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Final Quarter Report for 2016 NPB Project

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VRI Evaluation in Georgia for 2016: The experiment carried out in the 2016 growing season on a 330 ac commercial peanut field. The field is located near Leary, GA. Initially the field was divided into Irrigation Management Zones (IMZs) by using field properties such as soil electric conductivity, elevation data, hydrology data which simulate how the water flows within the field and historical aerial images of the field as well. The IMZs were delineated by using the EZZone software. This software is a free online resource for delineating Agricultural Management Zones from univariate georeferenced data. After IMZ delineation, the field was divided into alternating conventional irrigation and dynamic VRI strips. The total number of strips was eight and the width of each strip was 162 rows (Figure 1). In four of the eight strips, irrigation scheduling was based on Irrigator Pro recommendations and water applied uniformly. Irrigator Pro is a computerized expert system designed to manage peanut irrigation and pest management decisions. The version of Irrigator Pro used in this study uses precipitation and soil temperature to make irrigation decisions. It is widely used in the southeastern USA by consultants and some farmers to schedule irrigation. It is used regularly by the grower who cooperated with us in this study as well. The other four strips were divided into IMZs which were irrigated individually based on UGA SSA recommendations.

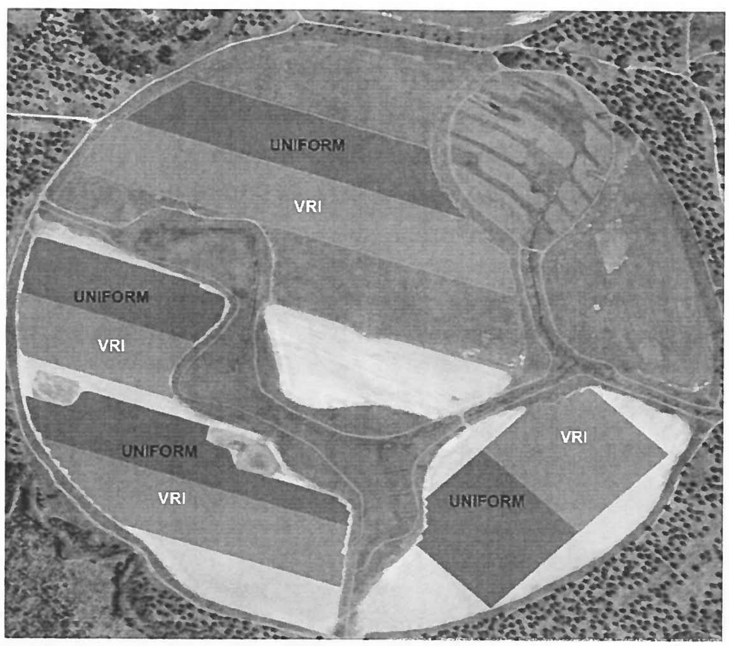

Figure 1. The eight strips where the two different irrigation treatments were applied.

After planting, University of Georgia Smart Sensor Array (UGA SSA) sensors were installed in each of the IMZs. The UGA SSA control system which was installed in the field consists of a wireless soil moisture sensing array with thirty sensor nodes and a web-based user interface (Figure 2). A detailed description of the UGA SSA system was presented from Liakos *et al.* (2015). Additionally, we installed several tipping bucket rain gages close to the nodes to evaluate the VRI system performance and understand how fast the UGA SSA nodes responded. The readings from the rain gages proved to be helpful for analyzing the performance of each treatment and calculating the irrigation water use efficiency.

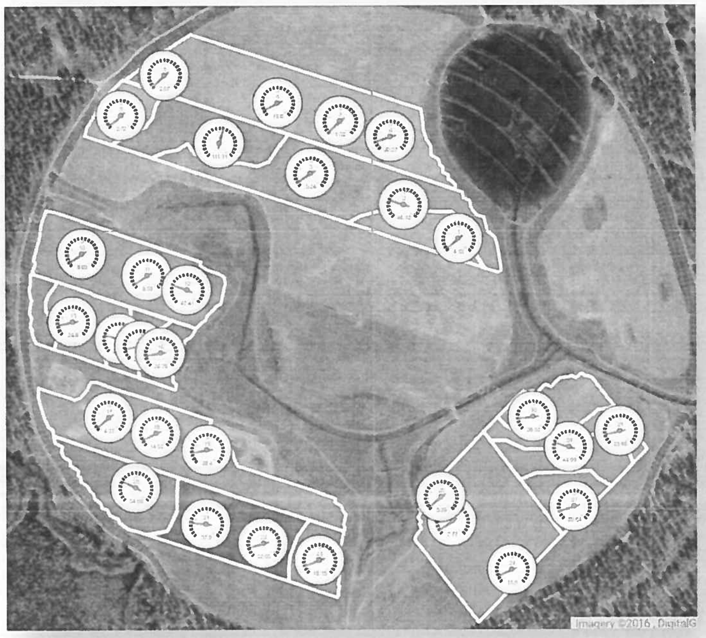

Figure 2. Each gage shows the exact location of each node within the field and the weighted average of the three soil moisture sensors.

During the 2016 growing season we checked the UGA SSA website every morning to create prescription maps (Figure 3). The UGA SSA website in addition to presenting the soil moisture data also works as a Decision Support Tool (DST) because it recommends water allocations based on the latest soil moisture readings.

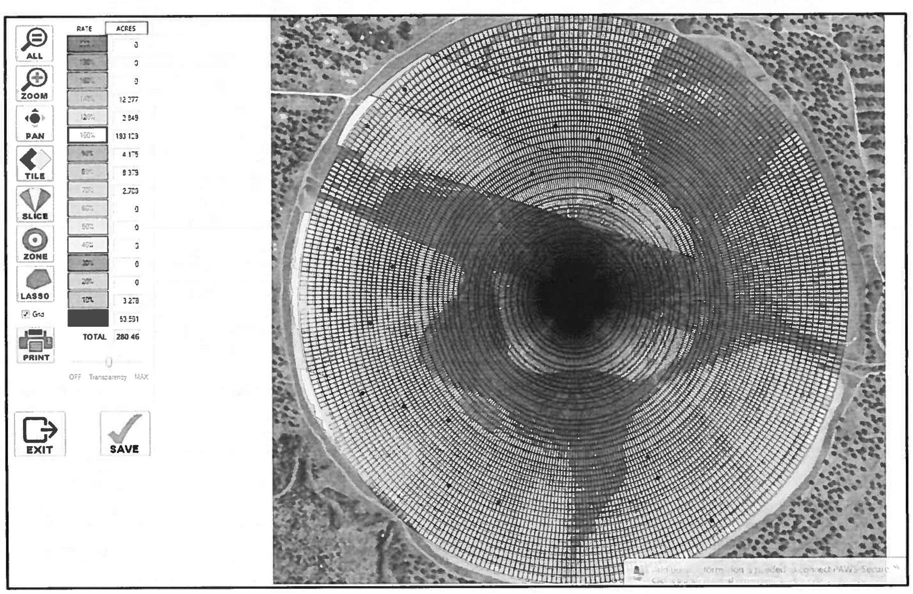

Figure 3. An example of a prescription map.

The pivot used at the experiment was well maintained with a commercial VRI system installed on it. The VRI system consisted of solenoid valves which allowed different water flow for each control zone. The Farmscan 7000 (Farm Scan Ag, Australia) was the solenoid controller. The Farmscan used was an upgraded version of the 7000 series which allowed to upload prescription maps by using USB jump drive or remotely through the internet.

The field was harvested between 10/11/16-10/13/16. No yield monitors were available to be used for the 2016 harvest. To compare the productivity and efficiency of the irrigation treatments we recorded the yield of each strip. To eliminate yield errors every truck with full trailer with the yield of each strip was sent to a professional scale which was near the field and the truck drivers reported the empty and the full weight of their trailers. Additionally, extra data such as peanut moisture and foreign materials were taken into account at the yield calculation for each strip.

Table 1 summarizes the yield and irrigation results from the 2016 growing season. A quick look at the column with the yield and the water allocations used in each strip clearly shows that the strips which received irrigation according to the IrrigatorPro treatment had 7% higher yield than the strips which were irrigated based on the UGA SSA recommendations. The average irrigated peanut yield in Georgia in 2016 was from 4500 lbs/ac to 5000 lbs/ac - so the yield from both treatments can be considered high. However, the strips which were irrigated conventionally received 31% more irrigation than the strips which irrigated with the VRI system. Furthermore, we divided the yield from each strip by the water allocations used to calculate the Irrigation Water Use Efficiency (IWUE) index. This index shows how many pounds per acres of yield were produced with one inch of water. As it was expected, the IWUE index was always higher for the precision irrigation strips than at the IrrigatorPro strips. This means that besides the lower yield of the strips which received irrigation based on the UGA SSA method the efficiency of the UGA SSA method is 36.3 % higher than the IrrigatorPro method or meaning that the UGA SSA method has the ability produce more yield with less water.

Table 1. Total irrigation, yield and irrigation water use efficiency for every strip.

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		12.8	90070	7010		1300	
VRI1	3.6	-1.8	18.3	117907	6448	-562	1800	38.5%
Uni2	4.7		8.6	58482	6762		1443	
VRI2	3.3	-1.4	7.2	45616	6366	-396	1948	35.0%
Uni3	4.7		10.6	69064	6500		1387	
VRI3	3.2	-1.5	11.9	71551	6032	-467	1892	36.3%
Uni4	5.0		9.6	67402	6994		1399	
VRI4	3.5	-1.5	9.9	64875	6564	-430	1894	35.4%
Uni avg	4.9				6816		1382	
VRI avg	3.4	-1.6			6352	-464	1883	36.3%

A more detailed analysis of the yield and the soil moisture conditions in each strip through the growing season revealed that the irrigation was not the limiting yield factor. Table 2 presents the average soil moisture data of each strip at three different depths. Additionally the weighted average of the three different sensors was calculated by using the function (1). The comparison of the weighted average of the soil water tension at the VRI strips and the Uniform strips showed that there were no significant differences. Specifically, the weighted average of the soil water tension of the VRI strips was 15.3 kPa while in the Uniform strips it was 10.7 kPa. In practicality a five kPa difference is not a significant enough difference in soil moisture to cause yield reduction. Furthermore, according to Table 2 the Uni2 strip was drier than the VRI2 strip but the yield was less at the VRI2 strip than at the Uni2 strip.

(1) Weighted Average = (0.5×SWT at 4 in) + (0.3×SWT at 8 in) + (0.2×SWT at 16 in)

where SWT: Soil Water Tension

Table 2. Average of soil moisture condition in each strip throughout the growing season.

Treatment	Avg 4in (kPa)	Avg 8in (kPa)	Avg 16in (kPa)	Weighted Average (kPa)	Yield (lbs/ac)
Uni1	9.9	9.5	21.3	9.8	7010
VRI1	17.1	15.9	36.3	16.6	6448
Uni2	17	16.7	38	16.9	6762
VRI2	16.6	18.9	37.4	17.6	6366
Uni3	9.3	9.8	34.2	9.5	6500
VRI3	13.6	20.9	48.3	16.5	6032
Uni4	7.9	5.4	21.3	6.9	6994
VRI4	9.7	11.9	43.2	10.6	6564

In conclusion, a dynamic VRI system was successfully implement on at the farm level during the 2016 production season. Even though yields were lower for the Dynamic VRI test strips when compared to strips irrigated with IrrigatorPro soil temperature recommendations the VRI strips had significantly higher IWUE. Upon further inspection of the average soil moisture of the VRI and IrrigatorPro strips, there were no significant differences between the two. This suggests that there is another factor causing the yield reduction in the VRI irrigated peanuts. This is not scientifically proven, but based on how IrrigatorPro operates the yield reduction can be attributed to the physiology of peanut growth and production. Meaning that a set irrigation trigger level was used for the VRI strips the entire year while IrrigatorPro accounts for the dynamic requirements of peanut growth and development and provides irrigation when necessary to the crop. This suggests that further studies could integrate the idea of dynamic VRI and IrrigatorPro to better manage peanut irrigation requirements.