Irrigation Strategies that Optimize Soybean Yield and Require Less Water

Trial Objective

- Soybean deficit irrigation strategies can achieve acceptable yield potential and returns.
- Soybeans are plastic, in the sense that they can conform to their growth environment as it changes throughout the growing season.
- The objective of this study was to compare soybean products under different irrigation strategies and to identify irrigation strategies that allow for acceptable yield potential while reducing the amount of irrigation water applied.

Experiment/Trial Design

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Gothenburg, NE	Hord silt loam	Corn	Strip-Till	05/21/2022	10/06/2022	90	160,000

- This trial was set up using a randomized complete block design with a split-plot structure where irrigation strategy was the whole plot and soybean product was the subplot.
- Three soybean products were selected for this study, two 2.9 maturity group (MG) and one 3.0 MG.
- All treatments were planted in 30-inch rows.
- Irrigation was applied using a sub-drip irrigation system, which allowed each whole plot to be irrigated with a different strategy. The irrigation treatments were as follows and are detailed in Table 1:
  - » Full irrigation (FI) to maintain soil moisture above 50% depletion of plant available water
  - » 66% FI (applied 1.0 inch when 1.5 inches was applied to FI)
  - » 33% FI (applied 0.5 inch when 0.5 inches was applied to FI)
  - » 0% FI (dryland)
  - » 33% FI to R2 and 100% FI R2 to R8
  - » 100% FI to R2 and 33% R2 to R8
- The season total irrigation amounts for each irrigation strategy are illustrated in Table 1.

Rainfall amount was 6.98 inches from planting to harvest with 0.73 inches in the remainder of May, 0.31 inches in June, 4.54 inches in July, 0.45 inches in August, 0.85 inches in September, and 0.1 inches in the first few days of October.[1]

- The trial was strip-tilled on 04/14/2022 with a base fertilizer application of 29 lb/acre of nitrogen, 60 lb/acre phosphorus, 25 lb/acre sulfur, and 0.25 lb/acre zinc.
- Plots were harvested with a combine, and grain moisture content, test weight, and total weight for the plot were determined.

Unterstanding the Results

- The 3.0 MG soybean product had a higher average yield than the 2.9 MG soybean products without considering the irrigation strategy.
- There was no interaction between soybean product and irrigation strategy, meaning that the different products responded to the irrigation treatments in a similar fashion.

ENVIRONMENT

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- Table 1 illustrates the application amounts and timing of applied irrigation. Note that the transition to the R2 growth stage occurred on July 14, 2022.

Table 1. Irrigation strategy and the total amount of water associated with each irrigation strategy. Note that rainfall from planting to harvest was 6.98 inches.

Irrigation Strategy	Total Irrigation Amount (inches)	Irrigation to R2 (inches)	Rainfall to R2 (inches)	Irrigation R2-R8 (inches)	Rainfall R2-R8 (inches)
Full Irrigation	13.5	4.5	3.79	9	3.19
66% FI	9	3	3.79	6	3.19
33% FI	4.5	1.5	3.79	3	3.19
100% FI to R2, 33% FI R2-R8	7.5	4.5	3.79	3	3.19
33% to R2, 100% R2-R8	10.5	1.5	3.79	9	3.19
0% Dryland	0	0	3.79	0	3.19

- The yield from FI was not significantly different from the 66% FI treatment and the 33% FI to R2, 100% R2-R8 irrigation treatment, although the difference between FI and reduced irrigation treatments in water applied was 4.5 and 3 inches of water, respectively (Figure 1).
- This resulted in the finding that under the environmental conditions of the 2022 growing season, applying more than nine inches of irrigation water did not result in increased yields.

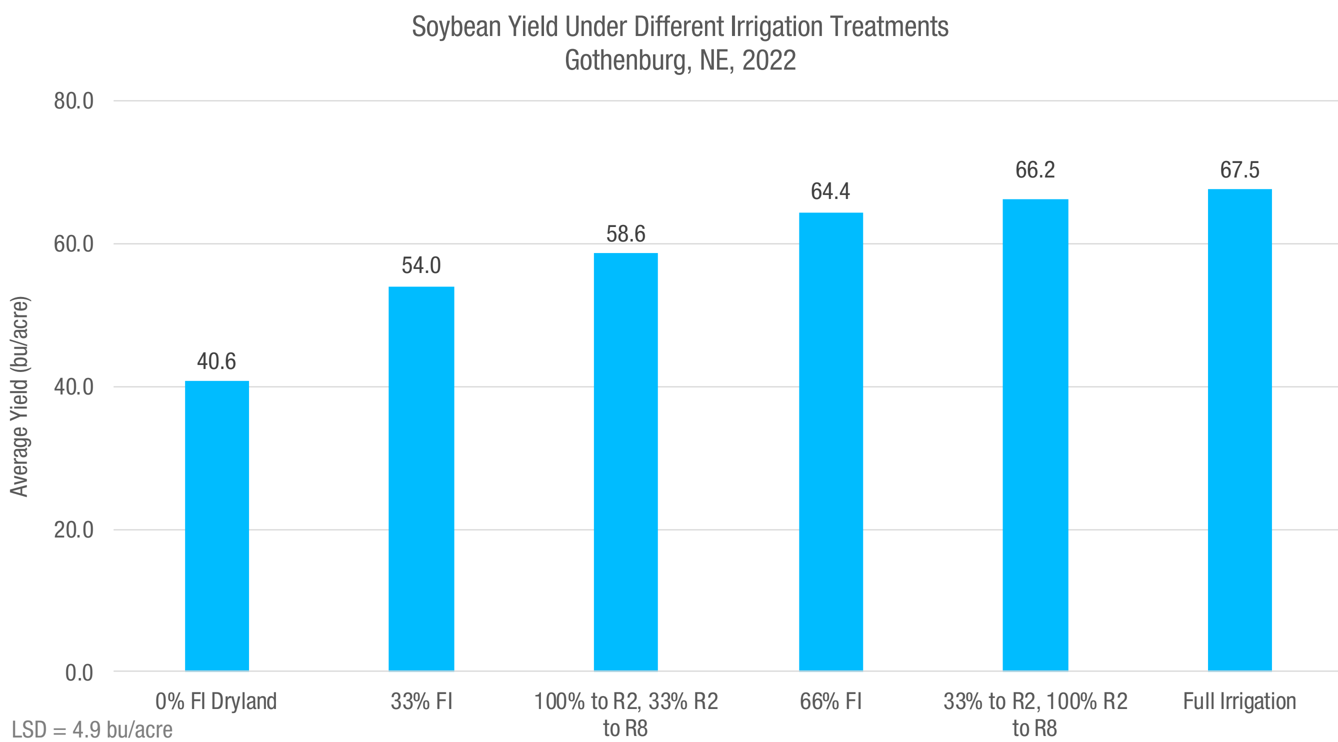

Figure 1. The average soybean yield resulting from each irrigation treatment across the three products used in this study.

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- Another way of looking at the treatments is in the economic impact of the irrigation treatments by calculating the extra dollars of return per inch or irrigation water for each treatment and the net return per acre when accounting for the irrigation cost.

Table 2: Irrigation treatment economic impacts using a soybean price of $15.00/bushel and an irrigation cost of $10.00 per acre inch.

Irrigation Treatment	Irrigation Amount (Inches)	Yield (bu/acre)	Return per inch of irrigation over previous treatment	Irrigation Cost @ $10.00 per acre inch	Net Return Per Acre accounting for irrigation cost
0 % FI Dryland	0	40.6	-	$0.00	$609.60
33% FI	4.5	54.0	$44.47	$45.00	$764.70
100% to R2, 33% R2 to R8	7.5	58.6	$23.05	$75.00	$803.85
66% FI	9	64.4	$58.10	$90.00	$876.00
33% to R2, 100% R2 to R8	10.5	66.2	$17.50	$105.00	$887.25
Full Irrigation	13.5	67.5	$6.75	$135.00	$877.50

- On average net revenue increased until 10.5 inches of irrigation was applied before revenue retreated with 13.5 inches of water applied.
- On average the 33% to R2-100% R2-R8 treatment where irrigation water was restricted in the vegetative and early reproductive growth stages and focused on the later reproductive stages had the highest net revenue.

Key Learnings

- Soybeans were able to maintain yields at acceptable levels when irrigation water was reduced from Full Irrigation.
- Water savings or 4.5 inches was achieved with season long reduction in irrigation and 3.0 inches by restricting the water early in the season (up to R2) and applying full irrigation during the later reproductive stages (R2-R8).

Legal Statements

The information discussed in this report is from a single site, replicated trial. This informational piece is designed to report the results of this demonstration and is not intended to infer any confirmed trends. Please use this information accordingly.

Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

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