DRAINAGE AND IRRIGATION EFFECTS ON COTTON PRODUCTION

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ABSTRACT. *Excessively wet and dry soil conditions can occur during the same year in the southeastern Coastal Plain of the United States. Water management systems that provide both subsurface drainage during wet soil conditions and irrigation during dry soil conditions are desired. Several water table management alternatives, possibly with surface irrigation such as microirrigation, could satisfy these needs. Three water table management (WTM) systems and microirrigation were evaluated for three cotton cultivars on a southeastern Coastal Plain soil during 1987-1989. The WTM systems included controlled drainage-subirrigation (CDSI), controlled drainage (CD), and subsurface drainage (SSD). All WTM systems had both surface microirrigation and rainfed treatments. Cotton cultivars were Coker 315, DPL 50, and DPL 90. Seasonal rainfall, subirrigation, and microirrigation amounts varied considerably during the three-year period. Water requirements for subirrigation in the CDSI system were high (1477 to 2841 mm), but neither microirrigation nor subirrigation water requirements were closely related to seasonal rainfall amounts. Cotton lint yields among WTM systems were significantly different in two of three years; yields for the CDSI system were lowest (836 and 766 kg/ha) and yields for CD and SSD were highest (1022 and 942 kg/ha, respectively). Wetter-than-optimum soil conditions in all irrigated treatments, especially in combination with the CDSI system, probably caused the reduced yield. Microirrigation produced significantly greater lint yields than the rainfed treatments in the first two years of the study (1127 and 1116 kg/ha versus 492 and 801 kg/ha), but not in the last year (872 versus 874 kg/ha) when seasonal rainfall was least of the three years but was better distributed. There were significant yield differences among cotton cultivars in two years, but no cultivar consistently produced the greatest or least yield. Cotton yield increases obtained with these WTM system-microirrigation combinations suggest the need to control the water table closer to the soil surface in southeastern Coastal Plain soils when surface irrigation is not used. The CDSI could provide a profitable management alternative if a water table fluctuates near the soil surface much of the time, especially during the growing season. Where subsurface drainage is needed part of the year, it may be more profitable to use CD or SSD systems with surface irrigation, especially when maintaining the water table near the soil surface in CDSI systems requires a large water volume. However, the combined cost of the subsurface drainage and microirrigation systems would be very high and might not be profitable for crops such as cotton.* **Keywords.** *Controlled drainage, Subirrigation, Microirrigation, Trickle irrigation, Subsurface drainage, Cotton, Water table control.*

Erratic rainfall distribution and low water storage capacity of coarse-textured soils in the southeastern Coastal Plain of the United States can cause both excessively wet and excessively dry soil conditions in the same growing season. Most soils in this region store enough water to support plant growth for only 5 to 15 days. Although annual, and often seasonal, rainfall is equal to or greater than evapotranspiration (ET), the distribution is so erratic that drought periods during the growing season occur in most years. Because periods of high rainfall can cause shallow water tables that fluctuate within 2 m of the surface of some soils, drainage is often required; however, crops on these same soils can suffer from drought stress during low rainfall periods. Water management systems that provide subsurface drainage during wet soil conditions and irrigation during dry soil conditions are ideal.

Several water table management (WTM) systems have been proposed and evaluated in recent years. Skaggs (1973), Skaggs et al. (1973), Doty et al. (1975), and Doty and Parsons (1979) showed that controlled drainage systems could produce satisfactory crop yields in southeastern Coastal Plain soils. Investigations by Williamson and Kriz (1970), Hiler et al. (1971), Campbell and Seaborn (1972), Williamson and Gray (1973), Follett et al. (1974), Rogers and Harrison (1974), Doty et al. (1975), and Hunt et al. (1993) indicate that best crop yields are obtained when water tables are maintained from 0.6 to 1.0 m below the soil surface. Skaggs (1977)

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found that overdrainage could occur in coarse-textured soils of the southeastern Coastal Plain and suggested closer drain line spacings (30 m) for subirrigation systems to minimize this effect during drought. Follett et al. (1974), Tovey (1969), and Carter and Floyd (1973) found that providing surface irrigation in systems where the water table was maintained within 1 m of the soil surface produced no increase in crop yield (corn, sugar beet, alfalfa, and sugar cane); however, some of these soils were fine-textured and had higher water storage capacities than soils of the southeastern Coastal Plain.

Most research with WTM systems has been done with water-intensive crops such as corn and sugar cane, or with soybean. With eradication of the boll weevil and improved market price, land area planted to cotton has increased in the Coastal Plain of the southeastern United States. The objectives of this study were to determine yield response of cotton to:

- Three different WTM systems.
- Surface microirrigation in combination with three WTM systems.
- Determine water requirements for both WTM and microirrigation systems.

Materials and Methods

The experiment was conducted on a 1.7-ha site of Eunola loamy sand (Aquic hapludults) that had a surface slope of 0.75% in the direction of the subsurface drains, but had no side slope. Treatments included three WTM systems, rainfed or microirrigation, and three cotton cultivars. The three WTM systems were controlled drainage-subirrigation (CDSI), controlled drainage (CD), and subsurface drainage (SSD) (fig. 1). In the CDSI system, water elevation in the drainage outlet control sump was adjusted to maintain the field water table at the desired elevation throughout the growing season. The control sump water elevation varied between 0 and 0.30 m above the soil surface, depending primarily upon rainfall amount, except during significant rainfall, when it was as low as 1 m below the soil surface. Water was pumped into the sump whenever necessary to maintain the desired water table elevation. In the CD system, the drainage outlet elevation was set to control the field water table at 0.6 m below the soil surface or lower, but no additional water was added. In the SSD system, water was allowed to drain freely from all drains throughout the season. Drain lines in all treatments were 65 m long. In the CDSI system, the drain lines were 80-mm-diameter, perforated, corrugated PVC conduits wrapped in coconut fiber and were installed with a laser-controlled drain-tube plow in 1974. These drain lines were spaced 8 m apart and had a slope of 0.2%. The drain-line depth in the experimental area varied from 0.9 m near the drainage outlet to 1.2 m at the other end. The three drain lines were connected to a nonperforated 200-mm-diameter main line that was perpendicular to the perforated laterals. The main line was connected to a constant head tank, which controlled the water entering or leaving the plot area via the drain line. Water was supplied to the constant head tank by a pump submerged in an adjacent pond. The volume of water pumped was measured by an in-line flow meter, which was observed and the data recorded five times each week.

Inside the CDSI constant head tank, a V-notch weir box was connected to the tank drainage outlet via a flexible tube. The water table in the experimental area was managed by manually adjusting the height of the weir box within the tank. The irrigation water supply was controlled by a float-operated switch mounted on the weir box. When the weir box height was adjusted to a higher or lower position, the irrigation float switch automatically adjusted also. Drainage occurred when the tank water level rose above the V-notch weir. Drainage volume from the experimental area was calculated from measurements of water elevation inside the tank (elevation changes and number of pump cycles). When subirrigation was required,

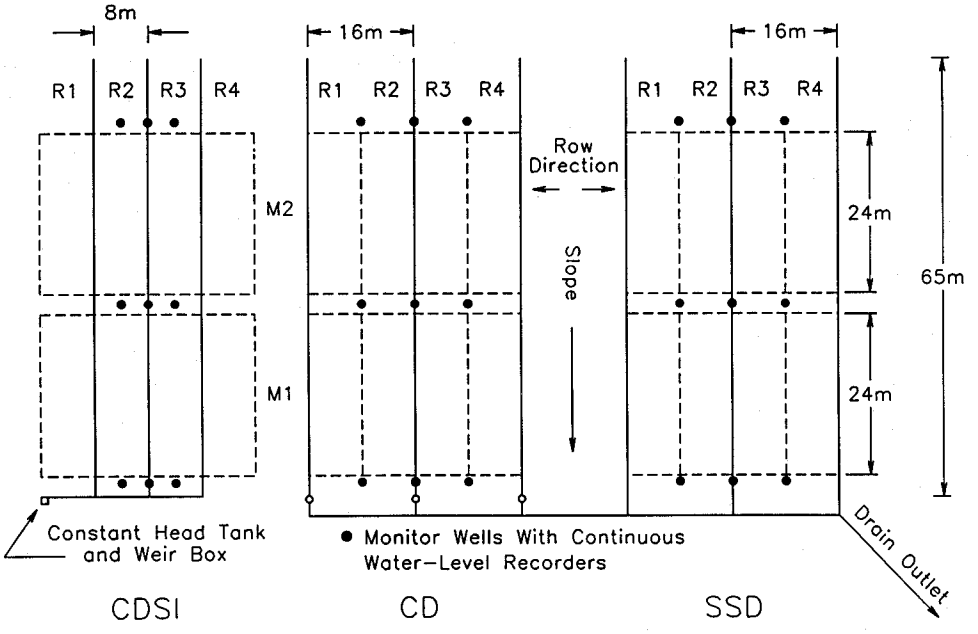

Figure 1–Diagram of experimental site showing three WTM systems, drain line locations (solid lines), well locations (solid circles), row direction, and plot boundaries (dashed lines) for each system. Replications are indicated by R1 to R4 and irrigation treatments by M1 and M2.

water flowed from the tank into the field through the main and perforated lateral drains. When the tank water level dropped about 60 mm below the V-notch of the weir box, the float-controlled electrical switch activated the pump and refilled the tank to the bottom of the V-notch weir. Additional details regarding drain line installation and operation of the constant head tank were reported by Doty and Parsons (1979).

Drain lines in the CD and SSD treatments were 100 mm diameter, corrugated polyethylene tubing and were spaced 16 m apart. These drain lines were installed with a trencher in 1978, replacing the original, coconut-fiber-wrapped drain lines in this portion of the experimental area. In the CD system each drain line was connected to a separate collection sump where the drainage outlet was 0.5 m above the bottom of the field drain line. This setting allowed the water table halfway up the drain line length to rise to within 0.6 m of the soil surface. During periods of low rainfall the water table dropped below this control point. Drainage water volume discharged from the CD system area was calculated from sump water level measurements recorded with a water level recorder. Drainage water in the SSD system was allowed to flow continuously through a gravity drain whenever drainage occurred. Drainage volume in the center drain of the SSD system was measured using a slotted tube inserted into the drain line. The slotted tube was connected to a stilling well where water elevation was measured continuously with a water level recorder.

Within each WTM system, two blocks, each 32 m × 24 m, were located over the drain lines. One of the blocks was irrigated using microirrigation on the soil surface and the other block received only rainfall. Four replications extended across all rows in a direction parallel to drain lines; consequently, row direction was perpendicular to drains. Three cotton cultivars were randomly assigned to plots within each replication of a WTM-microirrigation treatment combination (fig. 1). Chapin Twin-Wall microirrigation tubing with outlet spacings of 0.20 m (external) and 1 m (between chambers), and a water delivery rate of 95 mL min^{-1} m^{-1} was installed on the surface in each row in 1987 and 1988. In 1989, Chapin Turbulent Twin-Wall tubing with outlets spaced 0.23 m apart and a water delivery rate of 60 mL min^{-1} m^{-1} was used. Irrigation timing and application amounts were determined using a water balance technique with daily ET estimated from screen-covered pan evaporation measurements (Campbell and Phene, 1976) and crop coefficient values obtained from the Soil Conservation Service (1970). Irrigation to refill the soil profile to the upper limit of available water (field capacity) was applied any day the soil water deficit was at least 12 mm.

Daily rainfall and pan evaporation amounts were measured with a recording rain gauge and a screen-covered Class A evaporation pan adjacent to the site. Water table elevation within each treatment area was measured continuously using water level recorders at nine locations within each WTM treatment area, two at the midpoint between drains and one near the middle drain line, and all at three different locations along the drain lines (fig. 1).

Three cotton cultivars [Deltapine 50 (DPL 50); Deltapine Acala 90 (DPL 90); Coker 315] were planted on 30 April 1987, 4 May 1988, and 17 May 1989 to provide a plant population of about 88,000 plants/ha. Broadcast preplant fertilizer included 98, 36, and 105 kg/ha N, P, and K in 1987; 42, 18, and 35 kg/ha N, P, and K in 1988; 21, 29, and 56 kg/ha N, P, and K in 1989. One additional N application of 76, 74, and 70 kg/ha in1987, 1988, and 1989, respectively, was made each year. The P and K fertilizer amounts were determined by soil test in 1988 and 1989, but soil test data were not available in 1987. The N fertilizer recommendations by Clemson University Extension Service (70 kg/ha) were used as a guideline in determining N fertilizer rates each year. Temik was applied at planting each year to control thrips, and weekly applications of Pydrin and Fundal were made beginning in June each year to control *Heliothis* spp. Defoliant (DEF + PREPP) was applied on 14 September 1987, but no defoliant was applied in 1988 or 1989 because of extreme variation in crop maturity.

Tensiometers were installed at five depths (0.15, 0.30, 0.45, 0.60, 0.90 m) at each of two locations within each WTM system-microirrigation treatment combination. All tensiometers were located between drains, from the quarterpoints to midpoints, in all WTM treatments. Tensiometers were serviced as required and measurements were recorded three times each week. Rainfall, pan evaporation, irrigation amount, water volume added to and removed from the CDSI system, and water table depths in all treatments were recorded manually at least daily (five days per week). A 2-m^2 area sample from one row in each plot was harvested by hand on 17 September 1987, 18 October 1988, and 10 October 1989 to determine yield. Cotton lint yield was calculated from lint percentages determined from samples collected from each plot. Cotton yields were analyzed as a split-split plot design with four replications using analysis of variance (ANOV) and least significant difference (LSD) procedures each year.

Results and Discussion

Water Table Control

Seasonal rainfall and irrigation for all WTM treatments and seasonal subirrigation amounts for the CDSI system during 1987, 1988, and 1989 are included in table 1. Daily rainfall and irrigation amounts during the growing season for all years are shown in figures 2 through 5. Rainfall amounts were about 25% greater in 1988 than in 1987 and microirrigation amounts were also slightly greater in 1988. Both seasonal rainfall and microirrigation amounts were less in 1989 than in either 1987 or 1988, but rainfall distribution during the growing season was better. Rainfall that occurred during August (days 220 and 230) significantly reduced the irrigation requirement in 1989. High winds (42 m/s) occurred on 21 and 22 September 1989 in association with Hurricane Hugo, but there was little rainfall. Soil at the 0.3 m depth in the microirrigation treatments was wetter than desired during the growing season all years. This suggests that the irrigation management technique, a water balance method that used pan evaporation to estimate ET, called for excessive irrigation amounts, especially in 1988. To maintain the desired water table elevation in the CDSI system, 1477 mm, 2841 mm, and 2556 mm of water (calculated as equivalent rainfall for the area) was pumped into the system in 1987, 1988, and 1989, respectively (table 1).

Table 1. Seasonal irrigation and rainfall amounts for three WTM systems, all with and without microirrigation, for a southeastern Coastal Plain soil

Year/ Treatment	Rainfall (mm)	Micro-irrigation (mm)	Sub-irrigation* (mm)	Total (mm)
1987				
CD†	423	278	---	701
CDSI	423	290	1477	2190
SSD	423	270	---	693
1988				
CD	559	314	---	873
CDSI	559	312	2841	3712
SSD	559	299	---	858
1989				
CD	361	152	---	513
CDSI	361	146	2556	3063
SSD	361	147	---	508

* Rainfall equivalent to water volume added as subirrigation for the CDSI system area.

† Treatment codes are defined as CD = controlled drainage; CDSI = controlled drainage-subirrigation; SSD = subsurface drainage.

These values are considerably greater than those reported for a comparable system operated on the same site during the period 1975 to 1977 (Doty and Parsons, 1979). The water volume required in 1987 was less than in other years, in part because the CDSI system was activated more than a month later than in 1988 or 1989, but that decrease in operating time would not account for the difference in water volume measured. The large water volume required for the CDSI system probably was caused by lateral and vertical losses through the coarse-textured subsoil. Doty and Parsons (1979) experienced difficulty in maintaining a shallow water table in this system during a previous experiment. They raised the control sump water elevation above the soil surface in an effort to obtain acceptable system operation, but were not entirely successful. The water volume required to maintain the water table is not closely related to seasonal rainfall amounts during any of the three years although rainfall is the predominant factor affecting water table elevation in these soils. The total water volume required for the CDSI-microirrigation treatment (water table and microirrigation) was three to six times greater than that required by the CD-microirrigation and SSD-microirrigaton treatments during each of the three years. Although the pump in the CDSI system required relatively low power (very low pressure head), the much greater water volume required (even if the water volume is reduced by the volume needed for microirrigation) would result in greater operating costs.

Water table depths at the midpoint between drain lines for the three WTM treatments during all three growing seasons are shown in figure 2. As expected, the water table fluctuated nearer the soil surface in the CDSI system most of the growing season each year, but water table depths were not closely related to the water volumes applied. Water table depths in the CD and SSD treatments were deeper than in the CDSI system in 1987. In 1988 and 1989, water table depths in the CD and CDSI systems were more similar than in 1987 although a large volume of water was added to the CDSI system. The water table in the SSD often dropped below the bottom of monitoring wells and

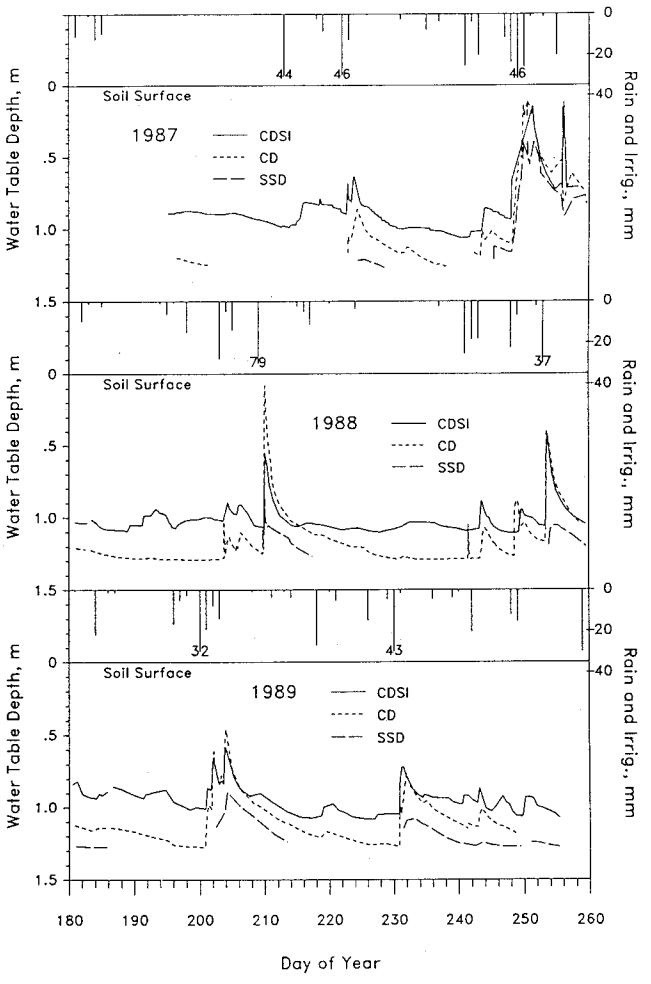

Figure 2–Water table depth and daily rainfall for three WTM systems during the cotton growing seasons in 1987, 1988, and 1989 on a southeastern Coastal Plain soil. Each data point is the mean of values for wells at two locations midway between parallel drains and about midway along the drain length. Numbers adjacent to daily rainfall amounts indicate off-scale values.

could not be measured all three years, but was above the well bottom more of the season in 1989 than in other years. Because there were no barriers around the perimeter of each WTM system, lateral water losses from the CDSI system could have influenced the water table in the CD and SSD treatments. However, almost no drainage outflow was measured from any WTM system during any growing season. A trace of outflow was recorded for the SSD system on a few occasions and minimal outflow was measured for the CDSI system when the weir box was lowered in anticipation of rainfall. Apparently water losses from the CDSI system were greater in the downward direction than in the lateral direction, which prevented the losses from affecting the water table in the CD and SSD systems enough to cause drain discharge. However, it is possible that the large water volume moving predominantly downward from the CDSI system could have caused the water table in the immediate area of the experiment to rise, which would have indirectly affected the water table in the CD and SSD systems.

Soil matric potential values at the 0.3 m depth were −10 kPa or greater after day 210 in 1987 for all WTM

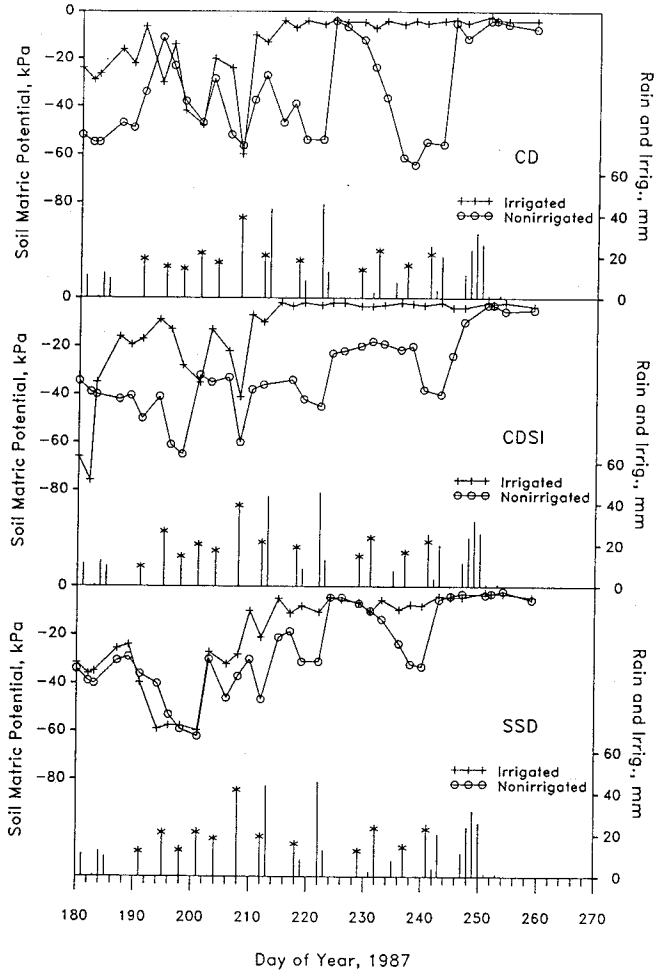

Figure 3–Soil matric potential at the 0.3 m depth during the growing season for three WTM systems, both with (+) and without (o) surface microirrigation, in 1987 for cotton. Each data point is the mean of two locations within a WTM-microirrigation treatment. Daily rainfall and irrigation (stars) amounts are indicated at the bottom of each panel.

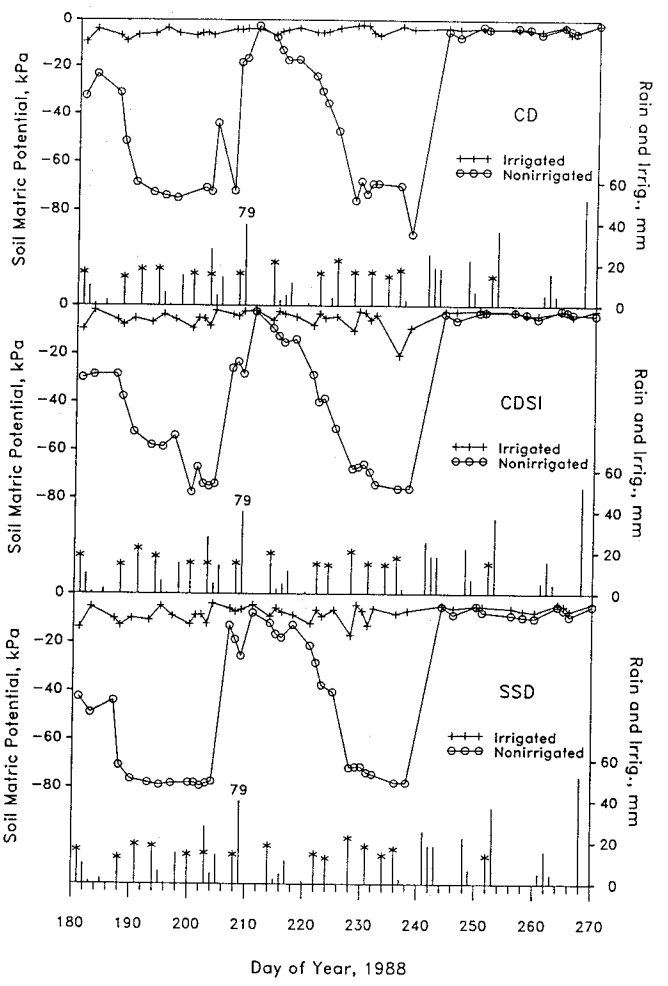

Figure 4–Soil matric potential at the 0.3 m depth during the growing season for three WTM systems, both with (+) and without (o) surface microirrigation, in 1988 for cotton. Each data point is the mean of two locations within a WTM-microirrigation treatment. Daily rainfall and irrigation (stars) amounts are indicated at the bottom of each panel. Numbers adjacent to daily rainfall amounts indicate off-scale values.

treatments with microirrigation, but values for the CDSI and CD systems were slightly greater than those from the SSD system (fig. 3). Although only matric potential values at the 0.30 m depth are reported, values at other depths, especially the 0.15 and 0.45 m depths, are similar and reflect similar trends. All values were significantly less (–60 to –10 kPa) through July (day 180 to day 210), which was probably caused by start-up problems with the microirrigation system. Matric potential values for the rainfed treatments were less than those for irrigated treatments in all WTM systems except during the first half of the growing season when the differences were often small, especially in the SSD system. In 1988, soil matric potential values were greater than –15 kPa throughout the growing season for all WTM systems with microirrigation, but were slightly wetter in the CDSI and CD systems most of the time (fig. 4). Matric potential values were much less for rainfed treatments than for microirrigated treatments on all WTM systems during the 1988 growing season except for short time periods following significant rainfall. In 1989, matric potential values for all WTM systems with microirrigation were greater than –15 kPa except for a period between days 180 and 200 when the soil was drier (–45 kPa to –10 kPa) (fig. 5). As in previous years, soils in the CDSI and CD systems were slightly wetter than the soil in the SSD system for most of the growing season. Differences in matric potential between the microirrigated and rainfed treatments were greater in 1988 than in 1987 but not as great as in 1989, and differences were greatest during the first half of the growing season. Matric potential differences between the CD and CDSI systems were less than between the SSD and CDSI systems in 1989. There was little difference in soil matric potential values among the rainfed WTM systems in all years, indicating little water table effect in the surface 0.30 m of the soil profile. Most soil matric potential values measured during the three-year period were generally high for all microirrigated treatments, indicating that less irrigation water could have been applied. The upper limit of available soil water (field capacity) is about –10 kPa for this soil, but consistent soil matric potential values above –10 kPa can cause root zone oxygen deficiencies (Campbell and Phene, 1977).

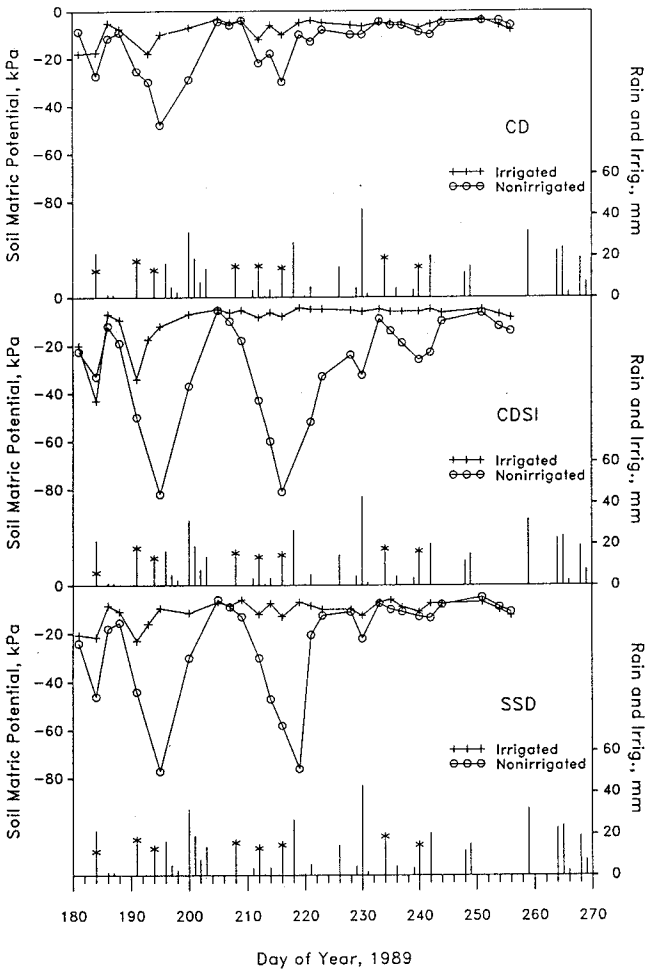

Figure 5–Soil matric potential at the 0.3 m depth during the growing season for three WTM systems, both with (+) and without (o) surface microirrigation, in 1989 for cotton. Each data point is the mean of two locations within a WTM-microirrigation treatment. Daily rainfall and irrigation (stars) amounts are indicated at the bottom of each panel.

Cotton Yields

Cotton lint yields for six WTM system-microirrigation treatment combinations for each of the three years are included in table 2. In 1987 there were no significant yield differences among the three WTM systems; however, for rainfed conditions, yield for the CDSI system was numerically greater than for the CD and SSD systems. Cotton lint yield was significantly greater for the microirrigated treatment (1127 kg/ha) than for the rainfed treatments (492 kg/ha) in 1987. Differences in cotton lint yields among WTM systems were numerically greater in 1988 than in 1987, and yield for the CDSI system was significantly less than yields for the other two WTM systems. Mean yield for the rainfed treatments (801 kg/ha) in 1988 was greater than in 1987, but again was significantly less than the mean yield for microirrigation treatments (1116 kg/ha). Mean cotton lint yields for WTM systems in 1989 were intermediate between mean yields for the two previous years except for the CDSI system, which yielded less. In 1989, some cotton lint and seed were removed by winds associated with Hurricane Hugo, which occurred after some cotton bolls opened, and probably caused most yields to be low that year. Because no difference in boll opening among treatments was observed, the yield reduction was assumed to be uniform across all treatments. Mean yield for the CDSI system was significantly less than yield for the SSD system, and yield for CD was not significantly different from yield for either SSD or CDSI. There was no significant difference between mean cotton yields for the microirrigation and rainfed treatments in 1989, possibly because of better rainfall distribution and differential losses caused by Hurricane Hugo.

Table 2. Mean lint yield of three cotton cultivars for three WTM systems, all with and without microirrigation, on a southeastern Coastal Plain soil

Year/ Treatment	Cotton Lint Yield		
	Irrigated (kg/ha)	Rainfed (kg/ha)	Mean (kg/ha)
1987			
CD*	1224	485	854 a†
CDSI	1013	603	808 a
SSD	1143	387	765 a
Mean	1127 a	492 b	
1988			
CD	1158	886	1022 a‡
CDSI	1013	658	836 b‡
SSD	1177	858	1017 a‡
Mean	1116 a	801 b	
1989			
CD	887	935	911 ab‡
CDSI	805	726	766 b‡
SSD	926	959	942 a‡
Mean	872 a	874 a	
All Years			
CD	1090	769	929
CDSI	944	662	803
SSD	1082	735	908
Mean	1039	722	

* Treatment codes are the same as those defined in table 1.

† Means followed by same letter within either a column or row in the same year are not different using least significant difference at P = 0.05 unless otherwise noted.

‡ Differences among these means were significantly different by LSD at P = 0.05 and ANOV at P = 0.07.

Cotton lint yields for the CDSI system were numerically less than for other systems in all years, for both microirrigation and rainfed treatments, except for the rainfed treatment in 1987. This may reflect marginally wet soil conditions during much of the growing season, especially with microirrigation. The greater yield variance in 1988 may have been caused by low plant population and poor seedling vigor, which was caused by unfavorable weather and soil conditions at planting. Differences in fertilizer rates during the three years, especially for N, should not have affected yield because all were at least equal to general recommendations for the soil and crop. The N fertilizer rate in 1987 was greater than in other years, and was probably excessive, especially for the cotton yields produced that year.

There were significant differences in cotton lint yield among cultivars in both 1988 and 1989 but not in 1987, as shown in table 3. In 1988, lint yield for DPL 50 was significantly greater than yield for Coker 315, but neither were different from DPL 90. In1989, yield for Coker 315

Table 3. Cotton lint yield of irrigated and rainfed treatments for three cotton cultivars and three WTM systems during 1987 through 1989

Year/ Treatment	Cultivar: Coker 315 (kg/ha)	DPL 50 (kg/ha)	DPL 90 (kg/ha)	Mean (kg/ha)
1987				
CD*	947	813	847	854 a†
CDSI	777	851	850	808 a
SSD	745	803	831	765 a
Mean	823 a	822 a	843 a	
1988				
CD	870	1044	1152	1022 a‡
CDSI	787	1019	700	836 b‡
SSD	1006	1017	1030	1017 a‡
Mean	888 b	1027 a	961 ab	
1989				
CD	1015	844	875	911 ab‡
CDSI	837	774	685	766 b‡
SSD	1050	824	953	942 a‡
Mean	967 a	814 b	838 b	
All Years				
CD	944	900	958	929
CDSI	800	881	745	803
SSD	934	881	938	908
Mean	893	887	880	

* Treatment codes are the same as those defined in table 1.

† Means followed by same letter within either a column or row in the same year are not significantly different using least significant difference (LSD) at P = 0.05 unless otherwise noted.

‡ Differences among these means were significantly different by LSD at P = 0.05 and ANOV at P = 0.07.

was significantly greater than yields for both DPL 50 and DPL 90. Because no cultivar consistently produced the greatest yield, these yield differences were most likely caused by other factors and cannot be explained by the data collected.

Summary and Conclusions

Cotton lint yield was determined for three WTM systems, microirrigation, and rainfall-only treatments, and three cotton cultivars during 1987, 1988, and 1989 on a southeastern Coastal Plain soil. Seasonal rainfall, irrigation, and subirrigation (CDSI) amounts varied widely during the three-year period, but microirrigation and subirrigation water requirements were not closely related to seasonal rainfall amounts. The subirrigation water volume required to maintain the water table in the CDSI system was much greater than required at the same site in a previous experiment. Water loss through the soil profile, both laterally and vertically, is the most likely reason for the large subirrigation water requirement. Microirrigation was scheduled using pan evaporation and a water balance procedure. This technique required more irrigation than was necessary for good cotton growth and yield, as indicated by soil matric potential measurements near –10 kPa for much of the growing season.

There were significant yield differences among the WTM systems in 1988 and 1989, when mean cotton yield for the CDSI system was less than for CD and SSD in 1988 and less than SSD in 1989. Yields for the microirrigation treatment were significantly greater than for rainfed treatments in 1987 and 1988, but not in 1989 when seasonal rainfall was least of the three years. Better rainfall distribution and differential yield losses caused by Hurricane Hugo in 1989 may have affected measured yield. The lesser yield for the CDSI system, especially in combination with microirrigation, may have been caused by wet soil conditions during the growing season, which was caused primarily by microirrigation. Significant yield differences among cotton cultivars occurred in 1988 and 1989, but no cultivar consistently produced the greatest yield.

Significant cotton yield increases were obtained with microirrigation, even where the water table was maintained within 1 m of the soil surface during the growing season. For the coarse-textured soils in the southeastern Coastal Plain, it may be necessary to maintain the water table closer to the soil surface when surface irrigation is not used and rainfall does not satisfy ET requirements. Based on results at this site, CDSI is not recommended for similar sites because the system could not maintain the water table near enough to the soil surface to satisfy crop water needs and it required a very large volume of water. The CDSI possibly could provide a profitable water management alternative for sites where the water table fluctuates near the soil surface much of the year, particularly during the growing season, and the volume of supplemental water needed to maintain the water table is not great. When subsurface drainage is required sometime during the year, either controlled drainage or subsurface drainage, in combination with microirrigation, could provide equivalent or greater yields and would not require as much water. However, the combined cost of the subsurface drainage and microirrigation systems would be very high, and probably would not be profitable for crops such as cotton.

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