Dry Bean Growth Dynamics in Response to Deficit Irrigation Under Surface- and Sprinkler-Irrigation Systems

Abhijit Rai¹, Jim Heitholt¹, and Vivek Sharma¹,²

Introduction
Dry edible beans (Phaseolus vulgaris L.) are grown on approximately 41,000 acres in Wyoming. Dry bean yields depend largely on amount of leaf area, speed of leaf formation, plant height, and normalized difference vegetation index (NDVI; an index that relates to plant health and greenness). To achieve optimal dry bean growth, favorable irrigation amounts and timings, proper nutrient levels, and other factors come into play. In recent years, however, many Wyoming farmers have faced water availability and climate variability issues. Under these circumstances, adopting efficient irrigation-management strategies (such as deficit irrigation) is crucial to maintain high productivity. Therefore, understanding growth dynamics of dry beans in response to various irrigation levels could help producers develop more efficient irrigation strategies, which, in turn, could help them maintain or improve yields.

Objectives
This study seeks to understand the response of dry bean leaf area index (LAI), plant height, and normalized difference vegetation index (NDVI) to full and limited irrigation under surface- and sprinkler-irrigation systems.

Materials and Methods
Field experiments were conducted in 2017 at the Powell Research and Extension Center (PREC). Dry bean cultivar ‘Othello’ was planted in sprinkler- and furrow-irrigated fields with five irrigation treatments: full irrigation treatment (FIT), 75% FIT, 50% FIT, 25% FIT, and 125% FIT (an excess irrigation treatment) in 22-inch rows at 90,000 seeds/ac. The experiment was laid out as a randomized block design with three replications. LAI, plant height, and NDVI were measured weekly throughout the growing season and stopped when the plants were nearing maturity.

Results and Discussion
The variation in LAI, plant height, and NDVI within and between the two irrigation methods and five irrigation treatments are presented in Figure 1. As expected for both sprinkler- and surface-irrigated dry beans, LAI and NDVI increased as the canopy developed, peaked in the middle of the growing season, and then decreased as the dry beans progressed toward maturity. Plant height gradually increased as the season progressed and peaked at the reproductive stage; thereafter, plant height changed little.

In the sprinkler-irrigated fields, imposing water stress resulted in shortening of the flowering and pod periods, and it also reduced leaf formation. LAI, plant height, and NDVI were highest in FIT and lowest in 25% FIT. The excess irrigation treatment (125% FIT) did not result in any additional benefit. In surface-irrigated fields, the highest LAI, plant height, and NDVI were recorded for 50% and 25% FIT, and lowest for 125% FIT. Lower LAI, plant height, and NDVI values for 75% and FIT are likely due to floodinglike stress. No statistically significant differences were observed between the values recorded for each treatment in surface irrigation.

Our study indicates that both modes of water application (sprinkler and surface) have a significant effect on dry bean growth parameters. For the two systems, both excess and insufficient irrigation resulted in growth parameters outside the range observed within the optimal irrigations.

Acknowledgments
The study is supported by U.S. Department of Agriculture Hatch funds and the Wyoming Department of Agriculture. We thank PREC crews for help with field activities.

Contact Information
Vivek Sharma at vsharma@uwyo.edu or 307-754-2223.

Keywords: irrigation, dry bean, normalized difference vegetation index

PARP: IV:3,4, X:1

¹Department of Plant Sciences; ²Powell Research and Extension Center.
**Figure 1.** Dry bean leaf area index (LAI), plant height (ht), and normalized difference vegetation index (NDVI) under FIT (full irrigation treatment), 75% FIT, 50% FIT, 25% FIT, and 125% FIT in surface- and sprinkler-irrigated fields at PREC.