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The irrigation research and extension team at the Edisto Research and Education Center in South Carolina has developed an affordable soil moisture monitoring system for growers. The system uses low-cost open-source electronics, cell phone communication, and Internet of things (IoT) technologies to collect and send data from soil moisture sensors installed on farmer's fields to the Internet in real-time. The farmer can see a graphical display of the information using a computer or cell phone and can use this site-specific real-time information to make timely and accurate irrigation scheduling decisions.

The objectives of this three-year project, funded by the NRCS-CIG, are to (1) Demonstrate the use of new sensor-based irrigation technology on commercial farms in South Carolina, (2) Evaluate the environmental and economic benefits of sensor-based irrigation technology, and (3) Train farmers and other water stakeholders in the state on the use and benefits of sensor-based irrigation technology. In 2020 we conducted an on-farm trial to demonstrate the use and benefits of soil moisture monitoring technology to help farmers irrigate more efficiently. We selected six prototype demonstration fields and installed soil moisture sensors to schedule irrigation effectively on different soil types. The demonstration fields were located in commercial farms in five counties in South Carolina, including Hampton, Allendale, Barnwell, Orangeburg, and Lexington Counties. The fields were planted with either cotton, peanut, or soybean. In each farm, a sensor field and a companion field were selected for comparison. Soil moisture sensors were installed in the sensor field, while no sensors were installed in the companion field. Watermark soil moisture sensors were installed in the sensor field at four soil depths (6, 12, 18, and 24 inches). Hourly data were collected automatically through a custom-made Internet-of-things (IoT) system, transmitting data to a Cloud server using the cellular communication network. The farmers were trained to irrigate the sensor fields based on the collected soil moisture data using a few simple guidelines. They were also guided through installing and using the app to monitor the soil moisture level on their cell phone. They used the data collected from the sensors to irrigate the sensor field using center pivots and irrigated the companion fields by following their standard irrigation practice. We collected agronomic (i.e., yield, water use) and economic data (i.e., income, irrigation cost) from the sensor and companion fields and conducted an economic evaluation of the two irrigation practices.

The data collected in 2020 showed that in general, farmers tended to apply more irrigation in the sensor field compared to the companion field. However, the additional irrigation tended to increase crop yields ranging from 7.8 to 150% and all farms had a considerable increase in net income in the
sensor field compared with the companion field. The increased net income ranged from $87.30/acre to $641.19/acre or 7.6% to 63.5%. The average increased net income for all the six farms in 2020 was $202.28/acre or 19.42%. Although these are the results of only one year, they look very promising. We are conducting the on-farm trial on six farms in 2021 and will conduct another trial in 2022 to see if the results still hold.

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**Peanut Varieties**

*Dan Anco, Extension Peanut Specialist*

A peanut variety is often the first line of defense in producing a profitable crop. Yield potential, grade, length of maturity, seed size, disease susceptibility characteristics, field history, and of course seed and contract availability are a few important factors to consider when deciding between individual varieties.

Funding from the South Carolina Peanut Board and the National Peanut Board have supported cultivar evaluation trials at Clemson University. These trials help provide efficacy data for farmers to consider when planting peanut varieties for their operations. Recent data has advanced Georgia 16HO, FloRun 331, and TUFRunner 297 as the most profitable runner cultivars, with Walton and Bailey II as the Virginia cultivars with the greatest potential for economic value. The picture at the right was taken of an inverted Georgia 20VHO runner peanut plant 122 days after planting.

<table>
<thead>
<tr>
<th>Runner type variety</th>
<th>Yield (lb/A)</th>
<th>Group</th>
<th>TSMK</th>
<th>Group</th>
<th>Acre value $/A</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Georgia 16HO</td>
<td>6721</td>
<td>A</td>
<td>74.0%</td>
<td>A</td>
<td>1193</td>
<td>A</td>
</tr>
<tr>
<td>FloRun 331</td>
<td>6560</td>
<td>A</td>
<td>69.8%</td>
<td>CD</td>
<td>1099</td>
<td>B</td>
</tr>
<tr>
<td>TUFRunner 297</td>
<td>6358</td>
<td>AB</td>
<td>71.8%</td>
<td>ABC</td>
<td>1096</td>
<td>B</td>
</tr>
<tr>
<td>Georgia 18RU</td>
<td>6193</td>
<td>ABC</td>
<td>73.0%</td>
<td>A</td>
<td>1078</td>
<td>BC</td>
</tr>
<tr>
<td>Georgia 06G</td>
<td>6180</td>
<td>ABC</td>
<td>72.4%</td>
<td>AB</td>
<td>1075</td>
<td>BC</td>
</tr>
<tr>
<td>AU NPL 17</td>
<td>6203</td>
<td>ABC</td>
<td>69.7%</td>
<td>CD</td>
<td>1047</td>
<td>BCD</td>
</tr>
<tr>
<td>Georgia 12Y</td>
<td>6019</td>
<td>BC</td>
<td>68.8%</td>
<td>D</td>
<td>1005</td>
<td>CDE</td>
</tr>
<tr>
<td>Georgia 09B</td>
<td>5753</td>
<td>CD</td>
<td>69.7%</td>
<td>CD</td>
<td>970</td>
<td>DE</td>
</tr>
<tr>
<td>TifNV-High O/L</td>
<td>5702</td>
<td>CD</td>
<td>70.4%</td>
<td>BCD</td>
<td>966</td>
<td>DE</td>
</tr>
<tr>
<td>Georgia 14N</td>
<td>5413</td>
<td>D</td>
<td>70.6%</td>
<td>BCD</td>
<td>930</td>
<td>E</td>
</tr>
</tbody>
</table>
Anthem Flex Herbicide Programs in Peanut

Contributing Author: Mike Marshall, Extension Weed Specialist

In peanut, Palmer amaranth, sicklepod, and morningglory rank among the most common and troublesome weeds in South Carolina. In addition, herbicide resistance concerns, especially ALS-inhibitors (i.e., Cadre) in Palmer amaranth over the past ten years have encouraged growers to use multiple herbicide modes-of-action. Recently, Anthem Flex, a premixed combination of pyroxasulfone (group 15) and carfentrazone (group 14), was introduced to the market for weed management in peanut. Pyroxasulfone provides residual control of many small-seeded broadleaf and grass weeds and carfentrazone has foliar activity on small, actively growing weeds. This study was initiated to evaluate Anthem FLEX efficacy on common broadleaf/grass weed in peanuts. As part of an over-lapping herbicide residual program, Anthem FLEX has the potential to add more options for South Carolina peanut growers.

<table>
<thead>
<tr>
<th>Virginia type variety</th>
<th>Yield (lb/A)</th>
<th>Group</th>
<th>TSMK</th>
<th>ELK</th>
<th>Group</th>
<th>Acre value $/A</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walton</td>
<td>5359</td>
<td>A</td>
<td>69.6%</td>
<td>40.2%</td>
<td>B</td>
<td>953</td>
<td>A</td>
</tr>
<tr>
<td>Bailey II</td>
<td>5254</td>
<td>A</td>
<td>69.6%</td>
<td>46.7%</td>
<td>A</td>
<td>938</td>
<td>AB</td>
</tr>
<tr>
<td>Bailey</td>
<td>5202</td>
<td>A</td>
<td>68.8%</td>
<td>40.6%</td>
<td>B</td>
<td>912</td>
<td>AB</td>
</tr>
<tr>
<td>Emery</td>
<td>4825</td>
<td>AB</td>
<td>69.5%</td>
<td>47.4%</td>
<td>A</td>
<td>864</td>
<td>ABC</td>
</tr>
<tr>
<td>Sullivan</td>
<td>4936</td>
<td>AB</td>
<td>67.2%</td>
<td>41.1%</td>
<td>B</td>
<td>848</td>
<td>BC</td>
</tr>
<tr>
<td>Contender</td>
<td>4386</td>
<td>B</td>
<td>69.5%</td>
<td>45.2%</td>
<td>A</td>
<td>783</td>
<td>C</td>
</tr>
</tbody>
</table>

2 weeks after PT2

Prowl (2 pt/A) + Anthem Flex (2 oz/A) PRE
Storm + Gramoxone + Anthem Flex (3 oz/A) PT1
Dual Magnum + Cadre + NIS PT2

2 weeks after PT2

Prowl PRE
Storm + Gramoxone + Anthem Flex (3 oz/A) PT1
Cadre+2,4-DB+Anthem Flex (3 oz/A) PT2
In summary, the Anthem Flex programs (PRE alone or followed by POST) provided excellent control of Palmer amaranth and other troublesome weeds in peanut. Another point is overlapping residuals are the key to managing weeds in peanut.

Project Funding Acknowledgment: South Carolina Peanut Board.

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**Peanut Maturity Determination Using AI**

*Contributing Author: Kendall Kirk, Dan Anco, Ben Fogle, and Justin Hiers*

The Clemson Precision Ag and Peanut Production programs have harnessed artificial intelligence to develop algorithms for determining peanut maturity using digital image analysis.

Determining optimum maturity for peanut harvest can make or break profitability of a crop. Digging too early can result in lower grades and reduced yields as a result of reduced pod fill, therefore lower SMKs. Digging too late can result in higher grades, but overmature pods tend to result in increased digging losses due to weakened pegs and therefore reduced yields. The “sweet spot” in maturity maximizes revenue as a function of grade and yield, combined. While days after planting can give a decent guideline of when this sweet spot will occur, differences in growing conditions—especially temperatures and soil moisture—will shift timing from one season to another.

Because pod mesocarp color is an excellent indicator of pod maturity, determining optimum digging time for a given field can be accomplished through maturity sampling. In maturity sampling, plants are pulled from the field and pods from those plants are evaluated for mesocarp color, following hull scraping or pod blasting. Sorting the sampled pods into three piles allows for application of the following recommendations from the Clemson Peanut Money Maker Guide: “For Virginia types, the maturity target is to have 70% of pods in the orange, brown and black categories combined, 30% of pods in the brown and black categories combined, and 1-2% coal black. For runners the target is to
have 75 – 80% in orange + brown + black categories, 40% in brown + black categories, and 5% coal black.”

While this method has proven over years of research to be a reliable method of optimizing digging date to maximize revenue, it can be time consuming to process multiple samples and human subjectivity can result in slightly different counts from one observer to another. Clemson researchers have worked for the last several years to develop an image analysis system to address these two issues, producing consistent maturity results at high throughput.

Clemson’s image analysis system uses a digital image of a pod-blasted sample (a sample of pods blasted with a pressure washer to reveal mesocarp color) spread out onto a high-contrast background—blue, pink, or green. Pixels in the image are analyzed to distinguish pod pixels from background pixels and an algorithm is applied to predict percent of pods in each of the color categories: white, yellow, orange, brown, and black. Results are available within seconds of taking the photo.

Figure 1. Example of a raw photo (left) used for digital image analysis and processed photo (right) used to apply mesocarp color algorithms (right). For this image, manual counts revealed 15% white-yellow, 40% orange, 32% brown, and 13% black pods. The image analysis algorithm predicted 17% white-yellow, 39% orange, 28% brown, and 15% black pods.

Algorithms were developed using digital images and manual counts from over 1400 pod-blasted samples across about a dozen peanut varieties. Average prediction accuracies were +/- 4% for orange-brown-black pods and +/- 3% for black pods. The software for applying the algorithms is currently implemented on a Windows platform, but plans are underway to seek funding for development of a cross-platform app, allowing the analysis to be performed on most web-enabled devices, from computers to cell phones. Development of this system has been underway for several years and a number of individuals deserve credit, including: Dan Anco, Kayla Carroll, Ben Fogle, Justin Hiers, Kendall Kirk, Wei-Zhen Liang, Misbah Munir, James Thomas, Andrew Warner, and Trevor Zorn.

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Beneficial Bacteria Promote Peanut Yield and Improve Management of Late Leaf Spot

Contributing Author: Hehe Wang

Many beneficial bacteria in soil could promote not only plant growth by enhancing nutrient uptake, but also suppress both soil-borne and foliar diseases by directly antagonizing fungal growth or inducing plant resistance to pathogens. During 2019 and 2020, with the funding support from South Carolina Peanut Board, we conducted field trials to evaluate several commercial beneficial bacterial products and local beneficial bacterial strains as in-furrow treatments and/or spray treatments for their effect on disease management and peanut yield.

Late leaf spot is one of the most important peanut diseases in South Carolina. In our research trials, the in-furrow treatment of beneficial bacteria (e.g. Serenade, Double Nickel) followed by Bravo spray performed consistently under both moderate and high disease pressure, and they significantly improved the late leaf spot control and peanut yield (148-791 lb/acre increase) compared to the standard Bravo treatment. In comparison to in-furrow treatments, spray treatments of beneficial bacteria in alternation with Bravo worked similarly as the standard Bravo spray program and efficiently controlled late leaf spot under the moderate disease pressure but their efficacy were lower than Bravo under high disease pressure.

The in-furrow beneficial bacterial treatments have great potential to serve as new options in the integrated management program to promote peanut yield and manage diseases in both conventional and organic peanut production. We are currently evaluating the in-furrow treatments of beneficial bacteria in different fields and their combination with organic chemical sprays to develop a management program for organic peanut production.

Fig. 1. Late leaf spot on peanut Fig. 2. Field trials to evaluate beneficial bacteria.
Gypsum Needs for Peanut Production

Contributing Author: Bhupinder S. Farmaha

Introduction

Gypsum is often supplied as a calcium source to produce high yielding and good quality peanuts through surface application on highly weathered soils of the southeastern US. The gypsum application also increases soil nutrient availability and plant nutrient uptake, but their over-application can potentially cause nutritional imbalances and decrease farm profits. The South Carolina recommendation is to apply 1,500 lb gypsum at bloom to all Virginia type peanuts, all seed production peanuts, and to runners with < 400 lb/ac soil test and 1,000 lb/ac gypsum to runners with 400 – 600 lb/ac soil test.

Our research evaluates the gypsum impact on total sound mature kernels (TSMK) and seed calcium concentrations

In 2018 and 2019, we conducted two field studies at Edisto REC to test Clemson University’s gypsum rate recommendations to large-seeded runner-type and large-seeded Virginia-type peanut cultivars. Results from these two studies showed that gypsum rate had mixed effect on pod yield with significant increase in pod yield of large-seeded Virginia-type cultivar (Sullivan) in one year and no significant effect on pod yield of large-seeded runner-type (297 and TUFRunner™ ‘511’) in both years. The lack of gypsum effect on peanut pod yields are not uncommon and are aligned with the results from several published studies. The effect of gypsum on pod yield can be dependent upon soil moisture availability as it relates to soil-available calcium availability. The pH and baseline soil Ca levels at test sites were not excessively low, partly explaining Ca non-significant response. Though peanut yield was non-responsive to gypsum application to both cultivars, but a linear increase in TSMK was found for 511 (Fig. 1) and seed calcium concentration for both varieties (Fig. 2).

Figure 1: Gypsum application rate effect on total sound mature kernels (TSMK)

Figure 2: Gypsum application rate effect on seed calcium concentrations

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Late Leaf Spot Management – Fungicide Combinations

Contributing Author: Dan Anco, Extension Peanut Specialist

Leaf spot integrated management programs are built around protecting the plant from infection and limiting the amount of defoliation that may follow. Our previous work has shown 40% defoliation as the approximate threshold above which yield loss increases more rapidly for Virginia type peanut. For runners, this level is slightly higher at approximately 50% defoliation. The picture to the right shows a Virginia type canopy where the lower 40% of the stem has lost its leaves.

Funded by the South Carolina Peanut Board, we are conducting work in 2021 to examine economical late leaf spot management programs, some of which do not include Bravo, due to uncertainties following its ban in the European Union. The bar graph below shows work from 2020 where fungicide combinations helped to contribute effective levels of late leaf spot management. Results from that trial showed encouraging control from tebuconazole (Folicur), Lucento, or Headline applied in combination with Microthiol Disperss (MD) sulfur. Trials in 2021 are examining several of these combinations again to confirm consistency of response as well as several season-long programs with and without Bravo.

![Bar Graph]

Bailey 129 DAP
2 applications, then 1 Bravo cover
MD rate was 3.75 lb/A
Horticultural Crops

Contributing Author: Gilbert Miller, Extension Vegetable Specialist

- EREC Watermelon Variety Trial Report – Seedless and Mini Watermelons
  - Handout available on EREC home page
- EREC Pumpkin Variety Trial
  - Southern Pumpkin Guide available on EREC home page.

**Pumpkin Variety Trial – New Zealand Hybrid Seed Company Ltd**

- 40 varieties of pumpkins: Ornamental; Halloween type; Eating
- Production practices including: drip irrigation; fertigation and pest control.

Fall production of pumpkins in the eastern part of South Carolina is very difficult for several reasons. 1.) Pest pressure, both insect and disease, is excessive. Populations of both pest types have increased during the spring and summer and are at a peak. 2.) Virus pressure is great due to the high population of insect vectors. 3.) Hot temperatures during July and August interfere with successful pollination and consequential fruit set.

The Pumpkin Variety Trial, ongoing for 7 growing seasons, has been evaluating pumpkin breeding lines to develop pumpkin varieties which suitably produce under the above-mentioned growing conditions.

**Field test of Polyoxin D (Oso) biopesticide (Certis USA) for control of gummy stem blight (GSB) in watermelons.**

- Four treatments were applied weekly to seedless watermelon (Fascination – Syngenta)
- Treatments included: 1.) Oso with surfactant; 2.) Growers’ standard; 3.) Oso alternated with Growers’ standard; 4.) No treatment
- Preliminary results indicate Oso does reduce severity of gummy stem blight on watermelon in the field.

Gummy stem blight crop protectants are critical for successful organic and non-organic production of watermelons. Non-organic producers have a large selection of GSB controlling pesticides. GSB controlling chemicals for organic production are limited. Oso which is OMRI listed for organic use will be a tremendous help for organic watermelon producers.
Drip Irrigated and Fertigated Sweet Potato Variety Trial

This variety trial looked at 11 sweet potato varieties, 4 commercial varieties and 7 experimental varieties. Two varieties, developed at USDA Charleston, have unique characteristics for specific markets. The variety, 09-130, because of its large size and substantial yield per acre is more suitable for the processing market. The variety, 04-136, with wire worm tolerance is more suitable for the organic market.

Use of Nematicides for Nematode Control in Cotton

Contributing Authors: M. T. Plumblee, S. Ahmed, and J. D. Mueller.

The majority of the corn fields in the Coastal Plain of South Carolina have soil textures that consist primarily of coarse textured sands. These soils harbor numerous species of nematodes that can infect corn, cause severe stunting in the roots and the entire plant (Figure 1). Ultimately, damage to the root system can induce drought stress, limiting nutrient uptake and cause yield losses that can exceed 15%. In most cases the roots exhibit the “stubby root” or “bottle brush” symptoms shown in Figure 2. The “stubby root symptom” can be caused by several nematode species including Stubby root nematode, Southern root-not nematode, Lesion nematode, Sting nematode, and Columbia lance nematode. These species are common throughout the Coastal Plain. Management of nematodes in corn is very difficult since there are no commercial hybrids known to be resistant to any nematode species.

We conducted a trial comparing 4 nematicides with a nontreated check in a very sandy soil heavily infested with Southern root-knot and Columbia lance nematodes. Appropriate plots were treated with 5 gallons per acre of Telone II on February 25. The other nematicides were applied in-furrow at-planting on March 23. Plots were planted to DKC 65-20. Nematode samples were taken at midseason and at harvest. Plots were harvested using a small plot combine.
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate Per acre</th>
<th>June SRK per gram root</th>
<th>April CLN per gram root</th>
<th>June CLN Per gram root</th>
<th>Yield: Estimated bushels per acre at 15.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
<td>N.A.</td>
<td>345</td>
<td>229</td>
<td>98</td>
<td>188</td>
</tr>
<tr>
<td>Counter</td>
<td>6.5 lbs.</td>
<td>335</td>
<td>124</td>
<td>28</td>
<td>186</td>
</tr>
<tr>
<td>Propulse</td>
<td>8.0 fl. Oz.</td>
<td>616</td>
<td>339</td>
<td>145</td>
<td>192</td>
</tr>
<tr>
<td>Velum</td>
<td>3.0 fl. Oz.</td>
<td>193</td>
<td>178</td>
<td>65</td>
<td>185</td>
</tr>
<tr>
<td>Telone II</td>
<td>5.0 gal.</td>
<td>48</td>
<td>81</td>
<td>52</td>
<td>179</td>
</tr>
</tbody>
</table>

SRK = Southern root-knot nematode & CLN = Columbia lance nematode.

Several species of nematode that infect corn were present in the field, but Columbia lance and Southern root-knot were the most prevalent and seemed to be the most important. Although Telone II provided the most nematode suppression it did not provide a yield response. Velum provided a lower level of nematode suppression than Telone II but it also did not provide a yield response.

Managing Important Insects in Cotton

*Contributing Author: Jeremy Greene, Professor of Entomology*

**Thrips**

Insecticide options for thrips at planting include seed treatments and in-furrow liquid or granular products. In general, insecticides separately delivered in the furrow with seed provide better control of thrips than seed treatments but are less convenient. Aldicarb (AgLogic) remains the most efficacious at-plant insecticide for control of thrips in seedling cotton (charts below). Several post-emergence insecticides, such as Radiant, Orthene, and Bidrin, provided adequate control of thrips on seedling cotton in 2021. The new Thryvon Bt trait for control of thrips and plant bugs provided good protection from thrips in field trials during 2021 and should be commercially available in 2022.
**Cotton Aphid**

The cotton aphid is usually not an economic pest of cotton in South Carolina; however, it can be under certain circumstances (i.e. early and severe infestations). The cotton aphid can transmit the Cotton Leaf-Roll Dwarf Virus (CLRDV), resulting in broad infection of plants and variable symptoms of disease, but widespread yield loss has not been attributed to the vector-pathogen combination to date. Control of aphids with insecticides will not prevent pervasive infection of cotton plants. Differential susceptibility of varieties to symptoms of CLRDV has been observed.

**Bollworm**

Captures of bollworm (BW) in pheromone-baited traps were relatively low-to-moderate in 2021 (left below), compared with captures during the record year of 2010 (inset below). Boll injury from bollworm in non-Bt cotton reached about 40% and about 6% in two-gene Bt cotton in field trials during 2021. A high of 2% boll injury from bollworm was recorded in three-gene Bt cotton. In bioassays with a pyrethroid, bollworm survival was elevated (right below), compared with previous years, when pyrethroids provided good control of bollworm.

**Plant Bugs**

The tarnished plant bug (TPB) was present in survey sampling for the insect, but most field sites hosted sub-economic levels of plant bugs when averaged across samples. The most critical range of susceptibility to TPB for cotton appears to be the month centered on first bloom (i.e. two weeks before and two weeks after first bloom). Numerous insecticides will provide control of TPB, and those options are listed in the Pest Management Handbook. Care should be taken to not use a broad-spectrum insecticide (pyrethroid or organophosphate) before bollworm flights out of corn in July because of decimating beneficial arthropods and reducing natural control of bollworm eggs and hatching larvae. The new Thryvon Bt trait for control of thrips and plant bugs should provide good protection from TPB in the Southeast and should be commercially available in 2022.

**Stink Bugs**

Numerous species of stink bugs make up a complex of boll-feeding bugs that represent the number one insect pest group of cotton in South Carolina. These species include the southern green stink bug (SGSB), the brown stink bug (BSB), the green stink bug (GSB), the brown marmorated stink bug (BMSB), and several others. The primary species (SGSB, BSB, and GSB) have recently been joined by BMSB as a fairly new one for us here in the Coastal Plain of South Carolina. The species originally invaded the USA in the northeastern states and has been slowly expanding its distribution to the South. The species is well-established in the Upstate, Piedmont, and across the state diagonally (BMSB seems
to be most established north of I-20), and this year is the first time I have observed significant reproduction in the Coastal Plain region in our state. The BMSB is very reproductively capable...much like SGSB. Thankfully, it is also susceptible to many insecticides...just like SGSB. Below are photos of an adult and a nymph of BMSB. Notice the white bands on the legs and antennae, and BMSB is also larger than BSB. We will likely see more of this species in the Coastal Plain in the future. Producers following the dynamic boll-injury threshold will control all species and preserve yield and lint quality. Pyrethroid insecticides provide great control of stink bugs in soybeans because of initial contact efficacy and residual control, but there are other classes of insecticide chemistry that also very good control of stink bugs in the crop.

BMSB (adult, left; nymph, right)

Managing Important Insects in Soybeans

Contributing Author: Jeremy Greene, Professor of Entomology; 803-284-3343; ext. 245; greene4@clemson.edu

Stem Feeders

Insect pests that feed exclusively on stems in soybeans include the threecornered alfalfa hopper (TCAH), the kudzu bug (since 2010), and a couple of stem-boring species, such as lesser cornstalk borer and Dectes stem borer. Of these, TCAH and kudzu bug are the most prominent pest species we see routinely in the crop. The indirect injury caused by stem feeders is not readily apparent because visual symptoms of feeding injury are often delayed until harvest. Compared with defoliating insects that feed on leaves, causing clear, visible injury to soybeans, stem-feeding insects cause hidden injury that can result in yield loss. Stem girdling by TCAH can result in weak points low on the main stem that often serve as breaking points on windy days before the combine can harvest standing plants. Stem borers can also weaken main stems, resulting in lodging, but they can also destroy the vascular system in infested plants, leading to reduced seed size and yields. The kudzu bug has made a comeback in recent years after being suppressed by natural enemies. The fungal pathogen Beauveria bassiana, an egg parasitoid, a parasitic nematode, and other beneficial organisms have been providing significant natural control of kudzu bugs since about 2015. Seemingly, kudzu bugs have found ways around some of these natural controls, and/or the environment has favored the pest and not the natural
enemies. Treatment thresholds and recommended insecticides for stem feeders are listed in the Pest Management Handbook.

**Defoliating Pests (caterpillars, grasshoppers, beetles)**

Insects that feed almost exclusively on soybean leaves make up a complex of defoliating caterpillars, including soybean looper (SBL), green cloverworm (GCW), and velvetbean caterpillar (VBC), as the major species, but several species of armyworms, saltmarsh caterpillars, and other defoliating lepidopterans contribute to loss of leaf material. Most of the defoliating caterpillars that infest soybeans in SC are migratory, meaning that they do not survive winters here and must fly here from southern latitudes. Selective insecticides must be used for SBL, but pyrethroids provide good control of GCW and VBC and will also help with grasshoppers and leaf-eating beetles that can also cause defoliation in soybeans. Grasshoppers are troublesome because we do not cultivate the soil broadly, as we did in the past. Grasshopper egg pods are deposited into the soil by female grasshoppers, and broad tillage used to destroy those eggs. Under minimum tillage operations, grasshoppers benefit from the lack of tillage and are a constant source of defoliation throughout the season. The insect growth regulator Dimilin can be used to break the life cycle, but it only works on immature grasshopper and must be mixed with an insecticide for control of adult grasshoppers. Treatment thresholds for insect defoliators in soybeans are at 30% defoliation before bloom and 15% after bloom. Ongoing testing of Bt soybeans in SC has shown that the technology will provide very good control of defoliating caterpillars species, as well as podworm.

**Seed Feeders (podworm, stink bugs)**

The podworm (also called bollworm, corn earworm, tomato fruitworm, etc—all the same species) feeds on soybean pods and developing seeds. This direct injury can affect yield significantly. Most of the podworm moths depositing eggs in soybeans developed on corn and perhaps other early season crops (e.g. early planted cotton), as the species uses several different hosts annually. We can observe higher pressure in wide-row soybeans with an open canopy, as the moths key in on exposed blooms and developing pods. The pyrethroid insecticides do not work as well as they once did (chart above in section on cotton insects), so alternative materials need to be considered in situations of heavy pressure.

Stink bugs are another important seed feeder in soybeans and, as a complex of species, are the number one insect pest group of soybeans in SC (just like in cotton). There are several species, including the brown stink bug (BSB), the green stink bug (GSB), and the southern green stink bug (SGSB), that routinely make up the complex, but a couple of invasive species, including the brown marmorated stink bug (BMSB) and the redbanded stink bug (RBSB), have become prominent. Treatment thresholds are based on numbers detected per rowft on drop-cloth counts or per sweep from sweep-net sampling. Thresholds vary by row spacing, but, for example, on 38-inch rows, the threshold is 1 bug per rowft. So, at this row spacing, on average, you would need to find 3 stink bugs (adults or nymphs) on 3 ft of row sampled with a drop cloth (that is one side of the drop cloth). The threshold for sweep-
net samples is 1-2 bugs per 10 sweeps, regardless of row spacing. Pyrethroid insecticides provide
great control of stink bugs in soybeans because of initial contact efficacy and residual control.

Teaching the Irrigation System What to Do

Contributing Authors: Jose O. Payero, Udayakumar Sekaran, and Dana Bodiford Turner
One of our most critical global challenges is how to increase food production to feed a rapidly growing population. In South Carolina, meeting this challenge will require changing from rainfed farming systems to irrigated systems, especially for row crops like cotton. This change is already taking place, and irrigated acreage in South Carolina has been increasing in recent decades. Most of the irrigation water comes from pumping groundwater, which requires energy and comes at a considerable cost to farmers. In South Carolina, overhead sprinkler systems (mostly center pivots and a few lateral move systems) are typically used to irrigate row crops, which cover much of the state's irrigated land. Although farmers in South Carolina have adopted efficient irrigation systems (i.e., center pivot and drip), managing these systems to achieve their full potential is still challenging.

This project's overall goal is to create and field-test an affordable system to help farmers increase water use efficiency by automating irrigation based on real-time soil moisture data using a wireless sensor network. The specific objectives are to: (1) develop a wireless sensor network to automate irrigation scheduling of cotton, based on real-time soil moisture using a lateral move irrigation system and, (2) field-test the irrigation automation system by evaluating the response of cotton to three irrigation trigger points. A wireless soil moisture sensor network prototype created in 2019 to automate irrigation of cotton using a subsurface drip irrigation (SDI) system was modified and adapted to a lateral move irrigation system. A field experiment was started at the Edisto Research and Education Center in 2020 to field-test the irrigation automation system. In this experiment, three irrigation treatments are being evaluated in which irrigation is automatically applied to cotton when the weighted-average soil moisture reaches either 30, 40, or 50 kPa using four replications. Soil moisture is measured using Watermark moisture sensors installed at three depths in each plot. Good results with the automation system have been obtained during several irrigation events in 2020 and 2021.

Benchmarking Economic Impact of Deer Damage as A Function of Deer Population

**Contributing Author: Perry Loftis, Cory Heaton, Kendall Kirk, Ben Fogle, Billy Thomas**

Most S.C. farmers will likely attest that deer damage to their crops has been significant, at least in certain fields and in certain years; some will say that it is significant in most fields and most years. Among other crops, soybean, cotton, and peanut are known to be preferred food sources for white-tailed deer, however the economic impact from deer damage to these crops is not well defined.

This study seeks to benchmark deer populations, deer damage, and economic impact from deer damage in an effort to draw a relationship between damage and population, by crop, and to quantify economic impacts to better inform farmers for making management decisions. Without knowing the potential economic impact to a crop, it is impossible for a farmer to assess the value of investment in damage mitigation strategies.

Deer population surveys using methods similar to those outlined by [Texas Parks and Wildlife](#) were conducted in March 2021 along four routes in Barnwell County. Populations along these routes ranged from 40 to 383 deer per square mile, with an average of 155. By comparison, a [2013 SCDNR deer density map](#) and a [2008 QDMA map](#) both suggested populations in the same areas to be 15 to 30 deer per square mile. No information was provided on the methodology of these surveys, although the QDMA report suggested that data was obtained from SCDNR. The tenfold difference in the Clemson...
densities and SCDNR densities may be explainable by changes in deer population between 2013 and 2021 but is also likely in part due to differences in methods. As an indication of likely increase in population, data from QDMA’s Whitetail Report 2019 shows an alarming 86% increase in South Carolina deer-vehicle accidents between 2003 and 2018.

The SCDNR 2020 Deer Harvest Report provides an estimate of current statewide deer population at 715,000 (22 deer per square mile), but does not outline methods for obtaining the estimate. Another SCDNR report suggests approximately $350M in annual economic impact of deer hunting in South Carolina. While deer hunting brings important economic value to the state, excessive deer populations, if and where present, also represent a large cost to citizens of the state in the way of property damage (crop losses and vehicle damage).

Strategies to mitigate deer damage on S.C. crops have been shown to be costly and/or time-consuming and generally only partially effective. Furthermore, S.C. farmers have little effective recourse against crop damage by wildlife, while neighboring farmers to our north are permitted to protect their property against damage by wildlife. Crop damage mitigation through S.C. depredation permitting is in many cases considered to be insufficient and many farmers do not have hunting rights to the land that they farm, so depredation is not an option to them anyway.

To better understand the current and trending economic impact of deer damage to S.C. crops, it is critical that we benchmark and track deer populations using an established, documented, and repeatable methodology, and that we also seek to establish a valuation on crop damage by deer in S.C. so that crop damage might be related to population densities and so that farmers can evaluate cost-benefit of investment in deer damage management.

As a part of this study, over 100 deer exclusion cages (Figure 1) were placed in cotton, peanut, and soybean crops in the areas where the deer population surveys were conducted. Each exclusion cage has an accompanying “check” plot where deer are free to browse on the crop. Deer damage as indicated by canopy reduction has been significantly lower in the caged plots in all three crops (Figure 2). While it is difficult to predict revenue loss as a function of canopy reduction, yield will be measured for all plots in the study as a measure of economic impact from deer damage, which will then be related to surveyed deer populations in those areas. As a part of this study, the research team plans to partner with local Extension agents to conduct additional population surveys across the state.

![Figure 1. Images of (left) a caged soybean plot in the study, four weeks after planting, and (right) a caged peanut plot, seven weeks after planting.](image-url)
Herbicide Systems in Dicamba Tolerant Soybean

Herbicide tolerant soybean account for greater than 95% of the varieties planted in South Carolina. Dicamba herbicide is very effective on several broadleaf weeds including Palmer amaranth, sicklepod, and morningglory. Dicamba must be applied before weeds exceed a certain growth stage (i.e., Palmer amaranth <4 inches in height). In addition, overlapping soil residual herbicides reduce weed pressure on postemergence herbicides. Some herbicides (ex., Liberty) cannot be tank mixed with dicamba because they interfere with the built-in volatility reducing components in the herbicide. In this case, a non-dicamba herbicide option would be the preferred option. In addition, if spraying near sensitive areas, towns, and natural areas containing endangered species, a non-dicamba herbicide program would be the best. A complete herbicide program with flexibility is recommended so that we do not rely on dicamba (or dicamba plus glyphosate).
The herbicides programs evaluated in this study provided excellent control of Palmer amaranth, pitted morningglory, and Texas panicum. The addition of a residual partner (ex., Dual Magnum or Zidua) is important in managing weeds in dicamba tolerant soybean.

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Cover Cropping for Cotton Production

Contributing Authors: Christianah T. Oladoye and Bhupinder S. Farmaha

Introduction

Numerous benefits have been attributed to cover crop utilization, ranging from nutrient enrichment, soil protection during harsh conditions or fallow periods, and minimization of pest infestation. With these benefits, the utilization of cover crops has little acceptance amongst farmers. The major constraint in cover crop utilization by farmers is the direct cost incurred on planting and terminating cover crops.

Our research evaluates:

1) Cover cropping impact on cotton stand count

Cover crop treatments were: Soil health Mixture “5W” (Rye, Vetch, Clover, Lupin, and Radish), Rye, Mixture of Rye and Vetch “R_V”, and no cover “NC”.

Rolled Rye had the highest cotton stand count than other cover crop treatments including no cover crop.

![Image of cotton plants]

Figure 1: Planted cotton between rolled cover crop “A” and in-season cotton growth of same plots “B”.

2) The role of cover crops in soil compaction

The ability of cover crops to alleviate soil compaction was measured during the cotton growing season using the pentrologger.

![Image of cotton plants]
Cover cropping decreased soil compaction in the top 0-5 cm, while from 5-40 cm; no cover crop had lower soil compaction relative to other cover crop treatments. However, the soil compaction among all treatments in the top 40 cm soil profile was lower than the 2 MPa, above which roots can’t penetrate.

Funding Acknowledgement: South Carolina Soybean Board

Cotton Production Automation

Contributing Author: Dr. Joe Mari Maja

The U.S. is the third-largest cotton-producing country in the world. Cotton producers must stay competitive by adopting the available technologies. The U.S. cotton industry has a significant impact on the economy, with almost 190k jobs and an economic impact of more than $25 billion per year. The U.S. cotton industry has a long history of adopting distributive technologies, from the invention of the cotton gin in the 1790s, mechanical harvesters in the 1950s, and module builders in the 1970s. These technologies significantly decreased labor requirements and allowed the labor to produce more than 200 kg bale of cotton fiber more than 4000 times compared to the 1940s. Despite the success of technology adoption, there are still many challenges faced by U.S. cotton producers. One major challenge is competition from polyester, where overproduction in China has resulted in lower polyester prices than cotton and suppressed cotton prices. Thus, producers must continue to increase their production efficiency as increased cotton prices are on the near horizon. Other challenges facing cotton producers are increased pest resistance, particularly glyphosate-resistant weeds, and early indications of bollworm resistance to Bt cotton (genetically modified cotton that contains genes for an insecticide).

Robots are becoming more integrated into the manufacturing industry. They have been implemented through the use of automation and with ranges of form factors, e.g., ground-based (e.g., intelligent
tractors, unmanned ground vehicle [UGV]), crane-based systems, aerial-based (e.g., unmanned aerial vehicles [UAV]). The need for the textile industry and advances in robotics have led to the proliferation, and use of mobile robot platforms applied to the cotton industry. Dr. Joe Mari Maja, a sensor engineer at Clemson University Edisto Research and Education Center, is focusing his research on using mobile robots for cotton production and looking at the effect of automation in cotton plants. “My Team has been designing different weeding modules and new harvesting modules that we can use to automate the weeding and harvesting operation for cotton.” Dr. Maja says.

Dr. Maja, is collaborating with Dr. Matthew Cutulle, a weed scientist at the Coastal Research and Education Center of Clemson University, in looking at the efficacy of the two weeding modules. The field trials will be at two separate locations; Edisto-REC and Coastal-REC. For this trial, common skip-row planting configurations will be implemented with alternate rows. For this year, two different weeder modules will be tested; (1) Adjustable harrow disk (https://youtu.be/_PDpEA4uHqQ) and (2) commercially available tiller from D.R. Pro. Both modules will be pulled behind the mobile robot and will cover at least two rows. The mobile robot can navigate autonomously by having a digital map of the field. Here is a youtube video of their mobile robot autonomous navigation (https://youtu.be/Zt3x7o4ib14). More information on the mobile robot platform can be found at this publication:


2021 Peanut Market Update

Nathan Smith, Ph.D., Extension Economist

Peanut Supply

- 2021 South Carolina planted acreage dropped to 67,000 acres.
- 2021 South Carolina average yield forecast at 4,000 lbs/acre heading into the beginning of harvest. Same as 2007 record.
- 2021 US Planted acreage decreased 5% to 1.58 million acres.
- US yield projected at 4,141 lbs/acre, 2nd largest if realized.
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<th>Harvested Acres 2020</th>
<th>Yield 2020</th>
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Source: NASS, USDA

Peanut Production, Use, Carryover
Rest of the Year Outlook

- Record crop potential in SC and US leading to increased production despite fewer acres.
- Pace of Demand increase continues led by peanut butter.
- Carryover Stocks grow modestly to of over million tons.
- Shelled prices likely remain stable.
- Increased production in 2022 with Premium Peanut’s announcement of plans to build a shelling facility in SC.

Peanut Marketing year Average Prices and PLC Payments

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<th>PLC Payment Rate</th>
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<td>2020/21</td>
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Executive Farm Management Program

The Executive Farm Management program is an exciting program offered by NC State Cooperative Extension Service, Clemson Cooperative Extension, ECU College of Business and University of Georgia Cooperative Extension. Proceeds supporting the Executive Farm Management program and fundraising activities for the program are managed by The North Carolina Agricultural Foundation, Inc. The program has been designed for large, family-owned operations across the country. Program curriculum focuses on the management aspects of the operation which is adaptable for all operations of any size, scale and commodity focus.

Course topics include


Contact Nathan Smith, Nathan5@clemson.edu or Scott Mickey, smickey@clemson.edu

Read more at: https://execfarmmgmt.ces.ncsu.edu/about-execfarmmgmt/

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