Effect of Variable Irrigation and Nitrogen Application on Sugarbeet Root and Sugar Yield

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Introduction

The sugarbeet (Beta vulgaris) is one of the most important row crops in Wyoming. In 2014, growers harvested 8.34 million tons on 30,200 acres. The value of the 2014 crop was $41 million (Brandt and Hussey, 2016). Sustainability of sugarbeet production in semiarid to arid regions of the western U.S., including Wyoming, is dependent on such factors as water availability, irrigation management, and nutrient management, including nitrogen (N). As Wyoming growers face significant management (sprinkler vs. surface irrigation, for example) and environmental changes (e.g., spatio temporal climate variability), a better understanding of the interaction of irrigation and N management could allow them to better utilize water while maintaining crop yields and quality.

Previous research under furrow irrigation suggests that as much as half of N applied as fertilizer can be lost from soils through runoff and leaching without being taken up by crops (Draycott and Christenson, 2003). Such losses are detrimental to both profitability and the environment. For example, runoff water carries heavy nitrate loads from fertilizer and eventually these nitrates make their way into streams, rivers, and lakes. Nitrates in water bodies can cause excessive algae growth; this depletes oxygen, which can kill fish and other aquatic life. Sprinkler irrigation systems provide the advantage of more even and controlled distribution of water above the canopy, which helps to minimize N leaching and reduce runoff losses.

Objectives

Objectives of this study are to evaluate the impact of variable irrigation and N application rates on sugarbeet root and sugar yield in the Bighorn Basin.

Materials and Methods

Field experiments were conducted in 2016 at the Powell Research and Extension Center (PREC). The dominant soil is a Garland clay loam, which is a fine, mixed mesic (Typic Haplarid). The area is characterized by a semiarid climate with long-term average annual and seasonal (April 1 to September 30) precipitation of 5.6 and 4.5 inches, respectively. The experiment was a split-plot design with variable irrigation and N levels. The investigated irrigation regimes were full irrigation treatment (FIT), 75% FIT, and 60% FIT. The N levels were 220 lb/ac (100 lb/ac at preplant and 120 lb/ac side-dress) and 150 lb/ac (100 preplant and 50 side-dress). The N fertilizer blend (SSN-46N and SSP 11-52-0) was broadcasted on March 9, and urea-ammonium nitrate (UAN 32%) was side-dressed on June 16. Sugarbeet hybrid 9418RR was planted on April 13 at a depth of 1 inch, emerged April 24–26, and was harvested on September 28. The number of plants per acre was approximately 48,000. Irrigation was applied using a Global Positioning System (GPS) guided variable-rate linear-move irrigation system (Valmont Industries Inc., Omaha, Nebraska). Irrigation scheduling was based off FIT and the 220 lb/ac N treatment. A total of 23 irrigation events occurred during the growing season. Sugarbeet yields were estimated by harvesting two rows at three locations within the same plot.

Results and Discussion

As expected, sugarbeet root yield increased with increasing levels of irrigation (Figure 1). A maximum sugarbeet root yield of 31 ton/ac was observed for FIT at 220 lb N/ac. The lowest yield (19 ton/ac) was obtained under 60% FIT for both N application rates. There was no significant difference in sugarbeet root yield between 75% FIT and FIT at a significance level of 0.05. This indicates that in the Bighorn Basin, irrigating at 75%
of the crop water requirements provides nearly equal sugarbeet root yield relative to a full irrigation strategy. This could reduce irrigation water usage by 25% and could also cut down on costs associated with irrigation, including labor and energy costs associated with pumping. The highest sugar content (15.3%) was achieved with the 150 lb/ac N application at 75% FIT. The lowest percent sugar content (14.0) was obtained for FIT at the 220 lb N level. Our results indicate that there is an optimal N level for each irrigation regime, and in general, lower N application rates are required to produce acceptable tonnage and maximum sucrose content at limited irrigation compared to FIT. This is an ongoing study, and this year we are adding more N levels (as low as 75 lb/ac to as high as 240 lb/ac) to better understand the irrigation and N interaction.

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Literature Cited


Figure 1. Sugarbeet root yield and sugar content response to nitrogen application rates (lb/ac) under full irrigation (FIT) and limited irrigation (75% FIT and 60% FIT) conditions at PREC in 2016.