PROJECT REPORT

Field Evaluation of Aluvio Precision Irrigation Scheduling

Growing season: 2024

Location: South Central Ag Lab
Clay Center, NE

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Executive summary

A field study was conducted in south-central Nebraska in 2024 to evaluate the performance of the Aluvio Precision Irrigation Scheduling tool and to compare it with the performance of Watermark soil tension sensors that have been historically used by local growers. Three Aluvio treatments and two Watermark (WM) treatments were studied (5 total), with each approach including one deficit irrigation treatment. Full irrigation treatments included Aluvio-1, Aluvio-3, and WM-1, while deficit irrigation treatments were Aluvio-2 and WM-2. For the full irrigation treatments, Aluvio-1 and Aluvio-3 resulted in 8.15 and 7.60 inches of seasonal irrigation application, respectively, smaller than the average irrigation for WM-1 (8.75 in). Aluvio-2, which was designed to apply 70% of full irrigation, resulted in 5.65 inches of seasonal irrigation, while WM-2 (the other deficit irrigation treatment) resulted in 4.38 inches of total irrigation.

Grain yields for the three Aluvio treatments ranged from 251.2 to 251.6 bu/ac. This suggests that the 70% irrigation applied to Aluvio-2 was adequate. The yield of the WM-1 was 254.4 bu/ac. The slightly larger yield than Aluvio treatments was not statistically significant. The average yield of similar corn hybrids planted within the 25-mile radius of the study site and reported by Bayer Crop Science was similar, confirming that our yield was comparable to what was achieved by local growers. The average yield of the WM-2 treatment, which received the smallest irrigation, was 239.5 bu/ac. The difference between this yield and the yield of Aluvio-1, Aluvio-3, and WM-1 was statistically significant.

Site description

The project was conducted at the South-Central Agricultural Laboratory (SCAL), located in Clay County in south-central Nebraska. With over 100 field research trials per year, SCAL is dedicated to developing and refining irrigated crop production practices. The total area of irrigated research fields at SCAL is about 600 acres. These fields are irrigated by different irrigation systems, including surface (furrow), subsurface drip, linear move, and center pivot. The Lab is strategically located in the state. Approximately 80% of the registered irrigation wells in Nebraska are within a 75-mile radius of the lab. As a result, research findings of projects conducted at SCAL receive a great deal of attention from local irrigators. Additionally, field days and other extension events at SCAL usually attract a large number of stakeholders. The soils at SCAL are mostly Crete and Hastings silt loam soils with deep profiles and large water holding capacity. The normal (1991-2020) annual precipitation at SCAL is about 30 inches (760 mm).

The experiment

Evaluation of Aluvio Precision Irrigation Scheduling tool was conducted under a two-span linear move system (T-L Irrigation, Hastings, NE). The system is equipped with variable rate

technology, which allows for irrigating 12 different zones along the length of the lateral. Each zone is about 20 ft wide, with 4 sprinklers (model Orbitor by Nelson Irrigation, Walla Walla, WA) per zone. To minimize the edge effects, each research plot in this study consisted of two zones (see Figure 1).

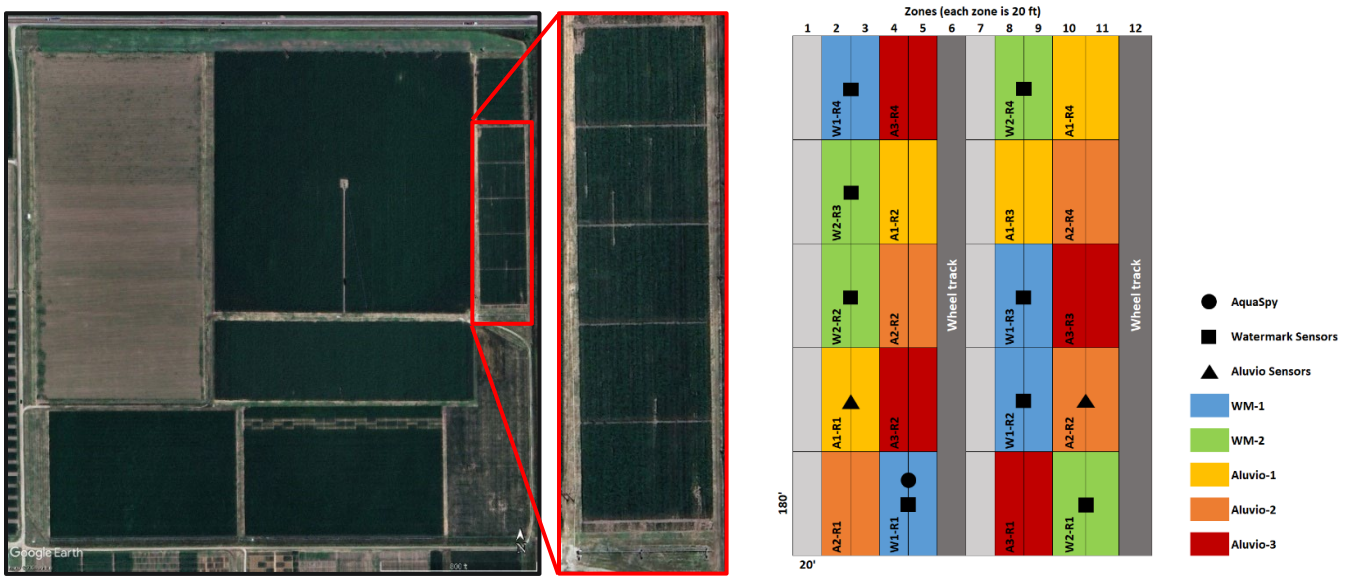

Figure 1. Google Earth map of the South-Central Ag Lab and a zoomed in map of the study field (Left), and the experimental layout (right). The aerial imagery of the maps on the left was captured in June 2024.

The irrigation treatments were based on two different technologies: the Aluvio Precision Irrigation Scheduling and the Watermark sensors installed at 1, 2, and 3 feet below the soil surface. Scheduling based on the Watermark sensors was included because this is the most common method of irrigation scheduling in the region after traditional scheduling based on the condition of crop and feel of soil. Nebraska has been historically a leader in sensor-based irrigation scheduling. The local Natural Resource Districts offer cost-share for purchasing and installation of Watremark sensors. Additionally, UNL extension efforts have focused on the use of Watermark sensors and the appropriate thresholds for triggering irrigation events. The irrigation treatments, each replicated 4 times, included

- Aluvio-1: standard recommendation of Aluvio for 100% irrigation
- Aluvio-2: standard recommendation of Aluvio for 70% (deficit) irrigation
- Aluvio-3: a new recommendation of Aluvio based on remotely sensing data only
- WM-1: irrigate when the average reading reaches 60 cb
- WM-2: irrigate when the average reading reaches 80 cb

Corn (Dekalb DKC61-40RIB) was planted at the research field on May 12, 2024, at the seeding rate of 32,100 seeds/acre. Row spacing was 30 inches, resulting in 16 rows of corn per research plot. Fertilizer application included one pre-plant application of 220 lb-N/acre (32-0-0 UAN). The sensors (Aluvio or Watermark) were installed in the middle of research plots. All

plots were harvested on October 21, 2024, using a plot combine. The yield of the center 4 rows was used in the analysis to avoid edge effects. All yield estimates were converted to the same grain moisture content of 15.5%.

During the season, the UNL team worked with the Aluvio team in Nebraska (Dan Davidson) and Brazil (Luis Pedro Saccol Fros) to understand the recommended irrigation prescriptions and to implement them as accurately as possible. Most irrigation events applied to Aluvio plots took place on the same day they were recommended by Aluvio. For a few cases, the actual irrigation date was one day off, due to the recommendation falling on a weekend or last-minute changes to the recommendation. The seasonal irrigation amounts were 8.15, 5.65, and 7.60 inches for Aluvio-1, Aluvio-2, and Aluvio-3 treatments, respectively. Aluvio-2 received 69% of the water applied to Aluvio-1, as designed. Aluvio-3, which was just based on satellite data, received 93% of the water applied to Aluvio-1. All replicates in the same Aluvio treatment received the same amount of water, but the replicates of Watermark treatments each received a unique irrigation amount since we had sensors in each Watermark plot. The ranges of seasonal irrigation amounts were 7.50-10.00 inches for the replicates of Watermark-1 treatment and 2.50-6.25 inches for the replicates of Watermark-2 treatment. Figure 2 presents the cumulative irrigation applied to each treatment during the study period (2024). As it can be seen, the first irrigation applied to Watermark treatments was about two weeks after the first irrigation recommended by Aluvio.

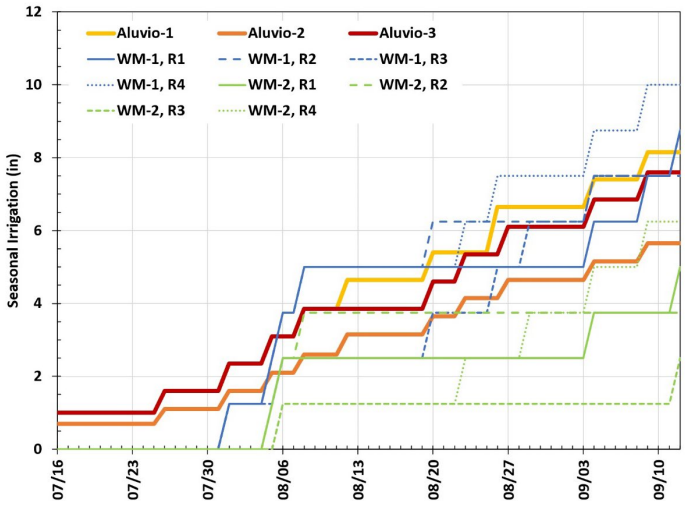

Figure 2. Cumulative irrigation depth.

Results

Crop growth

The growth and condition of the crop were monitored during the growing season by conducting weekly site visits. The growth stage was determined and documented during each visit. In addition, a UAV (Inspire 1, DJI, Shenzhen, China) was used four times during the season to collect multi-spectral imagery over the research plots. Figure 3 demonstrates maps of Normalized Difference Red Edge (NDRE) index for the field on July 8th, July 18th, August 15th, and August 30th. The general growth of corn and some differences among plots can be observed in these maps.

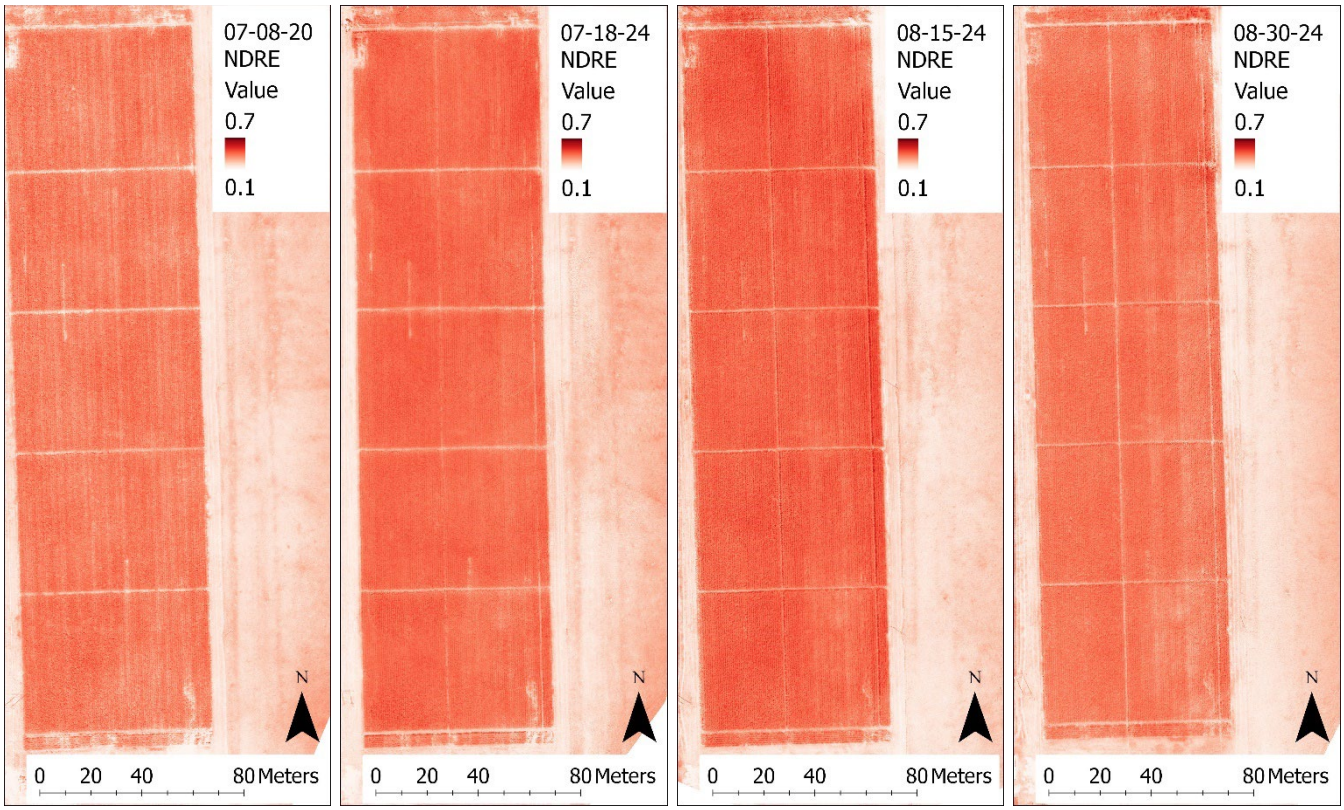

Figure 3. Maps of NDRE index generated using multispectral cameras on a UAV.

In addition to field visit and UAV imagery, leaf area index (LAI) was measured at two growth stages of R1 and R6 for all research plots using destructive sampling of plants. For the first measurement date (R1 stage), Aluvio-1 had the largest average LAI of 4.13, followed by the LAI of WM-1 (4.08), Aluvio-3 (3.91), Aluvio-2 (3.70), and WM-2 (3.58). These differences we consistent with our field observations, and expected, since they were strongly correlated with the amount of irrigation water applied. As the crop went into senescence on the second measurement date (R6 stage), all LAI values dropped to about one (ranging from 0.90 to 1.08).

Yield

The measured yield was similar among all treatments, except for the WM-2 treatment that received the smallest amount of irrigation. The average yield was 251.6, 251.5, and 251.2 bu/ac for Aluvio-1, Aluvio-2, and Aluvio-3 treatments, respectively. The average yield was 254.4 bu/ac for WM-1 and 239.5 bu/ac for WM-2. Statistical analysis revealed that the differences between the yield of WM-2 and all other treatments except for Aluvio-2 (70% irrigation) were significant. Although the yield of WM-2 was significantly lower than most other treatments, it should be noted that the yield reduction was smaller than the reduction in applied irrigation. Compared to the WM-1 treatment, WM-2 had 6% lower yield at 50% smaller seasonal irrigation amount.

The yields obtained in this study were similar to the yields reported by local producers. According to Bayer Crop Science, the reported irrigated yields of their DEKALB® products (same as this study) in the region within the 25-mile radius of SCAL ranged from 236.5 to 287.0 bu/ac in 2024. Yield results are summarized in the below table and figure.

Table 1. Average yield of irrigation treatments converted to a standard grain moisture content of 15.5%.

Treatment	Yield (bu/ac)
Aluvio-1	251.6 [a]
Aluvio-2	251.5 [ab]
Aluvio-3	251.2 [a]
WM-1	254.4 [a]
WM-2	239.5 [bc]

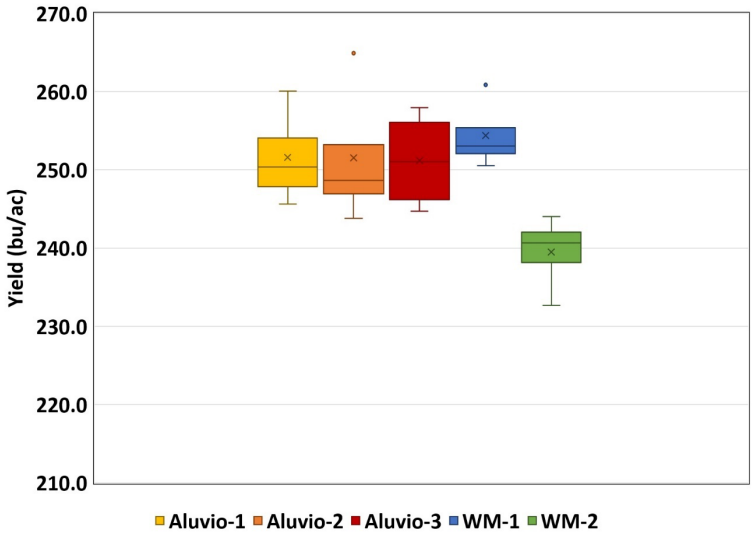

Figure 4. Boxplots of measured yield for each treatment.

The average yield of dryland (no irrigation) corn at SCAL for the same hybrid and same row spacing was 180 bu/ac in 2024. Based on this, we can estimate the Irrigation Water Productivity (IWP) as the yield increase that was achieved compared to the dryland yield because of irrigation application. The value of IWP was 8.8, 12.7, 9.4, 8.5, and 13.6 bu/ac per inch of applied irrigation water for Aluvio-1, Aluvio-2, Aluvio-3, WM-1, and WM-2 treatments, respectively. As expected, irrigation water productivity was larger for deficit irrigated treatments.

Supplemental data

Table S1. Irrigation application depths (inches).

	Aluvio-1	Aluvio-2	Aluvio-3	WM-1, Rep 1	WM-1, Rep 2	WM-1, Rep 3	WM-1, Rep 4	WM-2, Rep 1	WM-2, Rep 2	WM-2, Rep 3	WM-2, Rep 4
07/16/24	1.00	0.70	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07/26/24	0.60	0.40	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08/01/24	0.75	0.50	0.75	1.25	1.25	1.25	1.25	0.00	0.00	0.00	0.00
08/05/24	0.75	0.50	0.75	1.25	1.25	0.00	1.25	1.25	1.25	0.00	0.00
08/06/24	0.00	0.00	0.00	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
08/08/24	0.75	0.50	0.75	1.25	1.25	0.00	1.25	0.00	1.25	0.00	0.00
08/12/24	0.80	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08/20/24	0.75	0.50	0.75	0.00	1.25	1.25	0.00	0.00	0.00	0.00	0.00
08/23/24	0.00	0.50	0.75	0.00	0.00	0.00	1.25	0.00	0.00	0.00	1.25
08/26/24	1.25	0.00	0.00	0.00	0.00	1.25	1.25	0.00	0.00	0.00	0.00
08/27/24	0.00	0.50	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08/29/24	0.00	0.00	0.00	0.00	0.00	1.25	0.00	0.00	0.00	0.00	1.25
09/04/24	0.75	0.50	0.75	1.25	1.25	1.25	1.25	1.25	0.00	0.00	1.25
09/09/24	0.75	0.50	0.75	1.25	0.00	0.00	1.25	0.00	0.00	0.00	1.25
09/12/24	0.00	0.00	0.00	1.25	0.00	1.25	0.00	1.25	0.00	1.25	0.00
Sum	8.15	5.65	7.60	8.75	7.50	8.75	10.00	5.00	3.75	2.50	6.25

Table S2. Measured yield (bu/ac) of each research plot converted to a standard grain moisture content of 15.5%.

	Aluvio-1	Aluvio-2	Aluvio-3	WM-1	WM-2
Rep. 1	248.6	264.9	244.7	260.9	232.7
Rep. 2	245.6	248.0	258.0	250.5	240.0
Rep. 3	252.1	249.4	255.4	253.5	241.4
Rep. 4	260.1	243.8	246.7	252.6	244.0
Avg.	251.6	251.5	251.2	254.4	239.5