441/1384
2015

Final Fiscal Year 2015/2016 Report for SPRI/NPB

Project Director: Wesley Porter

Co-Principal Investigators: George Vellidis, Scott Monfort

The University of Georgia (UGA) Precision Agriculture team recognized more than 15 years ago that variable rate application of irrigation water was a key enabling technology for adoption of precision agriculture in the southeastern USA (Southeast). This was because fields in this region are highly variable in soil type and texture, moisture holding capacity, and slope. Ignoring site-specific water needs while attempting to vary other inputs like fertilizers would not result in the desired efficiency gains theoretically possible by using precision agriculture. In the Southeast, irrigation of agronomic crops is now applied by center pivots. Conventional center pivots apply the same rate of water along the entire length of the pivot and cannot account for within-field variability or non-farmed areas. Because of this, the UGA Precision Ag team focused on VRI technology for pivots.

Thus, much time and resources have been focused on the development of tools and technologies to aid in the implementation of VRI on the farm level. These tools and technologies range from the development of sensor systems such as the UGA Smart Sensor Array (SSA), to better methods of delineating irrigation management zones (IMZs), and the development and refinement of methods of irrigation scheduling that can be easily implemented by producers at the farm.

Research Station Trials:

Peanuts were planted in Georgia on May 18, 2015. Four irrigation treatments and a dryland check were implemented under both conventional and strip tillage scenarios. The treatments included a soil moisture sensor, PeanutFARM, UGA Checkbook, and UGA EasyPan. The peanuts were dug on October 5, 2015 and were harvested on October 12, 2015. The yield differences between tillage methods of the two trials was not significant when only evaluating tillage method, the conservation or strip-tillage treatment had 7.14 inches of irrigation applied on average across treatments and yielded 4737.3 lbs/ac, while the conventional tillage treatment had 6.95 inches of irrigation applied on average across treatments and yielded 4804.4 lbs/ac. The conservation tillage plots have been in a strip tillage treatment for multiple years, thus there should be not residual treatment effect. This shows that there is little to no agronomic benefit to planting in a conventional tillage scenario. Based on the irrigation scheduling method, typically the conventional tillage plots yielded higher than the strip-tilled plots. Overall, there were no significant yield differences between tillage or irrigation scheduling method. The largest difference was between the UGA Checkbook method and other scheduling methods. On average the UGA Checkbook required double the amount of irrigation compared to the other treatments, but had the lowest numerical yields. This additional irrigation required increased input costs with no additional benefit, this result has been observed in many irrigation scheduling trials over the past few years.

Table 1. Conventional versus strip tillage irrigation treatment differences.

Irrigation Scheduling Differences Conventional vs. Strip Tillage 2015			
Irrigation Treatment	Irrigation Amount (in.)	Total Water (in.)	Yield (lb/ac)
Dryland	0.50	23.15	4800.3
UGA SSA-Strip	5.00	27.65	4639.1
UGA SSA-Con.	4.25	26.90	4721.2
PeanutFarm-Strip	5.75	28.40	4766.8
PeanutFarm-Con.	5.75	28.40	5069.5
Checkbook-Strip	12.05	34.70	4563.8
Checkbook-Con.	12.05	34.70	4611.6
EasyPan-Strip	5.75	28.40	4916.6
EasyPan-Con.	5.75	28.40	4815.4

On-Farm Research

Precision Irrigation: During 2015, we identified a producer who has five fields equipped with VRI in southwestern Georgia. We used the 230 ac field shown in Figure 1 to conduct our study. The field was divided into alternating conventional irrigation and precision irrigation strips with each strip 72 rows wide (Figure 1). We used aerial photographs, soil maps, soil electrical conductivity, topography, yield history, producers' knowledge of the fields and geostatistical software to develop irrigation management zones (IMZs) in the precision irrigation strips. After planting and establishment we installed UGA SSA sensor probes in each of the IMZs. Each probe contained three Watermark sensors. When the probe was installed the sensors were located at 4, 8, and 16 in below the soil surface. The data from the sensors was used to dynamically develop irrigation scheduling recommendations for each IMZ. A 50 kPa weighted mean soil water tension (SWT) was used to trigger irrigation in the VRI strips. At each irrigation event, the mean SWT sensor data from each IMZ were

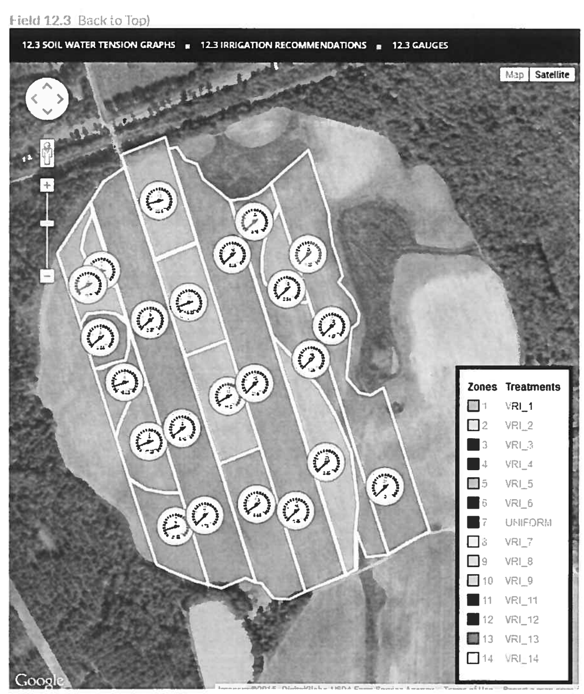

Figure 1. VRI Zones and field used for the 2015 on-farm VRI evaluation of dynamic VRI. The gages indicate the location of UGA SSA sensors.

automatically converted into irrigation recommendations using a van Genuchten model we developed (Liang et al., 2016) (Figure 2) and then into a prescription map which is downloaded remotely to the pivot VRI controller.

UGA SSA sensor probes were also installed in the conventional irrigation strips to monitor soil moisture conditions. The conventional strips were irrigated uniformly by the producer using Irrigator Pro (Davidson et al., 2000) for irrigation decisions. Irrigator Pro is a public domain irrigation scheduling tool developed by USDA which utilizes soil temperature, ambient temperature, and precipitation to provide yes/no irrigation decisions for peanuts.

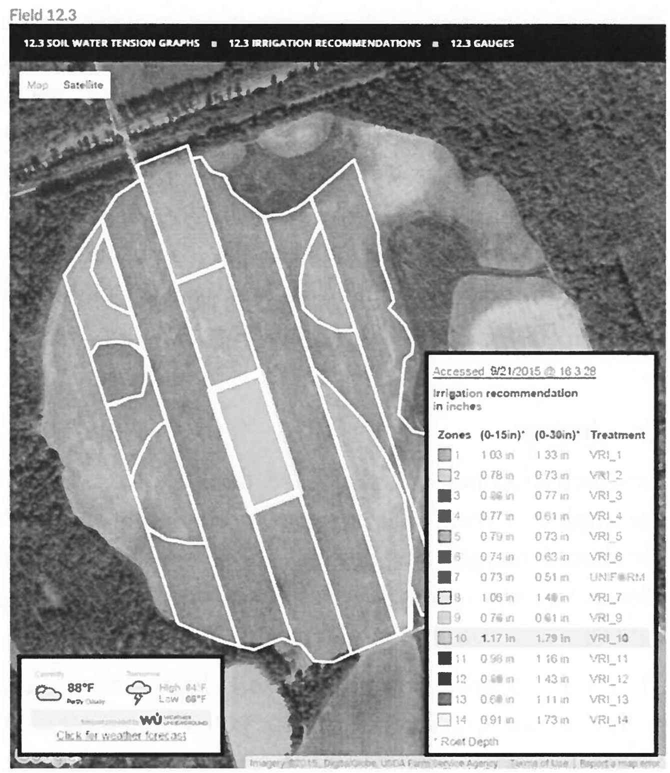

Figure 2. Dynamically developed irrigation scheduling recommendations for each IMZ. Clicking on either the zone or the recommendation will highlight both. In the figure, zone 10 is highlighted. The recommendations are to bring the soil profile to within 75% of field capacity.

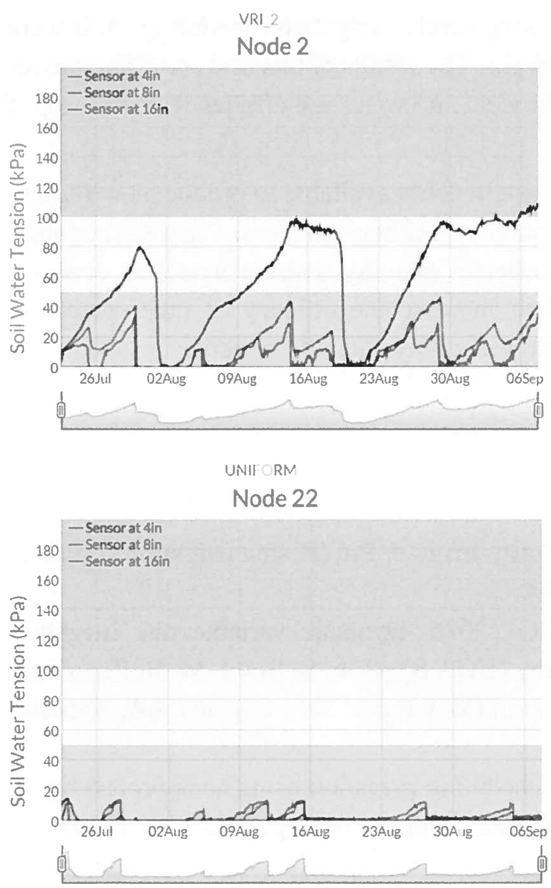

Figure 3. Season-long soil moisture data graphs from the VRI strip (top) and Uniform strip (bottom). The soil in the uniform strips is being maintained much wetter than in the VRI strips.

Over the entire growing season, the dynamic VRI system (sensors + van Genuchten model + VRI) recommended an average irrigation amount of 76 mm compared to 109 mm by Irrigator Pro with approximately the same overall yields for both methods. The parallel strips allowed us to directly compare yields between precision-irrigated and uniformly irrigated areas with similar soil and topographic properties and assess the benefits of dynamic VRI. The average yield for the dynamic VRI system strips was 5543 kg ha^{-1} while the average yield for Irrigator Pro strips was 5552 kg ha^{-1}. The 2015 growing season was wetter than average and the dynamic VRI system outperformed Irrigator Pro in yield by 8.4% in the wetter areas of the field which were mostly areas of lower topographical relief. In contrast, Irrigator Pro outperformed dynamic VRI yields in sandy areas with higher elevations by 9.6% indicating that the 50 kPa irrigation trigger may have been too dry for these areas (Liakos et al., 2016). In this field, approximately 72 hours were required for the center pivot irrigation system to circle the field. Because plant AWC is very small above 50 kPa in sandy soils, any delay in irrigation results in the SWT increasing rapidly and the crop experiencing water stress. In retrospect, it appears that the threshold for these areas should have been lower to account for time to irrigation. Figure 3 shows SWT graphs from two nodes in the field. The top graph is from a node in the northwestern area of the westernmost VRI strip. The SWT data line at 16 in (black line in Figure 3) clearly shows that for large periods of time, SWT at this depth was around 100 kPa and the plateaus on the graph indicate that the peanut roots were no longer able to extract water from the soil. In contrast, the lower graph which is from the easternmost uniform strip shows that the soil profile in this area was mostly saturated for the entire growing season.

Conclusions

Research trials conducted at UGA facilities have shown that producers can gain a significant benefit from the implementation of an irrigation scheduling strategy more advanced than the checkbook method. The checkbook method was designed to be conservative, thus ensuring that water was not the limiting factor. However, more recent research is showing promising benefits from better timing of irrigation rather than having it as a non-limiting factor.

To aid in the validation of the results found from research plots, similar irrigation scheduling trials were performed through an on-farm research trial in southwest Georgia. The results of this trial show that proper irrigation management has the potential to both increase field yield and water use efficiency of the crop if irrigation is properly managed.

Thus, the overall conclusion of this study is that there are major benefits available to producers willing to adopt more advanced irrigation scheduling methods than just the checkbook method. These scheduling methods can be coupled with technologies such as VRI to better spatially manage irrigation across a production field. These methods also have the potential to increase the efficacy of other precision agriculture operations by better matching all inputs to the field variability and requirements.

References

Davidson Jr., J.I., Lamb, M.C., Sternitzke, D.A., 2000. Farm suite-Irrigator Pro (Peanut irrigation software, and user's guide), The Peanut Foundation, Alexandria, VA.

Liakos, V., Porter, W., Tucker, M., Liang, X., Vellidis, G., 2016. Dynamic variable rate irrigation scheduling with University of Georgia Smart Sensor Array (UGA SSA). In S. Boyd, M. Huffman and B. Robertson (eds) Proceedings of the 2016 Beltwide Cotton Conference, New Orleans, LA, National Cotton Council, Memphis, TN, paper 16778, p.349-358.

Liang, X., V. Liakos, O. Wendroth, and G. Vellidis. 2016. Scheduling irrigation using an approach based on the van Genuchten model. Agricultural Water Management (in press – accepted 23 May 2016)