A HOLISTIC SOLUTION TO USING SOIL MOISTURE DATA FOR SCHEDULING IRRIGATION

Project Coordinators: Dr. George Vellidis, Dr. Bill Liakos, and Dr. Wesley Porter
Crop & Soil Sciences Department, University of Georgia
office: 229.386.3442; mobile: 229.402.1278; e-mail: yiorgos@uga.edu

OBJECTIVE: Evaluate the response of peanuts to irrigation management zones (IMZs) when used in conjunction with a Dynamic Variable Rate Irrigation (VRI) System.

FINDINGS:

The overall goal of the project is to improve our dynamic variable rate irrigation (VRI) system and refine its use with peanuts. Our dynamic VRI system consists of a VRI-enabled pivot, the UGA Smart Sensor Array (UGA SSA) and our irrigation scheduling Decision Support Tool (DST). The operational paradigm for our dynamic VRI system is that the field is divided into irrigation management zones (IMZs) and UGA SSA sensor nodes are installed in large numbers to monitor soil moisture within the zones and provide regular soil moisture measurements to the DST. The DST uses the soil moisture data to develop irrigation scheduling recommendations for each IMZ. The recommendations are then approved by the user (farmer) and downloaded wirelessly the VRI controller on the center pivot as a precision irrigation prescription. When the center pivot irrigation system is engaged by the farmer, the pivot applies the recommended rates. During 2015, with support from the Georgia Peanut Commission and the Southern Peanut Research Initiative we conducted a field-scale dynamic VRI experiment on a 330 ac grower's field near Leary to test our dynamic VRI control system.

In the field we established four pairs of parallel strips (Figure 1). Strips were 162 rows wide. Each pair of strips contained one conventionally irrigated strip and one dynamic VRI strip. Irrigation scheduling in the conventional strips was based on Irrigator Pro. Irrigator Pro is a public domain irrigation scheduling tool developed by USDA's Agricultural Research Service (ARS). For peanuts, it utilizes soil temperature, ambient temperature, and precipitation to provide Yes/No irrigation decisions. It takes peanut phenology into account but does not recommend an amount of water to be applied. The farmer involved in this project is a top-level irrigation manager who visited the field daily to collect soil temperature and precipitation data to run Irrigator Pro. Irrigation in the conventional strips was done uniformly and the rate was assigned by the farmer. In the dynamic VRI strips, irrigation decisions and amounts applied were made individually for each IMZ by the DST. When irrigation was initiated, the VRI system varied the rates accordingly.

Dynamic VRI resulted in an average irrigation water use efficiency (IWUE) gain of 37% but its average yield (6375 lb/ac) was 440 lb/ac lower than Irrigator Pro (6815 lb/ac) (Table 1). Overall, soil moisture was not significantly higher in the conventional strips and in one pair of strips was approximately the same throughout the season (Table 2). Consequently, we do not believe that the yield differences were the result of differences in soil moisture. This result challenged our team to understand why Irrigator Pro outperformed dynamic VRI. We concluded that Irrigator Pro did so because it accounts for crop phenology and it recommends irrigation based on many factors. For example, soil temperature is a critical factor when peanut is flowering and setting fruit. High soil temperatures such as those we encountered in 2016 prevent the pegging. Irrigator Pro takes this into consideration and will recommend irrigation to reduce soil temperature.

ARS recently developed a new version of Irrigator Pro for peanuts which uses soil moisture (soil water tension) in addition to soil temperature to make Yes/No decisions. ARS has also developed a version of the new model which can automatically pull in UGA SSA data. Our findings and the model developments have motivated our team to integrate Irrigator Pro into the current DST to create a new holistic DST that considers crop phenology in addition to soil moisture and temperature.

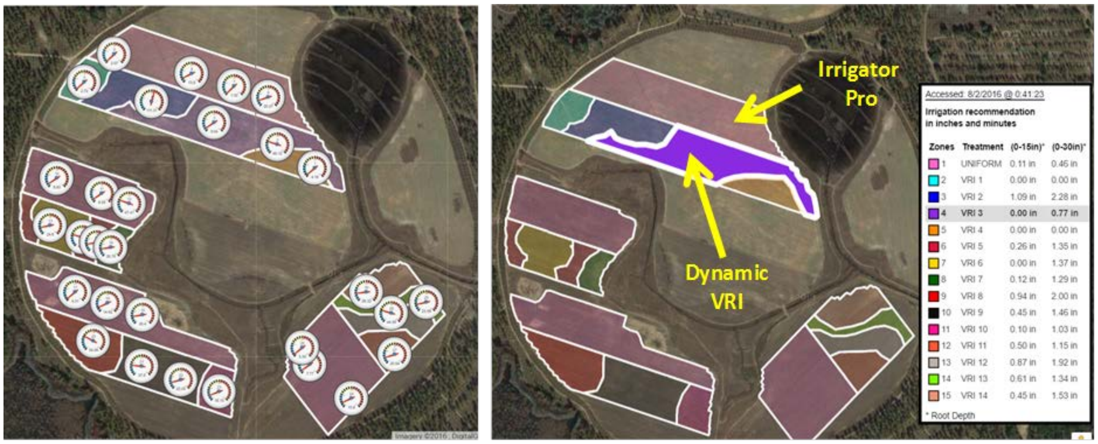

Figure 1. Field used for the 2016 dynamic VRI pilot study funded by the Southern Peanut Research Initiative in which we used four pairs of parallel strip. Each pair contained a strip irrigated using dynamic VRI and a strip irrigated using Irrigator Pro. Gages indicate the location of UGA SSA nodes. The legend on the right shows the amounts of water prescribed to each VRI IMZ on 02 August 2016.

Table 1. Results from the 2016 pilot dynamic VRI study conducted on the field shown in Figure 1. Uni= uniform, VRI = dynamic VRI, IWUE = irrigation water use efficiency. The 2016 Georgia state average yield for irrigated peanuts was 4500 – 5000 lb/ac.

Treatment	Irrigation (in)	Irrigation Difference (in)	Strip size (ac)	Yield (lbs)	Yield (lbs/ac)	Yield Difference (lbs/ac)	IWUE (lbs/ac-in)	IWUE Difference (%)
Uni1	5.4		13.0	89,880	6935		1284	
VRI1	3.6	-1.8	18.3	117,660	6415	-520	1792	39.5%
Uni2	4.7		8.5	58,360	6842		1456	
VRI2	3.3	-1.4	7.1	45,520	6420	-421	1969	35.3%
Uni3	4.7		10.5	68,920	6564		1397	
VRI3	3.2	-1.5	11.8	71,400	6051	-513	1909	36.7%
Uni4	5.0		9.7	67,260	6920		1384	
VRI4	3.5	-1.6	9.8	64,740	6613	-307	1917	38.5%
Uni avg	5.0				6815		1380	
VRI avg	3.4	-1.6			6375	-440	1897	37.4%

Table 2. Season-long averages of soil moisture data in terms of soil water tension for each of the parallel strips reported by depth. Each entry in the table consists of an average of 3360 individual data points. Note that the averages are quite similar for some pairs of strips – especially between Uni2 and VRI2.

Treatment	Avg 10cm (4in) (kPa)	Avg 20cm (8in) (kPa)	Avg 40cm (16in) (kPa)	Weighted Average (kPa)	Yield (lbs/ac)
Uni1	9.9	9.5	21.3	9.8	6935
VRI1	17.1	15.9	36.3	16.6	6415
Uni2	17.0	16.7	38.0	16.9	6842
VRI2	16.6	18.9	37.4	17.6	6420
Uni3	9.3	9.8	34.2	9.5	6564
VRI3	13.6	20.9	48.3	16.5	6051
Uni4	7.9	5.4	21.3	6.9	6920
VRI4	9.7	11.9	43.2	10.6	6613