MICROIRRIGATION SCHEDULING AND TUBE PLACEMENT FOR COTTON IN THE SOUTHEASTERN COASTAL PLAIN

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Microirrigation Scheduling and Tube Placement for Cotton in the Southeastern Coastal Plain

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Abstract. *Three irrigation scheduling methods and two microirrigation tube placements were evaluated on three cotton (*Gossypium hirsutum *L.) cultivars for three years on a southeastern Coastal Plain soil. Irrigation scheduling methods included two computer models, GOSSYM/COMAX and PRISM, and a method using tensiometers. Microirrigation tubing was placed on the soil surface, either adjacent to every row or in alternate furrows. Growing-season rainfall amounts ranged from 313 mm in 1990 to 544 mm in 1988. Rainfall distribution also varied widely within each year. In a similar manner, irrigation amount and frequency varied among scheduling methods and years, but no method consistently required the largest or smallest amount of irrigation. Cotton lint yields ranged from 850 to 1105 kg/ha over all years, but there were few significant differences among irrigation treatments within a year, even between the rainfall-only and irrigated treatments. Lint yields were significantly greater for the PD3 and DPL90 cultivars than for the Coker 315 cultivar during the three-year period, and the PD3 cultivar had a greater yield response to irrigation. The tensiometer-every row tube placement is the only irrigation treatment that produced cotton lint yields significantly higher than the rainfall-only treatment each year. The tensiometer scheduling method also produced significantly greater yields each year. Although yield differences occurred, they were relatively small. This fact, along with the inconsistent differences in the amount of irrigation water required, suggests that the preferred method for a particular application will probably depend more upon water or labor requirements, cost, or personal preference. Also, there was no difference in yield between the two tube placements. Because the alternate-furrow placement requires only half as much tubing, which will reduce installation costs by about 30%, it appears to be the preferred placement for this soil. Further research is needed to refine irrigation scheduling for cotton in this region.* ***Keywords.** Irrigation management, Irrigation systems, Irrigation scheduling, Computer models, Computer-based water budget, Tensiometers.*

Irrigated cropping area has increased significantly in the southeastern Coastal Plain during the past 15 years. Because of poor rainfall distribution and low water storage in coarse-textured soils, irrigation is required about every other year in order to produce optimum yields for most crops (Sheridan et al., 1979). With eradication of the boll weevil and improved market price, cotton has again become an attractive crop in the region. To produce higher and more consistent yields, with better lint quality, many growers are now considering irrigation.

Although sprinkler irrigation is most often used for agronomic crops, microirrigation offers several advantages, including low application rates, precise water placement, and low pressure. A major disadvantage for agronomic crops is the high initial cost of the system and annual replacement of many system components. System designs that either reduce the tubing quantity required or allow use of components for multiple seasons would improve profitability. Cotton yields were similar for microirrigation laterals spaced up to 2 m apart on a coarse-textured soil in Arizona, but were much lower for a spacing of 3 m (French et al., 1985). Microirrigation tubing installed 0.2 to 0.3 m deep has been used for cotton (Tollefson 1985), corn (Camp et al. 1989), and fruits and vegetables (Bucks et al. 1981; Phene et al. 1987). Profitability of irrigating cotton in humid areas can also be affected by the manner in which irrigation is scheduled and whether rainfall is used efficiently. Several irrigation scheduling methods, including tensiometers, evaporation pans, and computer models are available but are not widely used (Lambert 1980). Computers have been used to estimate daily evapotranspiration (ET) from weather data and to compute water balances, which have been compared to other scheduling methods for corn in the southeastern Coastal Plain (Camp and Campbell, 1988). Limited information is available on cotton plant responses to water stress in humid areas. Cotton yield is dependent on production and retention of bolls, which can be decreased by water stress (Guinn and Mauney, 1984). High-frequency micro-irrigation can prevent cyclical water stress that is found with other irrigation methods, and can minimize root deterioration during fruit filling (Radin et al., 1989).

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Contribution of the Coastal Plains Soil, Water and Plant Research Center, USDA-Agricultural Research Service, Florence, SC, in cooperation with the South Carolina Agricultural Experiment Station, Clemson.

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Objectives

The objectives of this study were to:

- Evaluate performance of two microirrigation tube placements.
- Compare three methods of irrigation scheduling and two tube placements (six treatment combinations) for three cotton cultivars.
- Compare yields for all irrigated treatments with that for a rainfall-only treatment.

Materials and Methods

The study was conducted on a 0.75-ha site of Norfolk loamy sand (Typic Kandiudults) near Florence, South Carolina. Microirrigation tubing was placed on the soil surface, either immediately adjacent to every row (ER) or midway between rows in alternate furrows (AF). Three irrigation scheduling methods (described in greater detail later) were: 1) GOSSYM/COMAX, a cotton growth model and expert system (GOSY); 2) a Precipitation, Runoff, and Irrigation Scheduling Manager (PRISM); and 3) tensiometers (TENS). Treatments included all combinations of two tube placements and three scheduling methods, and rainfall only (RAIN) to provide a total of seven treatments, which were evaluated for three cotton cultivars. The three cotton cultivars were Deltapine Acala 90 ('DPL90'), 'Coker 315', and 'PD3'. The experimental design was a split-plot with whole plots arranged in a randomized complete block. Each of seven treatments was considered a whole-plot treatment. Each whole plot was split for random assignment of three cotton cultivars and there were four replications of each treatment. Each plot was 15 m long and 12 m wide, which provided 12 rows spaced 0.96 m apart, four rows for each cultivar.

Irrigation for the PRISM treatment was scheduled using a water balance model developed by Camp et al. (1990). Generally, this model computes the water stored in several soil layers using available soil water, rainfall and irrigation amounts, and ET estimated from weather data. Daily input requirements are irrigation and rainfall amounts, weather data, rooting depth, and allowable depletion of stored soil water. Irrigation was initiated when stored water decreased to the designated allowable depletion level (usually 50%). PRISM was operated twice each week using measured weather data for the days since last model operation and using forecast weather data for as many as five days ahead, depending upon data availability. Five-day weather forecasts were obtained from the U.S. Weather Service, Columbia, South Carolina. PRISM was re-initialized periodically during the growing season using measured soil water content by layer.

GOSSYM is a cotton growth and yield simulation model that has been coupled with an expert system decision aid, COMAX, that controls simulation parameters (Baker et al., 1983; Lemmon, 1986). While not designed specifically for scheduling irrigation, this model does compute a water stress index using a water balance procedure and indicates the need for additional water when the value of this index falls below 0.75 kPa. For the GOSY treatment, the model was operated three times each week to determine the need for irrigation. Because GOSSYM/COMAX could not utilize forecast weather data without extensive file editing, simulations were made for three weather scenarios (hot-dry, normal, and cool-wet) to estimate future irrigation requirements in the GOSY treatment.

Both models require daily maximum and minimum temperatures, solar radiation, and rainfall and irrigation amounts. GOSSYM/COMAX also requires daily wind run. Soil water retention values by layer are needed for both models. However, GOSSYM/COMAX has an extensive soil hydrology database that may include the required information for a specific site. All other soil and plant data inputs were essentially the same for the two models. Both models considered irrigation as a uniform application for the entire area, as with rainfall; consequently, tube placement treatments could not be scheduled separately.

Initiation of irrigation in the TENS treatment was based on general recommendations and common practice for these soils. Irrigation was initiated when the mean reading of tensiometers at the 0.3-m depth in any four plots exceeded 30 kPa or in any two plots exceeded 35 kPa. Normally, irrigation application amounts were 6 mm/d, the estimated value of mean daily ET for cotton in this region. When ET was high enough to cause continued depletion of soil water storage after the 6-mm/d application, the irrigation amount was increased to 12 mm/d until soil water storage increased to an acceptable level. Because the same volume of irrigation water was applied and the same tubing was used for both tube placement treatments, duration of irrigation application was about twice as long for the AF treatment as for the ER treatment. This resulted in different soil wetted zones for these treatments.

The irrigation system consisted of individual polyvinyl chloride (PVC) pipe manifolds for each scheduling treatment in each replication. Each treatment could be controlled independently using solenoid valves. Irrigation tubing (Netafim Inline Dripperline) had in-line, labyrinth emitters spaced 0.6 m apart, each delivering 1.9 L/h. Each manifold had removable end caps for flushing and each lateral had self-closing, flushing end caps. Pressure was regulated at about 100 kPa using in-line pressure regulators in the manifold at each plot location. The tubing was recovered each year before harvesting cotton and used the following year. Water was supplied from a well, stored in a pressurized tank, and filtered using a 100-mesh cartridge filter. All irrigation applications were monitored and controlled by a programmable microprocessor-based irrigation controller. Tensiometers were installed at depths of 0.3 m, 0.6 m, and 0.9 m in 1988 and at 0.3 m and 0.6 m in 1989 and 1990. They were installed in the Coker 315 cultivar for all irrigation treatments in two replications and distributed randomly among the DPL90 and PD3 cultivars for all irrigation treatments in the other two replications. No tensiometers were installed in the RAIN treatment. Tensiometer readings were recorded three times each week and tensiometers were serviced as required. Rainfall and U.S. Weather Service Class A pan evaporation were measured on site. Growing-season rainfall was computed for the period from planting to two weeks prior to first harvest.

The entire site was limed to achieve pH 6.0 based on soil testing and subsoiled in two directions prior to seed bed preparation in 1988. Each year the seed bed was prepared by disking, in-row subsoiling, and bedding. Both preplant fertilizer and sidedress nitrogen were applied in granular form each year. Total nutrient applications were

Table 1. Seasonal irrigation and total water amounts for seven water management treatments in a cotton experiment on a southeastern Coastal Plain soil in 1988, 1989, and 1990

Treatment		1988		1989		1990		Mean	
Schedule /	Placement	Irrig	Total*	Irrig	Total	Irrig	Total	Irrig	Total
		(mm)							
GOSY†	AF	90 (9)‡	634	25 (3)	510	115 (11)	428	77	524
GOSY	ER	95 (9)	639	30 (3)	515	129 (11)	442	85	532
TENS	AF	175 (18)	719	96 (10)	581	127 (14)	440	133	580
TENS	ER	173 (17)	717	108 (10)	593	162 (14)	475	148	595
PRISM	AF	89 (8)	633	75 (6)	560	192 (17)	505	119	566
PRISM	ER	89 (7)	633	77 (6)	562	184 (17)	497	119	564
RAIN		--- ---	544	--- ---	485	--- ---	313	---	447

* Total water amounts include seasonal rainfall amounts which were 544 mm in 50 events in 1988, 485 mm in 56 events in 1989, and 313 mm in 33 events in 1990.
† Treatment codes are defined as follows: GOSY = GOSSYM / COMAX model, TENS = TENSiometer, PRISM = PRISM model, AF = Alternate-Furrow tube placement, and ER = Every-Row tube placement.
‡ Numbers in parentheses refer to the number of irrigation events during the growing season.

96 kg/ha N, 15 kg/ha P, and 59 kg/ha K in 1988; 94 kg/ha N, 29 kg/ha P, and 56 kg/ha K in 1989; and 89 kg/ha N and 13 kg/ha K in 1990. Pesticide applications consisted of aldicarb (Temik) at planting to control thrips, trifluralin (Treflan), and fluometuron (Cotoran) for weed control, and weekly applications of fenvalerate (Pydrin), permethrin (Ambush), or chlordimeform (Fundal) beginning in July each year to control *Heliothis virescens* and *Helicoverpa Zea* (tobacco budworm and cotton bollworm, respectively). Defoliant (DROPP + PREP) was applied on 30 September 1988 and 29 September 1990, but was not applied in 1989 because of defoliation caused by Hurricane Hugo. Cotton was planted on 4 May 1988, 17 May 1989, and 9 May 1990. A 27-m^2 area of the center two rows of each four-row sub-plot was harvested by spindle picker on 11 October and 3 November in 1988, on 10 October 1989, and on 25 October 1990. Cotton lint yield was calculated from lint percentages determined in the laboratory on a saw gin from subsamples collected from each plot at harvest.

Yields were analyzed by year as a split plot design and for all years combined as a split-split plot design using analysis of variance (ANOVA), all with four replications. Analyses for all years combined consisted of one using a non-factorial design to determine differences between individual irrigation treatments and the RAIN treatment and one using a factorial design to determine effects of irrigation scheduling method and tube placement. In the factorial design for all years combined yield data were analyzed as a split-split-plot design, with the six placement-schedule combinations as main plot treatments; cultivar as subplot treatments; and year as sub-subplot treatments. Because the subplot error b was smaller than the sub-subplot error c, the latter was used for testing cultivar and its interactions with schedule and placement (table 5). Means were separated by computing a least significant difference (LSD) and by contrasts (SAS, 1990).

Results and Discussion

Seasonal rainfall and irrigation amounts for all irrigation treatments and the RAIN treatment during 1988, 1989, and 1990 are included in table 1. Growing-season rainfall ranged from 544 mm in 1988 to 313 mm in 1990. Although there were six more rainfall events in 1989, seasonal

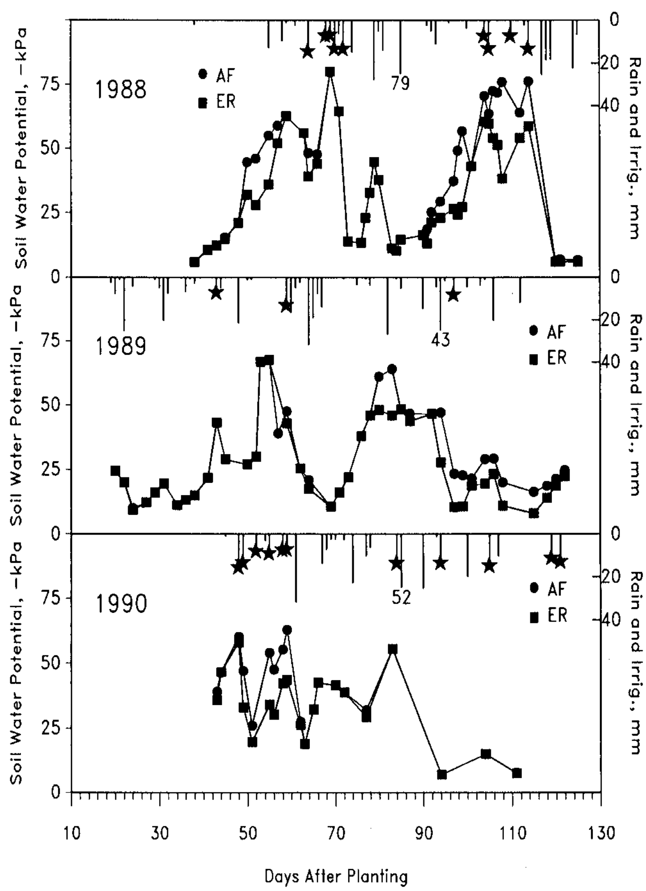

Figure 1–Seasonal soil matric potential at the 0.30-m depth for two tube placements and irrigation scheduled by GOSSYM/COMAX in 1988, 1989, 1990. Daily rainfall and irrigation amounts (stars) and distribution are shown at the top of each panel.

rainfall was 59 mm lower than in 1988. In 1990, when seasonal rainfall was smallest, all irrigation treatments except TENS required more irrigation than was required in the other years. Daily rainfall amounts during the growing season in 1988, 1989, and 1990 are shown at the top of each panel in figure 1. Hurricane Hugo caused substantial damage in the general area on 21 September 1989, but the large rainfall amounts normally associated with hurricanes did not occur. TENS required more irrigation in 1988 when rainfall was greatest, but there were 50 rainfall events, compared to 56 in 1989. This may reflect the effect of rainfall distribution on irrigation requirements, particularly when growing-season rainfall is generally adequate. The difference in irrigation requirements for the two computer methods (GOSY and PRISM) was not as great in 1990 as in 1989. TENS required the greatest amount of irrigation for two years (1988 and 1989) and PRISM required the greatest amount in 1990. GOSY required the smallest amount of irrigation for two years (1989 and 1990) and GOSY and PRISM required the smallest amount in 1988.

Yield analysis for the seven water management treatments (six irrigation scheduling-tube placement combinations and RAIN treatment) using the non-factorial design showed significant treatment, cultivar, and year effects. The treatment-cultivar-year interaction was not significant but the treatment-year and treatment-cultivar interactions were significant. Cotton lint yields for all

Table 2. Cotton lint yields for seven water management treatments and three years on a Coastal Plain soil

Treatment Schedule / Placement		1988	1989	1990	Mean
		(kg / ha)			
GOSY*	AF	1090	880	765	910
GOSY	ER	1220 a†	860	870	985
TENS	AF	1165 a	830	855	950
TENS	ER	1275 a	965 a	955 a	1065
PRISM	AF	985	835	835	885
PRISM	ER	1050	750	835	880
RAIN		975	810	825	870

* Treatment coes are the same as those defined in table 1.
† Means within a column followed by the letter 'a' are different from the RAIN mean by LSD at P ≤0.05 (LSD_{05} = 124).

seven treatments by year, averaged over all cultivars, are reported in table 2.

In 1988, lint yields for the TENS-ER and GOSY-ER treatments were greatest and yields for the PRISM-AF and RAIN treatments were smallest. Although yields for all irrigated treatments were greater than yield for the RAIN treatment, only the TENS-ER, TENS-AF, and GOSY-ER treatments were significantly different from RAIN. Generally, yields were not related to irrigation amount. The TENS treatments received about twice as much irrigation as the GOSY and PRISM treatments but comparable increases in lint yield were not always achieved. Also, yields for PRISM treatments were less than those for GOSY-ER, although similar amounts of irrigation water were applied.

Cotton lint yields for all treatments in 1989 were less than those measured in 1988 (table 2). Although there were numerical differences in yields among treatments, only yield for the TENS-ER treatment was statistically different from yield for the RAIN treatment. Damage caused by Hurricane Hugo, which occurred after some cotton bolls had opened, was a factor in causing lower yields in 1989. Because there did not appear to be a difference in boll opening among treatments, it is assumed that the yield reduction caused by wind removal of cotton was uniform across all treatments. Cotton yields were not consistently related to irrigation amounts in 1989. The TENS-ER treatment produced the highest yield and required the greatest amount of irrigation. However, the TENS treatments required about four times as much irrigation as the GOSY treatments, but only the TENS-ER lint yield was significantly greater.

Cotton yields for all treatments in 1990 were similar to those in 1989 (table 2). Again, there were relatively small numerical yield differences among irrigation treatments and yield for the TENS-ER treatment was greatest. Although rainfall in 1990 was 170 to 230 mm less than in the two previous years and 115 to 192 mm of irrigation was applied, only the TENS-ER treatment was statistically different from the RAIN treatment.

Lint yields for the seven water management treatments by cultivar, averaged across all years, are reported in table 3. Lint yield for the RAIN treatment was greater for DPL90 than for the other two cultivars, indicating better resistance to water stress, and DPL90 did not respond to irrigation. This cultivar appeared to recover from very hot, dry weather during August, 1990 better than the other cultivars. For Coker 315, the TENS-ER treatment significantly increased yield over the RAIN treatment. This possibly indicates a low response of this cultivar to irrigation. PD3 demonstrated the greatest yield response to irrigation, with the TENS-ER, TENS-AF, and GOSY-ER treatments all significantly greater than the RAIN treatment.

When these data were analyzed using contrasts, there were differences among scheduling methods ($P < 0.05$) and between tube placements ($P < 0.10$). Because the treatment-cultivar interaction was significant and most treatments consisted of a combination of irrigation scheduling method and tube placement, a factorial ANOVA analysis, without the RAIN treatment, was performed in an effort to determine the optimum scheduling-placement combination for each cultivar.

Mean cotton lint yields for the six irrigation schedule-tube placement combinations averaged over all years are given in table 4. Mean squares from ANOVA of yield data are given in table 5. The effect of placement on cotton lint yield was significant at the $P = 0.09$ level (table 5) and the ER treatment produced higher yields in seven of the nine schedule-cultivar combinations reported in table 4. However, the placement-schedule and placement-cultivar interactions were not significant. The effect of schedule on yield was significant ($P = 0.03$) and lint yield for the TENS scheduling treatment was significantly higher than yield for the PRISM treatment, but yield for the GOSY treatment was not different from either (table 4). The effect of year was also significant ($P = 0.0001$) and the year-schedule and year-cultivar interactions were significant only at the $P = 0.10$ level.

Table 3. Cotton lint yields for seven water management treatments and three cultivars on a southeastern Coastal Plain soil during 1988-1990

Treatment Schedule / Placement		Coker 315	DPL90	PD3	Mean
		(kg / ha)			
GOSY*	AF	850	980	905	910
GOSY	ER	945	1005	1000 a	985
TENS	AF	900	905	1040 a	950
TENS	ER	1055 a†	1025	1115 a	1065
PRISM	AF	870	885	895	885
PRISM	ER	875	915	850	880
RAIN		840	955	815	870

* Treatment codes are the same as those defined in table 1.
† Means within a column followed by the letter 'a' are different from the RAIN mean by LSD at P ≤ 0.05 (LSD_{05} = 89).

Table 4. Cotton lint yields for three irrigation scheduling methods, two tube placements, and three cultivars on a southeastern Coastal Plain soil during 1988-1990

Scheduling Method	Coker 315 AF*	Coker 315 ER	DPL90 AF	DPL90 ER	PD3 AF	PD3 ER	Mean
	(kg / ha)						
GOSY	850	945	980	1005	905	1000	950 ab†
TENS	900	1055	905	1025	1040	1115	1005 a
PRISM	870	875	885	915	895	850	880 b
Mean	915 b		950 a		965 a		

* Treatment codes are the same as those defined in table 1.
† Means followed by the same letters within a column or row are not significantly different by ANOV and LSD at P ≤ 0.05. Standard errors (s.e.) are as follows: s.e. (placement mean) = 24, s.e. (schedule mean) = 29, and s.e. (cultivar mean) = 18.

Table 5. Analysis of variance table for yield as affected by three irrigation scheduling methods, two microirrigation tube placements, and three cotton cultivars over the three-year duration of the experiment (1988-1990)

Source of Variation	df	Mean Square	F Value	Pr > F
Replication	3	57533		
Placement	1	199194	3.27	0.0906
Schedule	2	282974	4.65	0.0269
Placement × Schedule	2	65472	1.08	0.3661
Error a	15	60884		
Cultivar	2	51059	2.19	0.1163
Placement × Cultivar	2	8718	0.37	0.6886
Schedule × Cultivar	4	51105	2.19	0.0739
Schedule × Placement × Cultivar	4	9503	0.41	0.8026
Error b	36	10840		
Year	2	1835230	78.79	0.0001
Year × Placement	2	38624	1.66	0.1950
Year × Schedule	4	47105	2.02	0.0958
Year × Schedule × Placement	4	17546	0.75	0.5578
Year × Cultivar	4	48130	2.07	0.0897
Year × Placement × Cultivar	4	5167	0.22	0.9258
Year × Schedule × Cultivar	8	20787	0.89	0.5253
Error c	116	23292		
Total	215			

Because of problems with the PRISM model in 1988, related primarily to model development and modification, more user input and judgment were required. Consequently, irrigation may not have been managed to the full potential of this method at some times during this year. Both the GOSY and PRISM models operated more consistently in 1989 than in 1988. The PRISM model was operational but several revisions and improvements were made during the 1989 season. The runoff partitioning module was installed near the end of the 1989 season. Both models operated satisfactorily in 1990. Because of modifications to PRISM made during and after the 1988 and 1989 seasons, the 1990 version of PRISM was used to simulate irrigation requirements for the 1988 and 1989 seasons using weather data for those years. For these simulations it was assumed that irrigation was applied when indicated by PRISM. The 1990 version of the model required 181 mm of irrigation (14 applications) for the 1988 season, an increase of 92 mm (six applications) over that required by the 1988 version of the model. The 1990 version of PRISM required 39 mm of irrigation (three applications) for the 1989 season, a decrease of 37 mm (three applications) from that required by the 1989 version of the model. Irrigation requirements for the 1990 version of PRISM were similar to that for TENS in 1988 and for GOSY in 1989. Consequently, the difference in irrigation water requirements among the different versions probably would not have significantly altered the yield result for the PRISM treatment in 1988 and 1989.

Tensiometer measurements indicated that there were no consistent differences in soil matric potential among irrigation scheduling treatments or among tube placements. Although the rainfall amount during the growing season was greatest in 1988, soil at the 0.30-m depth appeared to be somewhat drier than in other years, as shown for two tube placements in the GOSY treatment in figure 1. There were significant fluctuations, both within years and among treatments, but there were no consistent patterns. The large variation in rainfall and irrigation amounts among years did not cause a major difference in soil matric potential, indicating that all irrigation scheduling methods and both tube placements provided an adequate soil-water environment for good cotton growth (fig. 1).

Although substantial amounts of irrigation water were applied each year for the three irrigation scheduling treatments, lint yields for only the TENS-ER treatment were significantly greater than for the RAIN treatment every year (table 2). This indicates that other factors may be affecting lint yield or that irrigation requirements for cotton in this region are not fully understood. Yield results for this experiment indicate that these irrigation scheduling methods provided a satisfactory soil water environment for cotton growth, but some may have required more irrigation than needed by the crop. Irrigation initiation criteria and model parameters, such as crop coefficients, may require modification. Additional research is needed to answer these questions, to determine the allowable soil water deficit before irrigation is initiated, and to further investigate the irrigation requirement for cotton in this region. Once a satisfactory model, possibly GOSSYM/COMAX, has been calibrated for the cultivars, and the soil and climatic conditions of the region, simulations using historical weather records and a range of applicable soils could help determine the need for cotton irrigation in this region.

Summary and Conclusions

There were differences in cotton lint yields produced and irrigation water required by the three irrigation scheduling methods used in this study. A clear relationship between cotton lint yield and the amount and/or timing of irrigation was not evident. The TENS method required the greatest amount of irrigation water for two of the three years, and the PRISM model required the greatest amount the third year. The GOSSYM/COMAX model required the smallest amount all three years although the amount was only marginally smaller for two years. Over the three-year period, cotton lint yield was significantly greater for the TENS method than for the PRISM model, but yield for the GOSSYM/COMAX model was not different from the other two methods. Also, the TENS-ER treatment is the only irrigation treatment that produced lint yields significantly higher than those for the RAIN treatment each of the three years. Because of the small differences in yield, the selection of irrigation scheduling method could be based on lower water requirement, lower labor requirement, lower cost, or personal preference. There was no consistent yield difference for the two irrigation tube placements evaluated in this study. Consequently, the alternate-furrow placement, which requires half as much microirrigation tubing, would be the placement method of choice for cotton under these conditions. This should result in significant savings in system cost, probably about 30%, depending upon the specific system design. The PD3 cultivar had the greatest yield response to irrigation, and the PD3 and DPL90 cultivars had significantly higher yields for the three-year period. However, there was considerable variation in yield among cultivars during the three years, with no cultivar consistently producing the greatest yield. More research is needed to further refine irrigation scheduling methods, to further investigate the need for irrigation of cotton in this region (especially among various soils), and to determine the allowable soil water deficit before irrigation is initiated.

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