



Impact of Limited Irrigation on Food Grade Corn

Trial Objective

- Producing corn suitable for snack food production can be more difficult than producing commodity corn suitable for broader markets.
- Selecting a corn product for food grade production may be limited to an approved list and often the premiums received for the grain is impacted by kernel characteristics important to snack food producers.
- This trial was developed to better understand food grade corn products in the local area and how the products respond to limited water environments in terms of yield potential and kernel quality.
- If lowering irrigation amounts has little impact on yield potential and kernel quality, that information could make it an easier decision to try reducing irrigation even to corn destined for a high-quality end use.

Experiment/Trial Design

Year	Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
2021	Gothenburg, NE	Hord silt loam	Soybean	Strip-Till	4/30/2021	11/04/2021	290	36,000

- This trial was set up as a split plot with irrigation as the whole plot-sub plot. Each treatment was replicated four times.
- Twelve corn products with either a food grade designation or listed as having high potential for a food grade designation were selected for the study.
- Irrigation was applied using a variable rate irrigation system on a linear move sprinkler programmed to provide 100%, 80%, or 60% of the crop water need per pass.
- The 100% irrigation treatment was managed conservatively so water was not over applied to the trial. A nearby moisture probe was used as well as hand probing to verify water treatments were completed correctly.
- On the season, the irrigation amounts were as follows (Figure 1):
 - » 100%: 6.0 inches
 - » 80%: 4.8 inches
 - » 60%: 3.6 inches
- Precipitation accumulation (Figure 1) was 15.25 inches on the growing season, but there was a long stretch from July 17th to August 18th with almost no precipitation. This occurred during the critical time of pollination and early grain fill, so a lack of water may have led to yield reducing stress. This was apparent in other trials at the Gothenburg Learning Center (GLC) that had dryland treatments compared to irrigated treatments.
- This trial was strip-tilled on 4/26/2021 and a base fertilizer application of 27 lbs of nitrogen (N/acre), 60 lbs of phosphorus (P/acre), 25 lbs of sulfur (S/acre) and 0.25 lbs of zinc (Zn/acre) were strip-till applied.
- An additional application of 100 lbs N/acre was broadcast with a streamer bar on 5/5/2021 and 60 lbs N/acre was applied with 360 Y-DROP® on 6/15/2021.
- Plots were combine-harvested. Grain moisture content, test weight, and total weight were determined.
- Additional information was gathered on kernel quality by hand harvesting five ears randomly from row 1 of each plot, and the ears were used to rate kernel quality. Horneous endosperm (HE), crown, and dent ratings were given to each plot and recorded for analysis.



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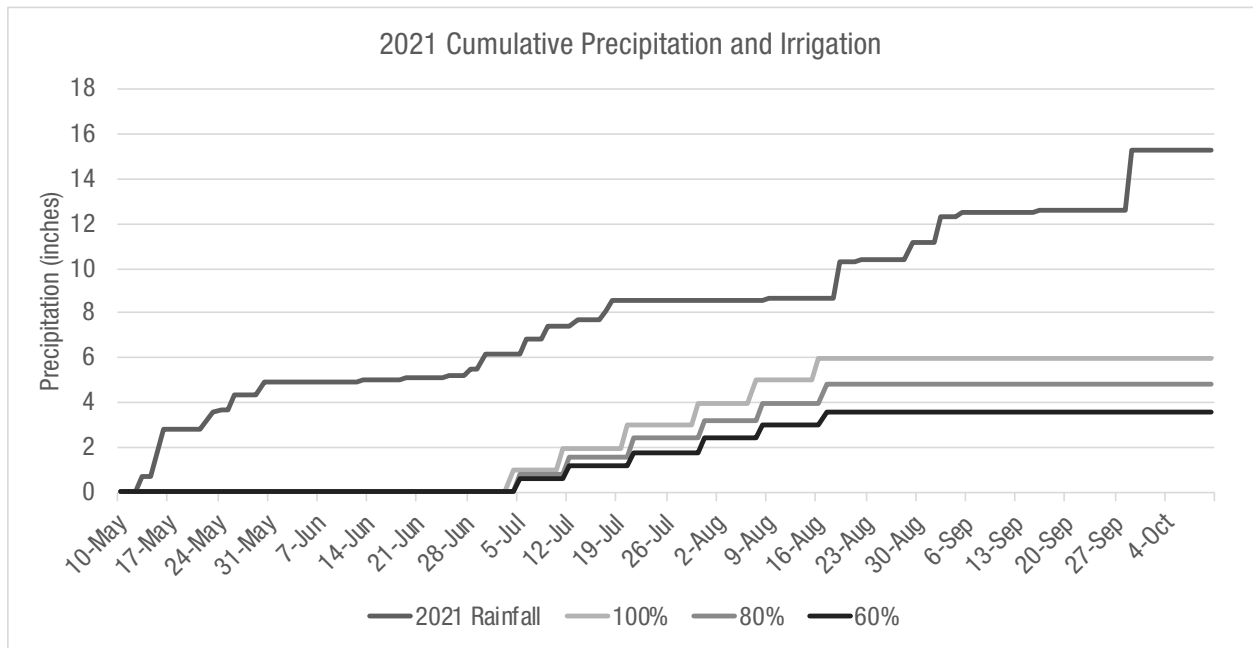


Figure 1. Precipitation and irrigation accumulation in 2021 at the Bayer Water Utilization Learning Center, Gothenburg, NE.

Understanding the Results

Corn Product Yield

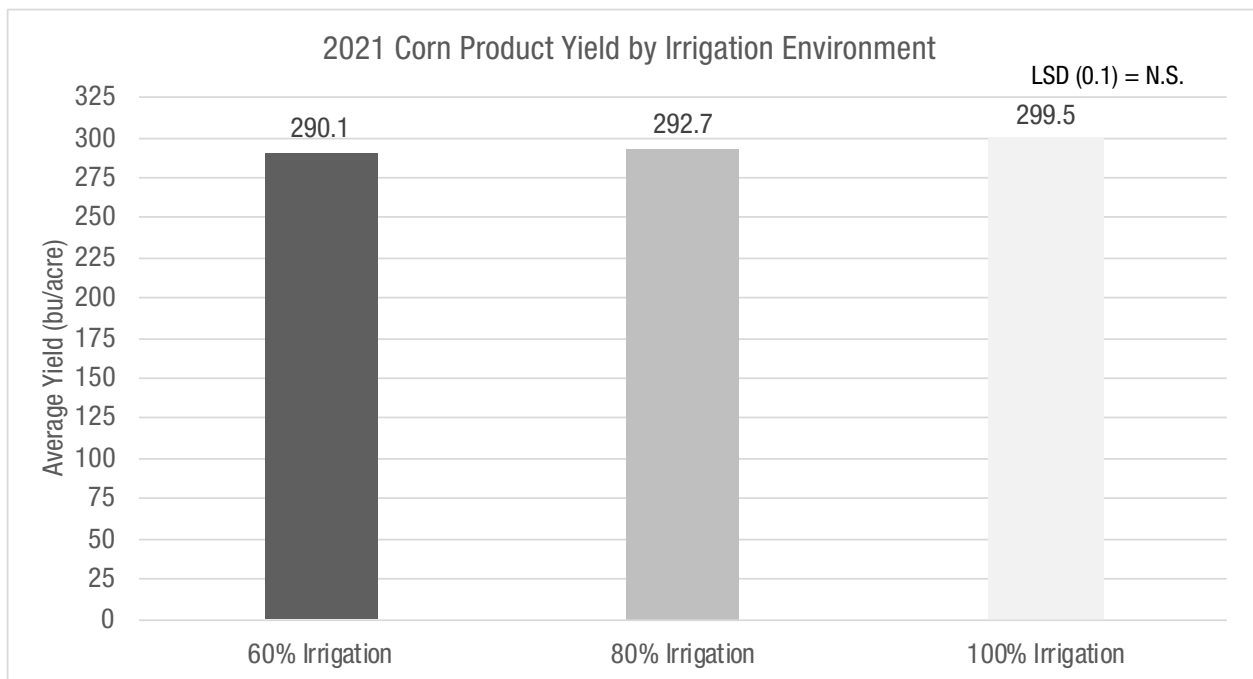


Figure 2. Average corn product yield by irrigation treatment at the Bayer Water Utilization Learning Center, Gothenburg, NE (2021).



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Table 1. Average corn yields by product and irrigation treatment and averaged across irrigation treatments at the Bayer Water Utilization Learning Center, Gothenburg, NE (2021).

Corn Product	Irrigation Treatments			Mean
	100% (6.0 in)	80% (4.8 in)	60% (3.6 in)	
	bu/acre			
105RM	294.1	275.9	271.8	280.6
106RM-A	307.0	294.6	294.8	298.8
106RM-B	308.0	295.3	297.5	300.3
107RM-A	298.8	290.3	282.2	290.4
107RM-B	298.6	291.1	286.6	292.1
108RM	290.3	288.8	286.7	288.6
111RM	292.1	281.3	275.6	283.0
113RM	293.1	284.7	294.4	290.7
114RM	312.3	312.1	304.3	309.5
115RM-A	291.5	294.0	291.7	292.4
115RM-B	304.5	306.8	299.0	303.4
116RM	303.8	297.9	297.0	299.6
LSD (0.1)	-----N.S.-----			8.57

- The average corn yield across irrigation environments (Figure 2) did not significantly change although there was a trend toward lower average yields as irrigation amounts were reduced.
- When yields were evaluated by corn product (Table 1), there were differences between corn products.
- Minor yield and yield stability variation was observed in the corn products when the irrigation amount was reduced, but the differences were not statistically significant.

Grain Characteristics

- Some grain characteristics are difficult to evaluate with the combine, but they are important to snack food end users.
- The dent rating (Figures 3 and 4), crown rating (Figure 5), and horneous endosperm rating (Figure 6) were evaluated with hand harvested ears on a rating scale from 1 to 9 where 1 is the most desirable.



Figure 3. Kernels on a corn ear displaying very shallow, rounded dents to almost no dent, which is desirable for food grade use. This ear was rated a 3 for dent.



Figure 4. Kernels with a dent score of 7. Note the deep dents in the kernel tops and wrinkles in some of the dents. This is less desirable for some food grade uses.



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Figure 5. Kernels with different crown scores. Note the upper kernels with a crown score of 2 where it is difficult to detect a crown on the kernel. The lower kernels have a crown score of 6 where the lighter colored crown of the kernel is clearly visible. A larger crown on the kernel is less desirable.



Figure 6. Two kernels with different horneous endosperm (HE) ratings when split. HE is the hard starch portion of the kernel while the soft endosperm is white floury starch that also makes up part of the kernel. A lower rating indicates more HE and a more desirable kernel for snack food processors.

Table 2. Grain characteristic measurements and ratings by irrigation treatment at the Bayer Water Utilization Learning Center, Gothenburg, NE (2021).

	Grain Characteristics				
	Grain Moisture	Test Weight	Crown Rating	Dent Rating	Horneous Endosperm
Irrigation	%	lbs/bu	1-9	1-9	1-9
100%	15.1	59.7	4.4	4.5	4.8
80%	14.6	58.6	4.3	4.3	4.5
60%	14.9	59.6	4.5	4.6	4.6
LSD (0.1)	-----N.S.-----				

- Like the average yield results of this trial, the irrigation treatment had no impact on characteristics like grain moisture and test weight at harvest. There was only about a 0.5% change in grain moisture across treatments and only a little more than a pound per bushel of variation in test weight.
- The crown, dent, and HE ratings were also not significantly changed by the irrigation treatment indicating that the amount of irrigation water did not impact processor acceptability for the rated characteristics. Grain moisture was higher in the longer maturity products at harvest with the 114 relative maturity (RM) through 116 RM products in the 16-17% range while all products 113RM and under were 15% or lower.
- Test weight did not differ significantly between corn products.
- The crown dent and HE ratings differed between corn products with all ratings 6 or lower showing products of consistent high quality for food grade uses.



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Table 3. Grain characteristic measurements and rating by products at the Bayer Water Utilization Learning Center, Gothenburg, NE (2021).

Product	Grain Characteristics				
	Grain Moisture	Test Weight	Crown Rating	Dent Rating	Horneous Endosperm Rating
	%	lbs/bu	1-9	1-9	1-9
105RM	13.5	59.6	6.0	5.8	5.1
106RM-A	14.2	59.0	5.3	5.3	5.2
106RM-B	14.8	60.2	4.2	4.3	4.2
107RM-A	14.2	59.9	5.8	5.4	5.7
107RM-B	14.4	60.1	4.3	4.3	4.7
108RM	14.1	60.5	3.5	3.5	3.6
111RM	14.1	60.1	5.0	5.5	5.7
113RM	15.0	58.8	2.9	3.3	4.2
114RM	16.3	59.6	4.3	4.8	4.5
115RM-A	17.1	60.0	2.7	2.6	3.3
115RM-B	16.2	60.2	4.7	4.9	5.1
116RM	16.1	59.8	3.9	3.8	4.3
LSD (0.1)	0.93	-----NS-----	0.56	0.52	0.60

Key Learnings

- Irrigation did not significantly impact corn yield or grain quality characteristics at the irrigation levels present in this trial.
- This indicates that lowering irrigation levels across these corn products, if necessary, may be possible without impacting the grain quality characteristics.
- However, there are limits to this, at least on the yield side, as the 2021 dryland treatments at the Gothenburg Learning Center in similar research yielded significantly lower than the treatments with six inches of irrigation or more.
- Adding a dryland or very limited irrigation treatment to this test could be interesting to see if there is a point where grain quality for food-grade purposes starts to drop off.
- This research continues as we strive to increase water use efficiency by decreasing the total amount of water applied while maintaining high yield potential and food grade corn quality.

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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