are shown in Figures 2-5. There were no significant responses to starter N in either plot, as shown in Figures 6 and 7.

Figure 1. Average Corn Yield Response to Starter Fertilizer at Ancaster and Elora, 2008



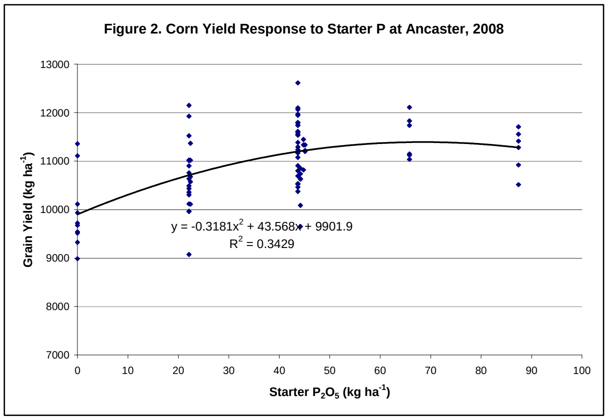


Figure 2. Corn Yield Response to Starter P at Ancaster, 2008

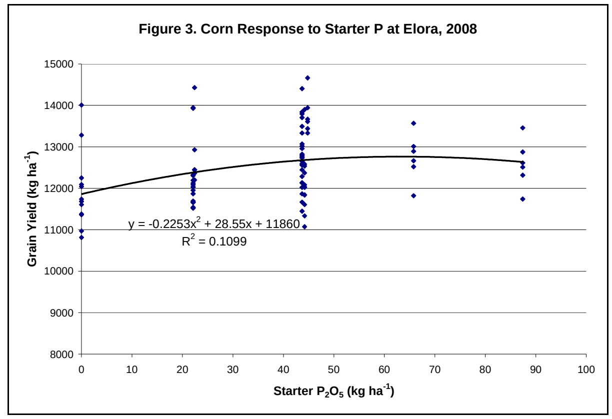


Figure 3. Corn Response to Starter P at Elora, 2008

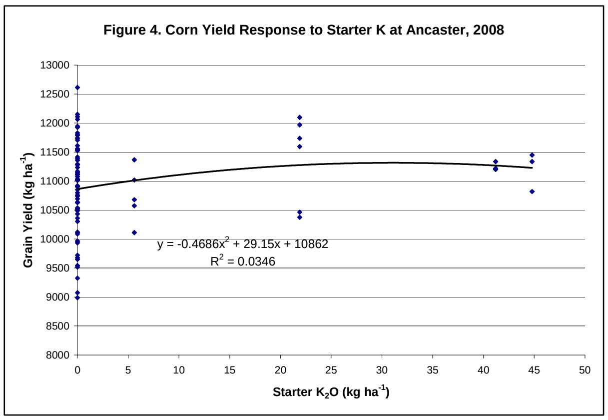


Figure 4. Corn Yield Response to Starter K at Ancaster, 2008

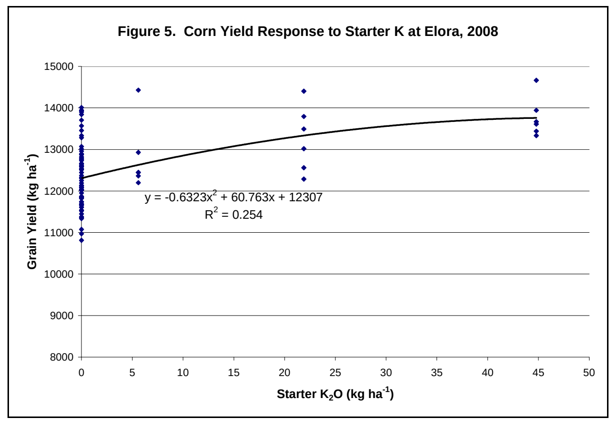


Figure 5. Corn Yield Response to Starter K at Elora, 2008

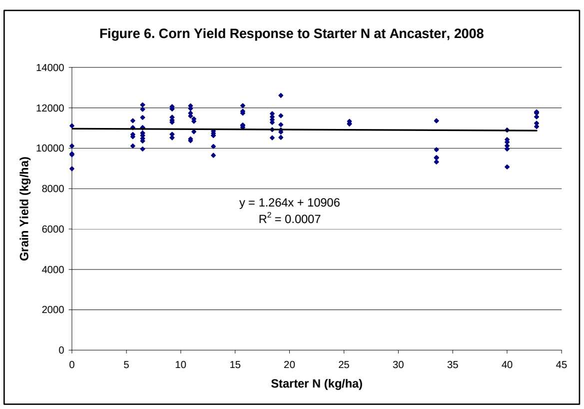


Figure 6. Corn Yield Response to Starter N at Ancaster, 2008

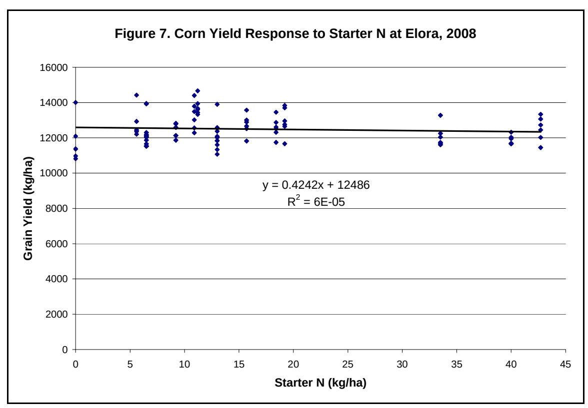


Figure 7. Corn Yield Response to Starter N at Elora, 2008

Conclusions and Continuing Work

Initial results from one year's data suggest that there is an advantage to including part of the potassium requirements for the crop in the starter fertilizer on low K soils, even where K has been broadcast before planting. These treatments are being repeated in 2009 to confirm how large this effect is. Additional plots have been added to look at the impact of tillage system, and also to assess whether low rates of starter K can provide similar yield benefits to high rates of broadcast K.

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