UNIVERSITY OF GEORGIA
EXTENSION

Shallow Subsurface Drip Irrigation: A Tool for Organic Vegetable Growers

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Subsurface drip irrigation (SDI) has been utilized in farming for decades (Coolong, 2013). There has been more than 30 years of ongoing research projects using SDI in corn in the Midwest, and it is a viable irrigation method that can save water resources while maintaining yields on the loamy soils in the region (Lamm, 2023). Many permanent or semipermanent SDI systems are used in agronomic crops, such as corn, and are buried at soil depths of 16–20 in.

In contrast, shallow subsurface drip irrigation (SSDI) is a system that is typically buried at depths of 3–5 in. and is removed annually or after a cropping cycle is completed. Because of the shallow roots of many vegetable crops, SSDI systems are often preferred. This publication highlights some of the ongoing research into using SSDI in organic vegetable crop production. SSDI facilitates cultivation without harming drip tubing and limits surface soil wetting, which may also reduce weed pressure. Prior research has shown that SSDI offers some advantages over surface-placed drip tubing in conventionally grown crops (Coolong, 2016).

In organic systems, the movement of surface-placed drip tubing may be required every time the crop is cultivated, making it somewhat impractical on a larger scale. It is important to note that this research has been conducted in the Piedmont region of Georgia, which has clay and loam soils. These soils hold more water and allow for more lateral water movement—and thus may be better suited to SSDI—than the sandy soils found in the Coastal Plain region. At this time, SSDI has not been thoroughly researched on the sandy soils of southern Georgia and it may not be a suitable alternative for farms in the region.

Shallow subsurface drip irrigation can be placed using a variety of implements. We utilize a purpose-built toolbar with drip reels and tubes modified from a bed shaper/plastic layer on our research site, but growers can use a variety of methods to install SSDI on their farms (Figure 1).

Figure 1. Two examples of SSDI tools. On the left is a sled-type device, while the implement on the right uses small tires to maintain a constant depth with the soil surface.

In research trials in Watkinsville, GA, the SSDI was placed between 4 and 5 in. deep (Figure 2). In spring we grew a large-seeded crop, sweet corn, and in the fall we grew transplanted broccoli. In both crops, a line of drip tubing was buried approximately 3–4 in. from the planted row.

Video showing one method of burying drip tubing from the edge of a field.

Figure 2. Overhead irrigation (right/bottom area of image) compared to SSDI (left side of image). Notice the small circles of surface wetting in the SSDI portion of the field. While soil moisture was adequately maintained below the surface, very little surface wetting was observed, resulting in less weed pressure.

In 2021 and 2022 we were able to successfully germinate sweet corn in spring and establish broccoli in the late summer using SSDI. Plots were compared to overhead irrigation as a control. In addition to comparing SSDI and overhead irrigation, two cultivation regimes reflective of tools available to organic growers in the region were compared (low input and high input), as well as non-weeded and fully hand-weeded control plots. The low-input cultivation regime featured a three-point hitch-mounted tine weeder that was used approximately once per week for 3–4 weeks after establishment. The high-input cultivation regime featured the tine weeder (Figure 3) in addition to a finger weeder mounted on a tractor that was specifically designed for cultivation. Cultivation ceased when plants were too tall to drive over (in the case of corn) or had formed complete canopies and could no longer be cultivated without damaging the crop (in the case of broccoli).


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Figure 3. A tine weeder (left) and finger weeder (right) used in cultivation research. Drip irrigation lines are buried to a depth of roughly 4 in. so they do not interfere with cultivation and are not damaged by the equipment.

Soil moisture levels were measured with a probe that was inserted in the soil at a depth of approximately 6 in. equidistant between two planted rows (and drip lines) in both SSDI and overhead-irrigated plots (Figure 4). Average soil moisture results suggest that the SSDI system maintained slightly greater moisture at a depth of 6 in. compared to overhead watering when applying the equivalent amount of irrigation water (Figure 5). While one might expect SSDI to maintain greater subsurface soil moisture than overhead watering, it is important to note that sensors were placed between the drip lines, which suggests that there is sufficient movement of water laterally in the Cecil loam soils where the trials were conducted. Maintaining adequate soil moisture throughout the soil profile while also preventing surface wetting is an advantage of SSDI.

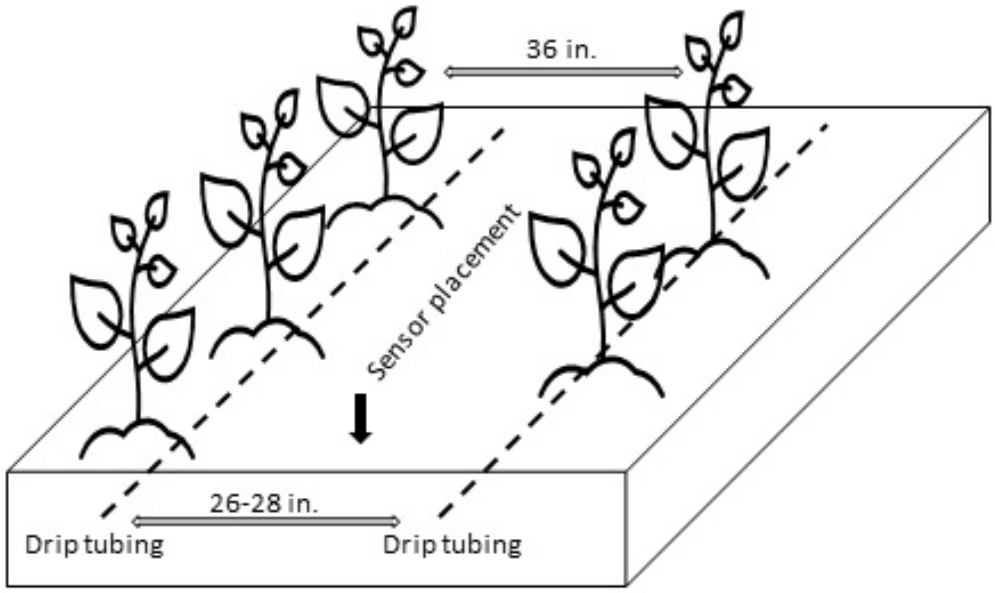

Figure 4. Layout of SSDI and sensors in the field.

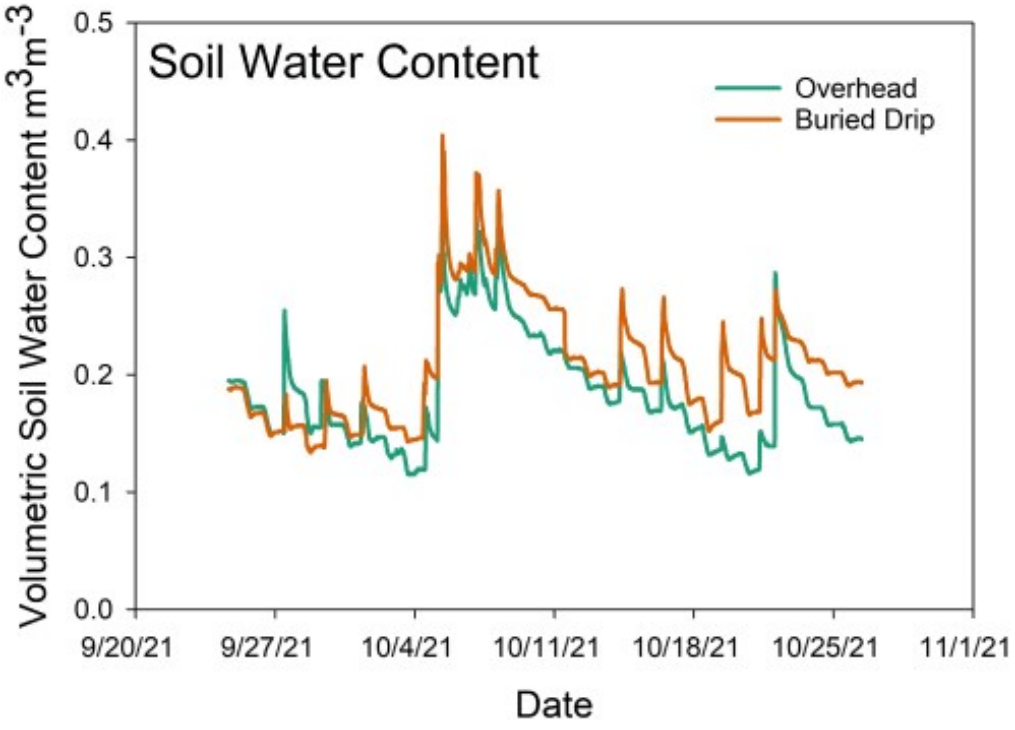

Figure 5. Average soil moisture levels in SSDI and overhead irrigated plots for fall-grown broccoli in 2021. The brown line is buried drip, while the green line is overhead watering. An increase in volumetric water content corresponds to increased soil moisture. Large increases in soil moisture in early October correspond to significant rainfall events.

Because of the lack of surface wetting, it is expected that SSDI systems will have less weed pressure than a comparable overhead system—particularly in periods of dry weather. During

periods of frequent rainfall, the difference in surface wetting between the two methods is minimized. Our research findings support this. In our research at UGA, we found that the SSDI system had less weed biomass compared to overhead irrigated plots and cultivation tended to reduce weed pressure in the SSDI plots to a greater extent than in overhead irrigated plots. Figure 6 shows sweet corn at harvest in different cultivation and irrigation treatments.


Drip Irr. Low Input
Cultivation


Drip irr. High input
cultivation


Overhead Irr. Low
Input Cultivation

Figure 6. Comparison of corn grown with different irrigation and cultivation methods. L to R:

SSDI low-input cultivation, SSDI high-input cultivation, overhead-watered low-input cultivation, overhead-watered high-input cultivation. Low-input cultivation (tine weeder only) with SSDI had comparable weed pressure to the high-input cultivation in overhead-irrigated organically grown sweet corn.

Figure 7. Comparison of broccoli grown under different cultivation methods; all plots shown were overhead irrigated. L to R: Non-weeded control, low-input cultivation (tine weeder only), high-input cultivation (tine plus finger weeder) and hand-weeded control plots. Despite a small number of grass weeds, the high-input cultivation was much cleaner than the low-input cultivation plots with overhead irrigation.

SSDI also was evaluated with different cultivation regimes in a fall-grown broccoli crop to

determine how well SSDI would perform during the establishment of a transplanted crop under the high temperatures experienced during planting in late August. Because of the fast growth associated with fall-planted broccoli, plants formed a canopy within 3 weeks of planting, limiting cultivation past this point. The charts in Figure 8 compares yields among broccoli grown using different cultivation regimes with buried drip or overhead irrigation.

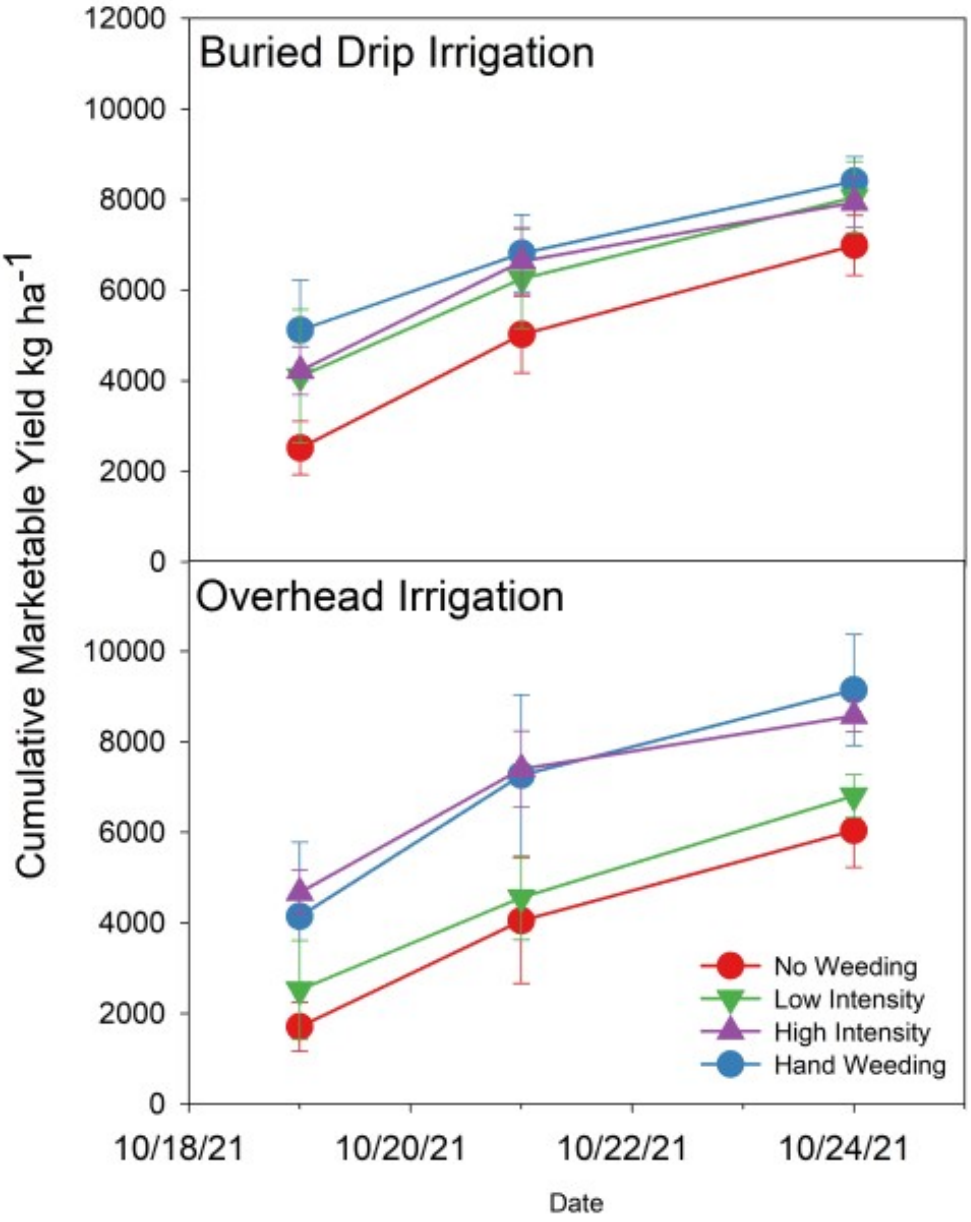

Figure 8. Yields of broccoli with different irrigation and cultivation regimes. The SSDI-grown plants were able to be managed with a lower input cultivation strategy (tine weeder only) and get comparable yields to a hand weeded control.

Similar to sweet corn, we found that the irrigation method interacted with cultivation for

broccoli yield. Broccoli grown with SSDI had equivalent yields with low-input and high-input cultivation and hand-weeded control. In the overhead irrigated broccoli, the high-input cultivation practices and hand-weeded controls yielded similarly, but the low-input cultivation practices did not yield as well (Figure 8). Broccoli was of high marketable quality with 5-in. crown cuts.

In general, we found that SSDI could work well for organic growers as it can be used in combination with regular tillage. At the end of the season, the emitter flow rate was not impacted by placement in the soil with no root intrusion observed. SSDI coupled with routine tillage with a tine weeder provided similar weed control as did overhead watering combined with a high-intensity tillage regime featuring tine weeders and a dedicated cultivating tractor with finger weeders. In our study, each planted row had a dedicated drip line placed 3–4 in. away from the row at a depth of 4–5 in. We did not evaluate whether an SSDI drip line placed equidistant between the two rows of plants would work as well. We anticipate that establishment of the crop would be challenging with only a single line of drip tubing between two rows of plants and we would not encourage growers to use only a single line without conducting research on their farms. Further, while we were able to successfully germinate a large-seeded vegetable such as sweet corn, given the lack of surface wetting, more research would need to be done before recommending SSDI for small-seeded vegetable crops.

Key takeaways:

- SSDI reduced weed growth and surface wetting.
- Soil moisture levels at a depth of 6 in. were slightly higher with SSDI compared to overhead irrigation.
- Crops performed at a commercially acceptable level with SSDI.
- SSDI facilitated routine cultivation in an organic production system.
- Accurate placement (depth and proximity to the planted row) is critical to success.
- Water savings were not evaluated in this research.
- Establishment of small-seeded crops with SSDI has not been evaluated in Georgia and at this time is not encouraged due to a lack of research.
- This research was conducted on soils in the Piedmont region of Georgia and has not yet been conducted on lighter soils of the Coastal Plain.

References

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