Final + Summary

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2015

VALIDATION OF THE PEANUTFARM IRRIGATION SCHEDULING TOOL 2015

BENCHMARKING ADVANCED IRRIGATION SCHEDULING FOR PEANUTS IN ALABAMA, FLORIDA, AND GEORGIA WHILE EVALUATING PLATING DATE AND IRRIGATION IMPACTS ON NEW PEANUT CULTIVARS, YIELD, GRADE, AFLATOXIN, AND WATER REQUIREMENTS AND USE OF DRONE TECHNOLOGY FOR MANAGEMENT DECISIONS

FUNDING YEAR: 2015, **PRINCIPAL INVESTIGATOR:** WESLEY M PORTER
PROJECT PARTICIPANTS: UGA: W. SCOTT MONFORT, GEORGE VELLIDIS, SCOTT TUBBS, CALVIN PERRY, **AUBURN/ACES:** KRIS BALKCOM, **UFL:** DIANE ROWLAND, BARRY TILLMAN, DAVID WRIGHT
TOTAL FUNDS REQUESTED: $69,000: ALABAMA: $11,000, FLORIDA: $33,000, GEORGIA: $25,000
LOCATION FOR RESEARCH:
ALABAMA: WIREGRASS REC (HEADLAND, AL) AND TWO PRODUCTION FIELDS NEAR THIS LOCATION
GEORGIA: STRIPLING IRRIGATION RESEARCH PARK (CAMILLA, GA), AND TWO PRODUCTION FIELDS NEAR THIS REGION
FLORIDA: North FL Research and Extension Center - Suwannee Valley (Live Oak, FL)
NEW OR CONTINUING PROJECT: **NEW, THIS IS PROPOSED TO BE A 2 YEAR PROJECT.**

RATIONALE: Irrigation management is becoming increasingly important for peanut production with more than 50% of the peanut acreage in Georgia and Florida now irrigated. In Alabama, the irrigated acreage is smaller but increasing rapidly as the state is providing incentives for producers to adopt irrigation. With the resulting increase in demand for water resources, it is imperative that we develop and adopt technologies and strategies which maximize water use efficiency. Recent research in peanut growing states indicates that several "advanced" irrigation scheduling methods including soil moisture sensing or canopy temperature sensing can be an effective and efficient way to irrigate peanuts. In addition, there are web-based tools that use estimated crop evapotranspiration to schedule irrigation. Precision irrigation is a tool that can be used to implement all of these practices and is defined as varying the application rate of irrigation water across the field to meet the crop's measured demand. Precision irrigation is made possible by two key technologies. The first is variable rate irrigation (VRI) for center pivot irrigation systems. The water conservation potential of the technology has been recognized by USDA-NRCS which provides 100% cost-share in Alabama and 75% cost-share in Georgia for VRI systems. The second critical technology is cheap, wireless, and easy to maintain soil moisture sensing systems which can be installed in high densities within fields to provide us with the data we need to calculate how much water to apply with our VRI systems. UGA has developed the UGA Smart Sensor Array (UGA SSA) which meets these criteria. However, the UGA SSA has not yet been used to schedule irrigation in conjunction with VRI-enabled pivots. In addition most of the other technologies described earlier have not been tested under southeastern conditions with the current peanut varieties. The addition of the Florida study will also add the following. Confirmation of the best planting dates for irrigated and non-irrigated peanuts and will help us determine management for the crop and if one cultivar is more suitable to either irrigated or non-irrigated production. We can determine which cultivars do the best with early planting and which do the best without irrigation as water issues become more important. This study will be a multi-year project since each year is different with different amounts of rainfall and impacts of thrips on peanut and TSW. NDVI (vegetative index) will be determined via infra-red cameras and irrigation needs via thermal imaging.

OBJECTIVES: This is now a combined project and the Objectives for each state are listed below:

Alabama, Georgia, and Florida:

- To evaluate advanced irrigation scheduling methods and determine water use requirements for commonly planted peanut varieties in Alabama and Georgia.

Alabama and Georgia:

- Assess the yield and water conservation benefits of using VRI and the UGA SSA to schedule irrigation on peanuts in Georgia and Alabama.

Florida:

- Compare 4 of the newest peanut cultivars (FL 107, FL 07, UF11301 and GA 12Y) in relation to Georgia 06G

- Evaluate these 5 peanut cultivars over 4 planting dates (Apr. 15, April 25, May 5 and May 15) for yield, grade, disease and other quality components
- Compare irrigated vs. non irrigated conditions for these 5 peanut cultivars in relation to yield, grade, disease, etc.
- Evaluate thermal and infra-red images to help determine irrigation scheduling and vegetative index to help determine stress from irrigation or pests.

METHODS:

Alabama, Georgia and Florida: – Advanced Irrigation Scheduling for Peanuts: We will use the Stripling Irrigation Research Park (SIRP) (Camilla, GA), North FL Research and Extension Center - Suwannee Valley (Live Oak, FL) and the Wiregrass REC (Headland, AL) to implement irrigation scheduling trials. Three sensor-based irrigation scheduling methods, an online scheduling tool, the UGA Checkbook method and rainfed (dryland) treatments will be evaluated in GA and AL; in FL, treatments will include grower based irrigation levels, rainfed, soil moisture sensor based scheduling, and scheduling using full PeanutFARM recommendations and PeanutFARM modified with Primed Acclimation. Treatments will be planted in randomized complete block design with at least three replicates at both SIRP, Live Oak, and Wiregrass. Irrigation will be scheduled based on individual treatment thresholds. Water application will be done using VRI-enabled overhead irrigation. In all treatments, soil moisture conditions will be monitored. Either the UGA Checkbook method or the FL grower utilized schedule will be used as the standard to compare water conservation potential of the other treatments.

Alabama and Georgia: – Precision Irrigation: We will select two fields in southwestern Georgia and two fields in southeastern Alabama already equipped with VRI-enabled center pivot irrigation systems. Two fields will ensure that in each year of the study at least one of the fields in each state is in peanuts. The fields will be divided into alternating conventional irrigation and precision irrigation strips with each strip at least 72 rows wide. We will use 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 will install two or more UGA SSA sensors in each of the IMZs. The data from the sensors will be used to dynamically develop irrigation scheduling recommendations for each IMZ. At each irrigation event, the recommended amount of irrigation water will be applied to each IMZ. UGA SSA sensors will also be installed in the conventional irrigation strips to monitor soil moisture conditions. The conventional strips will be irrigated uniformly based on typical producer practice. At the end of the growing season we will harvest the fields using a UGA combine equipped with a yield monitor. The parallel strips will allow us to directly compare yields between precision-irrigated and conventionally irrigated areas with similar soil and topographic properties.

Florida: Five of the newest peanut cultivars will be planted over 4 planting dates with and without irrigation. Four replications will be used for the varieties. These will be managed using IFAS extension recommendations and harvested at maturity. All cultivars will be graded with yields from each planting date and evaluated for disease and TSW impacts. A drone will be flown over the field 4-6 times during the growing season to obtain data for irrigation scheduling and other stress factors.

MEASURABLE OUTCOMES AND POTENTIAL IMPACT: We will provide an unbiased assessment of the advanced irrigation scheduling tools used in the study. We will report on the water use requirements for commonly planted varieties and make irrigation scheduling recommendations for them. We will also calculate total volumes of water used and water use efficiencies of each method. Finally, we will draw conclusions on the efficacy of using precision irrigation in peanuts. Our results will be used by researchers, extension specialists, and extension agents to provide recommendations to producers in Alabama, Georgia, and other southeastern states. This information can help growers with timeliness in their farming operations. For years growers planted peanuts in April to take advantage of soil moisture and to ensure that all of the peanut crop would be planted timely. As we moved into the TSWV era we began planting later to lessen the impacts of the disease. In recent years, we believe that we have better cultivars that have more resistance to TSW than Georgia Green with the result of starting to plant earlier. Likewise, we have little research on impacts of planting date with and without irrigation. This study should help confirm best planting dates for irrigated and non-irrigated peanuts and will help us determine management for the crop and if one cultivar is more suitable to either irrigated or non-irrigated production. This study will be a multi-year project since each year is different with different amounts of rainfall and impacts of thrips on peanut and TSW.

Potential Pitfalls: As with any on-the-farm project there are associated issues. We have tried to ensure that our methods prevent any opportunities for errors to occur. However, research schedules and production schedules do not always match, there could be instances where to producer does not feel comfortable following one of our recommendations and makes an independent decision. This could cause the data to not fully align with our research plots, but at the same time we want to have field level results, thus we are prepared to deal with these types of issues.

Final Report for the Florida site 2015:

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Objectives:

1. Assess the effectiveness of reduced irrigation schemes for sustaining grade and yield across genetically diverse peanut genotypes. Reductions of grade and yield of peanut genotypes to reduced amounts of irrigation will be reflected as a percentage of the yield of genotypes managed with a full rate of irrigation.
2. To evaluate the performance of a K_c based soil water balance irrigation scheduling tool known as PeanutFARM. This was conducted by examining these tools in comparison to irrigation scheduling based on soil tension.
3. To evaluate inherent root architecture of diverse peanut genotypes and the responsiveness of component root traits in response to irrigation management.
4. Assess canopy development of peanut genotypes under varying irrigation treatments and quantify correlations between root and canopy development.

The study objectives were achieved by experiments at two sites in 2015: Plant Science Research and Education Unit (PSREU) in Citra, FL and at Suwannee Valley Agricultural and Extension Center (SVAEC) in Live Oak, FL. To date, the experimental data has been completed for the 2015 season and ongoing for the completion of the 2016 season.

PSREU Site - 2015

Materials and Methods:

Site characteristics and experimental design

The field study was initiated in 2015 at the University of Florida's Plant Science Research and Education Unit in North Central Florida (29° 24' 38" N, 82° 10' 12" W). The soil is classified as an Arredondo sand (Loamy, siliceous, semiactive, hyperthermic Grossarenic Paleudults). Daily meteorological data will be recorded using an automated weather station located within 1500 m of the experiment. Rainfall was collected using a data logging rain gauge placed within 200 m of the experiment (Spectrum Technologies, Inc., Aurora, IL).

Irrigation and peanut genotypes treatments were randomized in complete block with a split plot arrangement with irrigation as the whole plot and peanut genotype as the sub-plot. Irrigation was applied using a lateral move system equipped with variable rate irrigation (VRI) (Lindsey Corporation, Omaha, NE). The irrigation treatments included: 1) irrigation scheduled using the University of Florida's PeanutFARM soil water mass balance scheduling tool with applications at a 1.9 cm amount for the entire season; 2) irrigation scheduled with tensiometers at an optimum application amount of 1.9 cm (100%) for the entire season; 3) PA managed using the treatment #2 to trigger irrigation but with an application of 1.1 cm until mid-bloom and 1.9cm following mid-bloom; 4) irrigation triggered using #2 but with 1.1

cm application amount for the entire season; and 5) a rainfed control. The tensiometer treatment had sensors installed at 0.31, 0.70, and 0.91 m (Irrometer Company, Inc., Riverside, CA). Irrigation in treatments 2, 3, and 4 were triggered when the tensiometers reach 25-35 kPa in the optimum irrigation treatment (100%) using tensiometers placed at 30 cm. Sub-plots were planted to four rows (7.6 meters in length with 0.91 meter between rows) of runner (*Arachis hypogaea*) type peanuts FloRun '107'™ and TUFRunner '511'™, and valencia (*Arachis fastigiata*) type peanuts New Mexico Valencia C and COC 041.

Field Measurements:

Ten composite soil cores were collected per rep prior to planting and analyzed to a depth of 0-40 cm for macro and micro nutrients. Volumetric soil moisture was record prior to an irrigation treatment at depths of 10, 20, 30, 40, 60, and 100 cm using a Profiler Probe (Delta-T Devices Ltd, Cambridge, UK). Volumetric soil water content was also measured 2 and 4 days after an irrigation treatment.

Mini-Rhizotron tubes were installed centered and parallel to the row immediately after peanut emergence at a 45° angle to a target depth of 1.0 m. Images were recorded every 1.3 cm using a BTC 100X camera (Bartz Technology Corporation, Carpimteria, CA). Root imaging occurred on a weekly basis during early crop development. As root growth slows later in the season, root imaging occurred every 2-4 weeks. These images were analyzed using Win RHIZOTRON software for root length, diameter, area and volume (Reagent Instruments INC., Quebec, Canada).

Canopy assessment of leaf area index (LAI) was initiated at approximately 30 DAP (LI-COR, Lincoln, Nebraska). Measurement intervals for leaf area index (LAI) occurred weekly early in the growing season, and subsequently every 2-4 weeks later in the growing season (LI-COR, Lincoln, Nebraska). Infrared temperature (IRT) sensors were installed to monitor peanut canopy temperatures from about 45 DAP to harvest (SmartCrop, Lubbock, TX).

At optimum maturity, mechanical digging of the two center rows occured and pods were separated from the vines using a mechanical thresher. Pod yield were determined at target moisture of 10.5%. Peanut grade was also measured as total sound mature kernels (TSMK).

Results:

Both canopy and root development varied among the peanut genotypes over the growing season. Measurements of leaf area index (LAI) after 48 days after planting (DAP) showed an increased amount of leaf area index when comparing the runner (TUFRunner™ '511'and FloRun™ '107') to the valencia (New Mexico Valencia C and COC 041) peanuts. The opposite trend was observed with the total amount of measured root length over the growing season. This trend was increased amounts of total root length following 35 DAP when comparing valencia to runner peanuts.

Pod yield of particular peanut genotypes did vary among the irrigation treatments. These differences were an increase in pod yield when comparing the 100% irrigation treatment to both the PeanutFARM scheduling and rainfed control irrigation treatments for peanut genotypes of COC 041 and FloRun™'511'. No differences in pod yield occurred among the irrigation treatments with peanut genotypes of New Mexico Valencia C and TUFRunner™ '511'. The 100% treatment had similar yields to the 60% and 60PA irrigation treatments for all genotypes. Irrigation treatments were also averaged across genotypes for an overall impact of the irrigation effect on pod yield of all genotypes. These results indicate the 60% and 60%PA to be the optimum water treatments since they had similar pod yields to the 100% treatment.

The overall findings of this research suggest that the two valencia peanuts partition more assimilates for root growth versus canopy growth when compared to the two runner genotypes in this study. Furthermore, the root growth continues to increase in the valencia's later into the growing season when reproductive growth is occurring. As a result of increased growth partitioning to roots, and decreased canopy growth later into the growing season/reproductive growth, the valencia peanuts have significantly less yield potential than the runner peanuts.

Model Calibration

Prior to the growing season, the PeanutFARM irrigation scheduling tool was modified based on field validation from the 2014 growing season. These modifications included decreasing the K_c values for the early and late portions of the growing season. The late season modifications proved to be successful in the fact that PeanutFARM did not call for irrigation when adequate amounts of rainfall were received post 50 DAP during the 2015 growing season. However, the early season adjustment was conservative in its water application resulting in pod yield decreases in comparison to the 100% irrigation treatment. Therefore, adjustments were made to the initial K_c to match the 100% irrigation treatment. This calibrated model is currently being validated in the 2016 field trial.

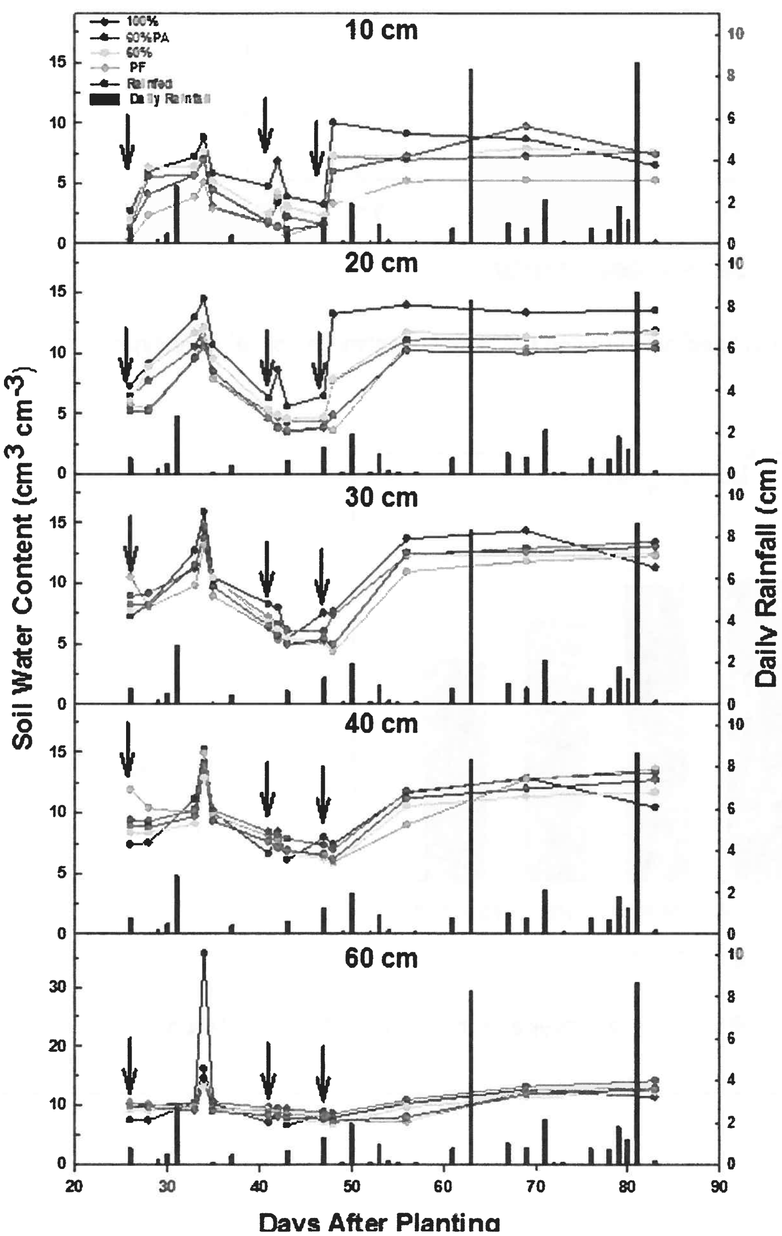

Figure 1. Volumetric water content for each irrigation treatment at soil depths of 10, 20, 30, 40, and 60 cm. Arrows indicate the soil moisture measurement prior to an irrigation application. Daily rainfall is also reported for this time period.

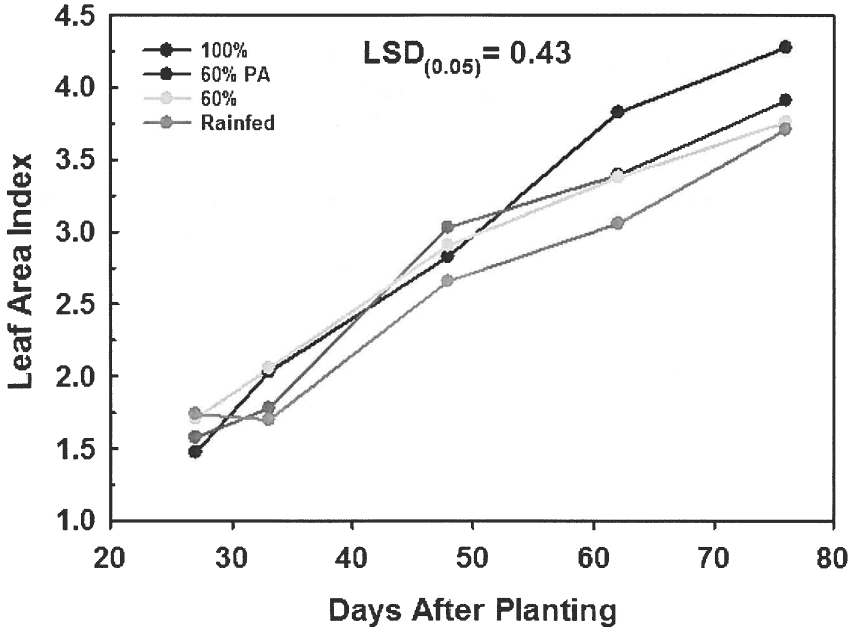

Figure 2. Leaf area index averaged across each irrigation treatment for all genotypes.

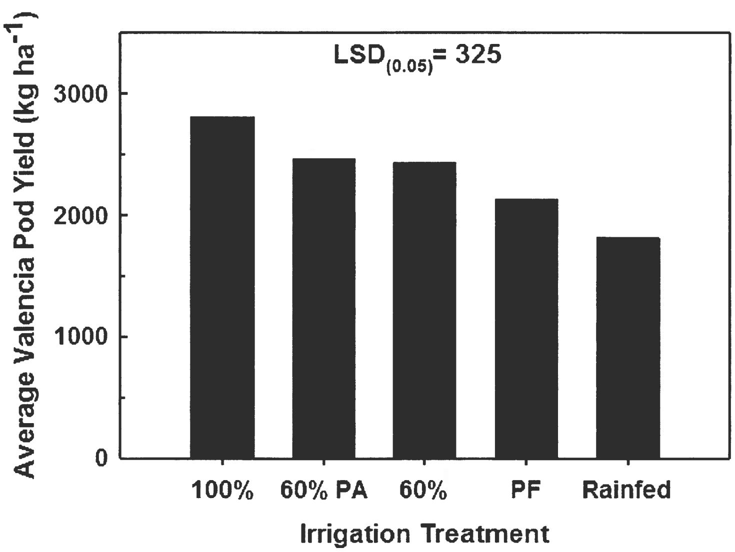

Figure 3. Average pod yield of Valencia genotypes for each irrigation treatment.

Live Oak - 2015

Design

The experimental design included four replicate plots for each treatment. A total of 60 plots per crop (5 irrigation treatments x 3 fertility levels x 4 replicates) were monitored. Peanut was planted on 19 May, 2015.

Treatment structure

1. 5 irrigation treatments
    a. I1 (Rationale): irrigation mimicked peanut grower's irrigation practices.
    a. I2 (PeanutFARM): irrigation was determined using the PeanutFARM app. As part of the inputs, rainfall data was obtained from the FAWN weather station located in Live Oak, FL.
    b. I3 (SMS): using the SENTEK probes, moisture content of the soil was monitored and irrigation was determined using the maximum allowable depletion (MAD) and field capacity (FC) points to refill the soil profile with irrigation accordingly.
    c. I4 (60% I1- Reduced): it corresponded to the 60% irrigation of I1 (60% of peanut grower's irrigation practices). This represented a low irrigation treatment.
    d. I5 (NO): non-irrigated plots.

Table 1. Treatment irrigation applied based on programmed ARs in VRI.

	Irrigation (in)				
Date	**I1**	**I2**	**I3**	**I4**	**I5**
7/10/2015	0.5	-	-	0.3	-
7/13/2015	-	-	0.6	-	-
7/15/2015	0.5	0.5	-	0.3	-
7/24/2015	0.7	-	0.4	0.4	-
7/31/2015	0.7	-	-	0.4	-
8/14/2015	0.7	-	-	0.4	-
8/21/2015	0.7	-	-	0.4	-
8/31/2015	0.7	-	-	0.4	-
9/4/2015	0.7	-	-	0.4	-

Cumulative water applied to each treatment

a. I1 (Rationale): 5.2 in
e. I2 (SWB): 0.5 in
f. I3 (SMS): 1 in
g. I4 (60% I1- Reduced): 3 in
h. I5 (NO): 0 in

Total Rainfall (5/19 – 10/8) = 25.52 in
Total Rainfall (5/19 – 10/8) = 21.05 in

Cumulative Irrigation: (see Figure 1)

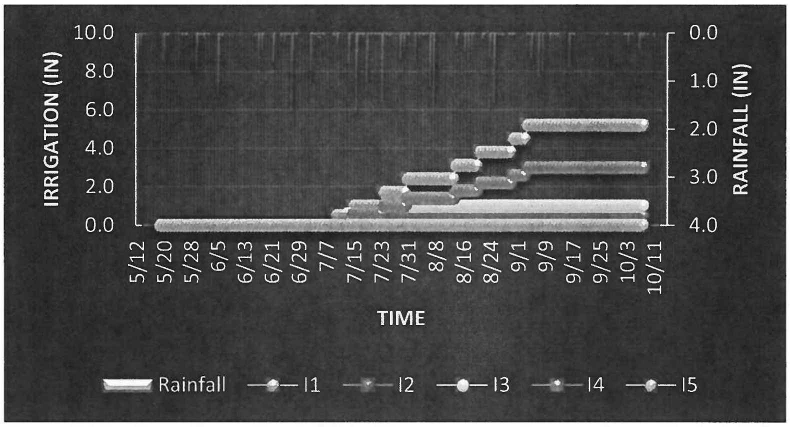

Figure 1. Treatment cumulative irrigation (in) applied based on programmed ARs in VRI.

Types of data collected

1. Soil moisture: a total of 27 SENTEK probes were installed at each crop. Each probe contains nine sensors which take readings of:

   a. Soil moisture content (SMC)
   b. Electric conductivity (EC)
   c. Temperature
   Sensors are installed at 2, 6, 10, 14, 18, 22, 26, 30, 34 inches depth within the probes. Probes were installed in the I3 treatments only.

2. **Biomass data**

Plant tissue sampling was conducted 4 times over the cropping season (including at harvest) to measure N uptake of the crop over time (see below).

Tissue Sampling Protocol

Tools and supplies needed: Clippers, spade, measuring tape, paper bags or cloth bags numbered, Ziplock bags, bucket to wash roots, Plastic baskets to transport the samples to the drying facility.

Parameters to be analyzed: Total kjeldahl nitrogen.

Sampling procedure (peanut):

- Collect all whole plants in a section of row (1m). Count the number of plants in the 1 m section.
- Separate the plants into aboveground (shoot) and belowground (root and pods) parts depending on their stage.
- Wash roots free of soil. Put all samples in bag and label it
- Blast the peanut pods. Count the number of pods for each 1 m section.
- Dry plant samples in 70°C for 72 hrs or until thoroughly dry. Record the dry weight of each part.
- Randomly remove 50 pods from each bag and separate the shells from seeds. Record the dry wt of shell and seed. Use the number to do a conversion for 1m section and then per ha basis. This can be used for calculation of shelling %
- Grind the shoots using Wiley mill, passed through a 2mm screen and subsample for lab analysis.
- Grind the peanut seeds and shell separately using coffee grinders. Put them in airtight Ziploc bags for lab analysis.

Presentations and Extension Articles

Zurweller, B., D.L. Rowland, P.P Payton, B.Tillman. Peanut genotypic root responses to irrigation. In: Proceedings of International Society of Root Research: Roots Down Under; 2016 Oct. 6-9; Canberra, Australia.

Zurweller, B., and D.L. Rowland. PeanutFARM irrigation and harvest tool is now mobile friendly. In: Panhandle Ag e-News; 2016 May. 20.

Zurweller, B. "What's new in determining peanut maturity and irrigation management." 40th Annual Tri-County Peanut Production Meeting. Branford, FL. 3 March 2016. Guest Lecture.

Leidner, J. Root work for drought tolerant genectics. In: Southeastern Peanut Farmer; 2016 Jan./Feb., Vol. 54.