Removing Peanut Foliage Adjacent Shallow Subsurface Drip Laterals to Reduce Rodent Damage

Ronald B. Sorensen*

Abstract
Using Shallow SubSurface Drip Irrigation (S3DI) in field crops has been successful from a yield and economic standpoint. However, the use of S3DI in peanut has been discouraging due to the amount of rodent damage to drip tube laterals. The objective was to determine if cutting peanut foliage adjacent the drip tube lateral would reduce rodent damage. Peanut foliage was cut 90 d after planting using coulters to cut 8- and 16-inch gaps adjacent drip tube laterals. Multiple cuts were needed to keep peanut branches from overlapping the drip tubing. Total foliage mass removed from cut middles was determined after each cut. Removed foliage mass was totaled and percentage removed per total available was calculated. Peanut was harvested, and yield and grade characteristics were determined. After harvest, drip tubing in each plot was manually extracted and evaluated for biological damage. There was no difference in the amount of foliage removed between the 8- and 16-inch cut gap. The average amount of foliage removed with either gap space was about 16% of the total forage available. There was no yield or grade difference with cut gap width. There were twice as many holes in the control and eight-inch gap compared with the 16-inch gap, such that rodent damage decreased as cut gap increased. This implies that within a peanut crop, foliage can be removed adjacent the S3DI drip laterals to reduce rodent damage without loss of peanut yield or grade.

The US Census of Agriculture estimates about 8% of all irrigated land in the United States is irrigated with some type of drip, trickle, or other low-flow microsystem (NASS, 2014). In the tri-state area of Georgia, Florida, and Alabama, almost 2.5 million acres are irrigated, which implies about 203,000 acres are irrigated with these micro-irrigation–type systems. Surface drip irrigation (SDI) is used on over 178,000 acres in FL alone (NASS, 2003). Both SDI and subsurface drip irrigation (SSDI) are used primarily for vegetable production in this tri-state area. In recent years, drip irrigation, either SDI or SSDI, have expanded with good success on field crops such as corn (Zea mays L.) (Lamm and Trooien, 2003; Mitchell, 1981; Mitchell and Sparks, 1982; Powell and Wright, 1993), cotton (Gossypium hirsutum L.) (Bauer et al., 1997; Camp et al., 1997; Sorensen et al., 2004; Sorensen and Lamb, 2008), and peanut (Arachis hypogaea L.) (Sorensen et al., 2001a,b; Zhu et al., 2004; Sorensen and Lamb, 2009).

The conversion of non-irrigated land to SDI or SSDI can be challenging for land owners, especially with the day-to-day management of these systems concerning rodent damage. Both SDI and SSDI are

Crop Forage Turfgrass Manage. 5:190010. doi:10.2134/cftm2019.01.0010
© 2019 The author(s). This is an open access article distributed under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
subject to rodent or other animal damage especially in crops where there is maximum crop cover such as peanut. Wildlife that can cause damage to SDI tubing include the hispid cotton rat (Signodon hispidus), house mouse (Mus musculus), eastern harvest mouse, (Reithrodontomys humulis), and white-tailed deer (Odocoileus virginianus). The cotton rat and harvest mouse had by far the greatest impact on SDI laterals (Sorensen et al., 2007). Both the mouse and rat tended to chew on the tubing while deer step on the tubing cutting it with their hoof when moving across the field. Sorensen et al. (2007) used insecticides, animal repellants, and rodenticide baits sprayed on or placed around the drip tubing to reduce rodent damage in SDI with no success. One approach that did work was burying drip tubing about two inches deep resulting in 2.3 holes acre\(^{-1}\) in drip laterals compared with an average over 803 holes acre\(^{-1}\) in drip laterals with all the other treatments. The result of burying the tubing about two inches deep coined the term shallow subsurface drip irrigation (S3DI).

The use of S3DI in field crops is easily installed and economical (Sorensen and Lamb, 2008; Sorensen and Lamb, 2009; and Sorensen and Lamb, 2015). Drip tubing was left in the field for five years with a cotton–corn–corn–corn–peanut rotation. This research showed that for tube longevity, conventionally-tilled (drip laterals removed and reinstalled annually) areas had less tube repairs compared with strip-tilled or no-tilled practices. Thinner wall tubing (8 mm) had 3.5 times more holes compared with thicker wall tubing (15 mm). The “cost-to-repair” versus “cost-to-replace” tubing indicates average replacement time at about 5.4 years (Sorensen and Lamb, 2015). Both corn and cotton have open-type canopies such that rodents cannot hide from predators quite as easily as compared with a closed canopy structure such as peanut. Sorensen et al. (2007) showed that buried drip tube laterals had less damage by rodents in corn and cotton compared with peanut. If rodent damage was higher in cotton and corn, then the drip tubing in the Sorensen and Lamb (2015) project would have been replaced earlier, showing a shorter time to replace than five years. This implies that a closed-canopy-type crop (peanuts) would have more rodent damage than an open-canopy-type crop (corn or cotton).

It would seem reasonable that removing peanut foliage adjacent to the shallow buried drip tubing would result in a semi-open canopy and may reduce rodent damage. With the open gap associated with the drip lateral, these animals may not move into this open space, thereby reducing the “opportunity time” for the rodent to find and chew on the tubing. However, reducing peanut foliage could reduce peanut yield. Sorensen et al. (2009) removed peanut foliage at different times of the growing season as possible feed for livestock. In this research, all peanut foliage was cut 6 to 8 inches height above the soil surface. They showed a 12% decrease in peanut yield for each peanut foliage harvest (Sorensen et al., 2009). The total forage mass removed ranged from 401 to over 2054 lb acre\(^{-1}\).

Therefore, cutting a small amount of peanut vines adjacent drip tube laterals should create an open-type canopy. Total foliage removed would be minimal to avoid affecting crop yield while still reducing rodent damage to the drip tube laterals. Therefore, the objectives of this research were to determine if removing peanut foliage adjacent drip tube laterals affects pod yield and if the open-type canopy could reduce rodent damage on the shallow subsurface drip irrigation system.

### Project Characteristics

#### Locations, Treatments, and Crop Management

This project was conducted from 2015 to 2018 at three locations in 2015 and one location in successive years. In 2015, the three locations were on three different soil series with either sprinkler or drip irrigation systems or both. The three locations were Bolton farm (Red Bay loamy sand; 31°47'25" N lat., 84°30'50" W long.), Newman farm (Tifton loamy sand; 31°47'02" N lat., 84°29'16" W long.), and HERC farm (Greenville sandy loam; 31°43'52" N lat., 84°23'42" W long.) in Southwest Georgia. Both the Bolton and HERC farms were irrigated via sprinkler while the Newman farm had both sprinkler and drip irrigation systems installed. In the years following 2015, all research was done at only the Newman farm and only on drip irrigation (S3DI). The sprinkler systems were used to determine yield response to removing peanut foliage.

Cut treatments were: (i) 8-inch cut gap over drip laterals, (ii) 16-inch cut gap over drip laterals, (iii) 8-inch cut gap in all row middles, (iv) 16-inch cut gap in all row middles, and (v) a no-cut control treatment. These proposed cut gaps may not remove a large amount of foliage, so in 2015 only, there was one treatment added to remove a large amount

<table>
<thead>
<tr>
<th>Table A. Useful conversions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>To convert Column 1 to Column 2, multiply by</td>
</tr>
<tr>
<td>Suggested Unit</td>
</tr>
<tr>
<td>inch</td>
</tr>
<tr>
<td>acre</td>
</tr>
<tr>
<td>pound per acre, lb acre(^{-1})</td>
</tr>
</tbody>
</table>
of foliage, about 70% of the total foliage, to have a possible yield decrease described by Sorensen et al. (2009). This cut removed all forage in a triangle shape with about an 18-inch base (9 inches on each side the row) without cutting the main stem of the peanut plant. The forage was removed using a hedge trimmer. After 2015, there were only three cut treatments consisting of 8- and 16-inch cut gap in alternate row middles and a no-cut control. The cutting treatments consisted of two cutting coulters spaced 4-inch adjacent each drip tubing for the 8-inch gap in alternate row middles over the drip tubing. The coulters would be moved to 8-inch distance adjacent to each drip tube in alternate row middles for a 16-inch gap. Coulters were added and removed to the tool bar to cut peanut branches in all row middles or alternate row middles to have the same 8- and 16-inch gap. Each treatment was replicated three times.

Peanut (GA-06G: Branch, 2007) was planted following a cotton–corn rotation at all locations and years. All crops were planted using a 36-inch row spacing. All locations used conventional tillage (deep turned, disk harrow, field cultivated, and cultipacked for a clean seed bed). Seeds were planted at recommended times and rates, 1 May to 15 May and 6 seeds ft⁻¹, respectively. The crop was managed for maximum yield with fertility, herbicides, fungicides, and insecticides being applied at recommended rates and timing as determined by field scouting and manufacturers recommendations.

Peanut foliage/branches were cut at about 90 days after planting depending on plant growth. The objective was to keep peanut branches from overlapping and covering the area above the buried drip tubing. Individual plots were 18 ft wide by a minimum 80 ft and a maximum of 200 ft long. There were six crop rows spaced three feet apart with three drip tube lines in alternate row middles in each plot (six feet apart). The cutting equipment consisted of a square 4- by 4-inch by 20-ft-long tool bar attached to a tractor via three-point attachment. Cutting coulters (20-inch diam.) were attached to the tool bar in alternate or every crop row depending on the cut treatment. This equipment would cover one plot at a time. In 2015, total plot area was large enough that each treatment was 18-ft wide and the middle lateral was evaluated for foliage removal and rodent damage. All other years, the cutting equipment was set such that one pair of coulters were set for 8-inch cut, another pair for the 16-inch cut, and the last pair for a no cut. Therefore, each lateral within the 18-ft plot was evaluated for rodent damage.

After each plot was cut, the total foliage mass from a 10-ft length in each cut middle was manually collected, dried, and weighed. A minimum of one cut and up to three cuts were made in a year depending on crop growth. The total yearly percentage foliage removed was determined by totaling the mass of material cut from the middle of the rows divided by the total mass removed prior to harvest. Prior to each harvest, three random areas of three feet by six feet of peanut row were cut to the soil surface to determine the total mass of plant material available. The dry mass from each cutting and each treatment was totaled to determine the total mass of peanut hay removed during the growing season.

Once peanuts were mature (Williams and Drexler, 1981), they were dug with a two-row inverter. After field drying, peanuts were combined using a two-row combine with a bag attachment. The middle two rows of each six-row plot were harvested for yield (2015). In all other years, each cut treatment or set of paired rows was used to determine yield. As the combine moved through the plot, the bagging attachment was engaged to collect a smaller subsample. The total sample was then transferred to an adjacent weigh buggy along with the subsample. The total mass was recorded. Moisture samples were collected, and all samples were dried below 10.5% moisture. The original subsample was split in half and one half was sent for an official grade. The other sample was held in reserve until all grades were returned.

**Irrigation System and Events**

Shallow subsurface drip irrigation systems were installed each year so that new tubing would always be evaluated. Following planting and peanut emergence, drip tubing was installed about two inches below the soil surface in alternate row middles, 6 ft apart (Sorensen et al., 2007; Sorensen and Lamb, 2015). Irrigation events for the sprinkler systems were scheduled using IrrigatorPro for peanut and verified with soil water potential sensors (Lamb et al., 2011; Lamb et al., 2014). Irrigation events for S3DI were scheduled using soil water potential sensors installed at a 10- and 20-inch soil depth. An event was scheduled when the average soil water potential of both sensors was between –50 and –60 kPa (Balkcom et al., 2004; Nuti et al., 2009).

**Drip Tube Evaluation**

After peanut harvest, drip laterals in each plot were manually removed from the soil and evaluated for biological damage. All repairs and holes that occurred during the growing season were counted and recorded. Because there were no drip tube laterals under the sprinkler system, these sites were used to determine possible yield reductions due to loss of peanut foliage for the five cut treatments.

**Statistical Analysis**

Sprinkler and drip irrigated fields were analyzed separately as well as by location. Treatments at all locations were arranged in a randomized complete block with a minimum of three (S3DI) and a maximum of six (sprinkler) replications per treatment. Sprinkler-irrigated fields were analyzed for crop yield, total sound mature kernels (TSMK), other kernels (OK), and total foliage removed during the growing season versus the cut treatment. Drip-irrigated fields were analyzed for crop yield, TSMK, OK, total foliage removed, and number of holes per area versus cut treatment. Data were subjected to general analysis of variance (ANOVA) procedure in Statistix10 (Analytical Software, Tallahassee, FL) within and across years. Yield data, TSMK, OK, foliage removed, and number holes were pooled across years when ANOVA F-test showed no significance ($p \leq 0.05$). Differences
Table 1. Yield, grade values, and foliage mass removed for peanut at individual locations for sprinkler irrigation during 2015.

<table>
<thead>
<tr>
<th>Location</th>
<th>Cut inch</th>
<th>Pod yield</th>
<th>TSMK⁺</th>
<th>OK</th>
<th>Foliage removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>HERC</td>
<td>0</td>
<td>4010a‡</td>
<td>78a</td>
<td>5a</td>
<td>0b</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>4080a</td>
<td>79a</td>
<td>5a</td>
<td>605a</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>3540a</td>
<td>78a</td>
<td>5a</td>
<td>797a</td>
</tr>
<tr>
<td>Bolton</td>
<td>0</td>
<td>5090a</td>
<td>78a</td>
<td>5a</td>
<td>0c</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>5200a</td>
<td>78a</td>
<td>5a</td>
<td>347b</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>4850a</td>
<td>78a</td>
<td>5a</td>
<td>723a</td>
</tr>
<tr>
<td>Newman</td>
<td>0</td>
<td>4150a</td>
<td>78a</td>
<td>4a</td>
<td>0b</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>4650a</td>
<td>78a</td>
<td>4a</td>
<td>656a</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>4130a</td>
<td>78a</td>
<td>4a</td>
<td>711a</td>
</tr>
</tbody>
</table>

† TSMK = total sound mature kernels; OK = other kernels.
‡ Mean yield values in each column followed by same letter(s) are not statistically different (p ≤ 0.05).

between variable means were determined using Tukey’s Honest Significant Difference (HSD) pairwise comparison when ANOVA F-test showed significance (p ≤ 0.05).

Forage Removal and Rodent Damage

Sprinkler Irrigation

At harvest, the total amount of forage removed prior to digging averaged about 2.5 tons acre⁻¹ across locations and years. There was no pod yield difference by cut gap for any of the three sprinkler locations tested (Table 1). The amount of foliage mass removed was significantly different with cut gap at the Bolton location compared with the other locations but only at the 8-inch gap treatment. Cut gap width had no effect on grade values of TSMK or OK across locations. The cut treatment of every row middle, as expected, had twice the amount of foliage removed compared with the alternate row middle without any difference in yield or grade (data not shown). The total amount of foliage removed from the cut treatments ranged from 350 lb acre⁻¹ (alternate row middle and 8-inch gap) to 1350 lb acre⁻¹ (cut every row middle and 16-inch gap) or about 7% to 27% of total foliage. This implies that the amount of foliage removed, up to 27%, did not seem to affect plant growth or affect peanut yield or grade. It was concluded from these data that cutting either an 8- or 16-inch gap in alternate row middles will not affect yield or grade and could be used on shallow subsurface drip irrigation.

Drip Irrigation

At harvest, the average total amount of forage that could be removed prior to digging averaged about 2.5 tons acre⁻¹, the same as the sprinkler systems described above. There was no yield or grade differences across the cut gap treatment (Table 2). There was also no difference in the amount of vine mass that was removed between the 8- and 16-inch gap treatment. There was more foliage removed with every row middle cut (880 lb acre⁻¹) versus the alternate row middle cut (570 lb acre⁻¹) or about 18% versus 11% of the total forage, respectively. At the Newman field site, there was a treatment the first year (2015) where about 70% of the forage was removed in the triangle shape describe previously. This treatment had a one-time cut only. There was an average of 4090 lb acre⁻¹ of forage removed or 82% of the total. Sorensen et al. (2009) showed forage cut at 90 or 120 days after planting removed about 70% of the total mass available. The difference in mass removed from this research to that of Sorensen et al. (2009) was possibly due to cultivar selection as well as meteorological differences with year. Pod yield decreased about 50% with no effect on grade parameters TSMK or OK. The reduction in pod yield in this research is much higher than that described by Sorensen et al. (2009) when cutting peanut foliage at about 90 days after planting. Sorensen et al. (2009) showed about a 12% yield loss with each cut. The difference in yield loss values of the two studies could be associated with different cultivars used and their response to cutting foliage during the growing season. This 70% cut treatment implies there is a level of forage removal where yield will be affected.

It was expected to have more foliage removed with the wider cut gap (16-inch) compared with the narrow-cut gap (8-inch). However, if peanut branches were cut just at or prior to overlap, then the difference total foliage between the 8- and 16-inch cut would not be that much different as all these branches are small in diameter and there would only be few branches. Later cut treatments would occur when peanut branches would just about overlap the drip tubing again with the same effect. It was noticed that as the coulter equipment moved through the field, peanut vines on the upper portion of the plant would be pushed out of the cutting path by the coulter without cutting the vine. Second and third cutting treatments may or may not cut these upper plant vines, again pushing them out of the way. Only vines that were long enough, extended into the row, and lower on the plant would be cut. Upper plant vines would be cut only when the branch was long enough and heavy enough not to be pushed out of the cutting path by the coulter.

Rodent Damage

The amount of rodent damage was variable by year (Table 3). There was minimal tube damage in high rainfall years (2017 and 2018) as well as the first year of the project (2015). The
most drip tube damage by rodents came in 2016 with only 11.7 inches of rainfall. There were only four inches of difference in rainfall between 2015 and 2016, however, the project in 2015 also had another project associated with this area which necessitated frequent visits to each individual plot for monitoring. These visits could have negatively impacted the invasion of rodents into the field area. In 2016 to 2018, each field area was a stand-alone project where the only field activity was for pesticide applications and to cut forage (up to three times depending on growth and climate). It is also hypothesized that during dryer conditions (2016), rodent invasion increased as animals would search for water. During other years, there was enough rainfall that irrigation was minimal, thus the search for water by rodents would have decreased.

Since 2016 was dryer and had greater damage to the drip tubing, data were analyzed independent of the other years (Table 4). There was no yield or grade difference with cut gap. There was no difference in the amount of foliage removed between the 8- and 16-inch cut gap. There was a higher amount of rodent damage as the cut gap decreased with over twice as many holes in the control and 8-inch gap compared with the 16-inch cut gap. This implies that within a closed peanut canopy, the foliage can be removed without loss to yield and can reduce rodent damage to the drip laterals.

**Conclusion**

The average amount of foliage removed with either the 8- or 16-inch cut gap was about 16% of the total forage available. Removing this amount of foliage did not result in any loss of yield. No yield loss would also imply no increase in plant damage that would affect yield. Therefore, it is possible to cut the peanut vines to add an open space adjacent S3DI tubing without loss of yield.

There was twice the amount of rodent damage to the drip tubing as the cut gap decreased from 16-inch to a closed canopy. This implies that more open space adjacent the S3DI laterals would reduce rodent damage.

Overall, it seems plausible that a grower could cut peanut foliage adjacent S3DI laterals without loss of yield and reduce rodent damage to the drip laterals. Less damage to drip laterals with peanut may increase the longevity of the drip tube laterals, reducing the per acre cost of this type of drip system.

<table>
<thead>
<tr>
<th>Year</th>
<th>Rainfall inches</th>
<th>Holes number/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>16.35</td>
<td>0</td>
</tr>
<tr>
<td>2016</td>
<td>11.74</td>
<td>59</td>
</tr>
<tr>
<td>2017</td>
<td>27.22</td>
<td>8</td>
</tr>
<tr>
<td>2018</td>
<td>22.58</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3. Total rainfall and average number holes in drip tubing across all cut treatments by year.

<table>
<thead>
<tr>
<th>Cut gap inch</th>
<th>Pod yield lb/ac</th>
<th>TSMK%</th>
<th>OK yield mass lb/ac</th>
<th>Foliage number/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5850±a†</td>
<td>69a</td>
<td>7a</td>
<td>4293a</td>
</tr>
<tr>
<td>8</td>
<td>5770±a†</td>
<td>70a</td>
<td>6ab</td>
<td>1276b</td>
</tr>
<tr>
<td>16</td>
<td>6010±a†</td>
<td>70a</td>
<td>5b</td>
<td>1267b</td>
</tr>
</tbody>
</table>

†TSMK = total sound mature kernels; OK = other kernels.
‡Mean yield values in each column followed by same letter(s) are not statistically different (p ≤ 0.05).

**References**


Table 4. Yield, grade values, foliage removed, and number of holes in drip tubing in 2016.


