Virginia Corn Board 2nd Year Report and Proposal

Title: **Evaluation of Subsurface Drip Irrigation in Virginia Corn Production**

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2nd Year Results for 2022 SDI in Virginia Corn

Executive Summary

Overall the 2023 growing season at the Tidewater AREC was an average rainfall year for corn and irrigation differences were lower between non-irrigated plots and irrigated plots for the study. Yields across the sites were lower on average compared to 2022 and this may be due to pre-emerge herbicide injury and/or starter fertilizer burn in 2023. However, no definitive answers were found for early season yellowing/chlorosis of lower leaves and slow growth. Despite the poor growth early in the growing season and significant rainfall that occurred and irrigation response was observed during the 2023 study. There was also a very positive response to the biological product, Pivot Bio® during 2023.

Weather Conditions and SDI Capabilities

Corn grain yield suffered as a result of moderate to severe drought in 2022, given that normal rainfall for Suffolk, VA from May through August is 19 - acre inches and measured rainfall at the study location was 9.5 - acre inches for the same period in 2022 (Fig. 1). The total rainfall during 2023 approached that of SDI plus rainfall in 2022 with a total precipitation

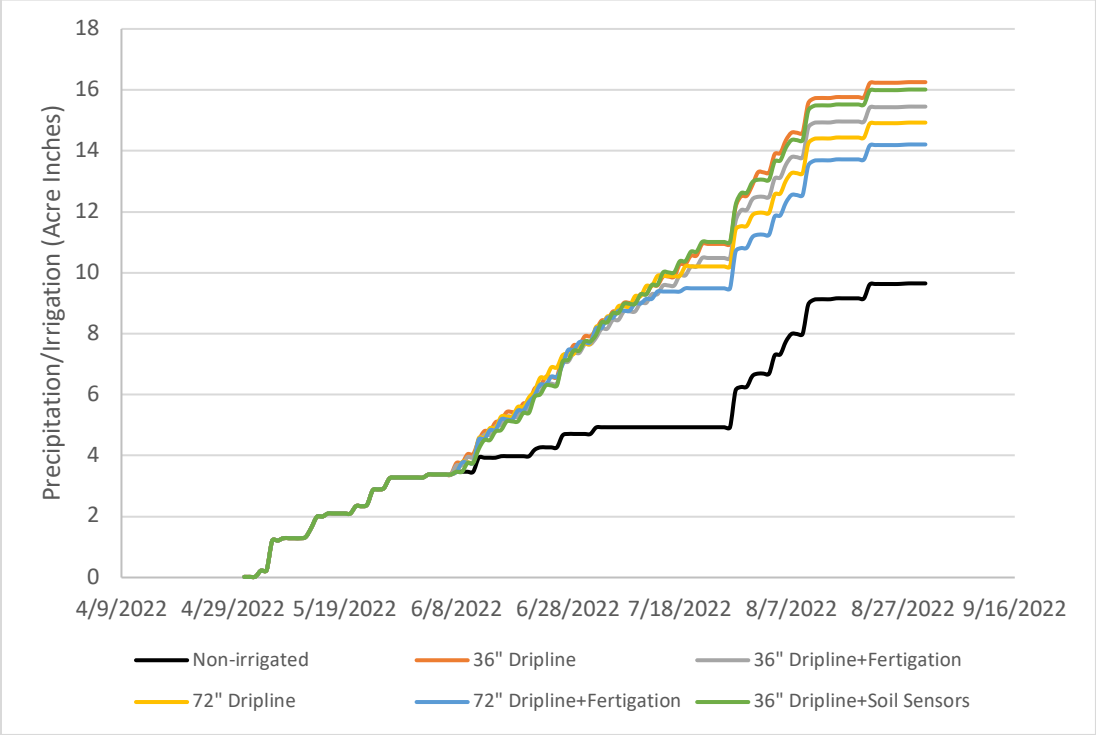

Fig. 1: Precipitation and SDI irrigation quantities at the study location from May 1, 2022 – August 31, 2022.

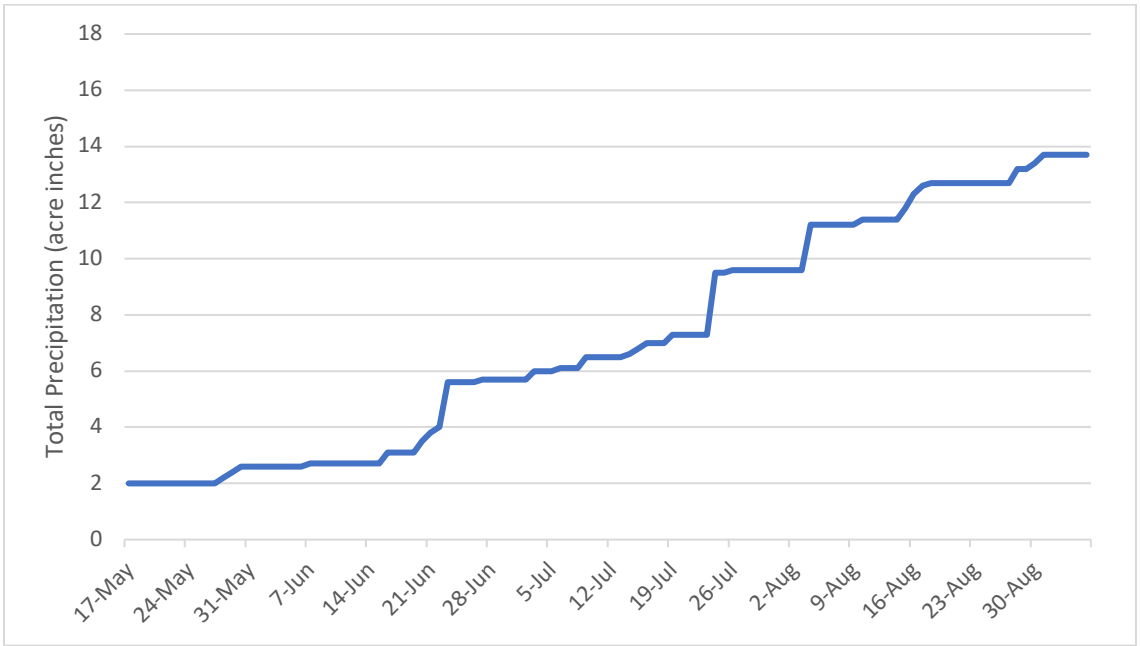

Fig. 2: Cumulative precipitation quantities during the 2023 growing season from May 18, 2023 – September 9, 2023.

Fig. 3: Drought stress observed in corn at the TAREC SDI study location on June 15, 2022 with non-irrigated corn on the left and SDI irrigated corn on the right.

inch dripline system needs to run twice as long. This substantially limits the amount of irrigation you can apply in a given amount of time. Given the need to apply irrigation water for all six irrigation treatments days were alternated between 36-inch dripline spacing and 72-inch dripline spacing treatments. If only the 36-inch dripline spacing was used then up to 2-acre inches of water could be supplied per week with the system. The maximum quantity of water applied in a week for the 2022 trial was 1.25-acre inches. Once corn reached tasseling the quantity of applied water was increased to the maximum from a rate of 0.9-acre inches from early June to the second week of July. However, even with the SDI system, regardless of dripline spacing, it still did not reach the average precipitation of 19-acre inches from May 1st through August 31st. The system was originally designed to meet the requirements for supplement irrigation in cotton, however if amount of

amount of 13.7 acre inches. Irrigation quantities were logged in 2022, though the Netafim portal to access the irrigation log has not been active and we are working with Netafim to access the portal to download that data. It should be noted that duration of irrigation was increased from VT to blacklayer in 2023 to increase the total irrigation quantity applied. During that timeframe an estimated 1.2 – 1.4 acre inches were applied weekly except in the sensor irrigation treatment which was reduced or no irrigated during frequent rainfall events. Only minor effects of drought were observed periodically during 2023 and were not prolonged as those observed in 2022 (Fig. 3).

Another key difference in study location is the soil difference from one end of the field to the other. Figure 4 are from the soil sensor data collected during the growing season with the top graph being in the sandier area (loamy sand) of the field and the bottom graph placed in the heavier soil (sandy loam). In the sandier area of the field soil moisture dropped below 5% even at the 16-inch depth at multiple points during the growing season. Whereas the heavier textured soil only the 8-inch depth dropped below the 10% soil moisture mark during the growing season (Fig. 4). The sandier soil was predominantly in the third replication of the study and produced markedly lower corn yields in 2022 and 2023. Though average corn yields in both years of the study were greater than 150 bushels per acre across all replications. An interesting observation is that the individual irrigation events cannot be observed from the soil moisture data though on the top graph it seems that the irrigation events were increasing soil moisture at the 20-inch depth over time compared to other depths. This may be due to the presence of a hard pan in that soil type. Rainfall events are very evident during the 2023 growing season (Fig. 4).

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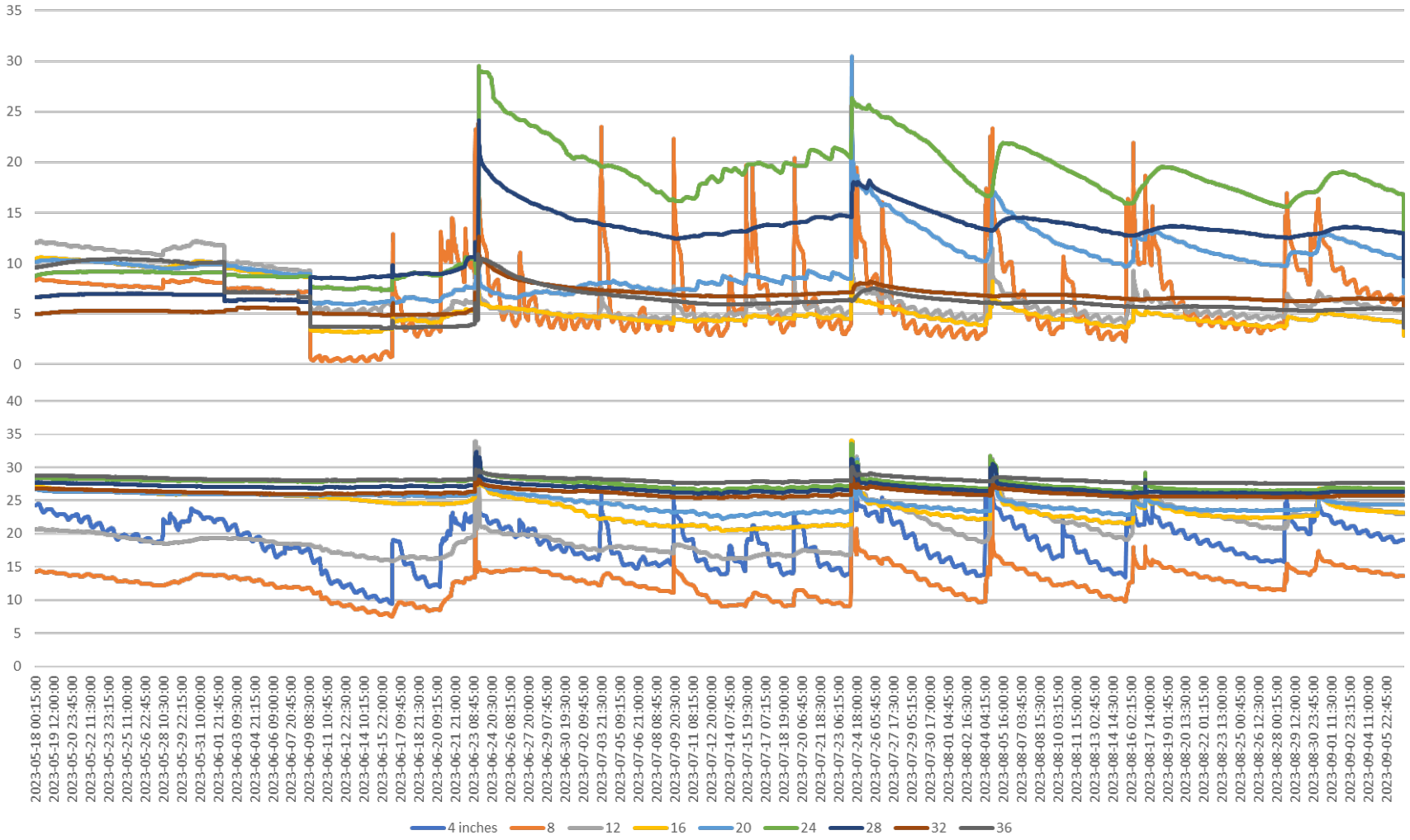

Fig.4: Volumetric soil water content at depths from 4 to 36 inches and from May 18, 2023 – September 5, 2023 at the SDI study site for two sections of the field for a loamy fine sand (TOP) and sandy loam (BOTTOM).

Corn Grain Yield and SDI Performance

The corn hybrid selected for the study was Dekalb 65-20 and was selected based on results and performance in the Virginia corn OVT program. Corn grain yields ranged from 137 – 196 bushels per acre in the 2023 study compared to a range of 97 – 213 bushels per acre in 2022. The slightly lower corn yields could be due to early season stress possibly due to herbicide injury and or cool wet weather during the month of May in 2023. Similar to 2022, there were population, irrigation and nitrogen rate differences observed during 2023. A change to the 2023 was the dropping of the 72" dripline spacing with fertigation to add the biological treatment, Pivot Bio ProveN40 product to the trial with 36" dripline spacing. Overall difference in the 2023 study followed the same trends observed in 2022.

For the effect of plant population there were differences with the 24,000 plants per acre seeding rate have the lowest average grain yield of 156 bushels per acre and was significantly lower than the grain yield for a 36,000 plants per acre seeding rate with a grain yields of 170 bushel per acre. However, 24,000 seeds per acre was not different from the 30,000 or 42,000 plants per acre during the 2023 study. The higher average grain yield of the 24,000 seeding rate in 2023 can be attributed to the higher precipitation where as the 36,000 seeding rate was 17 bushels per acre lower than in 2022. There was no interaction of seeding rate and irrigation during the 2023 study as observed in the 2022 study.

The effect of irrigation was significant in the 2023 study though the 36" dripline spacing with a full soil fertility program applied had significantly higher grain yields compared to the non-irrigated system with 178 and 147 bushels per acre, respectively (Fig. 5). The 72" dripline spacing produced slightly lower yields than the narrower dripline spacing and was similar to the findings in the 2022 study. The irrigation plus fertigation again was lower in grain yield than the

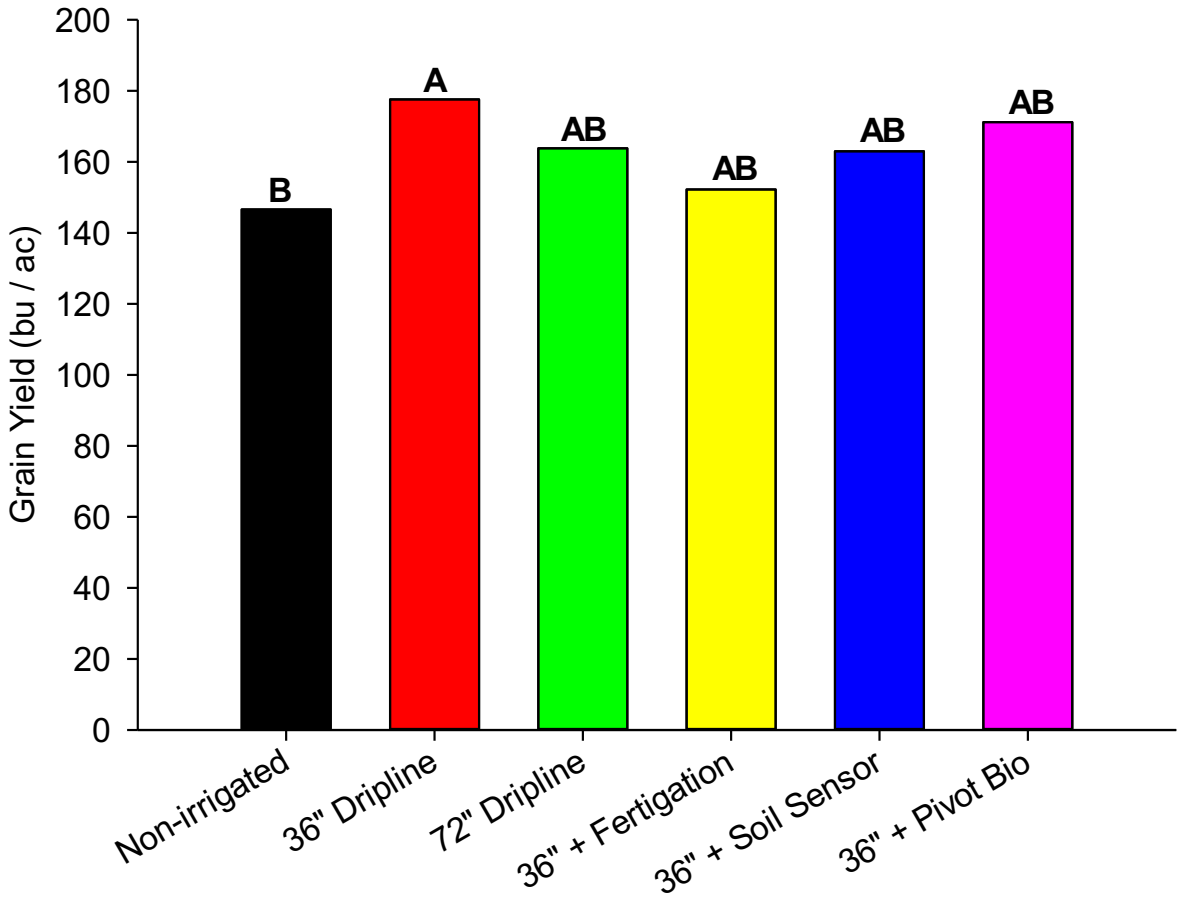

Fig. 5: Corn grain yield across irrigation strategies for the 2023 SDI irrigation study. Columns with the same letter are not significantly different at alpha = 0.1.

conventional fertility system, which may be indicative that the nutrients are not be taken up when applied through the SDI system, due to a number of reasons such as placing nutrient too deep in the soil profile or not available when the corn needs the nutrients (Fig. 5). The soil sensors were slightly lower in grain yield across nitrogen application rates and seeding rates during the 2023 study though statistically the same of the 36" dripline spacing. The one surprise for the 2023 study was the performance of Pivot Bio's Proven N40 in-furrow inoculant which had the closest grain yield to the 36" dripline spacing with 171 bushels per acre compared to 177 for the 36"

dripline spacing (Fig. 5). This was interesting as the ProveN40 treatment received 40 lb N less than other irrigation strategies due to the claim that the material can provide up to 40 lb N per acre to a corn crop. The positive result is that in a sandy soil with low organic matter and N mineralization that this treatment performed the closest to recommended N fertility program is promising moving forward. Though this is one year of data and needs to be repeated in order to be verified.

Across nitrogen application rates, grain yields again differed in 2023 and ranged from 139 – 176 bushel per acre from 120 – 300 lb N per acre, respectively. Although these are the averages across irrigation strategies and seeding rates for the study. There was a nitrogen application rate and irrigation interaction strategy during the 2023 study (Fig. 6). When comparing across irrigation strategies yields ranged from 137 to 196 bushels per acre with 36" dripline spacing having the highest yields and greatest nitrogen application rate response during the 2023 study (Fig. 6).

Conclusion from 2023

Overall, grain yields were lower during 2023 compared to 2022 study though precipitation was higher throughout the growing season. However, the 36" dripline spacing still offered a 31 bushel per acre increase over the non-irrigated treatments and the irrigated treatments still averaged 19 bushels more than the non-irrigated corn. With corn prices hovering around $5 per bushel that's an economic return ranging from $95-155 per acre using SDI system. The goal of reaching 300 bushels per acre was not achieved in 2023, though it was only the second time ever using SDI to irrigate corn ever in the state so there is a learning curve. For the 2024 study, there has been a small grain cover seeded to the site in hopes of removing carryover

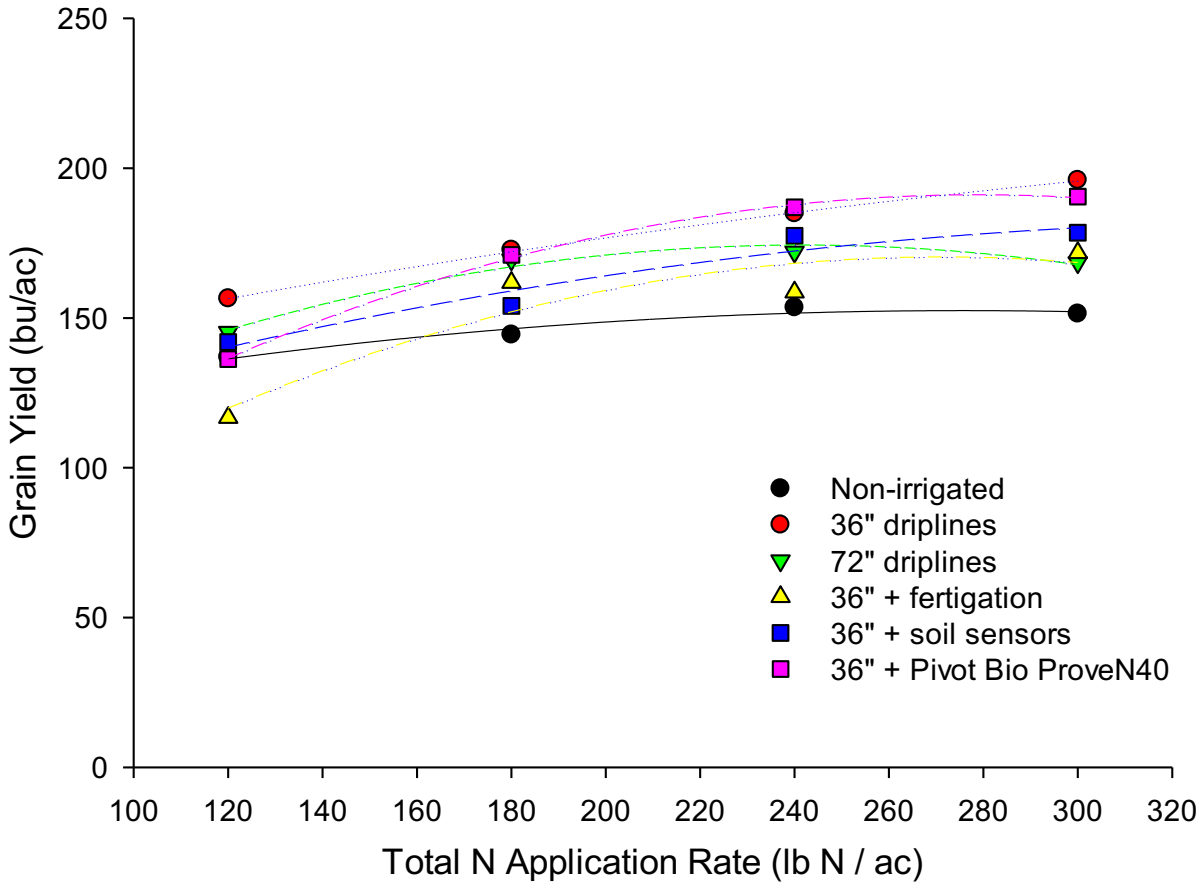

Fig. 6: Grain yield response across nitrogen application rates and irrigation strategies for the 2023 study.

nitrogen and pre-plant and at-planting herbicide will be applied by the field crops agronomy program to ensure injury will occur in 2024. The one bright result from the 2023 study was the performance of the Pivot Bio ProveN40 product and the possibility of reducing nitrogen application rates with a biological in-furrow product in the future. However, these results must be tested across space and time to be verified.

Third Year Funding Proposal

The objectives of this proposal are to:

1. **Quantify the effect of subsurface drip irrigation (SDI) strategies on corn grain yield in Virginia**
2. **Evaluate the impact of seeding rate and nitrogen application rate on corn grain when applied in conjunction with SDI.**
3. **Evaluate the performance of Pivot Bio ProveN40 on corn grain yield**

Materials and Methods

The study will be conducted at the Tidewater AREC in Suffolk, VA on the 3.5-acre SDI system. There will be a total of 96 treatment combinations arranged in a split-split plot design with three replications of each treatment. The whole plots will be the SDI irrigation strategies which will include: no irrigation, 36-inch dripline spacing, 72-inch dripline spacing, 36-inch dripline spacing + fertigation, 36-inch dripline spacing + Pivot Bio's ProveN40, and 36-inch dripline spacing scheduled with soil volumetric moisture sensors. Volumetric soil sensors will be leased from John Deere and record soil moisture at 4-inch depth increments down to depths of 36 inches during the growing season. Driplines for the system are at a depth of 10-inches below the soil surface. All other irrigation will be scheduled using a checkbook method based on corn water use with growth stages.

Within each irrigation strip, sub-plots will be assigned seeding rates of 24,000, 30,000, 36,000, and 42,000 seeds per acre. Seeding rates will applied in blocks 8-rows wide by 57 feet in length. This range in seeding rates represents the normal seeding rates for corn production in Virginia and has one seeding rate above a one above the optimum range. The corn hybrid

selected for the trial will be based on 2021 corn OVT program results from grain crops research program.

The sub-sub plots will be treated with varying nitrogen (N) application rates and will be 4-rows in width and 25 feet in length. The chosen N application rates are 120, 180, 240, and 300 lb N per acre. Nitrogen will be applied in two applications, except for the fertigation irrigation regimes where N will be applied via irrigation water through the driplines. At planting 40 lb N will be applied in a 2X2 starter band at planting and the remaining N will be applied at V5-V7 as a single application utilizing a N injection applicator. For the fertigation strips, 80 lb N will be applied over a 8 week period with 10 lb N per week. The remaining N will be applied in a single side-dress application at V5-V7. An example would be 180lb N per acre, would have 40 lb N at planting, 80 lb N applied through driplines over 8 weeks and 60 lb N applied V5-V7 growth stage. All other nutrients will be applied based on soil test results and based on Virginia Cooperative Extension recommendations.

At VT stage of development, corn ear leaf samples will be collected from each plot to ascertain the nutrient status during the growing season. As well as in-season measurements to be taken will be aerial images taken via UAV platform outfitted with a Micasense Altum multispectral camera. Using this platform Normalized Difference Vegetative Index (NDVI) and Normalized Difference Red Edge Index (NDRE) will be calculated at tasseling and black layer.

The center two rows of the four row plots will be harvested for yield using a Zurn 150 small plot combine outfitted with a Harvestmaster Classic Graingauge. Grain yields will be reported at 15.5% moisture at 56 lb/bu test weight. Data will be analyzed at split-split plot design using PROC GLIMMIX in SAS 9.4 (SAS Institute, 2012). Linear regression analyses in Sigma Plot 12.5 will be used to determine impact of seeding rate and N application rates on grain yield.

The Tukey-Kramer mean separation will be used to analyze difference in irrigation strategies and an alpha level of 0.1.

Expected Outcomes

1) Sustain corn grain yields in excess of 300 bushels per acre while maximizing seeding rates and N application rate on Virginia soil types.
2) Establish a base data set for corn irrigated with SDI for Virginia corn producers to make educated decisions when installing irrigation in the future.
3) Preliminary development of irrigation best management practices for Virginia row crop producers.
4) Serve as a demonstration plot/system for Virginia row crop producers for the technology that is available for SDI systems.

Budget

Salary, Research Specialist …….	$ 6,696.00
Fringe Benefits……..…	$ 3.195.00
Undergraduate Wage……	$ 2,222.00
Materials/Supplies…….....	$ 1,587.00
Soil Sensors……..	$ 2,000.00
Corn Ear Leaf……	$ 2,500.00
2024 Funds Requested	**$ 18,200.00**

Budget Justification

The salary and fringe benefits included in the budget are for my research technician will be implementing the trial, collecting data during the trial, and conducting the data analyses post-harvest. The materials and supplies for the trial will be to acquire nitrogen fertilizer and other materials (i.e. flags, stakes, etc.) needed to properly carry out the protocol. Lastly, $2,500 is requested to lease the soil water volumetric sensors and wireless dataloggers to monitor soil water for irrigation scheduling.