Dry Bean Yield Response to Deficit Irrigation Under Surface- and Sprinkler-Irrigation Systems

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Introduction
The aim of any crop production scheme is better quality and quantity. Dry bean is very sensitive to water deficit, which can lead to large yield reductions. The extent and duration of drought stress in dry bean are directly associated with total dry bean biomass and seed yield, number of pods and seeds per plant, root length and mass, and maturation time. In Wyoming, dry bean production is largely dependent on irrigation; however, in recent years the state has faced both water availability and climatic variability challenges. In addition, irrigation-management decisions by growers are increasingly influenced by costs associated with irrigation, e.g., labor, water, pumping, etc. Therefore, it becomes essential to understand dry bean yield response to various irrigation levels under different irrigation systems. Having a better understanding of yield dynamics should enable growers to use water more efficiently and, in turn, increase farm income.

Objectives
This study seeks to understand dry bean yield response to full and limited irrigation under surface- and sprinkler-irrigation systems.

Materials and Methods
The field experiments were conducted in 2017 at the Powell Research and Extension Center (PREC). Dry bean variety ‘Othello’ was planted in sprinkler- and furrow-irrigated fields under five irrigation treatments: FIT (full irrigation treatment), 75% FIT, 50% FIT, 25% FIT, and 125% FIT (an excess irrigation treatment). The experiment was laid out as a randomized block design with three replications. At maturity, an area 10 feet long by two rows wide was hand-harvested from three locations in each plot for bulk yield analysis (Fig. 1A). In addition, two plants and their pods were harvested separately to analyze pod harvest index, seeds per pod, and number of pods per plant (Figs. 1B–D, respectively).

Results and Discussion
Drought stress affected both the seed yield and yield components. Figures 1A–D summarize the average yield, pod harvest index (PHI), seeds per pod (SP), and number of pods per plant (PP) in response to treatments under sprinkler and surface irrigation. In the sprinkler-irrigated treatment, maximum yield (2,935 lb/ac), PHI (75%), SP (3), and PP (17) were observed for FIT. The 75% and 125% treatments produced lower yields, PHI, SP, and PP compared to FIT. Imposing more stress on the crop by further reducing the applied water to 50% and 25% of FIT resulted in a significant yield reduction and lower PP (p<0.05); however, no significant differences were observed in PHI and SP at 25% and 50% FIT, compared to FIT.

In the surface-irrigation treatment, the highest yield of 2,204 lb/ac and PHI of 74% were observed for 50% FIT, while the highest SP (3.7) and PP (18) were observed for 25% FIT. The lowest yield, PHI, SP, and PP were observed for the excessive irrigation treatment (125% FIT). This is due to excess water stress, which promotes early plant maturation and yield reduction. No significant difference was observed between the values recorded for each treatment in surface irrigation.

Overall, our results indicate that for FIT, dry bean performed better under sprinkler irrigation compared to surface irrigation; however, mixed responses for yield and yield components were observed for the deficit-irrigation treatment. For both the sprinkler- and surface-irrigation treatments, dry bean did not perform well with excessive irrigation. This is an ongoing study, and for 2018 we are collecting plant biomass for additional analyses to evaluate the performance of dry bean plants with different irrigation regimes.

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Figure 1A. Dry bean mean yield (14% moisture content).

Figure 1B. Pod harvest index. PHI=(seed weight)/(seed weight + pod wall weight).

Figure 1C. Seeds per pod (SP).

Figure 1D. Pods per plant (PP).