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ON THE COVER:

Figure 1. Two replications of test in 1965 showing row direction plots and instrument housing.

THE INFLUENCE OF ROW DIRECTION ON THE MICROCLIMATE AND YIELD OF SKIP-ROW COTTON

By W. I. SPURGEON[1] and JOHN S. HURSH[2]

In some of the early skip-row tests conducted at the Delta Branch Experiment Station, it was observed that both row direction and row position influenced cotton yield. For example, skip-row cotton tended to produce more from north to south as compared with east to west rows while solid planted cotton reacted in an opposite manner. The south row always produced more than the north row when cotton was planted in an east to west direction.

The higher yield as affected by row direction and position was believed to be partially associated with the plant microclimate. More specifically, light was considered to be one microclimatic factor responsible for higher yields. Row direction could conceivably influence the amount of light received by cotton plants and consequently affect yield.

An experiment was conducted from 1964 through 1967 to quantitatively measure microclimate regimes in skip-row cotton planted in four new directions. The major regime measured was light with an attempt to correlate this factor with cotton yield.

Materials and Methods

This experiment was conducted at the Delta Branch Experiment Station farm on a Dubbs silt loam soil of medium fertility with respect to phosphorus and potassium. A randomized block design was used with four treatments replicated four times.

The treatments were 2 x 2 skip-row cotton planted in four-row directions; north to south, east to west, northeast to southwest, and northwest to southeast (Fig. 1). One replication only was used for making microclimatic measurements. One replication was used for yield in 1964 and four were used the last three years.

The principle microclimatic factor which was measured is referred to as light penetration of the cotton foliage. An effort was made to measure light that was reflected from the soil surface after it had penetrated the cotton foliage. This was accomplished by using single silicon solar cells mounted under copper shields and placed in the cotton foliage approximately one foot above the soil surface.

Five solar cells, thus arranged, were placed at intervals of 4 feet apart in each outside row of 2 x 2 cotton within all row directions. The five solar cells for each outside row were parallel wired and connected to Rustrak milliampere recorders (Fig. 2). Separate recorders were used for each outside row of all row direction plots.

The cells and recorders were calibrated by using a constant light source and external shunt of wire of appropriate lengths. The recorders measured on a scale of 0-100 milliamperes with a chart speed of one inch per hour.

The light measurements were started each year at the approximate squaring stage of cotton growth (June 15 to July 1) and continued until the cotton was defoliated in the fall. The daily recorded curves

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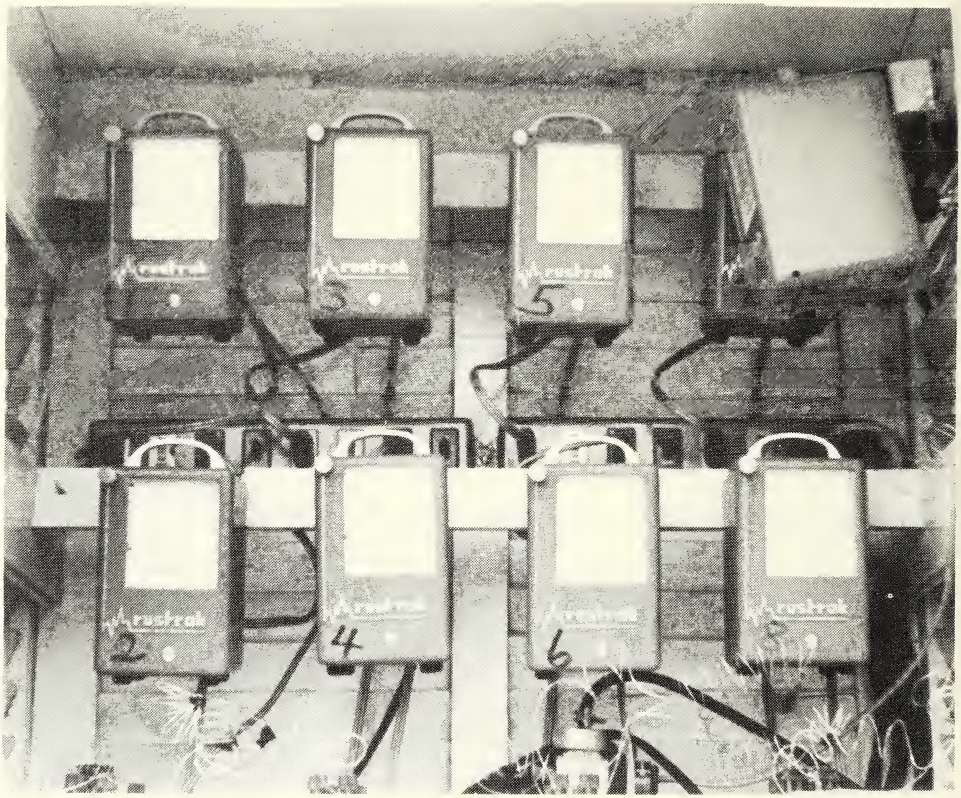


Figure 2. Rustrak recorders in operation.

for light penetration (as reflected by the recorders Fig. 3) were measured with a planimeter in square inch units and expressed on a percentage basis with 10 square inch units equivalent to 100 percent.

The 1965 measurements of wet- and dry-bulb temperatures were recorded in each of the four row directions. An aspirator made up of two thermisters, a squirrel-cage fan and water reservoir was placed between the two rows containing the light sensors. A continuous flow of air was pulled past the wet and dry sensors from one foot above ground level.

Net radiation was measured over bare ground near the center of the project as was the wind speed. A thermal net radiometer was used and its output was recorded on a scale of -5/0/+15 millivolts.

The cotton was planted and cultured in the conventional manner each year until time for installation of the light measuring equipment. The cotton middles, skips and alleys were treated with a sub-surface soil application of trifluralin and diuron immediately before installation of the light equipment. This lay-by treatment adequately controlled weeds and eliminated the need for further cultivation.

The plots were harvested by hand pickers in 1964 and with a mechanical picker modified for plot work the last three years.

Results and Discussion

The light penetration of cotton foliage was influenced by light intensity, wind velocity, row direction, row position, and the degree of vegetative growth.

Light intensity was very low, during periods of rain, and in fair weather, considerable light restriction occurred as a result of late morning and afternoon cumulus clouds (Fig. 3-A, C and D).

High wind velocity caused more plant movement which resulted in greater light penetration of foliage. The wind velocity was variable but, generally, velocity was highest during the early and late parts of the growing season.

The light penetration was greatest, in 2 x 2 skip-row cotton where the rows were directed perpendicular to the sun (Fig. 3-C and D). The greatest light penetration of cotton foliage for the four row directions was in the descending order of north to south, northeast to southwest, northwest to southeast and east to west rows (Fig. 4).

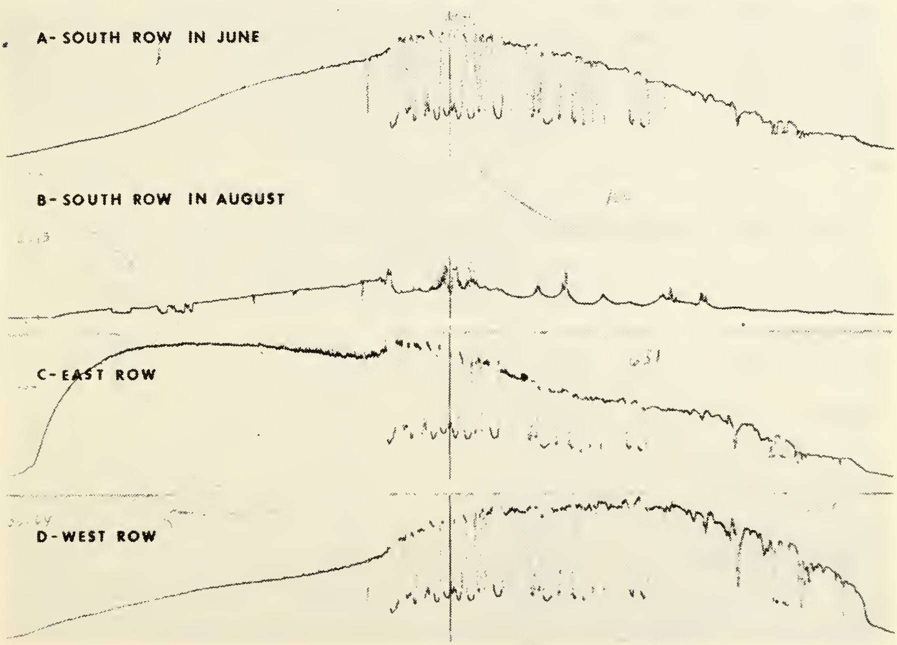
The amount of vegetative growth, influenced light penetration of cotton foliage. Light penetration was high at the initiation of the measurement period (Fig. 3-A). but decreased as vegetative growth increased until a low point was reached in August (Fig. 3-B).

Since only one replication was used in 1964 these data are reported separately. The data for 1964 as shown in Table 1 does not show any relationship between percent light and cotton yield with respect to row direction. It does, however, indicate that within any given row direction the row which received the most light produced the most cotton.

The difference in yield between row directions is due to soil position. The east to west and northwest to southeast rows were on better soil sites.

In 1965, a 40-day period (July 13-Aug. 21) of daytime temperatures and relative humidities was analyzed but differences between row directions were very small

FIG. 3-RECORDER CURVES FOR LIGHT IN 1964



and no significant relationships between these two elements and yields could be established.

The effect of row direction and position on light penetration of plants and yields for 1965, 1966, 1967 and the 3-year average are shown in Table 2. The percent of light penetration as shown for each year is an average for the total period of measurement. The percent light figures were lower in 1965 as compared with the two latter years because the cotton was earlier with more vegetative growth when the light measurements were begun.

Although light penetration was greater for plants of different row directions (Fig. 4), there were no significant differences in yield between row directions for any year.

Within three row directions, north to south, east to west, and northeast to southwest, the row with the greatest light penetration produced the most cotton. However, the yield difference between rows which received more as opposed to less light was not significant, except in 1966. An exception was the northwest to southeast rows where the row with less light penetration produced more cotton.

Figure 5 shows the percent light penetration of cotton (4-year average of row directions) along with the mean air temperature as recorded at the Stoneville Weather Station for the same period. The average light penetration and temperature are plotted at intervals of two weeks. Temperatures are shown only to illustrate uniformity when averaged for the 4-year period.

During the first two-week period light penetration was high because the cotton plants were small. As vegetative growth increased light penetration decreased until a low was reached at the two-week period August 7-20 (Fig. 5). This low point of light penetration represents the greatest stage of vegetative growth.

Immediately following the vegetative peak, light penetration increased rapidly which indicated that maturity was likewise rapid. Percent light penetration was correlated with cotton yield for two of the two-week periods. During the period of greatest vegetative growth (Aug. 7-20) light penetration was negatively correlated with yield. At the Sept. 4-17 period, or four week following the peak of vegetative growth, there was a positive correlation between percent light penetration and yield. It appears that light penetration, as determined in this experiment, more effectively measured the stage of vegetative growth and maturity rather than the effect that quantity of light had upon yield.

Two week averages of percent light

Table 1. Effect of row direction and position on light penetration and yield of 2x2 skip-row cotton (1964).

Row Direction	Row Position	Percent light*	lbs. seedcotton per acre
North-South	East	63.6	4313
	West	77.7	5219
	Average	70.7	4766
East-West	North	54.5	5619
	South	56.0	5733
	Average	55.3	5676
Northeast-Southwest	Northwest	61.4	4722
	Southeast	77.5	5132
	Average	69.5	4927
Northwest-Southeast	Northeast	61.4	5323
	Southwest	66.4	5680
	Average	63.9	5502

* Relative light penetration into plant canopy (average from June 26 through Sept. 17).

FIG. 4. PERCENT LIGHT PENETRATION AS INFLUENCED BY ROW DIRECTION AND POSITION.

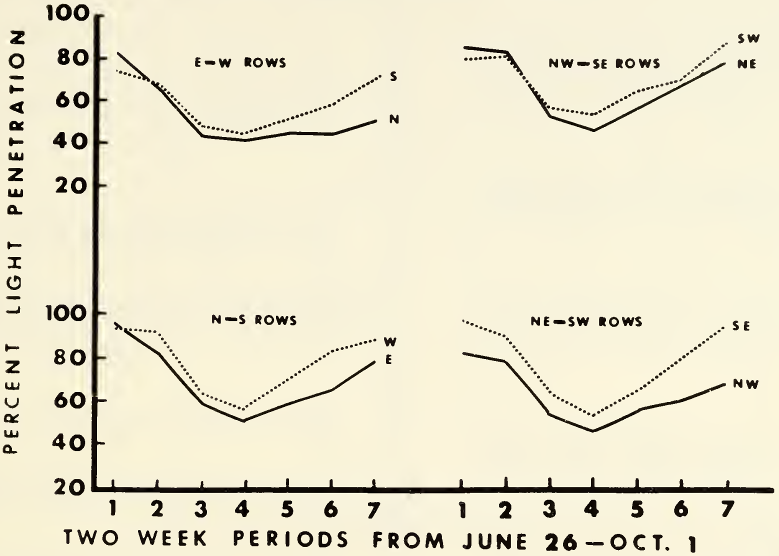


FIG. 5. PERCENT LIGHT PENETRATION OF COTTON (ROW DIRECTION AVERAGE FOR 4 YEAR PERIOD) AND MEAN TEMPERATURE

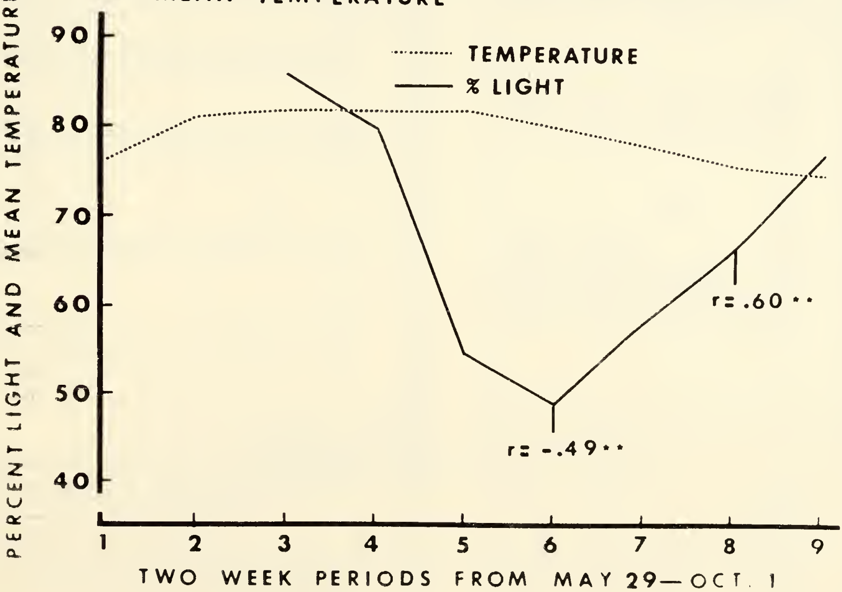


Table 2. Effect of row direction and position on light penetration and yield of 2x2 skip-row cotton (1965-1967).

Row Direction	Row Position	1965 % light	1965 Yield	1966 % light	1966 Yield	1967 % light	1967 Yield	3-year average % light	3-year average Yield
North-South	East	54.9	4378	71.3	4657	76.3	3612	67.5	4216
	West	61.6	4544	78.4	5031	81.7	4051	73.9	4542
	Average	58.3	4461	74.9	4844	79.0	3831	70.7	4379
East-West	North	46.3	4538	50.3	4587	52.3	3190	49.6	4105
	South	49.8	4639	68.2	4693	52.3	3320	56.8	4217
	Average	48.1	4589	59.3	4639	52.3	3255	53.2	4161
Northeast-Southwest	Northwest	55.1	4396	70.4	4378	61.8	4146	62.4	4307
	Southeast	59.5	4526	79.7	5019	81.9	4704	73.7	4750
	Average	57.3	4461	75.1	4699	71.9	4425	68.1	4528
Northwest-Southeast	Northeast	48.6	4508	73.8	5186	69.7	3748	64.0	4481
	Southwest	53.6	4289	74.1	4485	75.4	3629	67.7	4134
	Average	51.1	4399	73.9	4835	72.6	3689	65.9	43.08

Table 3. Average temperatures (F^0) and total rainfall as recorded at the Delta Branch Experiment Station Stoneville, Mississippi from 1964-1967.

Two-Week Periods Start - End	1964 Temp. Max.	1964 Temp. Min.	1964 Rainfall inches	1965 Temp. Max.	1965 Temp. Min.	1965 Rainfall inches	1966 Temp. Max.	1966 Temp. Min.	1966 Rainfall inches	1967 Temp. Max.	1967 Temp. Min.	1967 Rainfall inches
April 3 - April 16	73	52	4.10	80	62	1.62	71	47	0.66	81	61	1.97
April 17 - April 30	79	61	5.53	77	53	1.27	77	59	2.52	76	56	1.06
May 1 - May 14	82	62	0.85	85	63	T	79	57	1.41	79	60	2.52
May 15 - May 28	90	64	0.18	86	67	4.27	84	64	1.44	81	59	3.38
May 29 - June 11	86	62	0.62	89	67	0.05	88	63	T	84	66	2.25
June 12 - June 25	96	74	0.13	87	66	2.11	90	67	0.77	94	72	0.25
June 26 - July 9	94	72	2.89	93	72	1.05	93	71	2.30	89	71	1.75
July 10 - July 23	92	70	1.34	95	72	0.38	97	75	0.59	87	67	1.06
July 24 - Aug. 6	95	73	0.54	92	69	0.47	92	71	0.69	91	73	1.55
Aug. 7 - Aug. 20	88	68	2.49	93	70	1.26	92	70	1.57	87	67	0.72
Aug. 21 - Sept. 3	91	70	0.56	89	70	0.91	88	64	0.62	84	63	0.29
Sept. 4 - Sept. 17	90	63	T	89	69	2.96	85	63	0.39	81	64	0.99
Sept. 18 - Oct. 1	83	61	2.77	81	62	1.54	82	59	1.16	82	57	0.92
Oct. 2 - Oct. 15	71	48	0.60	77	54	0.94	79	52	0.92	80	52	0.15
Oct. 16 - Oct. 29	76	47	0.07	74	46	T	68	44	1.29	74	47	0.59
April 3 - Oct. 29	86	63	22.67	86	64	18.83	84	62	16.33	83	62	19.45

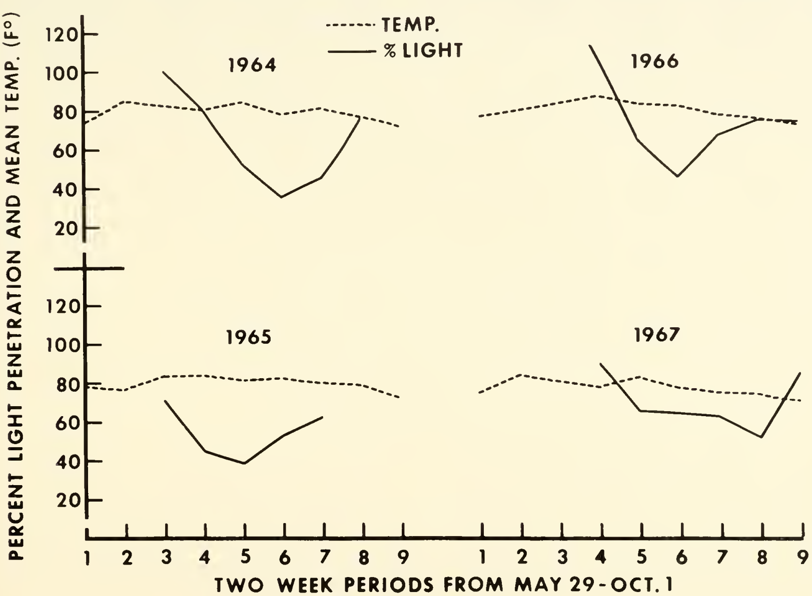
penetration of cotton and the mean temperatures for the growing season of each year are shown in Figure 6. The lowest point of percent light penetration, as previously mentioned, coincides with the peak of vegetative growth. As illustrated in Figure 6, this peak of vegetative growth seems to give a reliable indication of the maturity date of cotton.

In 1964 and 1966 the vegetative peak was reached during the 6th two-week period (Aug. 7-20). The mean temperatures were relatively high in 1964 and 1966 with some minor fluctuation but did not fall much below 80° during the critical growing period.

In 1965 the vegetative peak occurred during the 5th two-week period, or two weeks earlier than in 1964 and 1966. The mean temperature was uniformly high (above 80°) during the growing period.

In 1967 the vegetative peak of growth and maturity occurred during the 8th two-week period (Sept. 4-17). The delay in vegetative growth and maturity was probably caused by a combination of low temperatures from July 10-23 (Fig. 6) and relatively high rainfall from June 26 through August 6 (Table 3). As a result of late maturity the 1967 cotton yield was much lower than that of the three previous years.

FIG. 6. PERCENT LIGHT PENETRATION OF COTTON AND MEAN TEMPERATURE DURING THE GROWING SEASONS (1964-1967)



Summary

An experiment was conducted at the Delta Branch Experiment Station from 1964-1967 to measure microclimatic regimes in 2 x 2 skip row cotton planted in four row directions. Light penetration of the cotton foliage was measured during each growing season for four years and relative humidity and temperature were measured for one growing season in 1965. Summary statements are listed below:

1. Row direction had no effect on relative humidity and temperature as measured within the plant canopy in 1965.

2. There was no significant difference in cotton yield between row direction during any year or for the four-year average.

3. Within row directions, the row which received the most light usually produced more cotton. However, the difference in yield between rows receiving more as opposed to less light was not significant, except in 1966.

4. Light penetration of the cotton foliage was higher for row directions more nearly perpendicular to the path of the sun.

5. There was no correlation between light penetration and cotton yield except for two periods during the growing season. A negative correlation was found during the two-week period of greatest vegetative growth (Aug. 7-20), while a positive correlation was found four weeks after the peak of vegetative growth, or during the two-week period (Sept. 4-17).

6. The percent light penetration of cotton foliage, as determined in this experiment, more effectively measured the stage of vegetative growth and plant maturity-rather than the effect that quantity of light had upon yield.