Nitrogen and Phosphorus Rates for Sugarbeet under Sprinkler Irrigation and Conservation Tillage

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Introduction
As irrigated agriculture continues to shift from flood to sprinklers, and from conventional to conservation tillage, new approaches to fertility management are needed. Improved control over water application reduces nutrient loss, and more soil organic matter (SOM) from less tillage increases water and nutrient supplying potential of soils. Both present opportunities for improved crop nutrient management. Improved understanding of interactions among conservation tillage, sprinkler irrigation, and nutrient management are needed. In this investigation we sought to establish nitrogen (N) and phosphorus (P) fertilizer rates in a sugarbeet–dry bean–barley rotation in transition to a conservation tillage system. This paper reports on sugarbeet yield and quality in response to five levels of N and P and two tillage systems. Responses of dry beans and barley, soil health parameters, and limited irrigation were also evaluated, and results are being analyzed.

Objectives
Our objectives were to establish optimum N and P rates and investigate whether reduced tillage affects those rates immediately after transition to conservation tillage.

Materials and Methods
Our crop-rotation experiment was established in 2014 under the lateral-move sprinkler at the Powell Research and Extension Center (PREC). Sugarbeet, dry bean, and barley were each planted in eight plots measuring 44 × 105 feet. Four plots under each crop were tilled by conventional methods and four by reduced-tillage practices, including strip-till to 10 inches using a Schlagel strip tiller for sugarbeet. Each of the plots was divided into 12 subplots measuring 11 × 35 ft. Five N and five P rates were randomly and permanently assigned to each plot, including zero, low, medium, high, and very high. The sugarbeet rates for N were 0, 65, 130, 195, and 260 lb N/ac, half incorporated preplant as urea and half side-dressed as urea-ammonium nitrate (UAN). The sugarbeet rates for P were 0, 35, 70, 105, and 140 lb P/ac. Fertilizer was added to residual soil N and P to attain target rates, so there are no 0-level plots in the results.

Results and Discussion
Results demonstrate some challenges in transition to conservation tillage and growing sugarbeets in the Bighorn Basin: yields were good in 2014, but very low in 2015 because of late frost and replanting, and even lower in 2016 because of poor emergence. Only the first two years were analyzed (Figure 1). This early in transition, conservation tillage did not affect yield. Soil P built up from past fertilization precluded response to P. Nitrogen rate significantly affected sugarbeet yield under full irrigation, and may provide some guidance for optimum economic N rates in high- and low-yielding seasons. Using 2015 prices for N fertilizer ($0.65/lb) and sugarbeet roots ($37/ton), the N rate yielding the maximum economic return would be 208 lb N/ac (residual + added) for 32 tons of roots/ac in 2014 and 121 lb N/ac for 7 tons of roots/ac in 2015. This suggests that if all goes well in the early season, producers should use a high-yield goal and side-dress to meet the full N rate. If late frost or other spring problems suggest that yields will be lower, producers can save money by adjusting down or eliminating early summer side-dressing. The economic optimum N rate varies with prices of sugar and N. In 2011, for example, root prices were about $60/ton and N prices were slightly lower than in 2015. Under these conditions, the economic optimum N rate for 2014 would be 217 lb N/ac.
We expect that more time under conservation tillage will change fertilizer needs as soils accumulate organic matter, which, in turn, improves soil water and nutrient supplying potential. The plots at PREC are intended to be long-term plots that will allow us to track those changes over three to four 3-year rotations, and possibly to repeat the fertilizer rate study after notable soil changes have been observed.

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*Figure 1.* Sugarbeet yield response to N rates in two study years. *P*-values less than 0.05 indicate that the fitted curves adequately explain the response according to the equation, where \( R_Y \) is root yield and \( x \) is N supply, including residual soil N plus added fertilizer.

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R_Y = 2.4598 + 0.625x - 0.00142x^2 \\
p = 0.0065 \\
\rho^2 = 0.4009
\]

\[
R_Y = 5.687 + 0.127x - 3.779 \times 10^{-4}x^2 \\
p = 0.0093 \\
\rho^2 = 0.1486
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