Screening Dry Bean Genotypes for Drought Tolerance in Wyoming

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Introduction
Sustainable dry bean production in the semiarid to arid regions of Wyoming is only possible with irrigation (surface or sprinkler), as rainfall does not supply the required amounts of water for growth. In recent years, many Wyoming dry bean production areas did not receive adequate irrigation water for the complete growing season(s), and producers are not certain that they will have adequate water to grow their bean crops in future years. Thus, profitability for Wyoming dry bean producers will require genotypes having drought tolerance.

Objectives
Our objectives are to identify dry bean genotypes that are tolerant to drought under the semiarid to arid conditions of Wyoming.

Materials and Methods
The field experiments were conducted during the 2016 and 2017 growing seasons at the Powell Research and Extension Center (PREC) and James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC). This paper highlights findings from 2017 (the 2016 results are in the 2017 Field Days Bulletin, pages 46–47, available at www.uwyo.edu/uwexpstn/publications/index.html).

Our 2017 study was a split-plot arrangement with 36 and 25 genotypes replicated three times at PREC and SAREC, respectively. Treatments included well-watered (full irrigation treatment [FIT]) and drought stressed (65% FIT). Plots were sown on May 23 and June 6, 2017, at PREC and SAREC, respectively.

A drought susceptibility index (DSI) based on minimization of yield loss under stress conditions in comparison to optimum conditions was used to characterize relative drought tolerance of dry bean genotypes (see Fischer and Maurer, 1978). Low DSI values represent the cultivars that have less difference in yield between well-watered and drought treatments. To further identify the cultivars that have lower DSI numbers and higher average yields, the average yield for each cultivar was correlated with DSI and divided into four different groups. This division was made based on DSI (numbers less than 0.8) and the average yield of all the genotypes tested at PREC and SAREC (Fig. 1).

Results and Discussion
Average yield data from both drought-stressed and well-watered treatments were compared to assess the effect of water stress on dry bean yield (Table 1). For the 2017 growing season, yields for the well-watered treatments were 25% and 34% higher at PREC and SAREC, respectively, than beans in the drought treatment (average for all genotypes). The difference between well-watered and drought treatment at SAREC, in part, is due to different management practices (30-inch row spacing at SAREC vs. 22-inch row spacing at PREC) and climatic conditions. The average total seasonal precipitation and air temperature at SAREC was 0.87 inches and 01.7°F greater than PREC for the 2017 growing season. The cultivars Common Red Mexican and Poncho exhibited the highest yield at PREC and SAREC.

DSI analysis showed that genotypes CELRK, Twin Falls (originally tested under the name UIP-40), CO91216-15, CO-33176-1, Talon, and CO-14790-3 were less susceptible to drought stress as indicated by their low DSI (Group A, Fig. 1). These genotypes, however, were among the lowest-yielding cultivars under full irrigation. For the Bighorn Basin growing area, our results indicate that genotypes such as Desert Song, Medicine Hat, Powderhorn, CO-46348, and Monterrey are higher yielding and ranked as drought tolerant (DSI less than 0.8; Group B, Fig. 1). For the bean growing areas of southeast Wyoming, genotypes including Poncho, Avalanche, CO-25069-2, UI-537, and CO-91216-15 are higher yielding and drought tolerant (Group B, Fig. 1).

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Literature Cited

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**Table 1.** Dry bean average, maximum, and minimum yield (lb/ac) under two watering regimes (well-watered and dry) during the 2017 growing season at PREC (Powell) and SAREC (Lingle).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Average</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Powell, WY 2017</strong></td>
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<tr>
<td>Well-Watered</td>
<td>2320 lb/ac</td>
<td>3565 lb/ac</td>
<td>1019 lb/ac</td>
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<tr>
<td>Dry</td>
<td>1743 lb/ac</td>
<td>2521 lb/ac</td>
<td>896 lb/ac</td>
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<tr>
<td><strong>Lingle, WY 2017</strong></td>
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<td></td>
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<tr>
<td>Well-Watered</td>
<td>3244 lb/ac</td>
<td>3856 lb/ac</td>
<td>2615 lb/ac</td>
</tr>
<tr>
<td>Dry</td>
<td>2134 lb/ac</td>
<td>2884 lb/ac</td>
<td>1774 lb/ac</td>
</tr>
</tbody>
</table>

**Figure 1.** Diagram showing the distribution of dry bean cultivars based on their average seed yield (across both irrigation rates) and drought susceptibility index (DSI). Horizontal and vertical lines indicate the mean average yield for 36 and 25 genotypes tested at PREC and SAREC, respectively. DSI <0.8 was used as our arbitrary cut-off for drought tolerance. Group A: genotypes that are less susceptible to drought produce lower yields. Group B: genotypes that are relatively high yielding and also less susceptible to drought. Group C: genotypes that are high yielding and more susceptible to drought. Group D: genotypes that are less yielding and more susceptible to drought.