September 15, 1967

To the Graduate Council:

I am submitting herewith a thesis written by Grady Eugene Neely entitled "The Effect of Light and Moisture on Cotton Fruiting Habits and Yield." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

W L Parker
Major Professor

We have read this thesis and recommend its acceptance:

R. J. Lewis

R. E. Hilton

Accepted for the Council:

Walton A. Smith
Vice President for
Graduate Studies and Research

THE EFFECT OF LIGHT AND MOISTURE ON COTTON FRUITING HABITS AND YIELD

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Grady Eugene Neely

December 1967

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This study was carried on under a research project of the Tennessee Agricultural Experiment Station, and the results of this study represent a contribution to that project.

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CHAPTER I

INTRODUCTION

The value of a cotton crop is closely related to the yield per acre. Although the expenses of producing an acre of cotton vary somewhat from farmer to farmer, those factors affecting yield are the ones that determine profit. Most farmers of today follow established management practices in growing cotton so there is little variation from one year to the next in this respect. However, yields may vary greatly from year to year. Although diseases and insects may from time to time affect yield, the different climatic conditions under which plants grow cause significant yield variations among years.

The process of fiber formation begins on the day the flower opens and continues until the boll matures. Therefore, it follows that environmental factors which influence boll set and development, also influence yield. The yield depends upon the climatic conditions being favorable or unfavorable from the date of squaring through boll maturation.

Many farmers of today have found they can create a more favorable environment for cotton by using various skip-row designs. Thus, this study was undertaken first to obtain data of the fruiting habits of cotton planted in various skip-row designs under varying light and moisture conditions; second to obtain yield data from varying skip-row planting patterns; and third to determine possible causes if yield variations occurred.

CHAPTER II

REVIEW OF LITERATURE

In this study, the fruiting habits and yield of cotton were considered. Hence, only the literature concerning the effects of environmental conditions on shedding and yield has been reviewed.

I. SHEDDING

Shedding is the dropping of fruiting forms from the cotton plant. These forms may consist of both squares and young bolls. Shedding does not occur in either the flower stage or to much extent with larger bolls. There are two forms of boll shedding. Natural, or normal shedding which may be a manifestation of physiological response. This shedding is slight early in the growing season, but generally increases during the season. Shedding may also take place because of injury to the top portion or to the roots of a cotton plant. According to Brown and Ware (7),[1] insects, diseases, or mechanical damage may cause these injuries.

Hanson et al. (26) stated that the indeterminate fruiting habit of the cotton plant exposed it to environmental changes within a single season. This makes the study of several environmental effects on cotton more difficult than for those crop plants with terminal

---

[1]Numbers in parenthesis refer to literature cited.

inflorescences and helps explain why there have been many experiments concerning the shedding of young bolls.

It has been shown by King et al. (31) in China and Alasingrackar (2) in Tennessee that after a rain, which prevents pollination, a heavy fall of young bolls results four or five days later. King also found boll shedding induced by spraying liquid insecticide in the forenoon was more serious than spraying in the afternoon.

The results of Eaton and Ergle (21) indicated that neither the relative number of bolls carried by a cotton plant, nor the percentage of bolls shed appeared to be influenced by the level of carbohydrate or nitrogen supply, but the absolute number it may develop was affected. They suggested that boll shedding was controlled by the balance between auxin produced in the leaves and an anti-auxin, or inhibitory material, moving out into the fruiting branches which prevented boll development. In a later study, Eaton and Ergle (20) stated that a plant discarded superfluous bolls when they exceeded six to seven per 100 grams of fresh leaves and stems. This was ascribed to an anti-auxin substance which curtailed vegetative expansion and induced abscission.

Dale (15) conducted field and glasshouse studies in Uganda, and showed that pedicels from which the boll and bracteoles had been removed, abscissed, and that the rate of abscission was reduced by the presence of developing bolls elsewhere on the plant. Plants which were continuously disbudded up to 23 and 35 weeks after planting by Dale (16), produced an average of 280 and 764 flower buds per plant, respectively. Control plants produced only 112 and 160 flower buds

per plant over comparable periods. These data indicated that during maturation, the bolls used nutrients which could have otherwise been used for further growth and development of the fruiting structure. Waddle (44), in a similar field experiment carried out in Arkansas to investigate to what extent a plant could recover from early loss of unopened flower buds, found yield was unaffected by removal of these buds for five weeks after their first appearance.

It has been revealed by Dark (17) in Sudan that shedding of cotton flowers could be prevented by painting the calyx and the inner surface of the bracteoles at pollination time with 1000 p.p.m. solution of α 2,4,5-trichlorophenoxy propionic acid as the sodium salt in distilled water plus a wetting agent.

In studies on the effect of light intensity on the cotton plant, Dunlap (19) obtained shedding readily by subjecting plants in active fruiting stages to low light intensities for a short period. He also found that wilting plants which were growing in containers for a few hours prior to each irrigation checked vegetative growth and decreased the shedding of flowers.

In an experiment designed to study physiological responses, Horowitz (28) working in France found that when plants were widely spaced more flower buds were formed and a smaller proportion was shed. The number of bolls per unit area was greatest in dense populations, but was offset by lower boll weight. Close spacing suppressed the development of monopodial branches.

The percentage of bolls shed may be determined by the variety in addition to other conditions affecting shedding. McNamara et al. (37) found medium to large boll varieties retained a smaller percentage of their immature bolls than did the small boll varieties. Kearney (30) stated that variations in the rate of shedding within a variety were determined chiefly by environmental factors including such external factors as insects and diseases.

Ewing (23), Newson et al. (38), and Saxsena (40) reported that blossoms produced during the first five weeks of the fruiting period made up 70 per cent of the open bolls.

There seems to be much controversy concerning the effect irrigation has on the shedding of young bolls. Comparing irrigated and nonirrigated cotton, Spooner et al. (41) in Arkansas found boll shedding was significantly reduced by irrigation. They also found in both treatments that boll shedding was greatest two weeks after the peak of flowering. Balls (5) reported that the usual cause of shedding was a shortage of water.

Others have found the opposite to be true. Using four levels of soil moisture Chang-Navarro (11) found physiological shedding tended to increase slightly with increased soil moisture. King (32) in Arizona obtained less shedding as the frequency of irrigation was reduced. According to Christidis and Harrison (12) increasing the frequency of irrigation resulted in greater flower production but also resulted in additional shedding. Albert and Armstrong (3) showed more shedding under high soil moisture (above field capacity)

than at a lower moisture regime which was considered nearly optimum for growth. Crowther (14) concluded that high soil moisture increased flower production, but medium soil moisture caused the least shedding. A similar response was obtained by Hawkins et al. (27) in Arizona who reported that extremes in vegetative growth were accompanied by increased boll shedding.

In comparison to the above two views, Horowitz (28) found irrigation had little influence on shedding. Hamilton et al. (25) working under conditions of limited plant growth in Arizona obtained no differences in either flowering or boll set in cotton irrigated 41, 21, or 12 times. Using three irrigation frequencies, Stockton et al. (42) in California recorded no difference in the percentage of bolls shed at first sign of moisture stress or after several days of wilting. There was only an 8 per cent increase over the other two levels when irrigation was made weekly, or at no sign of moisture stress. Beckett and Dunshee (6) and Adams et al. (1) reported that infrequent irrigation was responsible for increased shedding of young bolls in California.

II. YIELD

There are many factors affecting yield, but here only the ones relating to this experiment will be discussed. Johnson and Wadleigh (29) studied certain weather factors in relation to yield in six eastern Arkansas counties for the period 1919-35 and found a high correlation between yield and rainfall for the months of April, May,

and July. They stated, "Rainfall at or near the minimum reported for these months was associated with the best yields, provided there was a proper distribution of these small precipitations." Yields above the mean were associated with rainfall on at least 5.5 days in April and not more than 8 days. Precipitation on more than 10 days in May was usually associated with lower yields. However, in June, above normal yields seemed to be related to the occurrence of rainfall on at least 3.5 days, while maximum yields were associated with precipitation on 6.5 days. Precipitation on fewer than 4.5 days was associated with departures from the mean in July, August, and September. However, precipitation on more than 7 days in July and on more than 4.5 days in August and September was related to little or no further change in yields.

Increasingly high mean maximum temperatures during May, June, and August were associated with increased yields. Mean maximum temperatures above 93° F. in July and above 86° F. in September were associated with decreased yields (29).

Knight (33) observed that shading plants in the field with a coarse white cloth caused a striking reduction in yield and an increase in fiber length. Shade produced a delay in the production of sympodial branches and also a reduction in their number. Eaton and Rigler (22) found that the fruiting activity, as compared to vegetative growth, was greater under high than low light.

A four-year study of skip-row planting was carried out by Grissom and Spurgeon (24) in Mississippi. Cotton planted in a silt

loam soil in a plant-four-fallow-four manner produced 45.1 per cent more than solid plantings. Cotton planted in the plant-two-fallow-two system on the same soil produced 67.3 per cent more than solid planting. When irrigated cotton planted in a plant-four-fallow-four manner was compared with irrigated solid cotton, the four year average yield of the skip-row was 24.7 per cent above the solid planting. One year's data, 1962, showed cotton planted in the plant-two-fallow-two manner produced 404 pounds more seed cotton per acre than where the plant-two-fallow-one system was used. Two-year results with interplanting showed higher yields of cotton with the plant-four-fallow-four system than when two rows of soybeans or two rows of sweet potatoes were planted in the four skipped rows. The reduction in yield was 500 pounds and 350 pounds per acre for the soybeans and sweet potatoes, respectively. When cotton was planted in an east to west direction in the plant-four-fallow-four system, the south row produced a higher yield than the north row. When cotton was planted in north to south rows, the east row produced more than the west row in the plant-four-fallow-four pattern. Two year averages for 1961 and 1962 showed the yield of the outside rows of the plant-four-fallow-four system was 58.6 per cent higher than the inside rows. The inside rows of the plant-four-fallow-four system produced slightly higher yields than solid planting. The outside rows of plant-four-fallow-four cotton also yielded more than plant-two-fallow-two cotton. The same experiment was conducted in a clay soil and the yield of cotton was not affected by skip-row planting. The plants here in all instances reached only about 2 feet high.

In a three year study on skip-row planting, Dick and Owings (18) also in Mississippi obtained an average of 46 per cent yield increase of plant-four-skip-four over solid planted cotton and an average of 77 per cent yield increase of plant-two-skip-two over solid planted. The two middle rows of the four row blocks produced a two year average of 320 pounds more seed cotton than solid planted rows or approximately a 16 per cent increase.

Longenecker and Lyerly (35) conducted a two-year experiment in Texas in a clay loam soil in which the skip-row pattern was plant-four-skip-two. Results showed the outside rows produced 500 to 700 pounds more lint per planted acre than the inside rows. The inside row yields varied from two to three bales per acre, and the outside row yields varied from three to four bales per acre.

An experiment by Bruce (8) on row spacing as it affected soil water utilization showed that water was uniformly removed by cotton planted in 40-inch rows. In a plant-two-skip-one design, there was 1.5 to 2.2 inches more water in the skipped row position than in the planted row. The yield per unit length of row from cotton planted in the skip-row pattern was significantly higher than that having a solid pattern. This increase ranged from 27 to 34 per cent. Burnett and Fisher (10) in a 22 year experiment obtained highly significant correlations between yield and available soil moisture at one, two, and three depths of determinations.

Spooner et al. (41) reported that irrigation increased yields by approximately one bale per acre, and that water applied before flowering did not cause a significant increase in yields.

Bruce and Skipp (9) proposed for Mississippi that cotton be held at the 0.16 - 0.33 bar level until three weeks past first flowering and at the 0.34 - 0.50 bar level thereafter for a combination of high yield and high water use efficiency. It was concluded by Marani and Fuchs (36) in Israel that a single irrigation at flowering initiation to wet the soil to a depth of approximately 90 cm. was most advantageous.

In a three year study of cotton irrigated at three frequencies by Stockton et al. (42) in California, yield results showed irrigation weekly, or at no sign of moisture stress, was not significantly different from cotton irrigated at the first sign of moisture stress. However, irrigation after several days of wilting gave a significantly lower yield than either of the other two frequencies.

Arnold (4) stated that in Mississippi the irrigation of cotton produced an average annual increase of 13 per cent in seed cotton over unirrigated cotton, but that this increase was uneconomical. In comparison Cook (13), also in Mississippi, indicated cotton yields may be increased or decreased by irrigation, depending on how rainfall was distributed during the growing and maturing seasons. He also suggested skip-row planting could be more profitable to most farmers than irrigation. A five year study by Phillips (39) in Louisiana indicated the average yield of seed cotton was increased by irrigating when the available soil moisture reached 25 per cent. Chang-Navarro (11) irrigated to field capacity when soil moisture at the 0 - 30 cm. level was reduced to 69, 47, 24, and 13 per cent availability. The

most frequent irrigation gave the lowest yield of seed cotton while, the driest regime gave the highest first harvest and the lowest second harvest yields.

Longenecker and Lyerly (35) and Spooner et al. (41) support the theory that the irrigation of cotton delays boll maturity.

CHAPTER III

MATERIALS AND METHODS

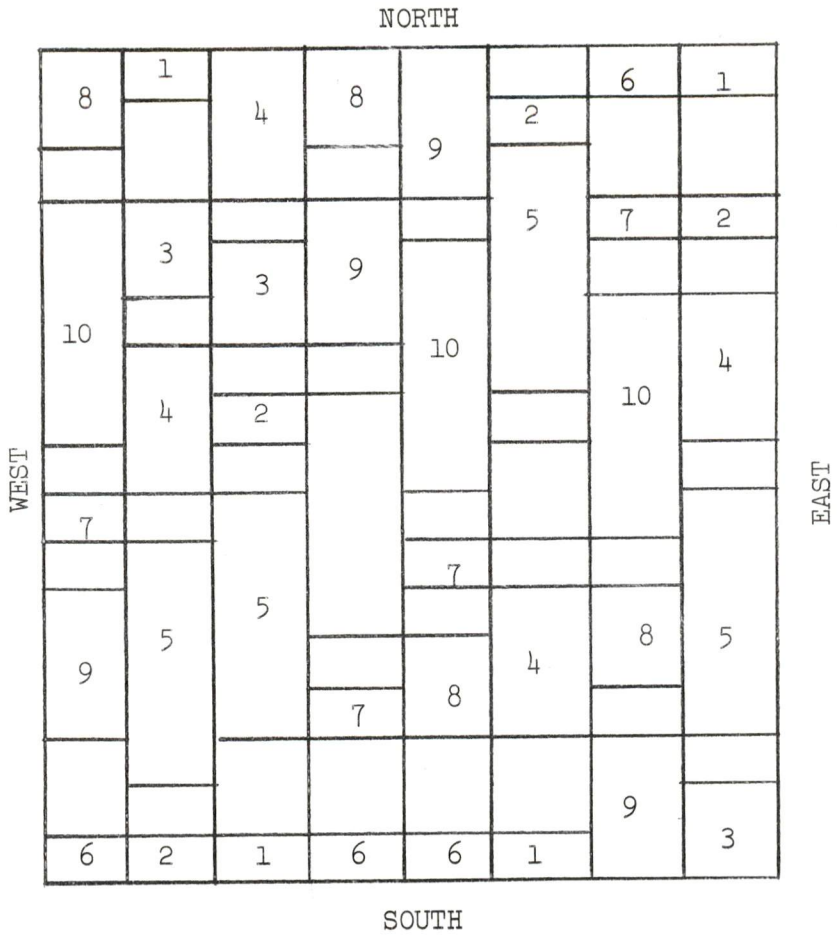
The results reported herein are based on an experiment conducted at the West Tennessee Agricultural Experiment Station at Jackson during the years 1964, 1965, and 1966. Each year Auburn M variety of cotton (Gossypium hirsutum) was planted in a Memphis silt loam.

I. SKIP-ROW PATTERNS

Four skip-row variations plus a single row with reflectors were used in this experiment. They were as follows: Plant-five-skip-one, plant-three-skip-one, plant-two-skip-one, plant-one-skip-one, and plant-one-skip-one with aluminized reflectors placed on each side of the row which provided for increased reflection.

II. DESIGN OF EXPERIMENT

A split plot experimental design with four replications was used in this experiment. The two main treatments were irrigated and unirrigated. Each of the main plots contained all five of the skip-row designs as illustrated in Figure 1. In the center row of each sub-plot, three plants in the same hill were randomly selected for bloom tagging and given a station number. In the two row patterns plants were chosen randomly from the north or south row. The size of the main plots was 48 x 51 feet, and each sub-plot varied accordingly with the number of rows. The dimensions of one row were 3 x 20 feet



LEGEND

Treatment number

Unirrigated	Irrigated	
1	6	One row plot, with reflectors.
2	7	One row plot, skip row both sides.
3	8	Two row plot, skip row both sides.
4	9	Three row plot, skip row both sides.
5	10	Five row plot, skip row both sides.

Figure 1. Field arrangement of all replications and treatments in the cotton environment experiment, 1964-1966.

with a 4 foot alley way at the end of each row. A skipped area consisted of one row.

III. PLANTING

The planting date for 1964, 1965, and 1966 was May 22, 7, and 23, respectively. Before planting each year, 100 pounds N, 70 pounds P_2O_5, 70 pounds K_2O and 20 pounds Borax per acre were incorporated in the soil. On the day of planting 0.6 pound of diuron per acre was broadcast each year. The cotton was thinned so that the hills were 7 to 8 inches apart and contained two to three stalks per hill.

IV. REFLECTORS

The reflectors were constructed of 2 by 8 feet pieces of one-fourth inch thick plywood that were coated with aluminum paint. Reflectors were installed approximately five weeks after planting each year. On both sides of the row for 8 feet, a reflector was placed at approximately a 45 degree angle to the row for maximum reflection.

V. IRRIGATION

A furrow irrigation system was used, and 2 acre inches of water was applied when the moisture level reached two bars tension or 10 per cent water by weight. The irrigation dates by year were as follows:

1964 4 August

1965 7 July, 4 August, and 20 August

1966 25 July

VI. TAGGING

A tag showing the date of bloom was tied on each bloom on the day of the blooming at each station. A station consisted of a three plant hill in each treatment. In the three and five row patterns, the station was always in the center row. Tagging was done six days a week; the number of blooms and dates on the tags of blooms that had shed were recorded at each station. During weekly harvests of the stations, records were kept of the blossom date on each boll picked along with the number picked and weights of bolls harvested at each station.

VII. HARVESTING

The cotton was hand-picked twice each year. All rows in the experiment were picked and weighed separately. Yields were computed using 20 feet of row except for reflected rows where 6 feet was used because of the reflector's length. Station weights were added to the row weights on which they occurred before yields were calculated. The yields for all skip-row designs used were made for the actual areas harvested without taking into consideration the skipped areas.

VIII. TEMPERATURES

Thermisters were used for soil and air temperature measurements 2 inches below and 14 inches above the soil surface, respectively. They were continually recorded in the single row reflected and single row unreflected cotton for both the irrigated and unirrigated treatments.

IX. ANALYSIS AND PRESENTATION OF DATA

The data were subjected to the analysis of variance in the usual manner (34). Duncan's Multiple Range Test was used to determine the significance of differences among treatments when the analysis of variance showed a variable to be significant at the 5 per cent level of probability. Statistical significance in the analysis of variance tables is indicated by the conventional use of asterisks as follows: significance at the 5 per cent level of probability is denoted by a single asterisk (*) and at the 1 per cent level of probability by a double asterisk (**).

CHAPTER IV

RESULTS AND DISCUSSION

The data from this study were divided into several related sections. They are in order of presentation: rainfall and temperature, blooms, bolls, and yields which were further divided into rows and their stations, skip-rows, reflectors, and row direction.

I. RAINFALL AND TEMPERATURE

The weekly rainfall and maximum and minimum temperature during part of July, all of August and part of September for 1964, 1965 and 1966 are presented in Figures 2 and 3. Since these environmental factors are known to strongly influence the various characters studied, the data are presented graphically to show the relative comparisons among the different weeks of the growing season.

The most precipitation occurred in 1964 during the cotton fruiting season of July and August, when 5.43 inches fell in July and 6.40 inches fell in August for a total of 11.83 inches that occurred on 20 different days. The driest of the three years was 1965 when 4.41 inches fell in July and 1.63 inches in August for a 6.04 inch total that occurred on 10 different days. In 1966, 4.19 inches fell in July and 3.77 inches in August for a 7.96 inch total that was received on 18 days of the two months. The number of days that precipitation occurred during the actual tagging period was 11, 5, 12 for 1964, 1965, and 1966, respectively.

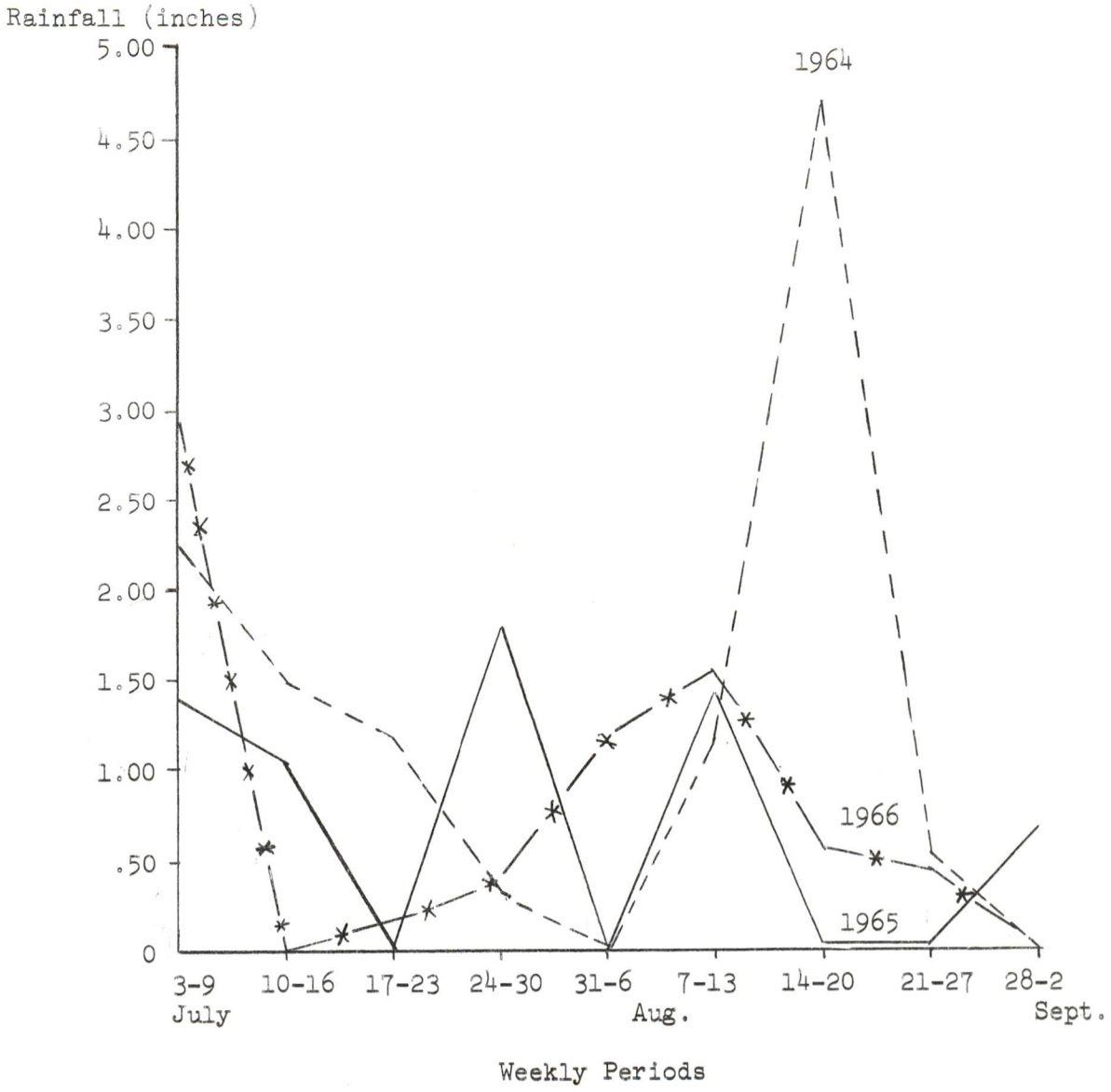


Figure 2. Weekly periods of rainfall at the West Tennessee Agricultural Experiment Station, 1964-1966.

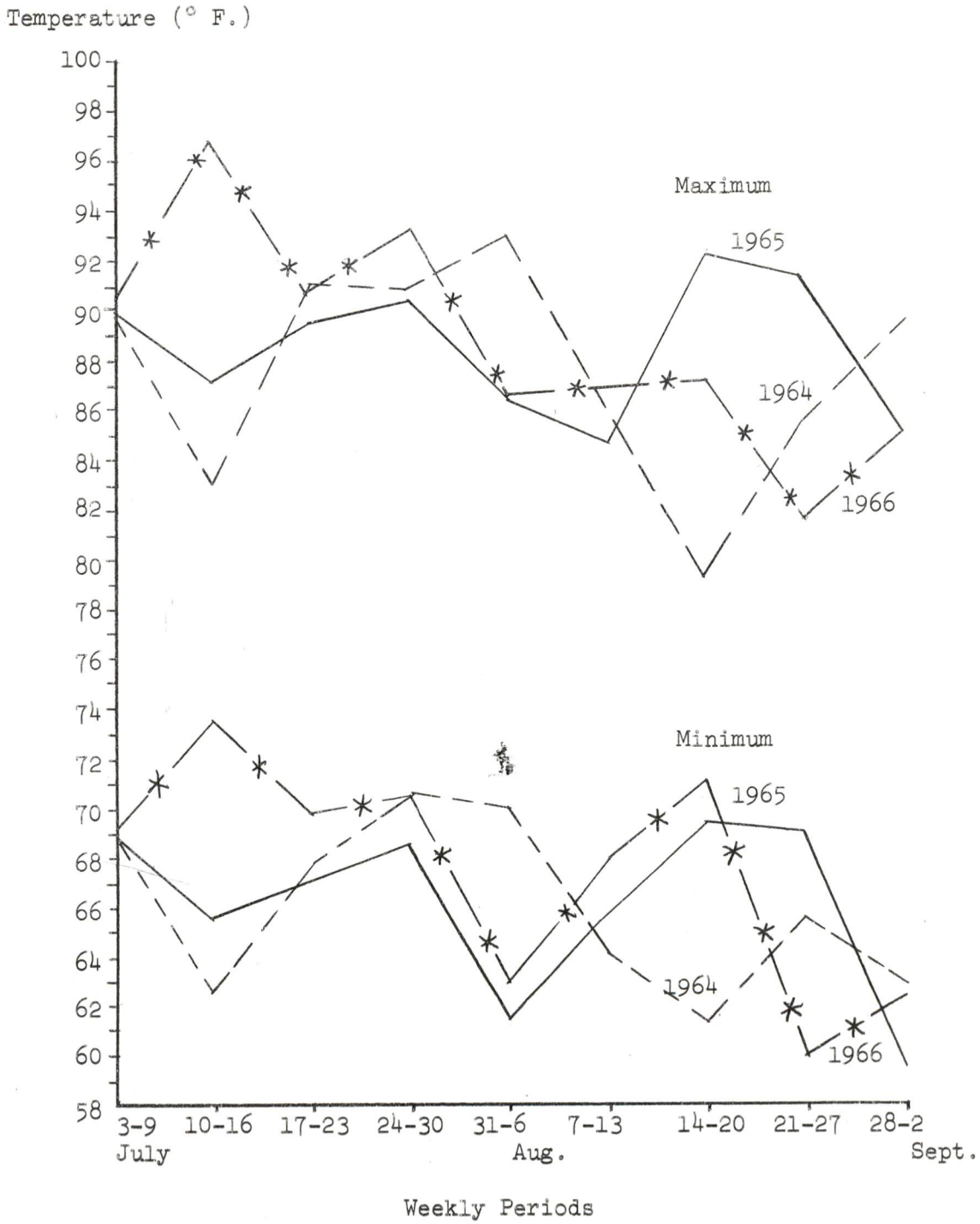


Figure 3. Weekly average maximum and minimum air temperature at the West Tennessee Agricultural Experiment Station, 1964-1966.

The weekly maximum and minimum temperatures during July and August for the three years showed no definite trends from one year to another (Figure 3, page 19). During the 1964 growing season, the range for maximum temperatures was from a high of 93° F. to a low of 79° F., and the minimum temperature range was from a high of 71° F. to a low of 61° F. The maximum range for 1965 was only from 92° F. to 85° F., while the minimum range was from 74° F. to 60° F. In 1965, the weekly maximum temperature varied only 7° F. while in 1964 and 1966, the variation was 14 and 15° F., respectively. The variation of the minimum temperature was 10, 10 and 14° F. for 1964, 1965, and 1966, respectively.

II. BLOOMS

Figure 4 shows the average number of blooms and the average number of bolls produced each week of the fruiting season by year for each of the treatments. The peak period for bloom production of each treatment in 1964 and 1966 usually was during the fourth week of blooming. While the peak period of blooming during 1965 usually was during the third week of blooming. The blooming rate during 1965 and 1966 usually dropped off rapidly in each treatment after the peaks were reached. However, in 1964, the year of lowest yields, the blooming rate for each treatment did not drop off as rapidly after the peak period as it did in the other two years of the study. Irrigation of all row patterns lowered the blooming rate during the first three or four weeks of blooming in 1965 and 1966 and during

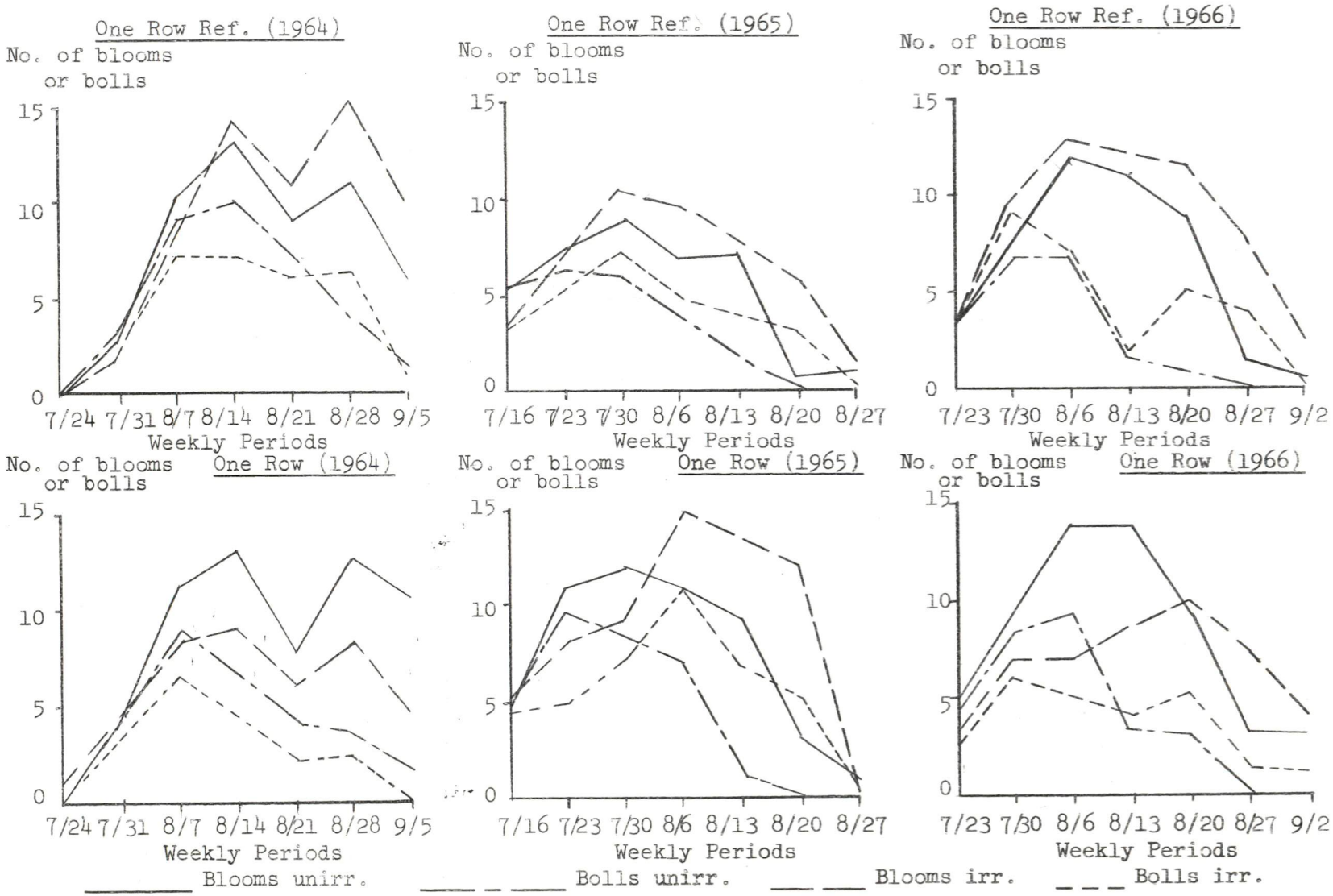


Figure 4. Weekly average number of blooms tagged and bolls retained per station in each treatment, 1964-1966.

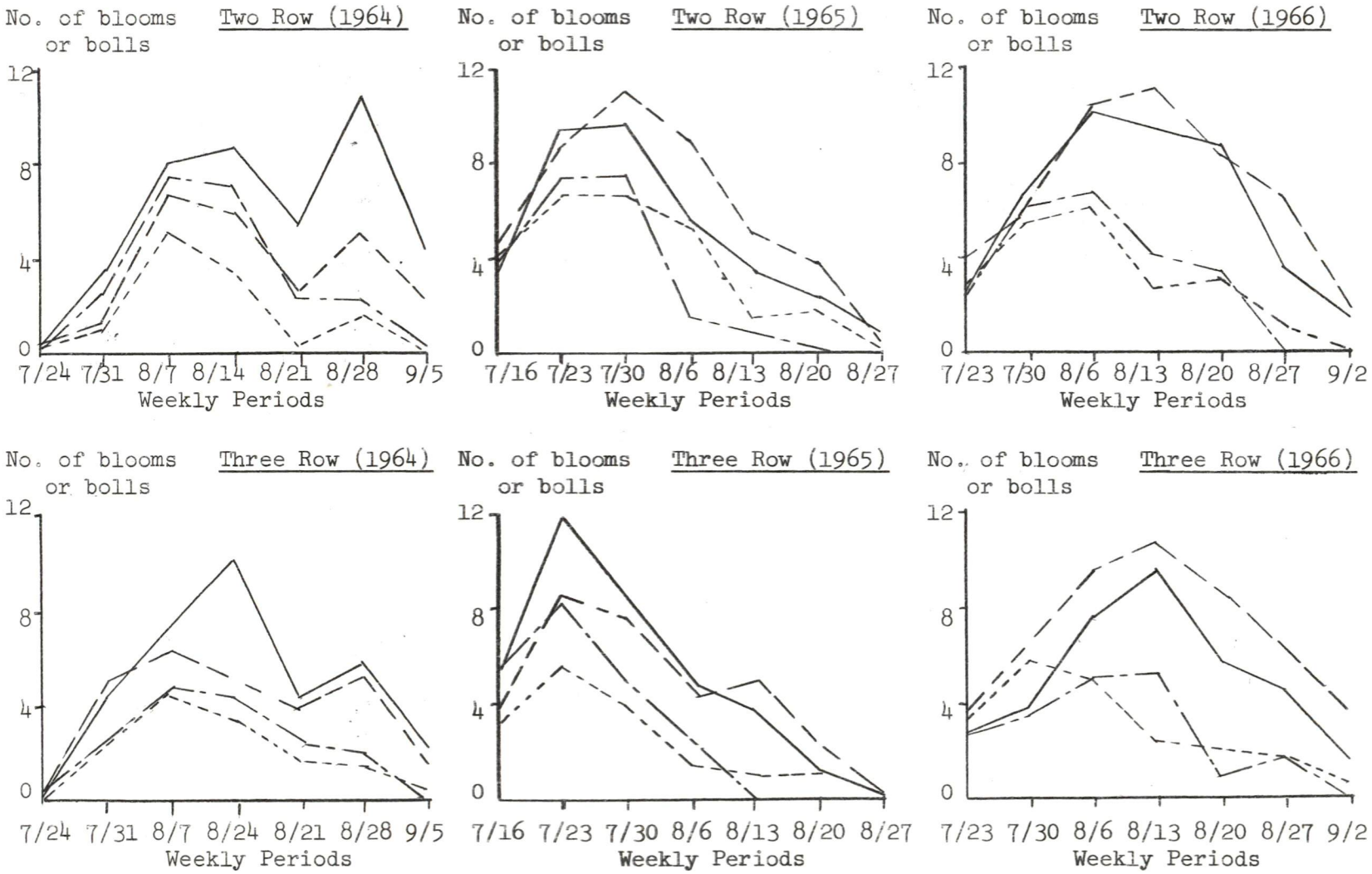


Figure 4. (continued)

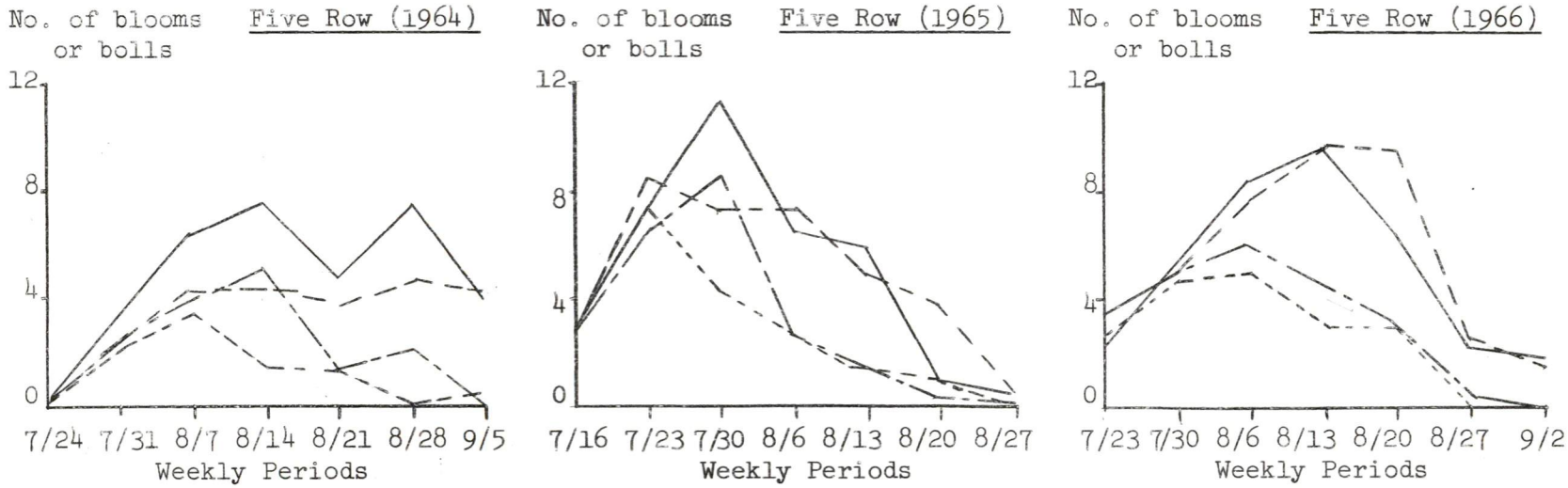


Figure 4. (continued)

the whole season in 1964. The blooming rate of all irrigated row patterns during the last part of the fruiting season in 1965 and 1966 was higher than that in the unirrigated patterns.

It is shown in Figure 5 that the per cent of blossoms tagged during the first month of blooming in 1964 for each treatment was less than in either of the other two years. This may explain why the rate of blooming after the peaks in 1964 was higher than 1965 or 1966 (Figure 4, page 21). The three year average of the unirrigated row patterns showed from 81 to 86 per cent of the blooms were tagged during the first month of blooming. Irrigating each of the designs caused small percentage differences in the per cent of blooms tagged during the first month of blooming, except for the single reflected and unreflected rows where irrigation reduced the three year average by 10 per cent.

It can be seen in Table 1 that the addition of water to each row pattern did not significantly increase or decrease bloom production for any of the five designs in the three years of the study. It is important to point out that the average number of blooms produced for the three year study in the one row treatments for the reflected and unreflected stations were significantly higher than similar averages for each of the multiple row patterns. For the three year experiment, the average number of blooms tagged in each of the two, three, and five row designs were not significantly different.

The average number of blooms produced per station for all treatments were not significantly different for any of the three

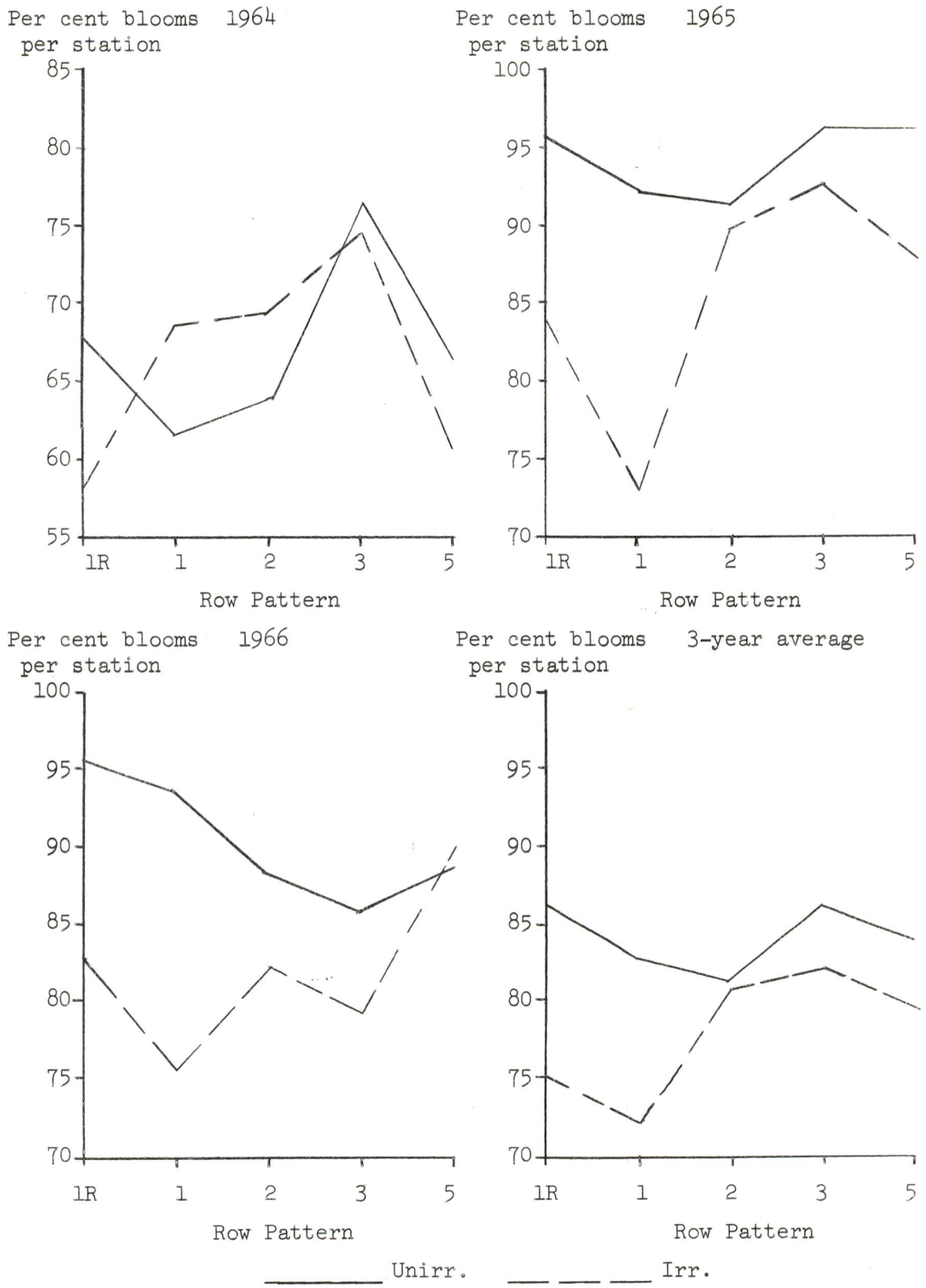


Figure 5. Per cent of blooms tagged for the year that were tagged in the first month of blooming per station in each treatment, 1964-1966.

Table 1. Multiple range groups of blooms tagged at stations for treatments, moisture, row patterns, and years, 1964-1966

Factor	Blooms/station*
Treatment	
One row reflected irrigated	59.1 a
One row unreflected unirrigated	58.6 a
One row unreflected irrigated	55.8 ab
One row reflected unirrigated	46.7 b
Two row unirrigated	40.6 c
Two row irrigated	40.6 c
Three row irrigated	36.4 c
Five row unirrigated	36.3 c
Three row unirrigated	35.8 c
Five row irrigated	34.4 c
Moisture	
Unirrigated	43.6 a
Irrigated	45.2 a
Row pattern	
One row unreflected	57.2 a
One row reflected	52.9 a
Two row	40.6 b
Three row	36.1 b
Five row	35.4 b
Year	
1966	46.6 a
1964	43.9 a
1965	42.6 a

*Numbers followed by the same letter do not differ significantly at the 0.10 level of probability according to Duncan's Multiple Range Test.

years as shown in Table 1, page 26. This indicated that the plants in each treatment produced relatively the same number of blossoms each year.

III. BOLLS

As indicated in Figure 4, page 21, the peak period of boll set in each treatment did not always occur during the peak of blooming. In each of the three years, more bolls were usually set during the week before or during the week of greatest blooming than during any other week. Therefore, in 1964 and 1966 the most bolls were set during the third and fourth weeks of blooming, while in 1965 the peak boll set occurred in the second and third weeks of blossoming. In contrast to the results found in blooming, the decline after the peak of boll set in 1964 did not seem to vary greatly from the decline in 1965 or 1966.

The per cent of bolls set during the first month of blooming was less in 1964 than in either of the other two years as shown in Figure 6. Similar percentages for 1965 and 1966 did not vary significantly from each other as the blooms did in the same years. The three year average for each of the unirrigated row patterns showed from 92 to 96 per cent of the bolls were set during the first month of blooming. A similar average for each of the irrigated designs showed that from 83 to 96 per cent of the bolls were set during the first month of blooming. It can be seen in the irrigated patterns that this percentage varied directly with the number of rows in the pattern while no such relationship existed for the blossoms.

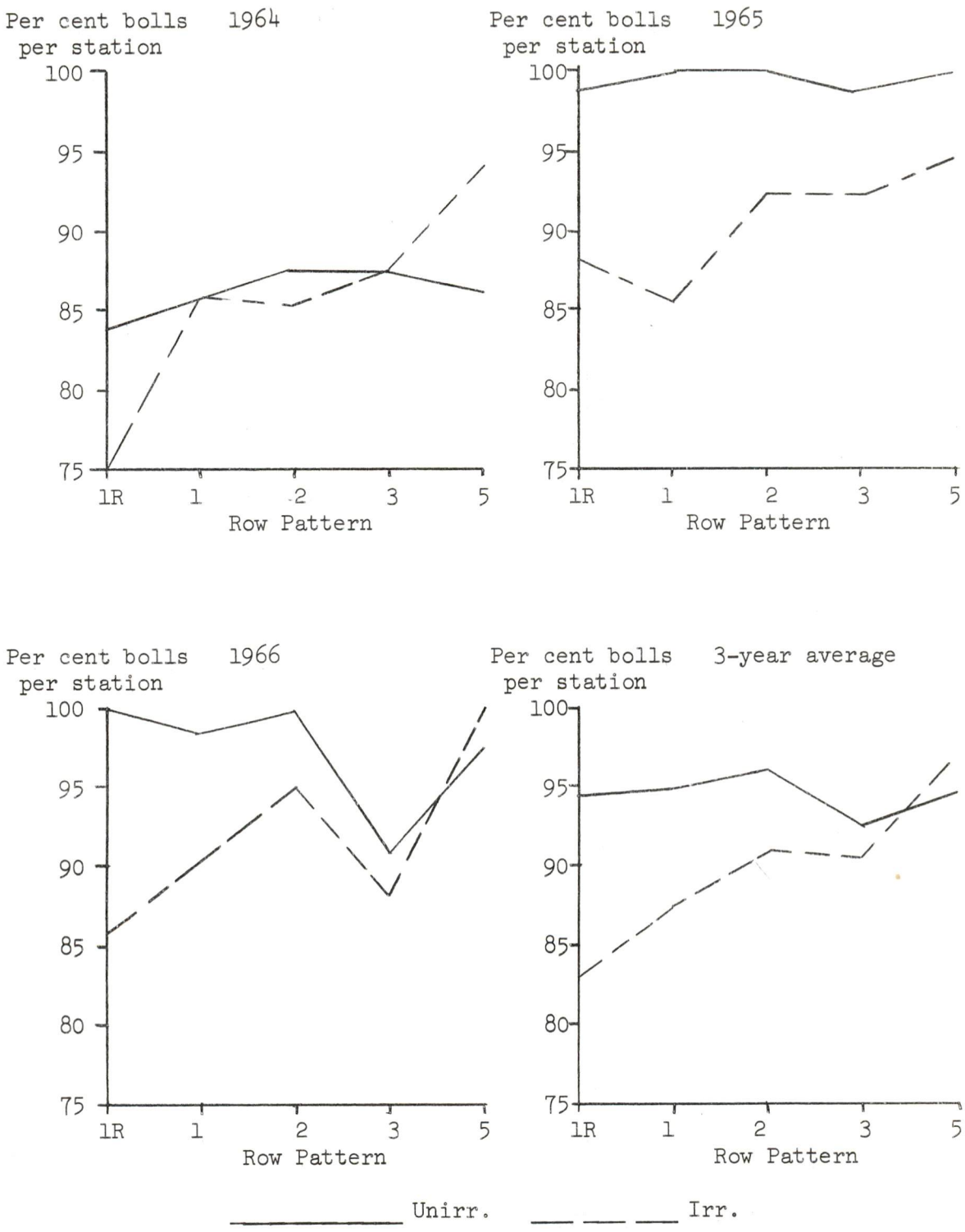


Figure 6. Per cent of bolls picked per station that were set in the first month of blooming in each treatment, 1964-1966.

The average percentage of bolls set at stations for each of the ten treatments for each of the three years and the three year average is presented in Figure 7. It is noted that in 1964, the year of lowest yields, a lower percentage of bolls set was shown for nearly all treatments than was recorded in either of the other two years. Also, in 1965, the year of the highest yields, the percentage of bolls set for each treatment was nearly always higher than in either 1964 or 1966. The three year average for the per cent of bolls set per station for each treatment indicates that unirrigated treatments had from a 3 to 8 per cent higher boll set than did each of the irrigated patterns with the only exception being the unreflected one row pattern where the percentages were approximately equal. It is also seen from the three year averages that none of the treatments varied more than 7 per cent from a 50 per cent boll set.

The three year average of the number of bolls picked per station for both the reflected row and the unreflected row were significantly higher than similar averages for the multiple row patterns (Table 2 and Figure 8). As was found with the blooms, the irrigation of each of the row patterns did not significantly change the number of bolls produced by any design. The average number of bolls picked per station for all treatments were not significantly different in any of the three years of the study. This was also true for the blooms.

As indicated in Figure 9, irrigation of all row variations increased the number of days from blooming to opening for bolls in 1965 and 1966. In 1965 irrigation delayed opening of bolls for each row pattern from 5 to 7 days. While the maturity date of irrigated

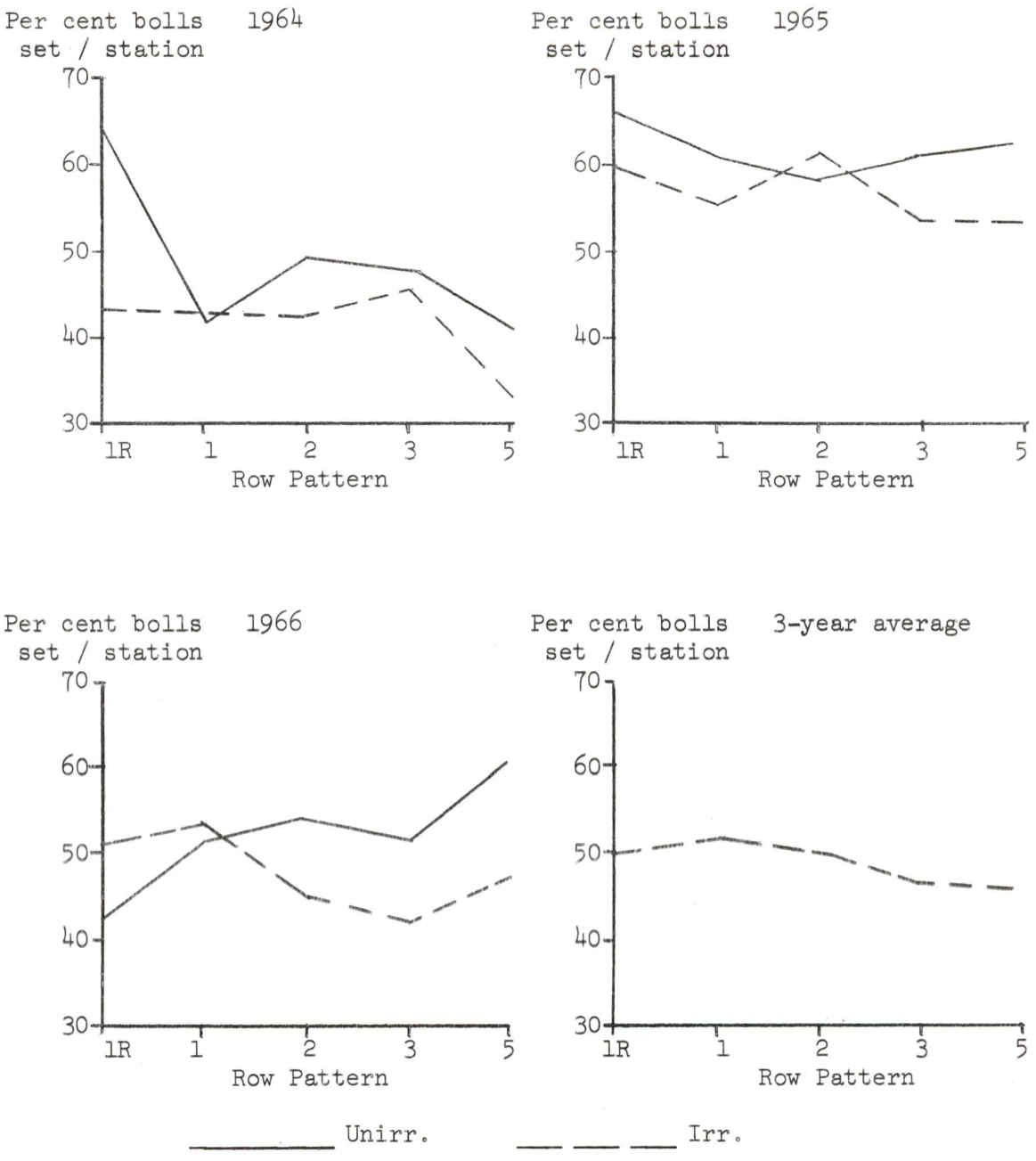


Figure 7. Yearly per cent of bolls set per station in each treatment, 1964-1966.

Table 2. Multiple range groups of bolls picked at stations for treatments, moisture, row patterns, and years, 1964-1966

Factor	Bolls/station*
Treatment	
One row reflected irrigated	29.6 a
One row unreflected unirrigated	29.6 a
One row unreflected irrigated	28.6 a
One row reflected unirrigated	26.7 ab
Two row unirrigated	21.8 bc
Two row irrigated	20.3 c
Five row unirrigated	19.8 c
Three row unirrigated	19.1 c
Three row irrigated	16.8 c
Five row unirrigated	15.7 c
Moisture	
Unirrigated	23.4 a
Irrigated	22.2 a
Row pattern	
One row unreflected	29.1 a
One row reflected	28.1 a
Two row	21.0 b
Three row	18.0 b
Five row	17.8 b
Year	
1965	25.2 a
1966	23.0 a
1964	20.1 a

*Numbers followed by the same letter do not differ significantly at the 0.10 level of probability according to Duncan's Multiple Range Test.

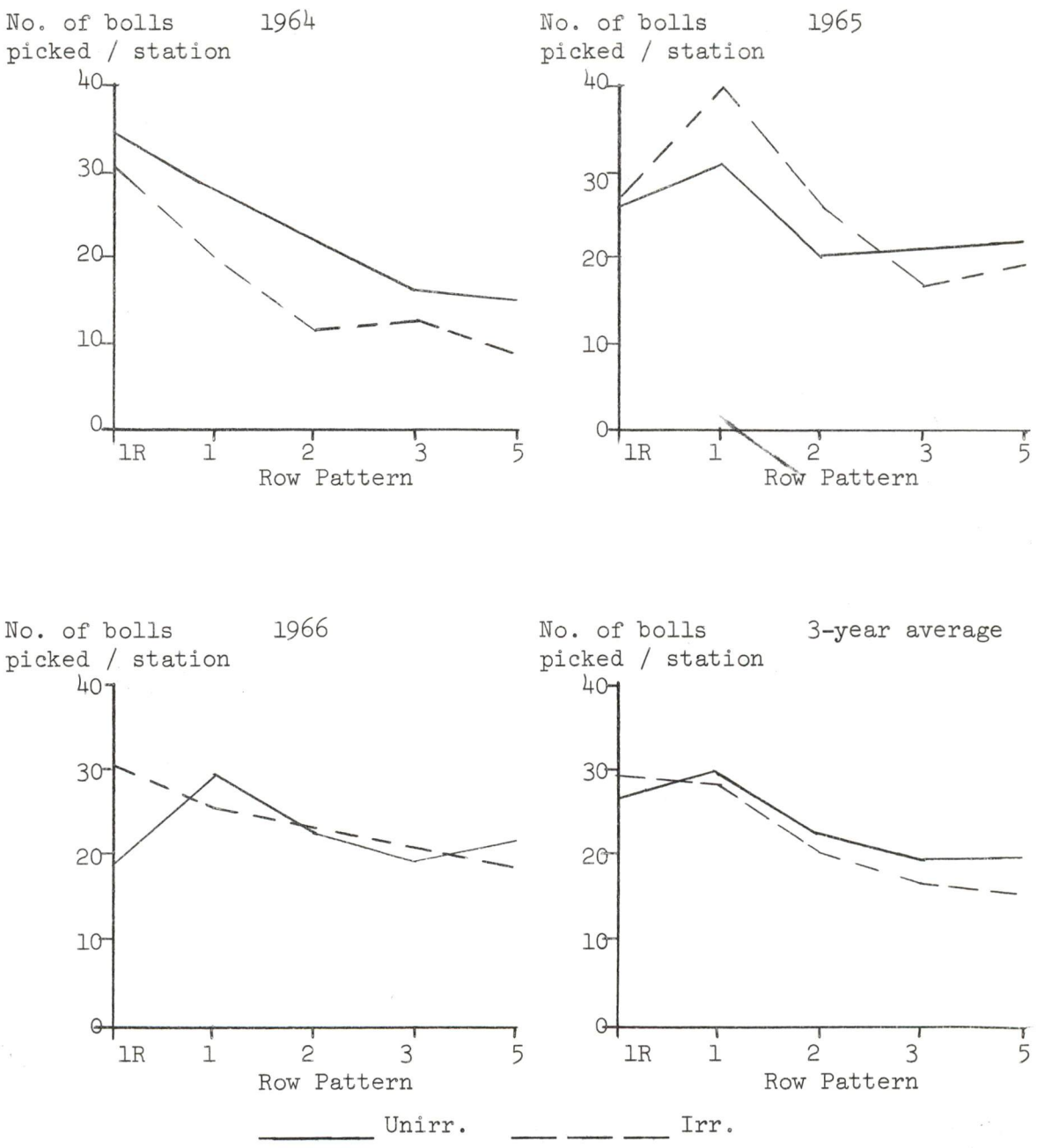


Figure 8. Average number of bolls picked per station in each treatment, 1964-1966.

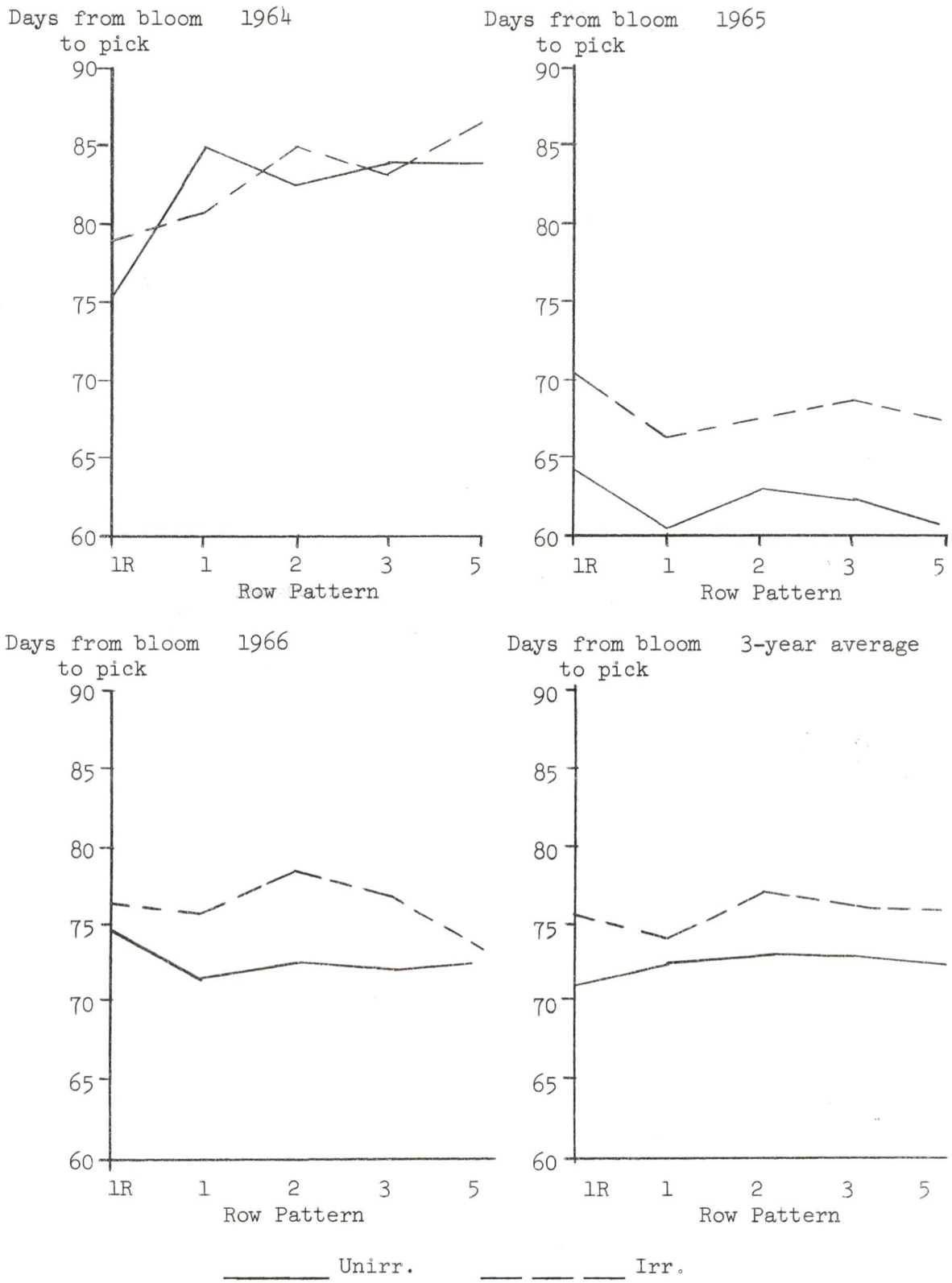


Figure 9. Average number of days from blooming to picking for bolls at stations in each treatment, 1964-1966.

bolls in 1966 was delayed from 1 to 6 days. The three year average shows irrigation delayed opening from 2 to 4 days. The averages for number of days from blooming to opening for bolls in each treatment in 1965 were less than similar averages for 1966 which were less than the 1964 averages. In general, the three year averages showed that the number of days from bloom to pick did not vary either directly or indirectly with the number of rows in the pattern.

The three year average weight of seed cotton per boll produced in each of the treatments as presented in Figure 10 shows that irrigation of the three and five row designs reduced the average boll weight from almost 6 grams to a little less than 5 grams. Differences among all other row patterns were negligible. It is also important to point out that the three year average boll weight for each treatment was near 6 grams with the exception of the above mentioned irrigated three and five row patterns.

IV. YIELDS

Seed cotton yields for each of the three years of study plus the three year average for each of the treatments are given in Tables 3 and 4 and Figure 11. The highest yields for all treatments were obtained in 1965, with the lowest yields occurring in 1964.

As indicated in Tables 3 and 4, irrigating each of the row patterns produced a slightly lower yield in 1964 and a slightly higher yield in 1965 and 1966 although the difference was not significant. The three year average of each treatment showed that

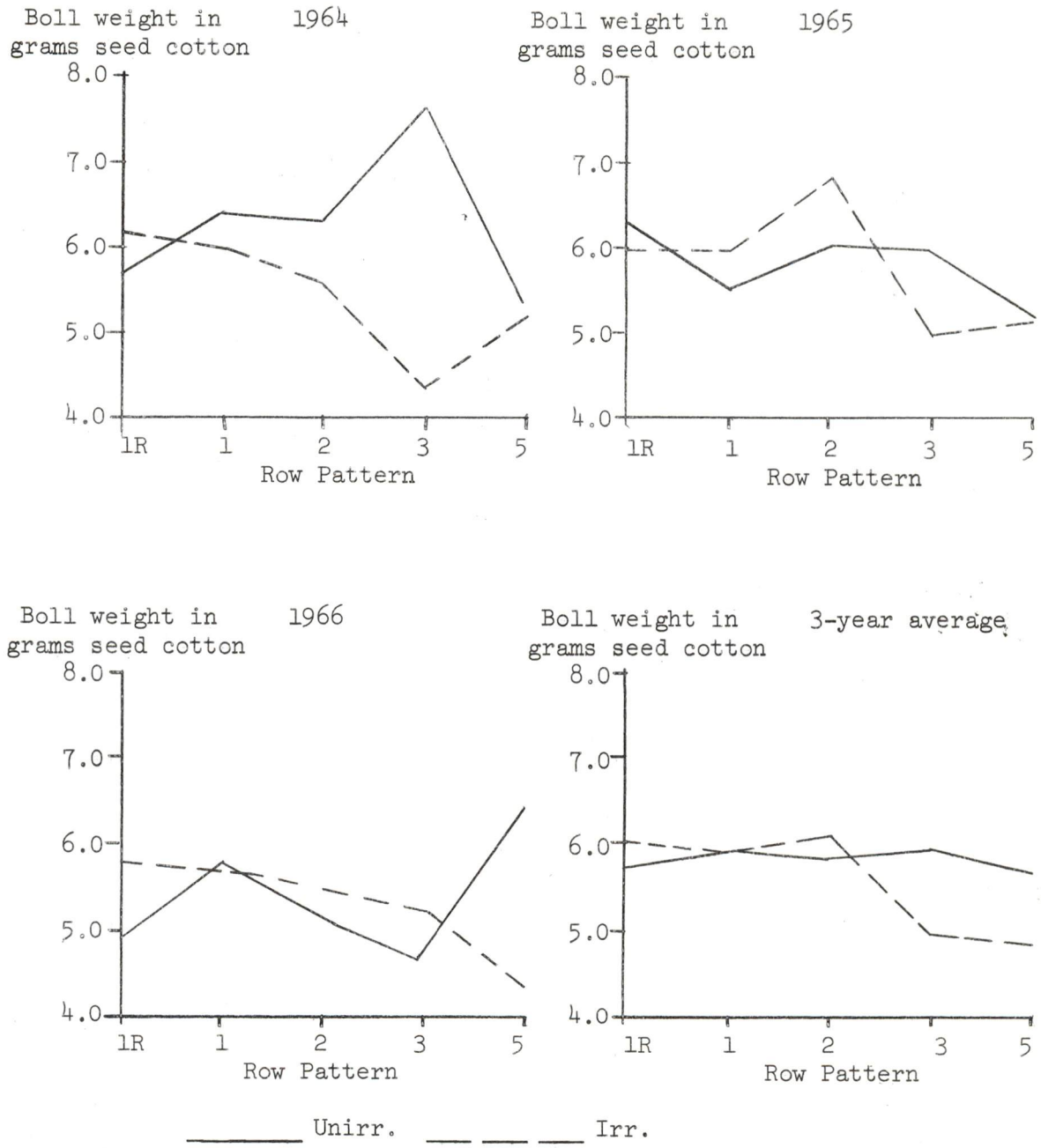


Figure 10. Average gram weight of seed cotton per boll at stations in each treatment, 1964-1966.

Table 3. Seed cotton yields in pounds per acre of skip-rows for treatments, moisture, row patterns, and all treatments, 1964-1966

Factor	Pounds of seed cotton per acre			
	1964	1965	1966	3-yr. av.
Treatment				
One row unirrigated	5,209	7,097	6,008	6,105
Two row unirrigated	4,284	5,518	5,086	4,963
Three row unirrigated	4,084	5,004	4,464	4,517
Five row unirrigated	3,336	4,432	4,177	3,982
One row irrigated	4,755	8,168	6,677	6,533
Two row irrigated	3,957	6,634	5,754	5,448
Three row irrigated	3,727	5,838	5,122	4,896
Five row irrigated	2,828	5,198	4,089	4,038
L.S.D. (5%)	1,137	1,270	1,215	991
(1%)	1,806	2,016	1,930	1,346
Moisture				
Unirrigated	4,228	5,513	4,939	4,891
Irrigated	3,817	6,459	5,411	5,229
L.S.D. (5%)	N.S.	N.S.	N.S.	N.S.
Row pattern				
One row	4,982	7,632	6,342	6,319
Two row	4,120	6,076	5,420	5,205
Three row	3,906	5,421	4,793	4,706
Five row	3,082	4,815	4,133	4,010
L.S.D. (5%)	620	699	771	386
(1%)	850	958	1,058	514
Average for all treatments	4,022	5,986	5,172	4,792

Table 4. Seed cotton yields in pounds per acre of reflected and unreflected rows for treatments, moisture, row patterns, and all treatments, 1964-1966

Factor	Pounds of seed cotton per acre			
	1964	1965	1966	3-yr. av.
Treatment				
Reflected unirrigated	6,413	8,222	6,647	7,094
Unreflected unirrigated	5,209	7,097	6,008	6,105
Reflected irrigated	5,627	8,821	7,590	7,346
Unreflected irrigated	4,755	8.168	6,677	6,533
L.S.D. (5%)	N.S.	N.S.	N.S.	N.S.
Moisture				
Unirrigated	5,811	7,659	6,327	6,599
Irrigated	5,191	8,494	7,134	6,940
L.S.D. (5%)	N.S.	N.S.	N.S.	N.S.
Row pattern				
Reflected	6,020	8,521	7,118	7,220
Unreflected	4,982	7,632	6,342	6,319
L.S.D. (5%)	849	N.S.	742	534
(1%)	N.S.	N.S.	N.S.	739
Average for all treatments	5,501	8,077	6,730	6,769

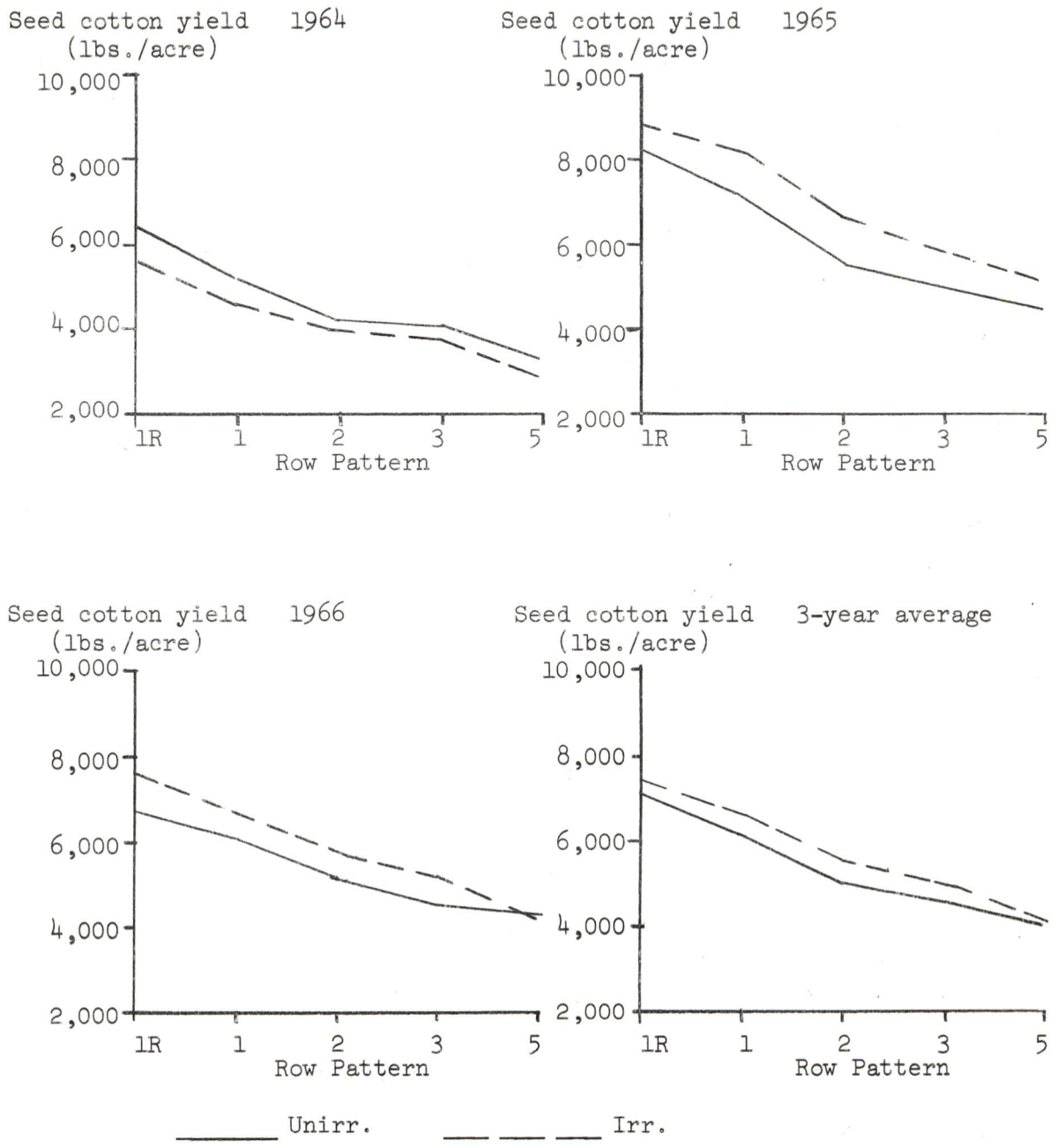


Figure 11. Seed cotton yield in pounds per acre of each treatment, 1964-1966.

the irrigated cotton produced a little more than the unirrigated, but this difference was not significant.

Rows and Their Stations

When the yields of stations were compared with the yields of rows on which they occurred (Table 5), the station yields appeared to be representative of the row yields. Therefore, the data obtained at the stations may be applied to the rows.

From the data in Table 2, page 31, it may be seen that the number of bolls picked at stations for the two, three, and five row patterns did not vary significantly while the yields of the station row in the two row pattern (Table 5), did vary significantly from the other two. The lower weight of the bolls in the irrigated three and five station row patterns (Figure 10, page 35) may account for this difference. Thus, the yield of a row in the experiment was possible related to the amount of radiant energy received by the plants in the row.

Skip-Rows

As indicated in Table 6, a significant difference in seed cotton yield per acre was obtained for each of the four skip-row variations. The one row design yielded 1,100 pounds more than the two row pattern which out-yielded the three row pattern by 500 pounds. The five row design yielded 700 pounds less than the three row pattern. These differences may have been expected, since the patterns were chosen for their expected yield differences.

Table 5. Multiple range groups of station yields and station row yields for treatments, moisture, row patterns, and years, 1964-1966

Factor	Seed cotton	
	Grams/station*	Pounds/acre*
Treatment		
One row reflected irrigated	177 a	7,346 a
One row unreflected unirrigated	175 a	6,104 b
One row unreflected irrigated	169 ab	6,533 b
One row reflected unirrigated	153 abc	7,094 a
Two row unirrigated	127 bcd	4,846 c
Two row irrigated	124 cde	5,215 c
Five row unirrigated	106 de	3,376 d
Three row unirrigated	97 de	3,539 d
Three row irrigated	96 de	4,029 d
Five row irrigated	80 e	3,382 d
Moisture		
Unirrigated	131 a	4,992 a
Irrigated	129 a	5,301 a
Row pattern		
One row unreflected	172 a	6,319 b
One row reflected	165 a	7,220 a
Two row	125 b	5,031 c
Three row	96 c	3,784 d
Five row	93 c	3,379 d
Year		
1965	148 a	6,091 a
1966	124 a	5,211 a
1964	120 a	4,137 a

*Numbers followed by the same letter do not differ significantly at the 0.10 level of probability according to Duncan's Multiple Range Test.

Table 6. Multiple range groups of seed cotton yields in pounds per acre for treatments, moisture, row patterns, and years, 1964-1966

Factor	Pounds seed cotton per acre*
Treatment	
One row irrigated	6,533 a
One row unirrigated	6,104 a
Two row irrigated	5,448 b
Two row unirrigated	4,962 bc
Three row irrigated	4,896 c
Three row unirrigated	4,517 cd
Five row irrigated	4,038 d
Five row unirrigated	3,982 d
Moisture	
Unirrigated	4,891 a
Irrigated	5,229 a
Row pattern	
One row	6,319 a
Two row	5,205 b
Three row	4,706 c
Five row	4,010 d
Year	
1965	5,986 a
1966	5,172 a
1964	4,022 a

*Numbers followed by the same letter do not differ significantly at the 0.10 level of probability according to Duncan's Multiple Range Test.

The yield for each row in the three and five row designs for both irrigated and unirrigated cotton is presented in Figure 12 for each of the three years and the three year average of the study. In all instances for both designs, three year averages show the rows nearest to the outside yielded more than the inside rows. The center row of the three row group yielded at least 1,100 pounds less than either of the two outside rows. The middle row of the five row pattern yielded from 175 to 300 pounds less than either of the two rows nearest it and from 1,300 to 1,600 pounds less than either of the two outside rows. This amounted to a 27 to 43 per cent increase for the outside row over the adjacent row in both the three and five row designs.

How the differences in yield occurred among skip row patterns may be explained by looking at both the station row (Table 5, page 40) and outside row yields (Figure 12) of each row variation and applying the combination of results to the whole pattern. The station row yields of the one and two row patterns were representative of the actual row yields for each pattern. However, a combination of the station row and outside row yields was considered in calculating the yields of the three and five row patterns. In the three row pattern, the station row yield plus the two outside row yields made up the average yield. In the five row design, the average yield was obtained from the station row, the two adjacent rows, and the two outside rows of the pattern.

When irrigation of the skip-rows was included as shown in Table 6, page 41, the unirrigated two row design was not significantly

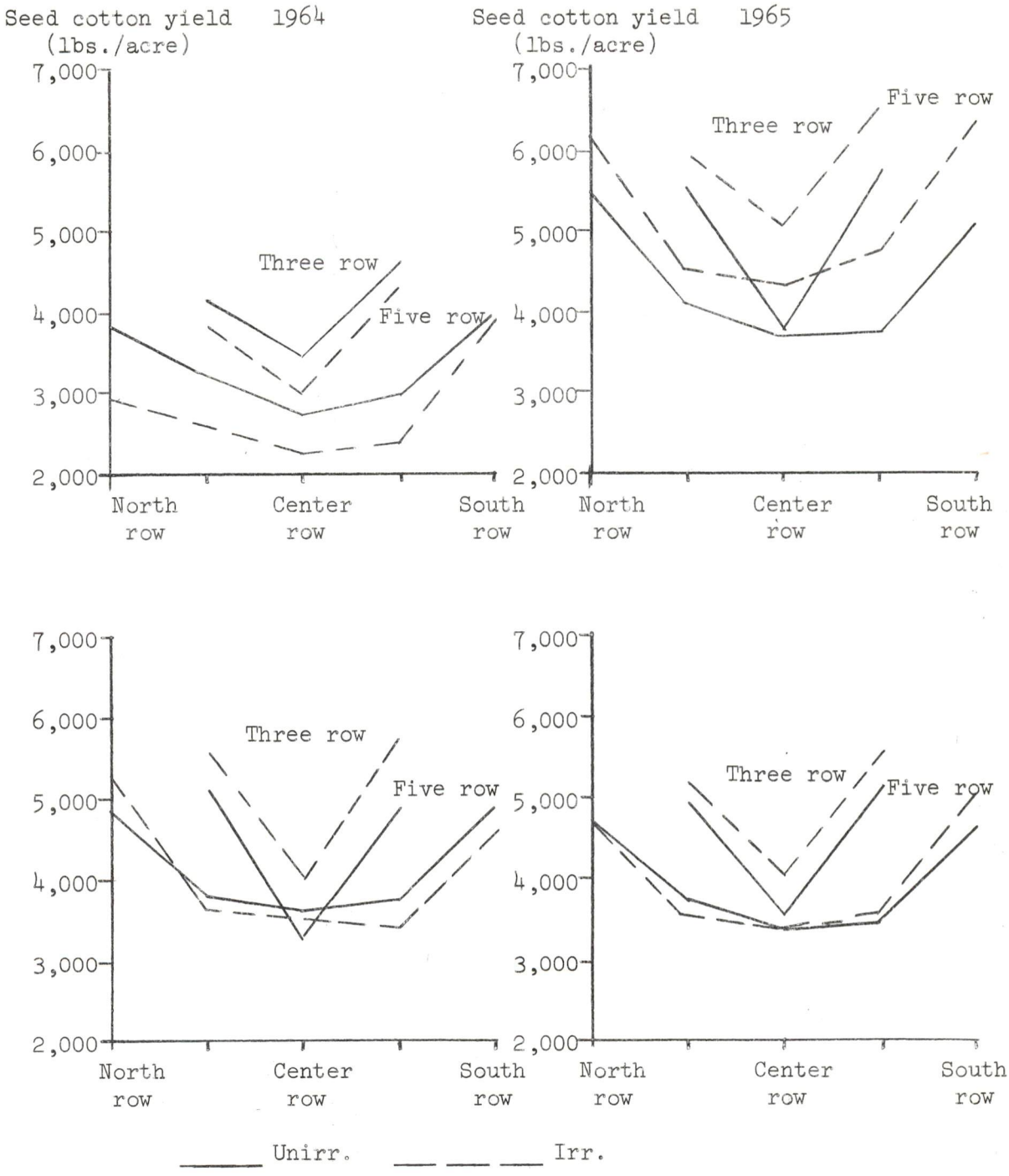


Figure 12. Yields of the three and five row patterns by row and direction, 1964-1966.

different from the irrigated and unirrigated three row pattern. Also, the nonirrigated three row design was not significantly different from the irrigated and unirrigated five row group. The yields of both the irrigated and nonirrigated of the one and two row patterns were significantly different from each other. This indicates that moisture may have been more of a limiting factor in the multiple row designs than in the single row patterns.

Reflectors

As indicated in Table 7, the addition of reflectors to one row treatments gave an average significant increase of 900 pounds in yield over the three years. The increase of the reflected row over the unreflected row was approximately 1,000, 900, and 800 pounds for 1964, 1965, and 1966, respectively.

The yearly yield variation in reflected rows varied over 2,500 pounds, as shown in Table 7. A high of 8,077 pounds per acre was reached in 1965, and the low of 5,501 pounds per acre was obtained in 1964. This indicates that both additional radiation in the reflected row and the year may have contributed to the yield increases in the one row treatments.

The weekly average maximum temperatures 14 inches above and 2 inches below the soil surface in both reflected and unreflected rows for each of the three years are presented in Figures 13, 14, and 15. In two of the three years, 1964 and 1966, early in the fruiting season, the maximum temperature in the reflected row 14 inches above

Table 7. Multiple range groups of single row seed cotton yields in pounds per acre for treatments, moisture, row patterns, and years, 1964-1966

Factor	Pounds seed cotton per acre*
Treatment	
One row reflected irrigated	7,346 a
One row reflected unirrigated	7,094 a
One row unreflected irrigated	6,533 a
One row unreflected unirrigated	6,104 a
Moisture	
Unirrigated	6,599 a
Irrigated	6,940 a
Row pattern	
One row reflected	7,220 a
One row unreflected	6,319 a
Year	
1965	8,077 a
1966	6,730 b
1964	5,501 c

*Numbers followed by the same letter do not differ significantly at the 0.10 level of probability according to Duncan's Multiple Range Test.

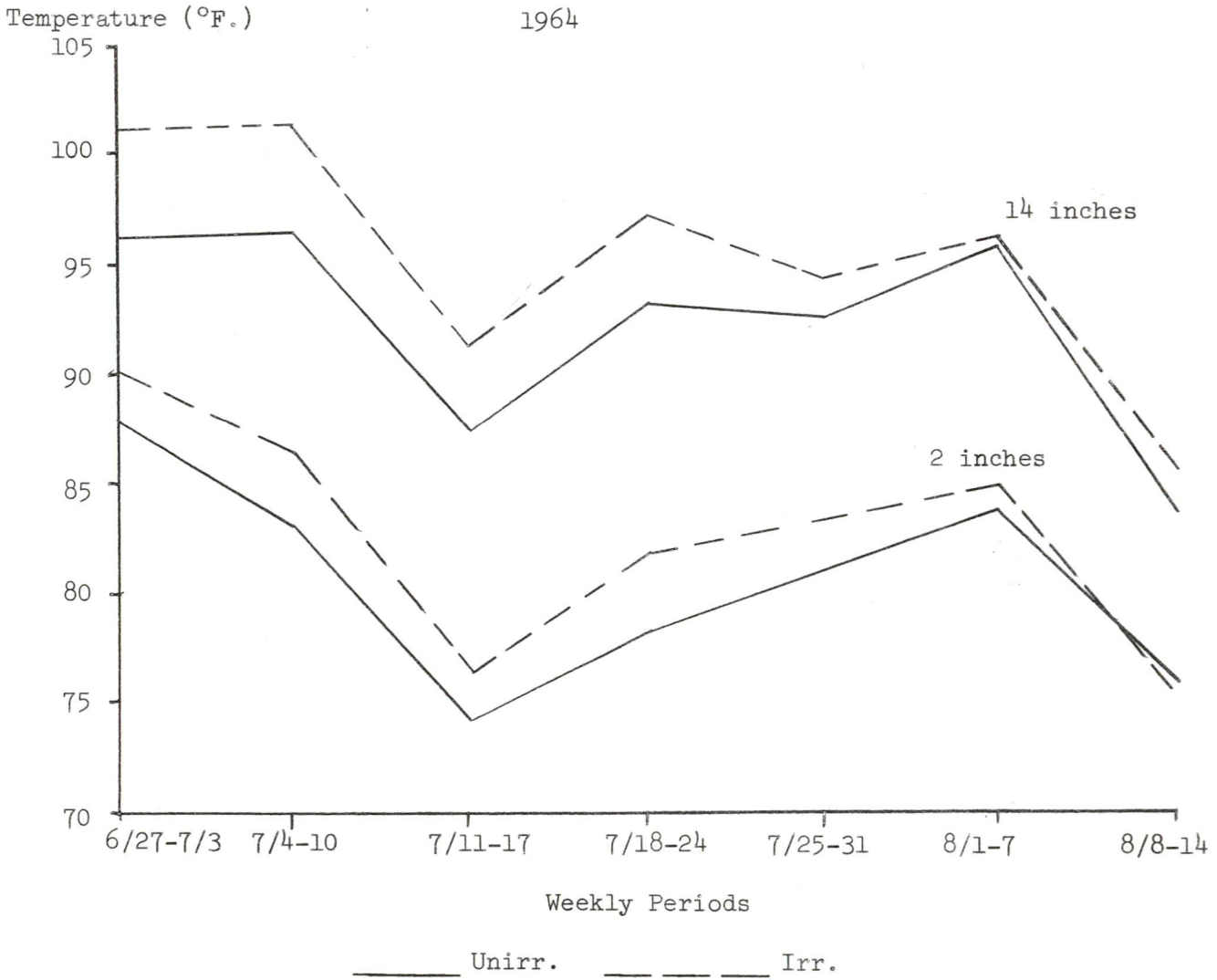


Figure 13. Average weekly maximum temperatures 14 inches above and 2 inches below the soil surface in both reflected and unreflected rows, 1964.

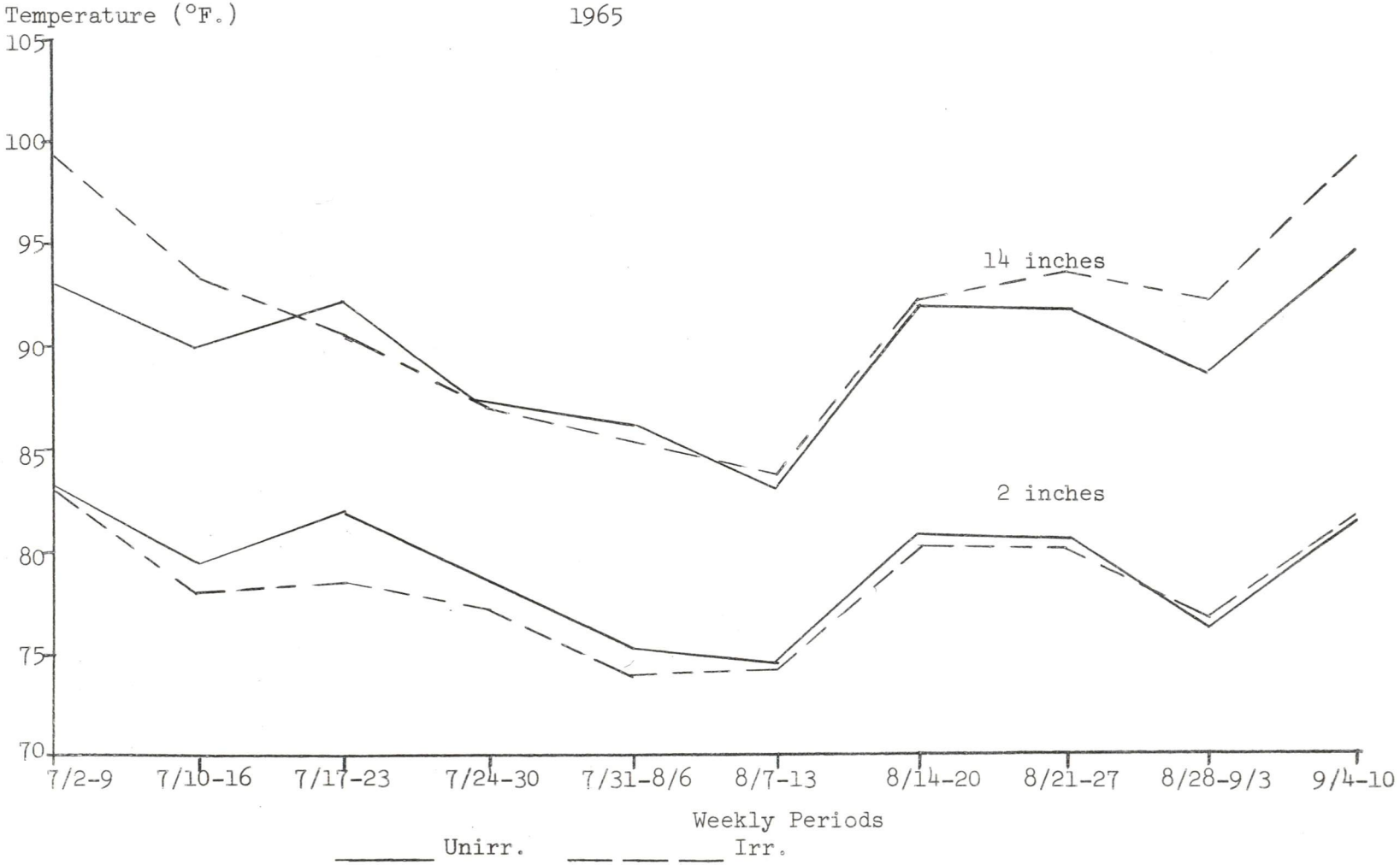


Figure 14. Average weekly maximum temperatures 14 inches above and 2 inches below the soil surface in both reflected and unreflected rows, 1965.

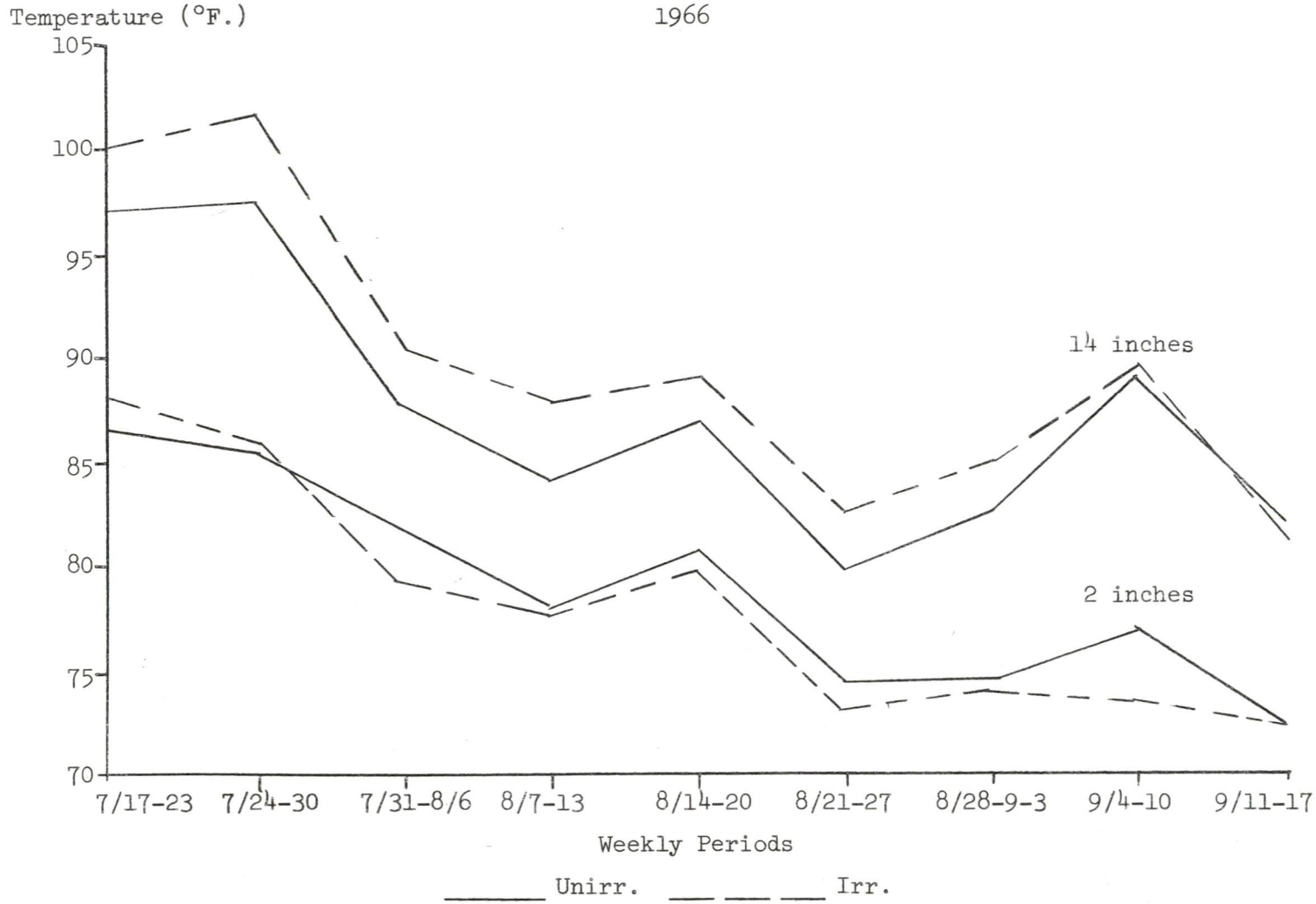


Figure 15. Average weekly maximum temperature 14 inches above and 2 inches below the soil surface in both reflected and unreflected rows, 1966.

the surface was 3 to 5° F. above the recorded maximum temperature in the unreflected row. In both years as the fruiting season progressed, the difference between the two treatments gradually diminished to zero by the end of the season. This may be explained by the increasing amount of foliage present late in each of the years which shaded the reflectors; thus, reducing the amount of reflected light received. In 1965, the maximum temperature 14 inches above the soil surface of the reflected row was 2 to 5° F. above that of the unreflected row for the first two weeks in July and for the three weeks after August 21. During the interval between the above mentioned dates, there was little difference in the two treatments. This may be explained by the planting date for 1965 which was over two weeks earlier than in the other two years, and by the amount of rainfall received in 1965. The earlier planting date allowed the plants to reach maturity earlier; thus, causing more shading of the reflectors early in the season than in other years. The low amount of rainfall in 1965 caused the plants to shed many of their leaves late in August which allowed for more reflection than had been present during the middle part of the fruiting season.

The weekly average maximum soil temperature 2 inches below the reflected row and unreflected row varied little in 1965 and 1966 as shown in Figures 14 and 15, pages 47 and 48. In 1964 (Figure 13, page 46) the weekly average maximum soil temperature under the reflected row remained 2 to 3° F. above similar measurements made in the unreflected row until late in the season when the differences were negligible.

These data suggest that no significant difference occurred in weekly average maximum soil temperatures 2 inches below the soil surface in the reflected and unreflected rows for the three years.

Minimum temperature measurements were made at the same levels as the maximum temperature measurements were made, and results showed there to be no difference in the two treatments for minimum temperatures.

Row Direction

In the east-west row arrangement in the experiment, the average yield of the south row of the two, three, and five row patterns was more than the north row by 557, 221, and 72 pounds of seed cotton per acre for 1964, 1965, and 1966, respectively. These differences were significant only in 1964. The three year average of the south row for the three multiple row patterns was 283 pounds of seed cotton more per acre than the similar average for the north row. This difference was not significant.

CHAPTER V

SUMMARY AND CONCLUSIONS

A three-year cotton experiment using varying skip-row designs and moisture levels was conducted at the West Tennessee Agricultural Experiment Station in Jackson. Each year Auburn M variety of cotton was planted in a Memphis soil. Four skip-row systems plus a single reflected row were used. Water was applied to irrigation plots when the soil moisture level reached two bars tension. The blooms were tagged daily at the designated stations.

The peak period for bloom production occurred either during the third or fourth week of blooming depending on the year. From 72 to 86 per cent of the blooms that were tagged each year were tagged during the first month of blooming. Irrigation did not significantly alter bloom production. The number of blooms tagged and bolls set in single row treatments were significantly higher than those in the multiple row patterns. The plants in each treatment produced approximately the same number of blossoms each year. More bolls were set one week before or during the week of greatest blooming than during any other week. The per cent of blooms tagged and bolls set during the first month of blooming was less in the year of lowest yield than in either of the other two years. From 83 to 96 per cent of the bolls were set during the first month of blooming. The year of highest yields had the highest per cent boll set for the year in each treatment, and the year of lowest yields had the lowest per cent boll set for each treatment.

The three-year average showed that irrigation delayed the opening of bolls only 2 to 4 days. The number of days from blooming to opening varied inversely with the yields for the years.

The row design did not affect the average weight of the bolls. Irrigation of the three and five row patterns reduced the average boll weight approximately one gram, but did not affect the boll weight in the other patterns.

The three-year average of each treatment showed that the irrigated cotton produced a higher but nonsignificant yield increase over the unirrigated.

A significant difference in yield was obtained for each of the four skip-row systems. The yields varied inversely with the number of rows in the pattern.

The individual row yields in the three and five row patterns showed the rows nearest to the outside yielded more than the inside rows. The yield of the center row in the three row plot was not significantly different from the yield of either the center row or its two adjacent rows in the five row plot.

The addition of reflectors to one row treatments gave a significant 900 pound increase in yield over one row without reflectors. Both additional radiation in the reflected row and the year contributed to this increase. In two of the three years, early in the fruiting season, the maximum temperature in the reflected row 14 inches above the soil surface was 3 to 5° F. above similarly made measurements in the unreflected row. As the fruiting season progressed the difference between the two treatments

gradually diminished to zero because of the shading of the reflectors by the plants.

The south row of the multiple east-west patterns produced a non-significant 283 pound per acre increase in yield over the north row yield for the same patterns.

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LITERATURE CITED

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APPENDIX

Table 8. "F" values from the analysis of variance for moisture treatments, years, irrigation x years, rows, moisture x rows, position, and errors "a" and "b" in mean squares for seven factors evaluated on cotton, 1964-66

Factor	Moisture treatments	Irrigations	Years	Irrig. x years	Error (a) in M.S.	Rows	Moisture x rows	Position	Error (b) in M.S.
Skip-row yield in lbs./acre	27.96**	.71[a]	8.18[a]	7.33**	519,562	51.12**	.63	-	443,430
Reflector yield in lbs./acre	9.42**	1.09	20.83**	2.17	1,274,768	12.94**	.14	-	753,036
Station yield in grams/station	3.60*	.01[a]	.79[a]	5.01*	2,316	15.79**	1.51	-	2,095
North and south yield in lbs./row	48.25**	.78[a]	9.33[a]	11.25**	0.80	3.67[b]	1.27[b]	3.33[b]	0.42
Station row yield in lbs./acre	19.65**	.54[a]	7.16[a]	5.82*	5,346,657	115.80**	.88	-	552,666
Bloom number tagged/station	1.78	.45	.89	3.35	186	13.87**	1.67	-	173
Boll number picked/station	3.92*	.20[a]	1.30[a]	4.08*	51	8.77**[c]	1.78*[c]	-	46

*.01 < P < .05. **P < .01.

[a]Mean squares for interaction of irrigations and years used as error term.

[b]Mean squares for interaction of moisture, rows, and position used as error term.

[c]Mean squares for interaction of moisture and rows used as error term.