Water Resource Development and Irrigation Management For Sprinkler and Subsurface Drip Irrigation

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Cotton is a major agricultural commodity in the Tennessee Valley of North Alabama. Annual yield fluctuations are quite common and often these fluctuations are related to drought or irregularly distributed rainfall. With financial and technical support from the Tennessee Valley Authority (TVA), an irrigation research and demonstration facility was constructed in 1995 at an Auburn University Research and Extension Center (TVREC) located in that part of the state. This facility is being used to evaluate the potential for enhanced irrigation water resources, to evaluate water quality in an off stream storage reservoir and to conduct research related to water management alternatives for sprinkler and subsurface drip irrigated cotton. Using this facility, water quality analysis and irrigation research has been underway since 1996 with data reported for 1998 through 2002.

Three experiments involving application and use of sprinkler and subsurface drip irrigation on typical silty clay loam soils for cotton production are ongoing at the Tennessee Valley Research and Extension Center, Belle Mina, Alabama. *

The experiments are as follows:

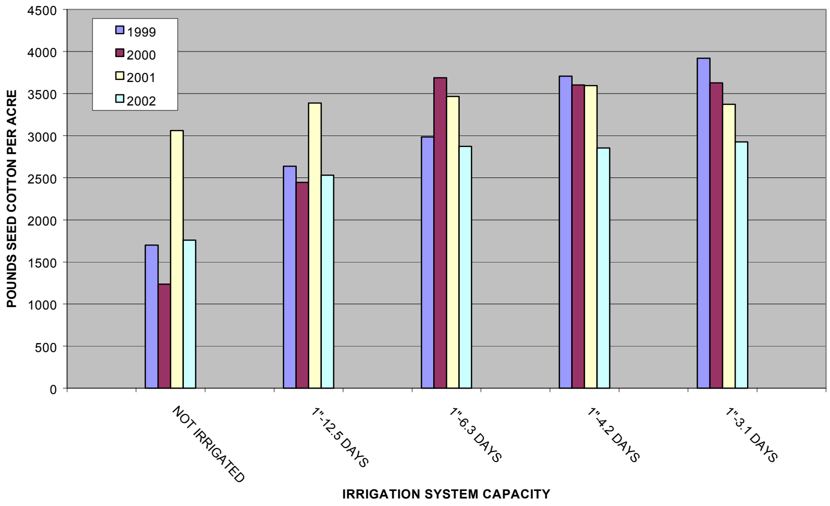
Experiment 1. Sprinkler irrigation water requirements and irrigation scheduling. This experiment was established in 1999 to evaluate a range of irrigation application capabilities to identify the minimum design flow rate that will produce optimum yields. Treatments included four sprinkler irrigation capabilities and a non-irrigated treatment. Irrigation was managed using soil moisture sensors and Moiscot (a spreadsheet-based scheduling method). The irrigation capabilities were (1) one inch every 12.5 days, (2) one inch every 6.3 days, (3) one inch every 4.2 days, and (4) one inch every 3.1 days. This one inch represents the maximum amount of irrigation that could be applied in the time indicated.

The results for 1999, 2000, 2001, and 2002 are presented in Figure 1. The 2002 data presented is not directly comparable because the experimental design was changed in 2002. Irrigated yields in 2002 were significantly higher than non-irrigated yields but the highest yields were less than in previous years for most treatments. The reason for this is unclear but may be related to shutdown of irrigation prior to sufficient boll maturity. Only very small yield differences were noted in 2001 while significant differences were measured in 1999 and 2000. Rainfall variability and treatment effects accounted for the wide range of yield responses for each of these years.

Least Significance Difference (LSD) Test—LSD Tests (on a year by year basis) for each year are indicated below. Treatment means (# seed cotton per acre) within columns followed by the same letter are not significantly different, $P \leq 0.05$.

Treatment	1999	2000	2001
		Year	
Non-Irrigated	1699.1 A	1236.0 C	3061.3 B
1”-12.5 Days or 1.5 GPM/Acre	2636.7 A	2443.7 B	3386.3 AB
1”-6.3 Days or 3.0 GPM/Acre	2984.3 B	3688.3 A	3466.0 A
1”-4.2 Days or 4.5 GPM/Acre	3708.0 B	3603.0 A	3594.7 A
1”-3.1 Days or 6.0 GPM/Acre	3920.0 C	3626.3 A	3371.3 AB

SPRINKLER IRRIGATION
COTTON YIELD RESULTS
FIGURE 1



Experiment 2. Subsurface drip irrigation (SDI) placement and irrigation water requirements. This experiment was initiated in 1998 to evaluate placement of SDI relative to crop row direction and to evaluate water requirements for cotton production using SDI. Drip tubing was buried 15 inches deep with emitters at two-foot intervals along the tubing. Tubing placement treatments were (1) between every other row—80 inch spacing between drip lines and (2) perpendicular to rows –80 inch spacing between drip lines.

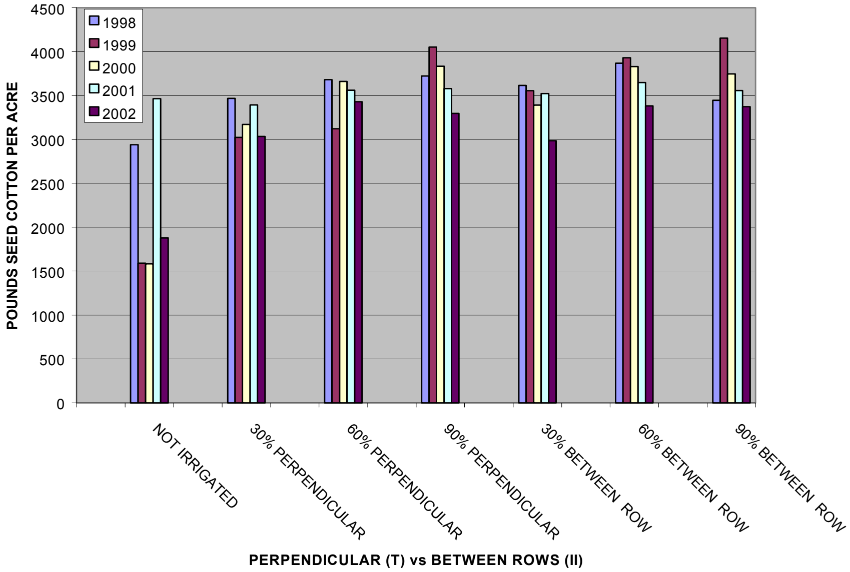
Irrigation treatments were based on daily applications equal to 30%, 60%, and 90% of pan evaporation after full crop canopy with adjustments based on percent canopy prior to full canopy cover. Yield results for five years (1998 through 2002) are presented in Figure 2.

Significant yield increases were achieved in 1998, 1999, 2000 and 2002 for all irrigated treatments as compared to dry treatments. In years 1999 and 2000, a significant linear yield response was measured for treatments with drip tape perpendicular to rows when daily application amounts increased from 30% to 90% pan evaporation. Also in 1999 and 2000 a similar trend, though not significant was noted for treatments where drip tape was placed between every other row.

Least Significant Difference (LSD) Test-LSD (on a year by year basis) for each year are indicated below. Treatment means (# seed cotton per acre) within columns followed by the same letter are not significantly different, $P \leq 0.05$.

	Year				
Treatment	**1998**	**1999**	**2000**	**2001**	**2002**
Non-irrigated	2846.3 B	1599.8 C	1624.5 C	3512.3 A	1891.3 B
30T	3469.0 A	3023.8 B	3170.8 B	3393.8 A	3034.5 A
60T	3680.8 A	3123.0 B	3660.8 AB	3560.3 A	3429.0 A
90T	3722.5 A	4053.5 A	3834.8 A	3580.0 A	3298.3 A
30II	3614.8 A	3556.3 AB	3391.5 AB	3522.3 A	2986.3 A
60II	3868.0 A	3930.0 A	3830.3 A	3647.3 A	3382.0 A
90II	3446.0 AB	4155.0 A	3747.8 AB	3557.3 A	3374.0 A

DRIP PLACEMENT AND IRRIGATION SCHEDULING
FIGURE 2



Experiment 3. Subsurface drip irrigation (SDI) tape products and fertigation. A SDI study initiated in 1998 was designed to compare five different drip irrigation tape products with a fertigation component included. This study was installed in an area where continuous crops have been produced for many years. Emitters were located two feet along the tape with tape buried 15 inches between every other row. Rows 340 feet in length were used to better simulate field conditions. Fertilizer management for each tape product was evaluated using a single (conventional) surface applied sidedress versus multiple sidedress applications injected through the SDI system. A tape product was also used on the surface using a conventional fertilizer treatment. Fertility treatments are indicated below:

	---------------------------Irrigated---	------------------------------	--	**Non-irrigated**
	Fertigated	Conventional	Drip tape on surface[2]	
Preplant	75#N + 60#K	75#N + 60#K	75#N + 60#K	75# + 60#K
Sidedress[1]	60#N + 60#K	60#N + 60#K	60#N + 60#K	60#N

[1]All sidedress was applied at early to mid square for conventional and drip tape treatments; the sidedress treatment was divided into eight equal applications for the fertigated treatments beginning at early to mid square.

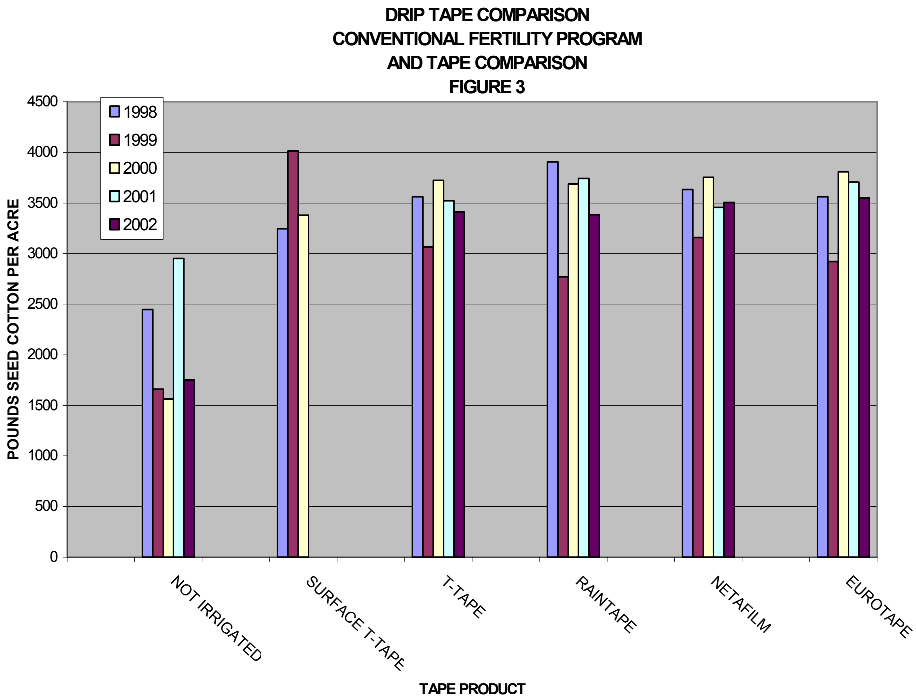
[2]The surface tape treatment was discontinued after 2000 because of damage and leaks caused by insects and animals.

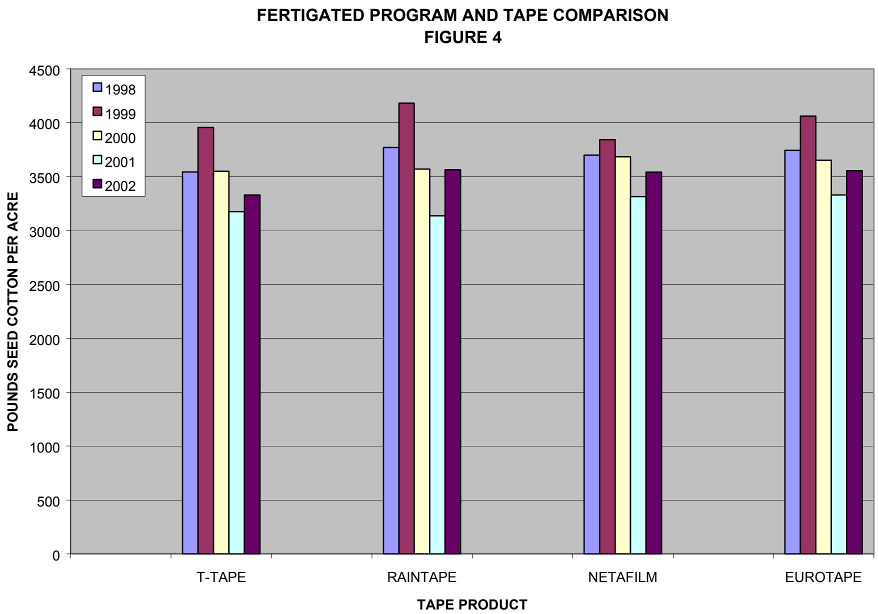
In 1998 little difference between fertility treatments was observed. In 1998 sufficient rainfall occurred late in the growing season so that fertilizer in the upper layers of the soil was more readily available. In 1999, extremely dry conditions in the upper layers of the soil profile made conventional applied fertilizer less available resulting in yield reduction compared to fertilizer applied through the irrigation system. In 2001 initiation of fertigation through the tape was inadvertently delayed more than two weeks. Even though the fertigation schedule was modified to insure that all scheduled fertilizer was applied, the delay reduced fertigated yields. Yields in 2002 were similar to previous years with little difference in fertilizer treatments but significant yield improvement over the non-irrigated treatment.

Significant yield differences were observed each year between non-irrigated plots and tape plots with fertility treatments. Figures 3 and 4 illustrate yield results for 1998 through 2002 for conventional and fertigated treatments. To date only minimal differences have been observed between the different drip irrigation tape products.

Least Significance Difference (LSD) Test—LSD Tests (on a year by year basis) for each year are indicated below. Treatment means (# seed cotton per acre) within columns followed by the same letter are not significantly different, P≤0.05.

Treatment		**Year**				
Tape Product	**Fertility**	**1998**	**1999**	**2000**	**2001**	**2002**
Non Irrigated	Conventional	2448.0 D	1658.8 E	1561.3 C	2950.0 E	1749.0 B
Surface T-Tape	Conventional	3244.5 C	4013.8 AB	3377.5 B	-	-
T-Tape	Conventional	3561.5 B	3064.8 C	3723.5 AB	3521.5 AB	3411.3 A
Rain Tape	Conventional	3904.8 A	2770.0 D	3689.8 AB	3742.5 A	3386.8 A
Netafim	Conventional	3633.8 AB	3153.8 C	3752.5 AB	3454.5 ABC	3506.0 A
Eurotape	Conventional	3563.3 B	2922.8 DC	3810.3 A	3704.8 A	3548.3 A
T-Tape	Fertigated	3543.3 B	3956.8 AB	3550.3 AB	3175.8 EDC	3329.8 A
Rain Tape	Fertigated	3769.8 AB	4183.0 A	3569.8 AB	3137.3 ED	3563.5 A
Netafim	Fertigated	3699.3 AB	3844.0 B	3685.0 AB	3315.3 BDC	3542.3 A
Eurotape	Fertigated	3743.8 AB	4061.5 AB	3651.0 AB	3329.5 BDC	3555.8 A


DRIP TAPE COMPARISON
CONVENTIONAL FERTILITY PROGRAM
AND TAPE COMPARISON
FIGURE 3
POUNDS SEED COTTON PER ACRE
1998
1999
2000
2001
2002
NOT IRRIGATED
SURFACE T-TAPE
T-TAPE
RAINTAPE
NETAFILM
EUROTAPE
TAPE PRODUCT


FERTIGATED PROGRAM AND TAPE COMPARISON
FIGURE 4
POUNDS SEED COTTON PER ACRE
1998
1999
2000
2001
2002
T-TAPE
RAINTAPE
NETAFILM
EUROTAPE
TAPE PRODUCT

[*]The variety selections for each experiment are indicated below:

	Variety Selection		
	-Experiment 1- Sprinkler Study	**-Experiment 2-** SDI Placement & Water Management	**-Experiment-3** SDI Tape-Fertigation Study
1998		DPL33B	DPL33B
1999	DPL33B	DPL33B	DPL33B
2000	DPL428B	DPL33B	DPL428B
2001	DPL428B	DPL33B	DPL428B
2002	DPL451BR	DPL451BR	DPL451BR