Effects of Potassium Fertilization on Corn and Soybean Yields and Soil Test Potassium

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Introduction

As corn (Zea mays L.) and soybean (Glycine max) yields increase so does the demand for macro nutrients like potassium (K). This long-term study was established on three distinctly different soils that represent much of the corn and soybean growing area in Minnesota. The purpose of this study was to create responsive sites for measuring yield and soil test responses to fertilizer K additions. Calibration and correlation data collected at these sites will be used to improve potassium fertilizer recommendations in Minnesota.

Objective

The objectives of this study were: to establish responsive sites on key Minnesota soils; to determine the effects of initial soil test K level and fertilizer K rate on yield, K uptake and K removal in corn and soybean; and to monitor changes in soil test K over time.

Methods

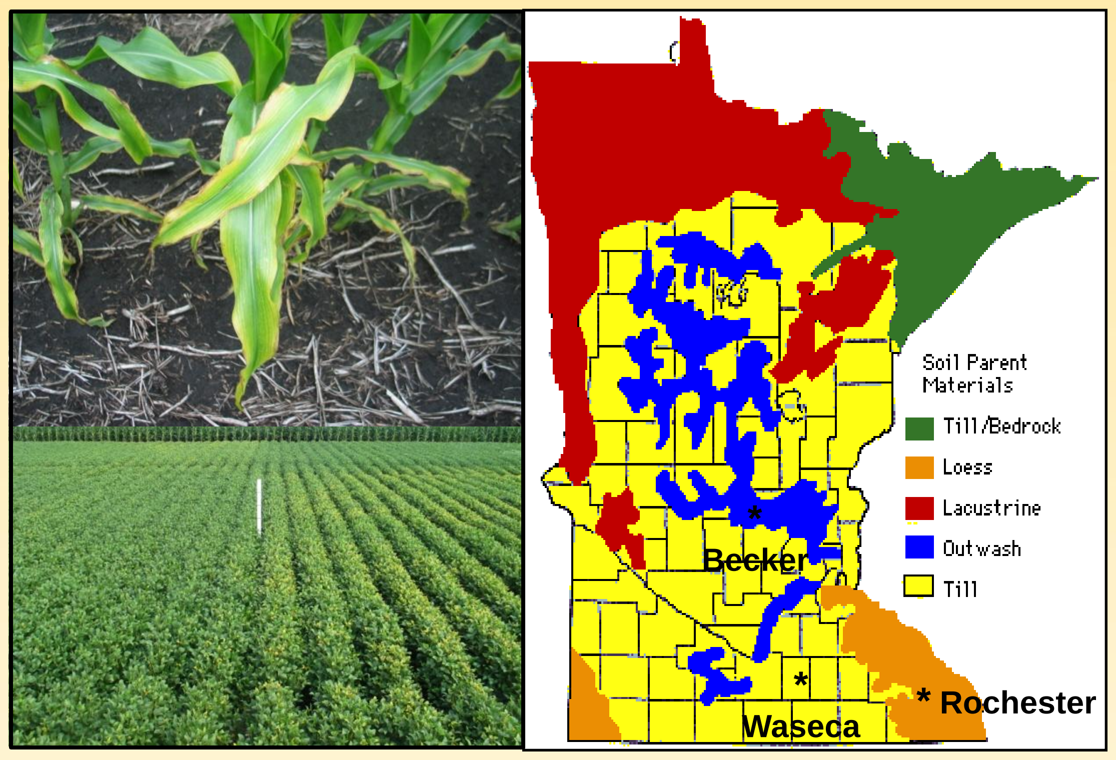
Experimental sites were located at Waseca, a Nicollet clay loam (Aquic Hapludolls); at Becker, an irrigated Hubbard loamy sand (Entic Hapludolfs); and at Rochester, a Mt. Carroll silt loam (Mollic Hapludalfs).

Three rates of potash fertilizer are fall-applied annually to each of the main plots. At two sites (Waseca and Becker) the rates were 0, 56 and 112 kg K ha^{-1}. At Rochester, 0, 37 and 74 kg K ha^{-1} were used because initial soil test K levels were greater than other sites. Fertilizer K was first applied in late October of 2011.

Soil samples were taken to a 15-cm depth and analyzed for K with ammonium acetate (dry soil) and Mehlich III (moist soil) extractants using standard methods.

All sites were cropped to a corn-corn-soybean rotation.

Treatments were arranged in a randomized complete block design with four replicates. Analysis of variance was performed using the Proc Mixed procedure in SAS (SAS® 9.2, SAS Institute). A mixed model was used with block as a random effect and K fertilizer rate as a fixed effect. Alpha=0.10 level of significance was used to determine differences in treatment means.



Potassium deficiency symptoms in corn (top left) and soybean (bottom left). Minnesota soil parent materials and research plot locations (right).

Minnesota soil test K (ammonium acetate) interpretation classes				
Very low	Low	Medium	High	Very high
------------------------------		mg K kg^{-1}		------------------------------
0 – 40	41 – 80	81 – 120	121 – 160	>161

Results

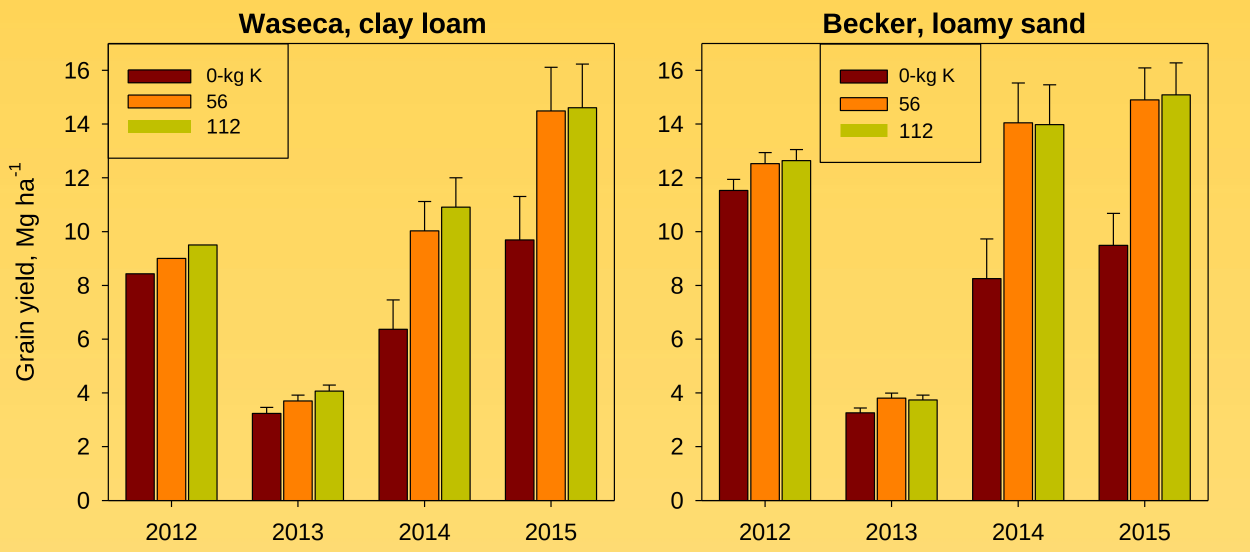


Figure 1. Corn and soybean (2013 only) yields as affected by fertilizer K rate (error bars indicate significance at alpha=0.10).

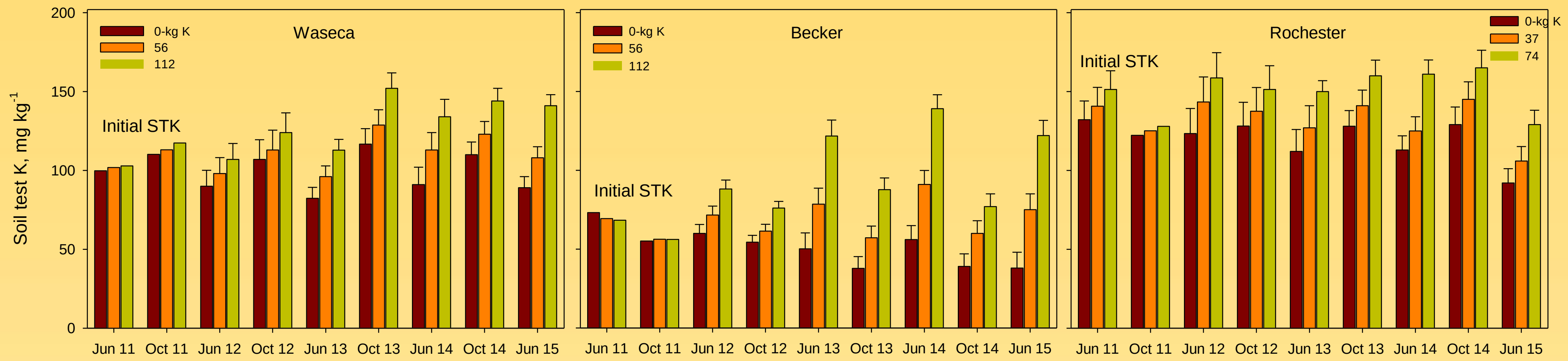


Figure 2. Soil test K (ammonium acetate) as affected by fertilizer K rate and sampling time (error bars indicate significance at alpha=0.10).

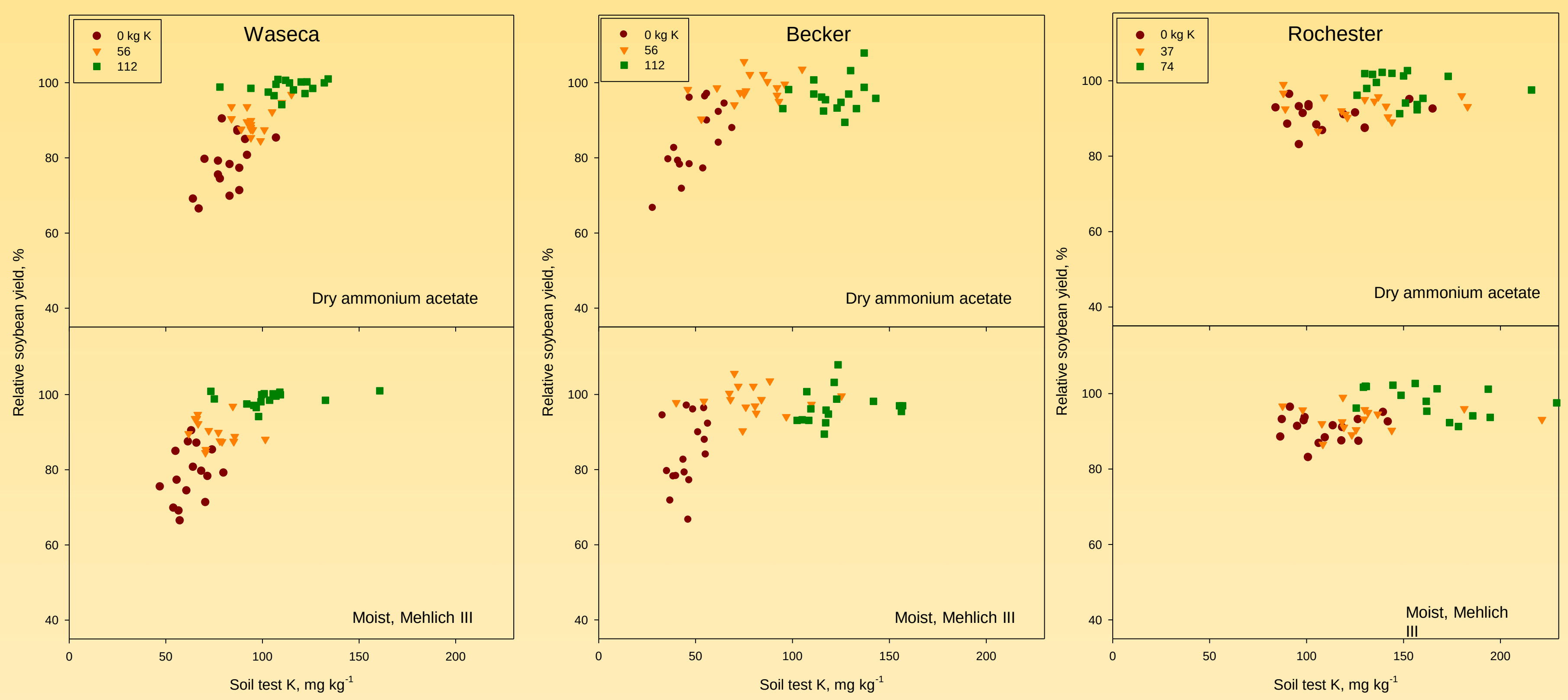


Figure 3 Relative soybean yield in 2013 as affected by K fertilizer rate and soil test method (dry, ammonium acetate vs moist, Mehlich).

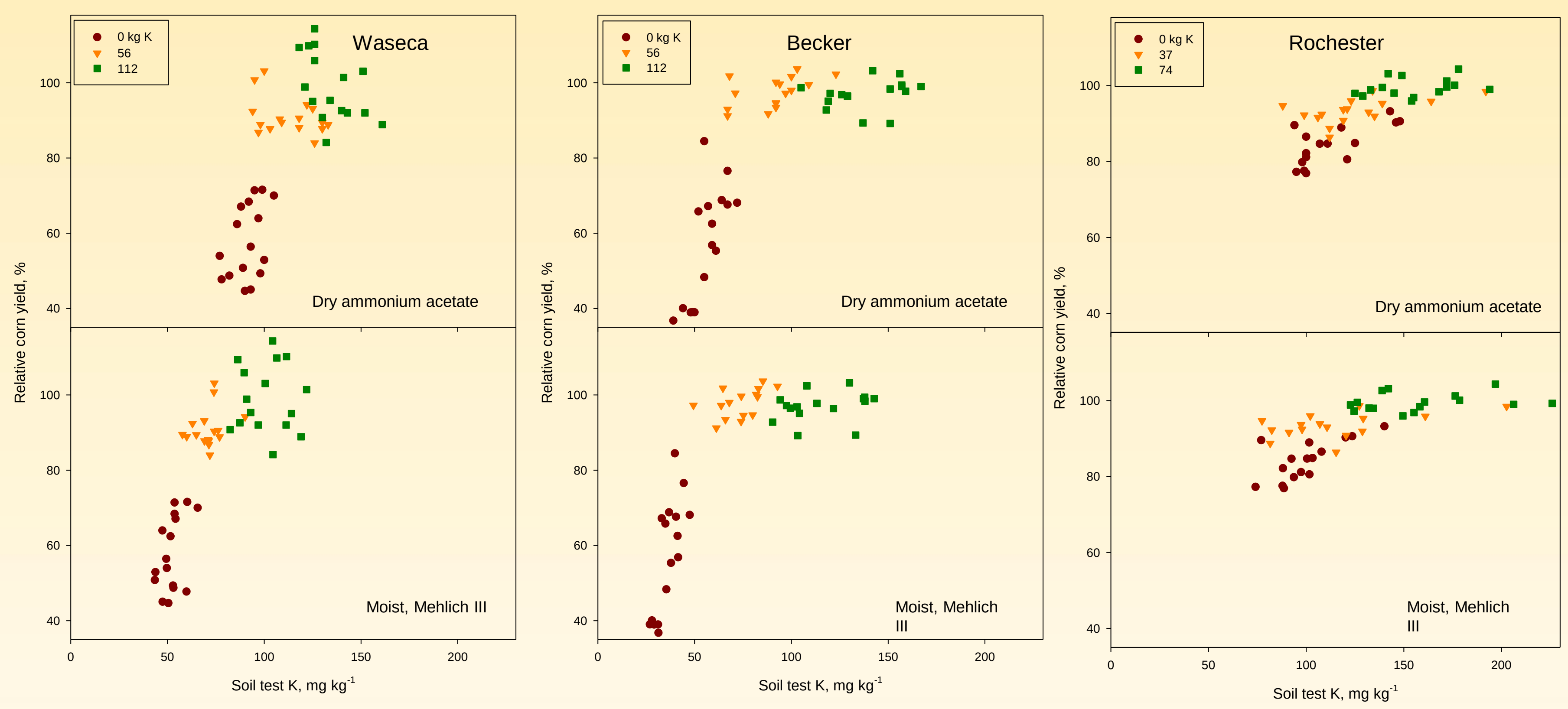


Figure 4 Relative corn yield in 2014 as affected by K fertilizer rate and soil test method (dry, ammonium acetate vs moist, Mehlich).

Discussion

Significant yield differences were found in 11 of 12 site-years (Figure 1). Drought increased yield variability at Waseca (clay loam soil) in 2012. No significant yield differences were found at Waseca in 2012.

Corn yield response to fertilizer K ranged from only 2% at Rochester (silt loam) in 2012 to 59% (5.6 Mg ha^{-1}, 89 bu ac^{-1}) at Becker (loamy sand) in 2015.

The 56 kg K ha^{-1} rate produced a large corn yield increase at Becker and Waseca in 2014 and 2015; furthermore, 56 kg generally maintained yields throughout the first four years of the study at both locations.

No difference between the 56 and 112 kg K ha^{-1} rates were found at Becker. Becker had the lowest average soil test of any site.

Soil test K (ammonium acetate): 1) declined at all sites with the zero K control treatment (Figure 2); 2) was generally maintained with the 37 and 56 kg K ha^{-1} rates; 3) increased with the 112 kg K ha^{-1} rates at Waseca (clay loam) and Becker (loamy sand); and was maintained with the 74 kg K ha^{-1} rate at Rochester (silt loam).

Generally, soil test K in June was: 1) less than October at Waseca; 2) greater than October at Becker; and 3) similar to October at Rochester.

Dry ammonium acetate extractable K was greater than moist Mehlich III K at Waseca (clay loam) in 2013 (Figure 3).

Minimal differences were observed between dry and moist soil test K at Becker (loamy sand) and Rochester (silt loam) in 2013.

Dry soil test K was greater than moist K at Waseca (clay loam) and Becker (loamy sand) in 2014 (Figure 4).

Moist K had a larger spread (lower lows and higher highs) than did dry K at Rochester (silt loam) in 2014.

Acknowledgement

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