THE RESPONSE OF COTTON STRAINS WITH DIFFERENT RATES OF MATURITY TO IRRIGATION AND PLANTING DATES

By

TARIK A. TABRAH

Bachelors of Science
Baghdad University
Baghdad, Iraq
1957

Submitted to the faculty of the Graduate School
of the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1965

THE RESPONSE OF COTTON STRAINS WITH DIFFERENT

RATES OF MATURITY TO IRRIGATION AND

PLANTING DATES

Thesis Approved:

Jay C. Murray
Thesis Adviser

L. A. Brinkerhoff

F. E. LeGrand

J. B. Boggs
Dean of the Graduate School

ACKNOWLEDGEMENT

The author wishes to express his gratitude to his major advisor, Dr. J. C. Murray, for his loyal guidance and sincere assistance. And through his faithful personality and scientific beliefs his constructive criticism and his valuable instructions the author was assisted in carrying out his research and writing up his thesis.

To the Agronomy Department, Oklahoma State University, thanks and appreciation are extended for the use of its facilities and equipment.

The author would also like to extend his special gratefulness to Mr. Jerome Simmons for his valuable assistance in carrying out the research in the field and to Mrs. Margaret Simmons, Mrs. Alva Clingenpeel, and Mrs. Joyce Livingston for their help in the fiber laboratory.

To Dr. R. D. Morrison and David L. Weeks the author expresses his appreciation for their assistance in the statistical analysis.

The author is very grateful to Dr. L. A. Brinkerhoff and Dr. F. E. LeGrand for their assistance in reading the manuscript and to Mrs. Cherie Holland for typing it.

To the Agency of International Development and to the Directorate General of Agricultural Researches and Projects, Ministry of Agriculture, Baghdad, Iraq, the author is extremely grateful for their financial assistance and nomination for this study.

To his parents the author owes all the devoted encouragement and help throughout his life and in implanting in him the desire to learn and acquire knowledge.

To the author's wife for sharing his feelings, help, and encouragement, he is very grateful.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The preference for early maturing cotton varieties over late ones has long existed because fast maturing crops escape much damage from insects and diseases. In Oklahoma where planting is often delayed and growing seasons are short, the early varieties appear to be especially desirable, particularly under irrigation.

Certain varieties are inherently earlier than others, but their agronomic characteristics are inferior. The investigation presented here was conducted to determine the possibility of developing an early variety which performs well in short seasons and has highly improved fiber properties.

In this study check varieties and strains representing different classes of earliness were used in the study in order to answer the following questions:

1. Do the varieties and strains differ in earliness and how much?
2. How is earliness associated with yield?
3. What effect does planting date and moisture level have on the comparative earliness and yield?
4. Can an early strain have good fiber properties?

REVIEW OF LITERATURE

Measurement of earliness.

Earliness is difficult to define. The simplest botanical definition for "true" earliness is the period from sowing to first flowering. A second measure of earliness is the date of peak of flowering. A third measure is by the bolling curve, and a fourth one, which is perhaps the most practical one of all, is proportion of first harvest to the total, where two or more harvests are made. These measurements can give different results when a strain fuzzed away (declined in yield) suddenly at the end of the fruiting period. This would give a small second harvest, and thus a high proportion of first, without necessarily starting either flowering or boll set earlier than others. Perhaps to characterize a strain as "really" early, it should be early by all these aspects as Brown (1951) pointed out.

Ter-Avanesjan (1954) found that the number of days from planting to the time at which bolls dehisce in 50 percent of the plants does not give a true measure of earliness; the real criterion is the yield of raw cotton produced before the frosts set in, a truely early variety giving 90-95 percent of its yield before the first frost. The capacity to do this differed in varieties which on the old criteria were classed as equal in earliness. Ter-Avanesjan (1954) also concluded that the phase from flowering to maturity comprises two periods, namely from flowering to the completion of boll growth and from there to maturity. These two phases behaved independently in inheritance.

In estimating the components of earliness in upland cotton varieties, Hintz and Green (1954) found the means and heritability estimates for boll period fit an arithmetic scheme, indicating that the character is controlled largely by genes having additive affects.

Richmond and Radwan (1962) employed seven methods of measurements to determine which of them would give the most definitive, as well as the most practical, estimate of earliness. They concluded that the seven estimates of earliness are significantly correlated and that any one of them could be used with confidence to estimate earliness in cotton on a single - plant basis. They suggested that the combined weights of the first and second pickings expressed as a percentage of the total seed cotton harvested is the most practical estimate. However, they recognize this method may not be suitable for every experiment and that the investigator should adjust the formula to fit the material under investigation.

Effects of irrigation on earliness.

Spooner et al (1958) found that the timing of irrigation affected yield, quality and fruiting of upland cotton as compared with non-irrigated plots and that the most efficient use of water in 1955 was obtained when the irrigation was intiated at blooming and during the entire period. However, in 1956 the most efficient use of irrigation was obtained when the first was applied 20 days after first blooms. The primary cause of the superior yield in this treatment was that these plants shed fewer bolls than in the treatments mentioned above.

The later maturity on the irrigated plots, as was indicated by lower yields at first harvest, resulted primarily from the long period from boll-set to maturity. Excessive vegetation tended to reduce light and restrict air movement on the irrigated plots, which may have delayed the opening of the bolls. Severe water stresses during the boll maturation period on the non-irrigated treatment may have resulted in early opening of the bolls. These data support Eaton's (1955) hypothesis that earliness in non-irrigated cotton is the result of drought shortening the boll maturation period.

Effect of environment and variety on fiber properties.

Brown and Ware (1958) found that, under any given set of conditions lint length is largely a species or varietal characteristic. Within species, coarseness in general is correlated with length and varies with variety and species. However, environmental conditions may alter the characteristic wall thickness. Within a variety or even within a group of varieties of similar staple length, Green and Stroup (1954) found that relative coarseness depends upon cell wall development and this in turn is influenced by the variety and the conditions under which it is grown. On the other hand, Baker (1950) stated that environment should have little effect upon the fiber properties since they are essentially genetically controlled.

Spooner et al (1958), Sturkie (1947), and Eaton and Ergle (1952) concluded that plants given moisture by irrigation produce fibers that are longer, weaker, more mature, and have greater weight per inch than unirrigated plants. Spooner et al (1958) also found an inverse correlation between fiber length and fineness, while Eaton and Ergle (1952) found that significant increases in tensile strength are accompanied by significant decreases in fiber length, uniformity ratio, weight per inch, and percentage of mature fibers. Adams et al (1942) also concluded that reductions in water supply resulted generally in losses in staple length (usually within 1/32 inch).

MATERIALS AND METHODS

The experiment reported here was conducted in 1964 on the Agronomy Research Station Farm at Perkins, Oklahoma on Vanoss loam soil.

The experimental design used was a split-split plot with four replications. The main plots were the irrigation versus dryland treatments; the sub plots consisted of three dates of planting and the sub-sub plots were nine varieties and strains representing different levels of earliness. The plots were single rows, 30 feet in length, with guard rows on either side planted to the variety Parrott. The row spacings were 40 inches.

Because of severe drought the dryland plots received one irrigation on August 6. The irrigated plots received irrigations on July 2 and 22, and on August 6. Approximately 5 inches of water were applied at each irrigation.

The three planting dates were (1) May 4, (2) May 26, and (3) June 15. These dates represent early, average, and late planting dates for the area.

The varieties and strains used in this experiment and their characteristics and origins are presented in Table I. The strains resulted from crosses between Acala 44, a late commercial variety with excellent fiber properties, and OK 86, an extremely early strain of Yugoslavian origins. Included in the study were strains selected from the F_2 and backcrosses of both parents. The three populations were assumed to represent three degrees of earliness.

TABLE I

THE CHARACTERISTICS AND PEDIGREES OF THE VARIETIES AND STRAINS USED IN THE STUDY

No.	Varieties & Strains	Characteristics and Pedigrees
1	Acala 44	A late commercial variety with good fiber properties
2	Verden	A commercial variety medium in earliness
3	Kemp	An early western commercial variety
4	31A097	Strain derived from the F_2 population
5	31A109	Strain derived from the backcross to Acala 44
6	31A112	Strain derived from the F_2 population
7	31A132	Derived from the backcross to OK 86 population
8	31A134	Derived from the backcross to OK 86 population
9	31A139	Derived from the backcross to Acala 44 population

The plants were thinned to 1 plant per foot, and a 4 foot alleys was cut between replications.

The test was sprayed once with Malathion solution for thrips shortly after emergence. Boll worms and bollweevils were controlled with Endrine and D.D.T. as needed. The plants were damaged on June 28 by strong hail when they were small, but they soon recovered.

The test was harvested on (1) October 5, (2) November 2 and 3, and (3) December 22. Weights of snapped bolls of each harvest were determined and the three harvests were then bulked and thoroughly mixed. A sample of about 2 pounds was taken and ginned on a saw gin to determine the lint percent and obtain lint for the analysis of the fiber properties. The comparative earliness is estimated on the basis of (a) the weight of first harvest and (b) the percent of the crop of snaps harvested at first harvest.

The lint yields were calculated on the basis of the lint percent of the sample and total yields of snaps.

The length, strength, and micronaire readings of the lint were obtained with the digital fibrograph, stelometer, and micronaire respectively.

EXPERIMENTAL RESULTS AND DISCUSSION

The effect of irrigation, date of planting, and strain on weight of first harvest.

The analysis of variance and the means for weight of first harvest are presented in Table II and III respectively. There was a highly significant difference in moisture treatments with the irrigated treatment giving significantly higher weight of first harvest than the dryland. The three dates of planting were all highly significantly different from each other. Date one, May 4, gave the highest weight at first harvest, date two, May 26, was second; and date three, June 15, gave the lowest weight at first harvest.

A moisture x date interaction was obtained at the 1% level. This interaction was due to the failure of either of the irrigation treatments to give the same relative weights of first harvest at the three different dates of planting or any one date under both moisture levels. Under the dryland treatment, date two had the highest weight of first harvest while under the irrigated treatment it had the second highest. Date three, however, ranked third under both moisture treatments.

There was a highly significant difference among strains regardless of the irrigation treatments or planting dates. The strains 31A134, 31A097, and 31A109 were not significantly different from each other, but strain 31A134 was significantly different from the other six strains. The strains 31A097, 31A109, 31A132, and 31A112 were not significantly different from each other. However, strains 31A097, 31A109, and 31A132 were significantly different from 31A139, Kemp Verden, and Acala 44. Strains 31A112, 31A139, and Kemp were not significantly different from each other, with strains 31A139 and 31A112 being significantly different from Verden and Acala 44. Kemp was not significantly different from Verden; however, it was significantly different from Acala 44. Verden and Acala 44 were not significantly different from each other.

TABLE II

ANALYSIS OF THE VARIANCE OF WEIGHT OF FIRST HARVEST AS AFFECTED BY MOISTURE, DATES OF PLANTING AND STRAINS, 1964

Source of Variation	d.f.	Mean Square	F Value
Moisture	1	30.8267	214.82**
Error (a)	3	0.1435	
Date	2	117.8274	243.85**
Moisture x Date	2	64.0467	132.55**
Error (b)	12	0.4832	
Strain	8	5.3914	18.11**
Date x Strain	16	0.9385	3.15**
Moisture x Strain	8	0.7571	2.54**
Moisture x Date x Strain	16	0.6318	2.12*
Error (c)	144	0.2977	

*Significant at the 5% level.
** Significant at the 1% level.

There was a highly significant date x strain interaction with all strains giving their highest weight at first harvest at the first date of planting, second highest on the second date, and the lowest on the third date of planting as can be seen from Figure I. Each strain gave a significantly different weight of first harvest under the three dates of planting apart from 31A132 which did not give a significantly higher weight of first harvest at first date of planting than on second date. However, it gave significantly higher weight of first harvest on second date than on third date of planting. The strain x planting date interaction are diagramed in Figure I. Under each date of planting the strains varied in their relative rank, which indicates that some strains were more sensitive to planting date than others. Figure I shows that strain 31A139 and Kemp were comparatively later in the two later plantings, and strains 31A109, 31A132 and 31A134 performed relatively better in the two later plantings. Kemp being an early commercial variety emphasizes the earliness of several of the breeding strains because of their being even decidedly earlier than Kemp in the later plantings. The strain 31A139, a backcross to Acala 44, had a rather low weight of first harvest in second and third dates of planting. Strains 31A132 and 31A134, backcrosses to OK 86 which is an extremely early variety, gave a high weight of first harvest on late plantings indicating their probable tolerance to a shorter growing season. However, strain 31A109, though a backcross to Acala 44, had a rather high weight of first harvest in the late planting. These fluctuations of strains may be that some were less tolerant to drought than others which caused premature boll opening and a low weight of first harvest was the result.

A significant moisture x strain interaction was obtained with all strains giving significantly greater weight of first harvest under irrigation than dryland treatment, as can be seen from Figure II. Strain 31A132 and Verden which are early and medium in earliness respectively did not show a high weight of first harvest compared to the other strains, probably due to increased vegetative growth and shading of lower bolls that delayed boll opening.

TABLE III

MEAN FIRST HARVEST WEIGHTS OF THE STRAINS AND VARIETIES UNDER THE DIFFERENT DATES AND MOISTURE CONDITION TREATMENTS

Strain	Dryland				Irrigated				Strain
	Planting Date				Planting Date				
	1	2	3	Mean	1	2	3	Mean	Mean
31A134	1.63	2.58	1.23	1.81	5.23	3.13	0.60	2.98	2.396
31A097	1.23	2.60	0.83	1.65	5.65	2.53	0.53	2.90	2.275
31A109	1.80	2.73	1.03	1.85	4.73	2.45	0.45	2.54	2.196
31A132	1.43	2.70	1.15	1.76	3.90	1.68	0.85	2.14	1.950
31A112	1.53	2.43	0.73	1.56	4.43	2.13	0.30	2.28	1.921
31A139	1.58	1.65	0.60	1.28	5.33	1.48	0.28	2.36	1.817
Kemp	1.73	1.70	0.08	1.17	4.88	1.03	0.00	1.97	1.567
Verden	1.53	1.73	0.08	1.11	3.60	0.80	0.00	1.47	1.288
Acala 44	1.38	1.00	0.00	0.79	2.78	0.60	0.00	1.13	0.958
Mean	1.57	2.12	0.63	1.44	4.50	1.76	0.33	2.20	

MEANS OF VARIETY AT DIFFERENT DATE OF PLANTING

Strain	Date of Planting			Mean
	1	2	3	
31A134	3.43	2.85	0.91	2.396
31A097	3.59	2.56	0.68	2.275
31A109	3.26	2.59	0.74	2.196
31A132	2.66	2.19	1.00	1.950
31A112	2.98	2.28	0.51	1.921
31A139	3.45	1.56	0.44	1.817
Kemp	3.30	1.36	0.04	1.567
Verden	2.56	1.26	0.04	1.288
Acala 44	2.08	0.80	0.00	0.958
Mean	3.033	1.939	0.483	

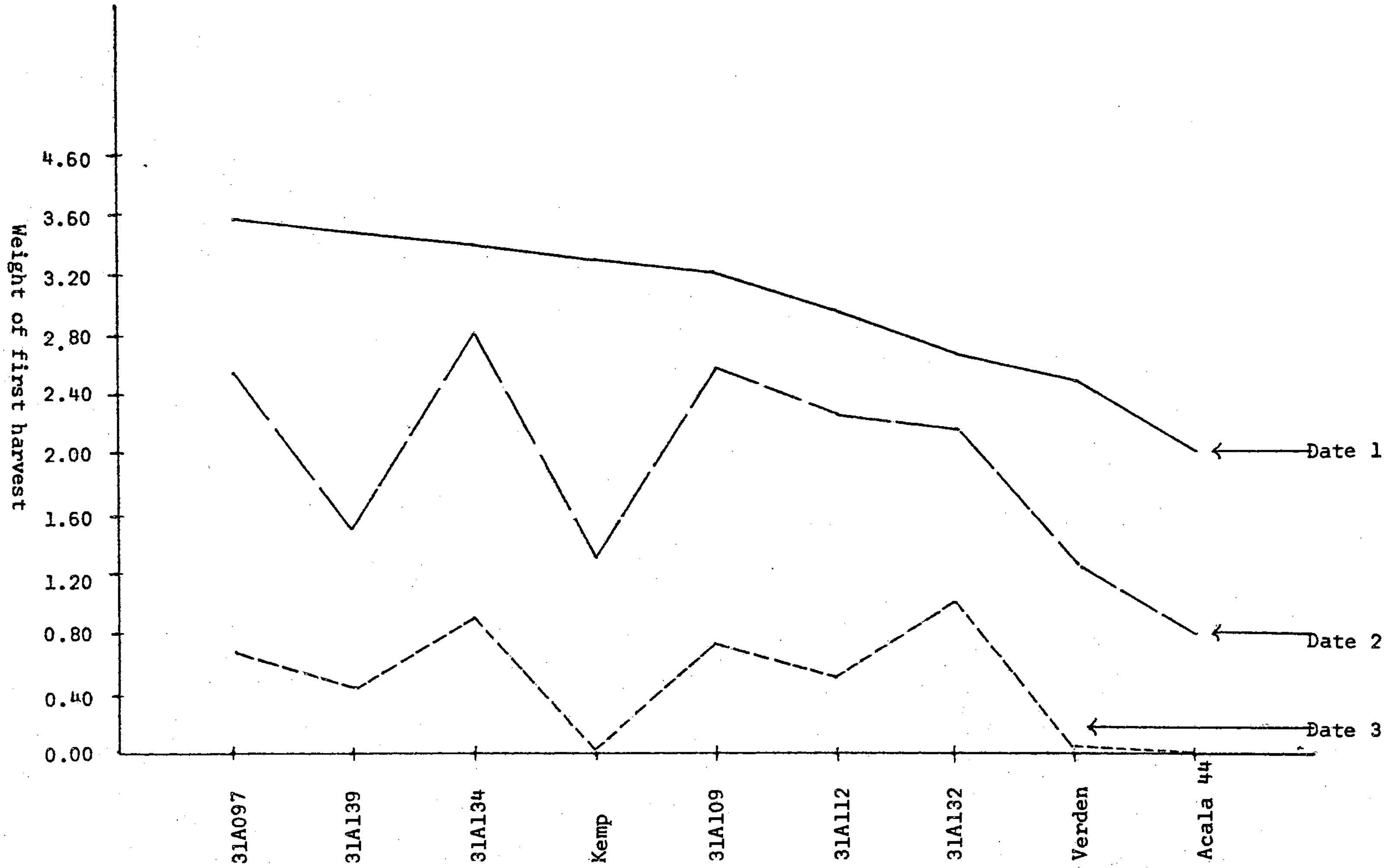

Figure I Diagram of the interactions of strains x planting date for weight of first harvest.

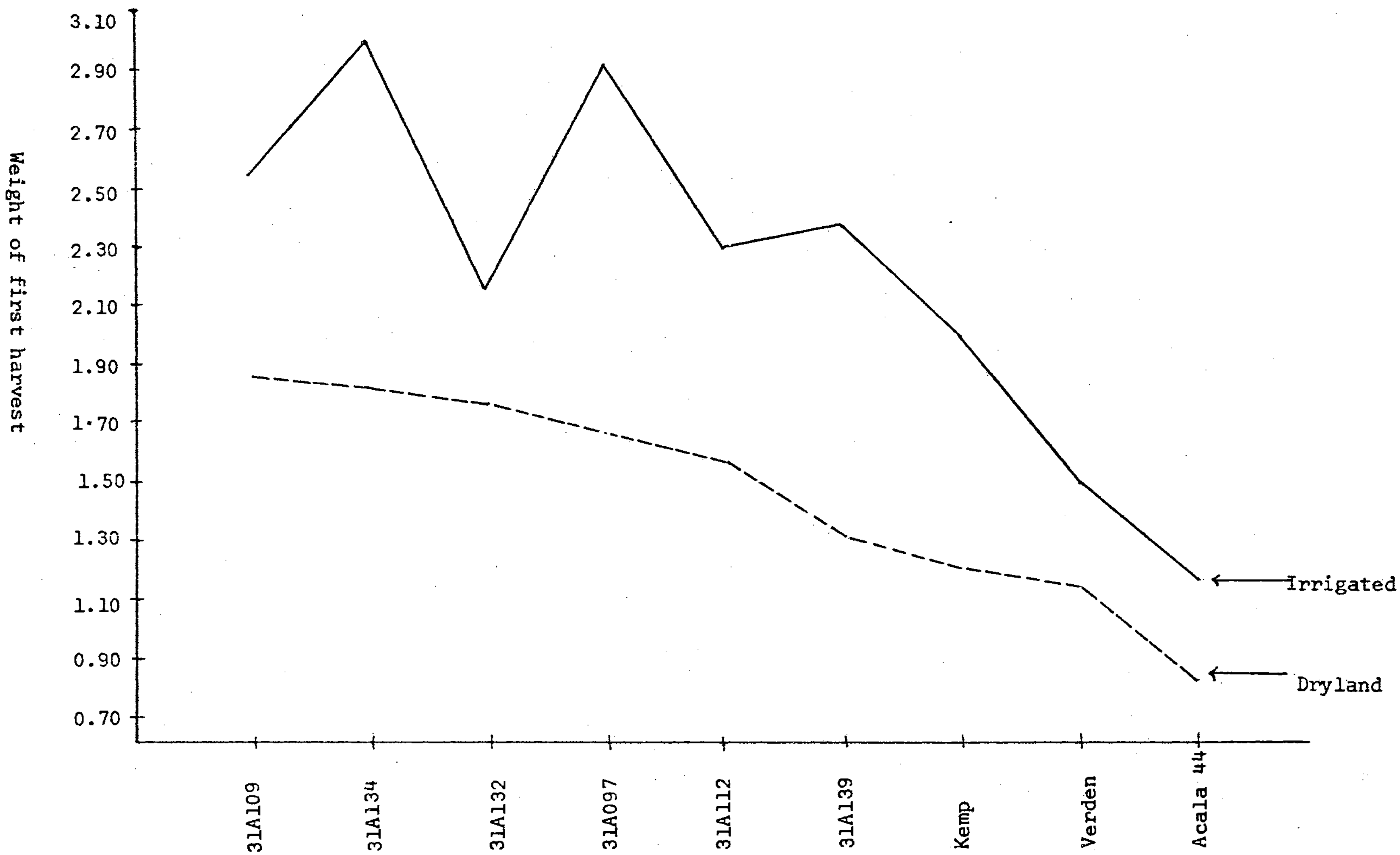

Figure II Diagram of the interactions of strains x moisture on weight of first harvest.

The significant moixture x date x strain interaction indicates that each of the three factors contributed to a change of weight of first harvest in any combination with the other two factors. As shown in Table III, Acala 44, Verden, Kemp, and strain 31A139 did not give significantly different weights of first harvest in the first and second dates on dryland. However, under date three they had a significant decrease when compared to their first harvest under both date one and two. Strain 31A097 behaved significantly different under the three dates of planting, giving its highest weight of first harvest under date two. Strain 31A109, 31A132, and 31A134 did not behave significantly different under the first and third dates, however, under date three their weight of first harvest was significantly greater than under date one and two. In general under the dry treatment the second date gave the highest weight of first harvest, date two second, and date three third.

Under the irrigated treatment all strains were significantly different in their weight of first harvest under all dates of planting apart from Acala 44 which was not significantly different under date two and three. All strains had the highest weight under the first date of planting. All strains gave significant increase in their weight of first harvest under the irrigated treatment and when planted in the first date when compared to all the strains under both levels of irrigation and all dates of planting.

The effect of irrigation, date of planting, and strain on percent of first harvest.

The analysis of variance and the means of percent first harvest are presented in Table IV and V respectively. The dryland treatment produced in a highly significant greater percent of first harvest than the irrigated treatment. Since the weight of the first harvest was higher under irrigation, these data indicate the dryland conditions were particularly hard on the later crops of bolls. Dates of planting influenced the percent of first harvest in much the same way as they did the weights of first harvest. Date one, two, and three were first, second, and third respectively at the 1% level.

TABLE IV

ANALYSIS OF THE VARIANCE OF PERCENT OF FIRST HARVEST AS AFFECTED BY MOISTURE, DATES OF PLANTING, AND STRAINS, 1964

Source of Variation	d.f.	Mean Square	F Value
Moisture	1	28105.5704	141.89**
Error (a)	3	198.0815	
Date	2	69418.7767	551.13**
Moisture x Date	2	5388.0788	42.78**
Error (b)	12	125.9582	
Strain	8	2641.2932	63.99**
Date x Strain	16	194.1978	4.70**
Moisture x Strain	8	58.6113	1.42
Moisture x Date x Strain	16	137.0197	3.32**
Error (c)	144	41.2780	

** Significant at the 1% level.

Moisture x date interaction was obtained at the 1% level with date one, two, and three significantly decreasing respectively under both moisture levels. Under irrigation, the weight of the first harvest and percent first harvest, behaved in the same way under the three dates of planting, but under the dryland treatment date one for percent first harvest gave 92.361 while it ranked second for weight of first harvest. These results result from the extremely low yield of the later crops of bolls under the dryland conditions that prevailed.

The strains over the whole test differed at the 1% level for the percent of their crop harvested at the first harvest date. The strains appeared to fall in definite groups. Strains 31A134 and 31A132 were not significantly different from each other, but they differed from other strains. Strains 31A097 and 31A109 formed a second group which were not significantly different from each other, but they differed significantly from other strains. Strain 31A112 and 31A139 behaved also in the same way in that they were not significantly different from each other, but were significantly different from other strains. Kemp differed significantly from all other strains. Verden and Acala 44 were not significantly different from each other, but they also differed significantly from all the other strains. All the strains ranked in their percent first harvest in the same way as they did in their weight of first harvest apart from strain 31A132 which ranked fourth for weight of first harvest while it ranked second for percent first harvest which caused strain 31A097 and 31A109 to move down in their order with the other varieties by one rank.

A date x strain interaction was obtained at the 1% level. This indicates that the relative proportion of percent of the crop harvested at the first harvest from the different strains varied with the planting date. This means that the relative earliness of the strains as measured by their percentage of first harvest will vary according to the planting dates. Consequently, success from selection for earliness among these populations will vary with the planting dates.

As shown by the interaction's diagram in Figure III, the strain x planting date interactions appear to be associated with dates two and three interacting with date one. Strains 31A134, 31A109, 31A132, and 31A112 appear to be relatively earlier in the later plantings, while 31A097, 31A139, and Kemp are comparatively later in these later plantings.

The analysis of variance presented in Table IV indicates the earliness of the strains was not differencially influenced by the moisture levels of dryland and irrigation. However, the behavior of the strains was not consistant as shown by the second order interaction.

TABLE V

MEAN PERCENT FIRST HARVEST OF THE STRAINS AND VARIETIES UNDER THE DIFFERENT DATES AND MOISTURE CONDITION TREATMENTS

Strain	Dryland				Irrigated				Strain
	Planting Date				Planting Date				
	1	2	3	Mean	1	2	3	Mean	Mean
31A134	96.25	65.23	26.40	62.63	69.08	40.63	11.15	40.28	51.454
31A132	100.00	66.30	29.98	65.43	59.43	32.65	15.85	35.98	50.700
31A097	100.00	54.10	14.88	56.33	63.90	30.75	9.40	34.68	45.504
31A109	91.43	58.80	20.38	56.87	54.70	30.45	9.43	31.53	44.196
31A112	94.78	52.25	15.53	50.85	47.23	28.45	5.63	27.10	38.975
31A139	93.05	33.38	12.48	46.30	55.33	21.83	5.18	27.44	36.871
Kemp	94.95	27.13	1.58	41.22	48.20	13.45	0.00	20.55	30.883
Verden	80.05	28.80	2.08	36.98	32.00	10.85	0.00	14.28	25.629
Acala 44	80.75	17.65	0.00	32.80	27.63	9.03	0.00	12.22	22.508
Mean	92.36	43.74	13.70	49.93	50.83	24.23	6.29	27.12	

MEANS OF VARIETIES AT DIFFERENT DATES OF PLANTING

Strain	Date of Planting			Mean
	1	2	3	
31A134	82.66	52.93	18.78	51.454
31A132	79.71	49.48	22.91	50.700
31A097	81.95	42.43	12.14	45.504
31A109	73.06	44.63	14.90	44.196
31A112	71.00	35.35	10.58	38.975
31A139	74.19	27.60	8.83	36.871
Kemp	71.58	20.29	0.79	30.883
Verden	56.03	19.83	1.04	25.629
Acala 44	54.19	13.34	0.00	22.508
Mean	71.596	33.983	9.994	

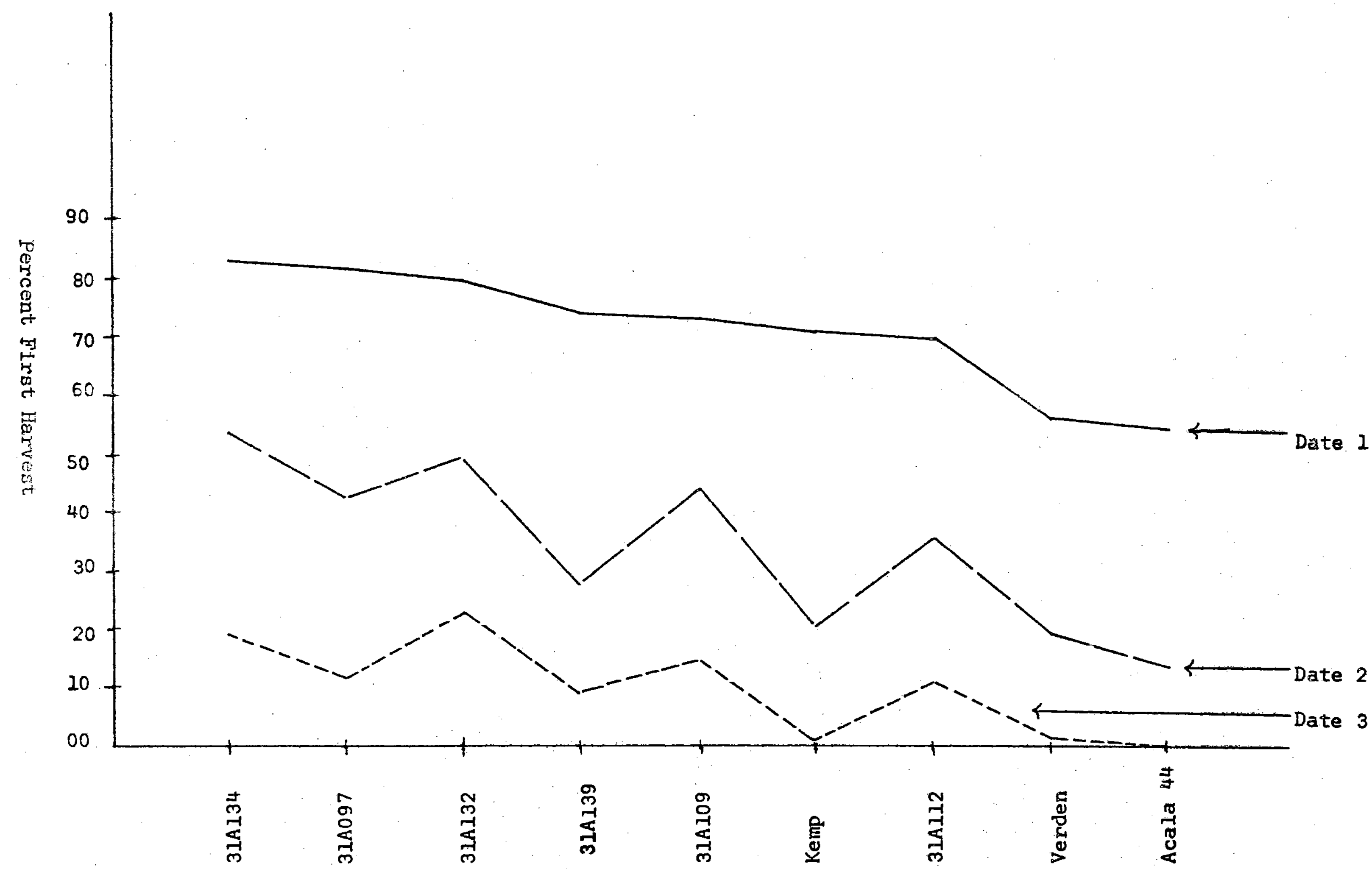

Figure III Diagram of the interactions of strains x planting date on percent first harvest.

The effect of irrigation, date of planting, and strains on lint yield.

The analysis of variance and the means of lint yield are presented in Table VI and VII respectively. Yield was highly significantly affected by irrigation, and the irrigated treatment gave almost double the dryland treatment of lint yield.

TABLE VI

ANALYSIS OF THE VARIANCE OF LINT YIELD AS AFFECTED BY MOISTURE, DATES OF PLANTING, AND STRAINS, 1964

Source of Variation	d.f.	Mean Square	F Value
Moisture	1	36.91314745	619.18**
Error (a)	3	0.05961666	
Date	2	4.65151417	56.89**
Moisture x Date	2	17.96018934	219.67**
Error (b)	12	0.08175969	
Strain	8	0.74792278	9.25**
Date x Strain	16	0.50339546	6.23**
Moisture x Strain	8	0.07845566	0.97
Moisture x Date x Strain	16	0.37215125	4.60**
Error (c)	144	0.08086439	

**Significant at the 1% level.

Dates of planting had a highly significant effect on lint yield. The three dates were significantly different in lint yield with date two being first, and date three third. Under irrigation the earliest planting had the highest yield and the latest planting the lowest.

The moisture x date interactions indicate the earlier the planting the higher the yields under irrigation, but earlier planting without irrigation is not necessarily better under these environmental conditions.

The higher yields of the second and third planting dates on dryland was a result of rainfall distribution. The rainfall during June and July and the first week in August was extremely low. The plants of the first planting had reached a stage by the time moisture became available to them that they were unable to utilize it. The plants of the second and third plantings, on the other hand, were able to go ahead and utilize the moisture and respond in yield.

The strains differed highly significantly in their lint yield over all plantings. Verden and Kemp were not significantly different, but Verden was significantly higher than the rest of the strains, while Kemp was only significantly higher in yield than Acala 44, 31A134, and 31A132. Kemp, 31A109, 31A139, 31A097, and 31A112 were not significantly different. Acala 44 was significantly higher than strains 31A132 and 31A134. Strains 31A132 and 31A134 were not significantly different from each other. Strains 31A132 and 31A134 must have received their additional earliness when backcrossed to OK 86, however, their yield was significantly less than all other strains.

There was a highly significant difference on date x strain interaction. The data diagramed in Figure IV show several points which are of importance in breeding for early long staple cotton. First, although the three commercial varieties performed better than the strains in the first planting and Verden and Kemp were better in the second

TABLE VII

MEAN LINT YIELD OF THE STRAINS AND VARIETIES UNDER THE DIFFERENT DATES AND MOISTURE CONDITION TREATMENTS

Strain	Dryland Planting Date 1	Dryland Planting Date 2	Dryland Planting Date 3	Dryland Mean	Irrigated Planting Date 1	Irrigated Planting Date 2	Irrigated Planting Date 3	Irrigated Mean	Strain Mean
Verden	0.52	1.72	0.71	0.98	3.36	1.88	0.86	2.03	1.507
Kemp	0.49	1.73	1.00	1.07	2.82	2.01	0.94	1.92	1.496
31A109	0.50	1.17	1.20	0.96	2.27	2.06	1.14	1.82	1.389
31A139	0.45	1.28	1.13	0.95	2.56	1.67	1.22	1.82	1.384
31A097	0.34	1.14	1.30	0.93	2.13	1.93	1.30	1.79	1.358
31A112	0.40	1.33	1.07	0.93	2.25	1.67	1.30	1.74	1.335
Acala 44	0.49	1.51	0.63	0.88	2.93	1.38	0.63	1.65	1.262
31A134	0.38	0.82	0.98	0.73	1.70	1.65	1.03	1.46	1.092
31A132	0.30	0.90	0.78	0.66	1.52	1.18	1.18	1.29	0.976
Mean	0.43	1.29	0.98	0.90	2.39	1.71	1.07	1.72	

MEANS OF VARIETIES AT DIFFERENT DATES OF PLANTING

Strain	Date of Planting 1	Date of Planting 2	Date of Planting 3	Mean
Verden	1.94	1.80	0.79	1.507
Kemp	1.65	1.87	0.97	1.496
31A109	1.38	1.62	1.17	1.389
31A139	1.50	1.47	1.18	1.384
31A112	1.32	1.50	1.18	1.335
Acala 44	1.71	1.44	0.63	1.262
31A134	1.04	1.24	1.00	1.092
31A132	0.91	1.04	0.98	0.976
Mean	1.410	1.501	1.022	

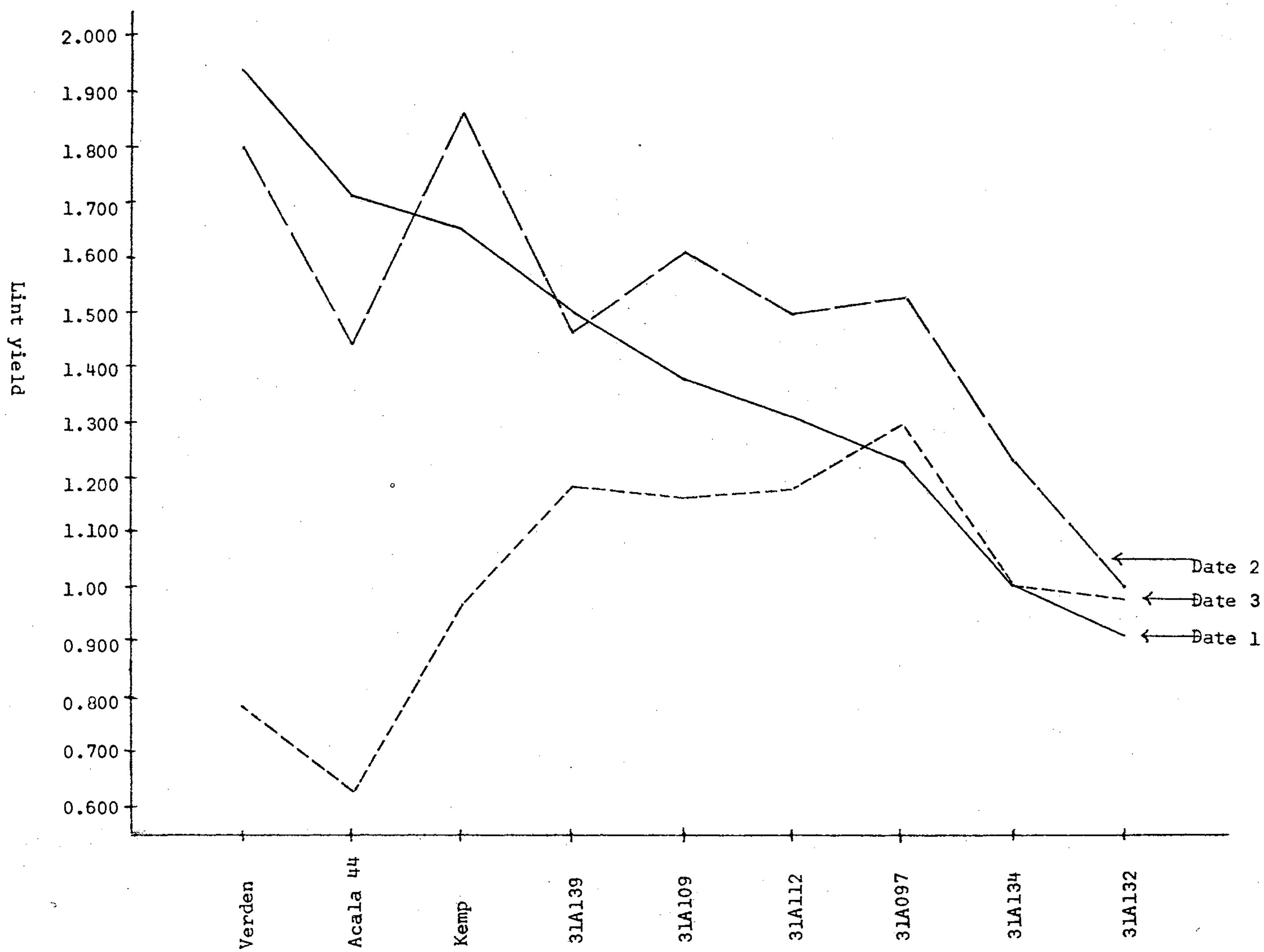

Figure IV Diagram of the interaction of strain x planting date for lint yield.

planting, the strains were all better than the commercial varieties in the third planting. Strains 31A132 and 31A134 are low in yield over all plantings, although they performed better than the three commercial varieties in the third planting. Strains 31A139, 31A109, 31A112, and 31A097 appear to offer promise as possible varieties, at least under late planting conditions that often occur in Oklahoma.

Planting conditions anytime after May 20, could be considered late, at least under the conditions of 1964. Since these represent only a sample of two strains from each of the Acala 44 backcross and F_2 populations, the data suggest these populations hold considerable promise for late planting conditions.

Although no moisture level x strain interactions were observed, a highly significant moisture x date x strain interaction was obtained. Several of the factors contributing to the second order interaction are obvious. Acala 44 performed rather well in the first planting, and on both dryland and irrigation, well in the second planting on dryland, but under irrigation Acala 44 was low in yield in the second and third plantings. Secondly, strain 31A109 performed well on first and third plantings on dryland and the second planting under irrigation. Strain 31A097 performed well in the second planting under irrigation, but not on dryland. Other similar interactions are present.

All strains under the irrigated treatment gave their highest yield when planted on the first date and their lowest yield when planted on the third date, apart from strain 31A132 which almost gave the same yield on the second and the third date.

<u>The effect of irrigation, date of planting, and strains on fiber length.</u>

The analysis of variance and the means of fiber length are presented in Table VIII and IX respectively. The data presented in Table IX shows that irrigation increased fiber length.

There was a highly significant difference among planting dates, which was due to the third planting being significantly longer than the first planting. However, the differences in length associated with planting date are a result of the plants in the first planting date on dryland not being able to effectively utilize the moisture that came in August, as previously discussed.

TABLE VIII

ANALYSIS OF THE VARIANCE OF FIBER LENGTH AS AFFECTED BY MOISTURE, DATES OF PLANTING AND STRAINS, 1964

Source of Variation	d.f.	Mean Square	F Value
Moisture	1	0.04734817	242.90**
Error (a)	3	0.00019493	
Date	2	0.10948624	51.79**
Moisture x Date	2	0.08335017	39.43**
Error (b)	12	0.00211409	
Strain	8	0.03758911	41.89**
Date x Strain	16	0.00193363	2.16**
Moisture x Strain	8	0.00106318	1.18
Moisture x Date x Strain	16	0.00092433	1.03
Error (c)	144	0.00089726	

**Significant at the 1% level.

Moisture x date interaction was significantly different at the 1% level. Under the dryland condition dates two and three were not significantly different, however, date one and two, and date one and three were. Date three, two, and one had the longest, longer, and shortest staple length respectively under both moisture treatments. Under the irrigated treatment all dates were not significantly different in their fiber lengths. The fiber lengths of the second and third plantings were not significantly different under the two moisture treatments, but they were different from that of the first planting which had longer fibers under the irrigated treatment. This indicates that planting date has a greater effect on staple length when the cotton plants are exposed to drought. This affect probably depends on the stages at which the plants are exposed to the droughtly conditions. There was a highly significant difference among strains in staple length. Acala 44 was significantly longer in staple length than all other strains. Strain 31A139 was significantly shorter than Acala 44, and it was significantly longer than all other strains. Verden and 31A109 were not significantly different, however, both were significantly longer than 31A112, 31A097, 31A134, Kemp and 31A132. Strains 31A112 and 31A097 were not significantly different in staple length, but each was significantly longer than 31A134, Kemp, and 31A132. The last three, 31A134, Kemp, and 31A132, were not significantly different from each other; however, they were significantly shorter than all the other strains.

The date x strain interaction was significant at the 1% level. As shown in Table IX, Acala 44 had the longest staple in all planting dates. As shown in Figure V, 31A139 had a comparatively shorter staple in the first planting as compared to those of Acala 44. The other pronounced interaction indicated in Figure V, is the relative longer staple for Kemp in the second and third dates as compared to the first date. The longer staples of the second and third plantings indicate the environmental conditions in the later part of the season were condusive to longer staple lengths. Acala 44 being a late variety was possibly maturing its fiber in the first planting was probably maturing its lint later than the others, hence its comparatively longer fiber under early planting conditions.

TABLE IX

MEAN FIBER LENGTH OF THE STRAINS AND VARIETIES UNDER THE DIFFERENT DATES AND MOISTURE CONDITION TREATMENTS

Strain	Dryland				Irrigated				Strain
	Planting Date				Planting Date				
	1	2	3	Mean	1	2	3	Mean	Mean
Acala 44	1.07	1.17	1.15	1.13	1.17	1.15	1.14	1.16	1.143
31A139	1.02	1.16	1.14	1.12	1.11	1.13	1.15	1.13	1.118
Verden	1.03	1.10	1.13	1.09	1.08	1.10	1.11	1.10	1.093
31A109	0.97	1.12	1.13	1.07	1.12	1.11	1.11	1.11	1.093
31A112	0.99	1.11	1.11	1.07	1.09	1.07	1.09	1.08	1.075
31A097	0.94	1.10	1.10	1.05	1.09	1.07	1.09	1.08	1.063
31A134	0.96	1.07	1.06	1.03	1.04	1.06	1.04	1.05	1.039
Kemp	0.89	1.06	1.07	1.01	1.03	1.06	1.10	1.06	1.035
31A132	0.93	1.03	1.05	1.01	1.04	1.02	1.08	1.04	1.025
Mean	0.98	1.10	1.10	1.03	1.09	1.09	1.10	1.09	

MEANS OF VARIETIES AT DIFFERENT DATES OF PLANTING

Strain	Dates of Planting			
	1	2	3	Mean
Acala 44	1.12	1.16	1.15	1.143
31A139	1.06	1.14	1.15	1.118
Verden	1.05	1.10	1.12	1.093
31A109	1.04	1.12	1.12	1.093
31A112	1.04	1.09	1.10	1.075
31A097	1.02	1.08	1.09	1.063
31A134	1.00	1.07	1.05	1.039
Kemp	0.96	1.06	1.09	1.035
31A132	0.99	1.03	1.06	1.025
Mean	1.031	1.094	1.103	

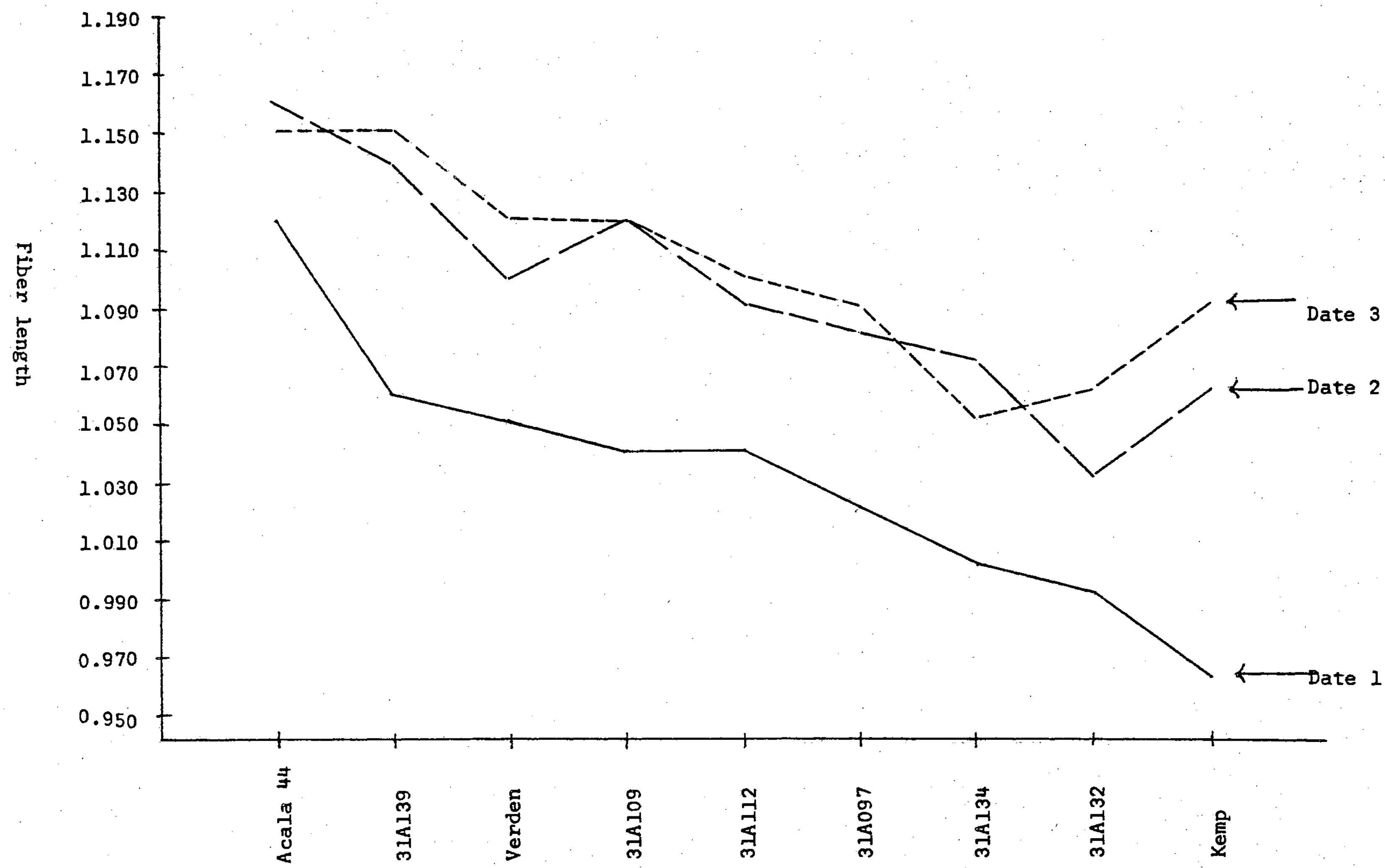

Figure V Diagram of the interaction of strains x planting date for fiber length.

The moisture x strain interaction was not significant. However, all varieties had longer fibers under the irrigated treatment. The second order interaction was not significant.

The effect of irrigation, date of planting, and strains on fiber strength.

The analysis of variance and the means of fiber strength are presented in Table X and XI respectively. Moisture did not have a significant effect on fiber strength, however, date of planting did at the 5% level. Date three had a significantly higher strength than either date one or two; however, there was no significant difference between the first and second planting dates. There was no significant interaction between moisture level and date of planting, indicating moisture is not the major factor in determining lint strength.

TABLE X

ANALYSIS OF VARIANCE OF FIBER STRENGTH AS AFFECTED BY MOISTURE, DATES OF PLANTING, AND STRAINS, 1964

Source of Variation	d.f.	Mean Square	F Value
Moisture	1	0.009467	0.66
Error (a)	3	0.014370	
Date	2	0.142685	4.38*
Moisture x Date	2	0.000645	0.02
Error (b)	12	0.032550	
Strain	8	0.290479	28.09*
Date x Strain	16	0.016958	1.64
Moisture x Strain	8	0.023690	2.29*
Moisture x Date x Strain	16	0.012588	1.22
Error (c)	144	0.010340	

*Significant at the 5% level.
**Significant at the 1% level.

TABLE XI

MEAN FIBER STRENGTH OF THE STRAINS AND VARIETIES UNDER THE DIFFERENT DATES AND MOISTURE CONDITION TREATMENTS

Strain	Dryland				Irrigated				Strain
	Planting Date				Planting Date				
	1	2	3	Mean	1	2	3	Mean	Mean
Acala 44	2.52	2.41	2.39	2.44	2.32	2.30	2.40	2.34	2.391
31A139	2.36	2.37	2.43	2.38	2.27	2.25	2.40	2.31	2.344
31A132	2.34	2.28	2.34	2.29	2.27	2.32	2.30	2.30	2.292
31A109	2.28	2.28	2.30	2.29	2.30	2.20	2.30	2.26	2.275
31A112	2.30	2.25	2.31	2.29	2.25	2.22	2.27	2.25	2.266
31A097	2.10	2.21	2.35	2.22	2.23	2.33	2.32	2.30	2.257
Verden	2.29	2.17	2.37	2.28	2.18	2.19	2.28	2.22	2.246
31A134	2.06	2.29	2.23	2.19	2.22	2.18	2.30	2.23	2.213
Kemp	1.87	1.97	2.07	1.97	1.91	2.06	2.11	2.03	2.000
Mean	2.22	2.25	2.31	2.26	2.22	2.23	2.30	2.25	

MEANS OF STRAINS AT DIFFERENT DATES OF PLANTING

Strain	Date of Planting			Mean
	1	2	3	
Acala 44	2.42	2.36	2.40	2.391
31A139	2.31	2.31	2.41	2.344
31A132	2.25	2.30	2.32	2.292
31A109	2.29	2.24	2.30	2.275
31A112	2.27	2.24	2.29	2.266
31A097	2.17	2.27	2.33	2.257
Verden	2.23	2.18	2.33	2.246
31A134	2.14	2.23	2.27	2.213
Kemp	1.89	2.01	2.09	2.000
Mean	2.220	2.237	2.309	

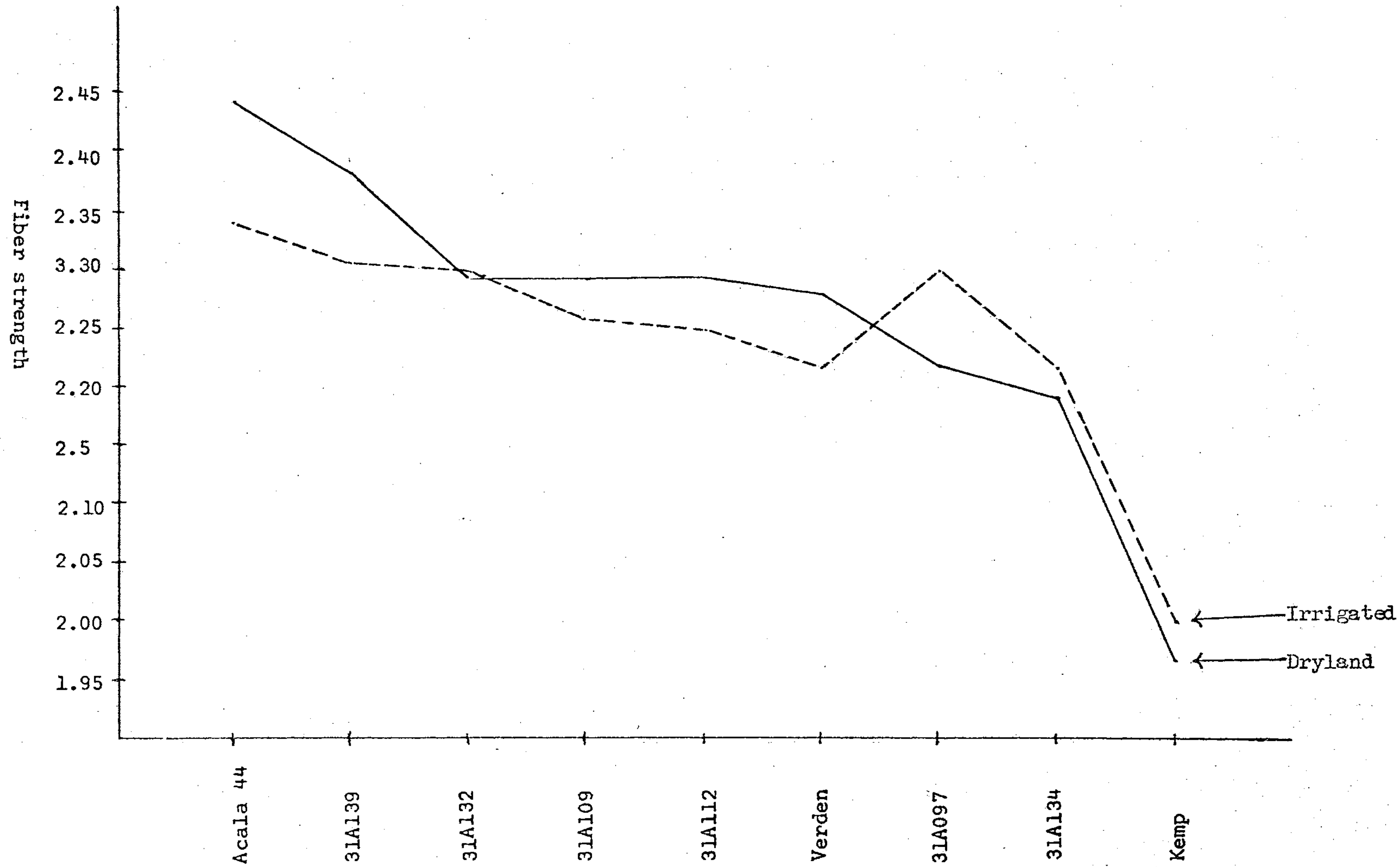

Figure VI Diagram of the interaction of strains x moisture on fiber strength.

The strains were significantly different from each other in their 1/8" stelometer tensile strength at the 1% level, as shown in Table X. The important finding is that most of these early strains have considerably better strength than Kemp and Verden which are typical varieties for the area. This is particularly important in view of their earliness.

There was no significant date x strain interaction, however, moisture interacted with the varieties at the 5% level. These interactions are diagramed in Figure VI. Acala 44, Verden, and 31A139 had a significantly greater tensile strength under the dry treatment than the irrigated treatment. Strains 31A097, 31A109, 31A112, 31A132, and 31A134 were not significantly different under either moisture level, however, Kemp was significantly higher in tensile strength under the irrigated treatment than the dryland.

The effect of irrigation, date of planting, and strains on fiber fineness or micronaire.

The analysis of variance and the means of fiber fineness as measured by micronaire are presented in Table XII and XII respectively. Moisture did not have a significant effect on fiber fineness. Date of planting had a highly significant effect on fiber fineness. The first planting date produced the highest micronaire but not significantly higher than date two. The first and second planting dates produced a significantly higher micronaire reading than the third date.

TABLE XII

ANALYSIS OF VARIANCE OF FIBER FINENESS AS AFFECTED BY MOISTURE, DATES OF PLANTING, AND STRAINS, 1964

Source of Variation	d.f.	Mean Square	F Value
Moisture	1	0.1612	1.98
Error (a)	3	0.0814	
Date	2	1.3692	16.18**
Moisture x Date	2	0.9056	10.70**
Error (b)	12	0.0846	
Strain	8	0.4620	12.09**
Date x Strain	16	0.1140	2.98**
Moisture x Strain	8	0.0396	1.04
Moisture x Date x Strain	16	0.0681	1.78*
Error (c)	144	0.0382	

*Significant at the 5% level.
**Significant at the 1% level.

There was a highly significant moisture x date interaction. Under the dry treatment date two gave significantly higher reading than date one and date three, however, date one and three were not significantly different. Under the irrigated treatment date one was significantly higher than either date two or date three. However, date two was not significantly higher than date three.

The strains were significantly different from each other at the 1% level. Strain 31A132 and 31A134 were not significantly different in the micronaire reading, but both of them were significantly coarser than all the other strains. The strains 31A134, 31A112, Verden, 31A097, Kemp and 31A109 were not significantly different from each other, but of this non-significant group only 31A112, Verden, and 31A097 were significantly greater in their micronaire readings than 31A139 and Acala 44. Strains Kemp, 31A109, and 31A139, however, were not significantly different from each other and Acala 44 was significantly less than all other strains in its micronaire reading.

A highly significant date x strain interaction was obtained as can be seen from Figure VII, a good part of this interaction is the result of the relative low micronaire of Acala 44 and the relative high reading of strain 31A097 in the third planting. Figure VII also shows that other combinations also contribute to the interactions to a lesser extent.

There was no significant moisture x strain interaction. However, all strains, except Kemp and 31A097, had lower micronaire readings under the irrigated treatment than the non-irrigated treatment.

A second order interaction was obtained at 1% level. This shows the varieties were inconsistant in their performance over the different environments. A good part of the second order interaction can be ascribed to the differential behavior of strain 31A112, 31A132, 31A109, and Verden. Strain 31A112 had a rather high micronaire in all plantings except the third planting of the irrigated plot.

TABLE XIII

MEAN FIBER FINENESS OF THE STRAINS AND VARIETIES UNDER THE DIFFERENT DATES AND MOISTURE CONDITION TREATMENTS

Strain	Dryland				Irrigated				Strain
	Planting Date				Planting Date				
	1	2	3	Mean	1	2	3	Mean	Mean
31A132	4.50	4.75	4.15	4.47	4.50	4.28	4.25	4.34	4.404
31A134	4.18	4.63	4.43	4.41	4.65	4.23	4.28	4.38	4.396
31A112	4.35	4.45	4.23	4.34	4.43	4.35	3.88	4.22	4.279
Verden	4.33	4.58	4.05	4.32	4.45	4.18	4.03	4.22	4.267
31A097	3.90	4.38	4.30	4.19	4.43	4.13	4.30	4.28	4.238
Kemp	4.25	4.15	4.13	4.18	4.38	4.10	4.18	4.22	4.196
31A109	4.28	4.20	4.15	4.21	4.40	4.23	3.88	4.17	4.188
31A139	4.15	4.28	3.93	4.12	4.35	3.95	3.88	4.06	4.088
Acala 44	4.23	4.18	3.73	4.04	4.28	3.88	3.53	3.89	3.967
Mean	4.24	4.40	4.12	4.25	4.43	4.14	4.02	4.20	

MEANS OF VARIETIES AT DIFFERENT DATES OF PLANTING

Strain	Date of Planting			Mean
	1	2	3	
31A132	4.50	4.51	4.20	4.404
31A134	4.41	4.43	4.35	4.396
31A112	4.39	4.40	4.05	4.279
Verden	4.39	4.38	4.04	4.267
31A097	4.16	4.25	4.30	4.238
Kemp	4.31	4.13	4.15	4.196
31A109	4.34	4.21	4.01	4.188
31A139	4.25	4.11	3.90	4.088
Acala 44	4.25	4.03	3.63	3.967
Mean	4.333	4.271	4.069	

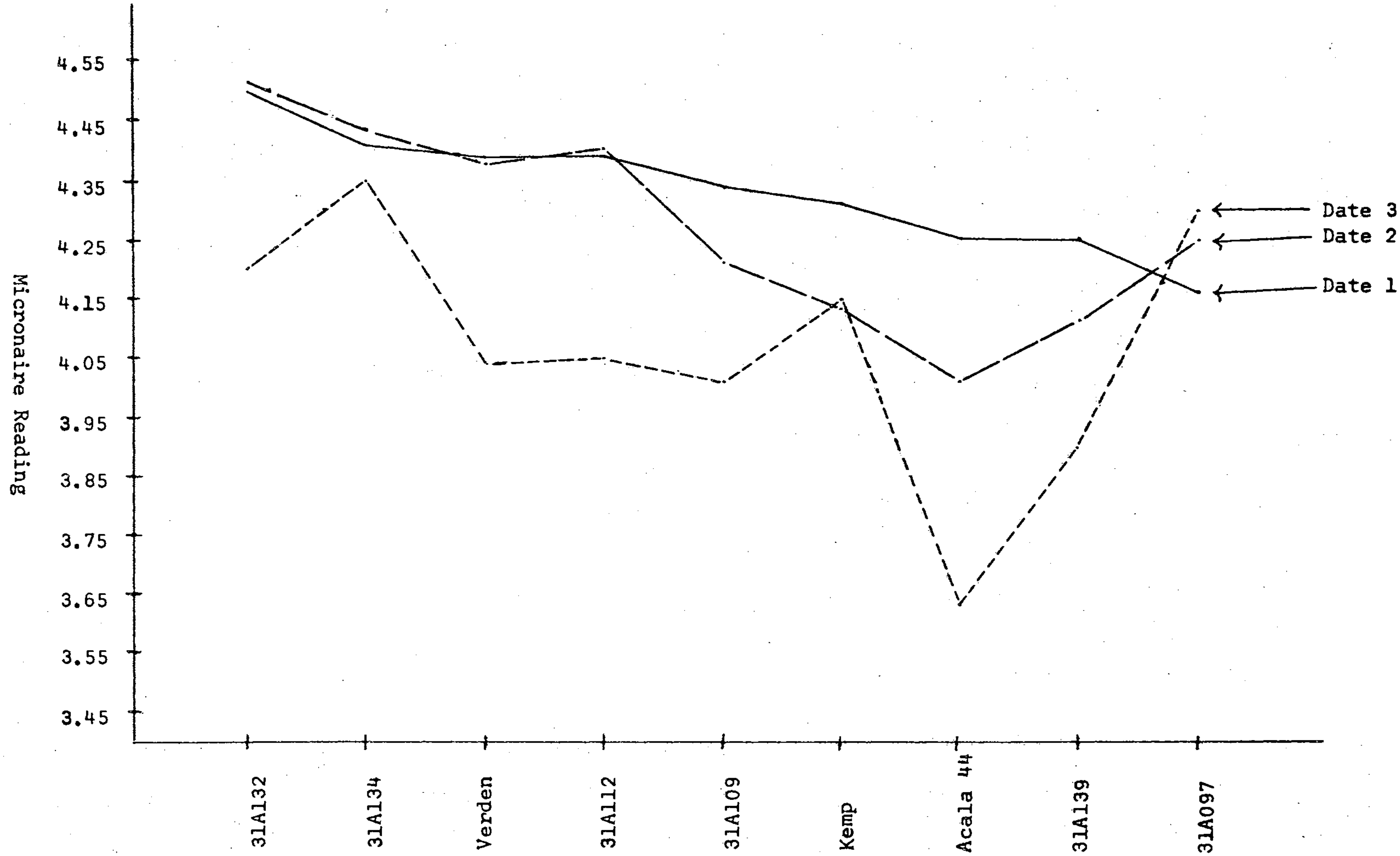

Figure VII Effect of date of planting on fiber fineness, 1964.

SUMMARY AND CONCLUSIONS

Moisture had a significant effect on increasing weight of first harvest and decreasing percent first harvest for all strains. However, the strains responded differently to irrigation. For weight of first harvest strains 31A097 and 31A134 had a great relative increase from irrigation while Acala 44, Verden, and 31A132 responded comparatively less to the irrigation. For percent first harvest strains 31A097, 31A132, and 31A134 had the highest percent of first harvest among all strains while Acala 44, Verden, 31A109, 31A112, and 31A132 had a greater proportional decrease in their percent first harvest to the other varieties, Figure III.

Planting date had a considerable effect on the earliness with the earliest plantings being the earliest in maturity, as expected. Considerable strain x planting date interaction was observed for both weight of first harvest and percent of first harvest. These interactions were primarily a result of strains 31A134, 31A132, 31A109, and 31A112 being relatively earlier than the other entries in the second and third plantings as compared to the first planting.

The strains differed in the yields of lint and strain x environmental interactions were present. The most important interaction for yield was the good performance of the commercial checks Acala 44, Kemp, and Verden in the early plantings and poor relative performances in the late planting. This observation stresses the advantage of early maturing varieties under short seasonal conditions.

The breeding strains had decidedly higher fiber strength than Kemp, a variety typical of those being grown in the area at the present. Most of the strains also had decidedly longer staple lengths than Kemp under both dryland and irrigated conditions. These results suggest that the quality of the crop produced in Oklahoma can be improved decidedly by plant breeding.

Fiber length was significantly affected by moisture. All strains produced longer fiber under irrigation. Fiber strength was affected by moisture at the 5% level. However, Acala 44, Verden and 31A139 gave significantly higher tensile strength on the dryland. The micronaire reading was not affected significantly by moisture for any strain. All strains were well above 4.00 micronaire under both treatments, except Acala 44, which gave a reading of 3.89 under irrigation. Date of planting had a highly significant effect on fiber length. All strains had a significantly longer staple in the second and third plantings than in the first planting.

Since late planting is often necessary in Oklahoma because of adverse weather conditions, these early maturing breeding strains appear to offer promise for increased production for late plantings as well as improved quality.

The use of these early maturing strains may have a particular place during dry seasons. Since several of the early strains produced very well in the third planting compared to the check varieties, more profit might be realized from the cotton crop if these early strains were used and deliberately planted late. This procedure could decrease the length of the season the plants were withdrawing moisture from the soil and also decrease the length of time the crop would need to be given insecticide treatments.

Since these strains were essentially chosen at random from their respective populations, strains that perform even better should be possible. Further research needs to be conducted to develop better early strains and to determine a system of late plantings of these early strains would offer a possibility for increased efficiency of cotton production.

LITERATURE CITED

Adams, F., F. J. Veihmeyer, and L. V. Brown (1942) Cotton irrigation investigations in San Joaquin Valley, California. California Expt. Bull. 668.

Baker, H. B. (1950) Fiber properties and their significance. Adv. in Agron. 2: 60-63.

Brown, C. H. (1951) Earliness, Emp. Cott. Gr. Rev. 28: 253-55.

Brown, H. B. and J. O. Ware (1958) Cotton. McGraw-Hill Book Company, Inc.

Eaton, F. M. (1955) Physiology of the cotton plant. Ann Rev. of Plant Physiol. 6: 315-320.

Eaton, F. M. and D. R. Ergle (1952) Fiber properties and carbohydrate and nitrogen levels of cotton plants as influenced by moisture supply and fruitfulness. Plant physiol. 27: 541.

Green, J. M. and G. E. Stroup (1954) Cotton quality as influenced by lint coarseness. Bull. Okla. Agric. Expt. Sta. B-442: 11.

Hintz, G. D. and J. M. Green (1954) Components of earliness in upland Cotton Varieties. Agron. J. 46: 114-18.

Richmond, T. R. and S. R. H. Radwan (1962) A comparative study of seven methods of measuring earliness of crop maturity in cotton. Crop. Sci., 2: 397-400.

Spooner, A. E., D. A. Brown and B. A. Waddle (1958) Effect of irrigation on cotton fiber properties. Arkansas Agr. Expt. Sta. Bull. 601: 1-27.

Spooner, A. E. C. E. Caviness and W. I. Spergeon (1958) Influence of timing of irrigation on yield, quality and fruiting of upland cotton. Agron. J. 50: 74.

Sturkie, D. G. (1947) Effect of environmental factors on the seed and lint of cotton. Ala. Agr. Expt. Sta. Bull. 263.

Ter-Avanesjan, D. (1954) The method of estimating earliness in cotton varieties. Hlopkovodstvo (Cott. Raising) (Russian) 8: 53-58.

VITA

Tarik Abdul-Jabbar Tabrah

Candidate for the Degree of

Master of Science

Thesis: THE RESPONSE OF COTTON STRAINS WITH DIFFERENT RATES OF MATURITY TO IRRIGATION AND PLANTING DATES

Major Field: Agronomy (Field Crops)

Biographical:

Personal Data: Born December 2, 1930, at Baghdad, Iraq, the son of Abdul-Jabbar Mehdi Tabrah and Farida Rasheed Ena'ia.

Education: Granted the primary Baccalaureate certificate in 1944 and the intermediate Baccalaureate certificate in 1947, Baghdad. Graduate from Baghdad Central Secondary School in 1949 and granted the high school Baccalaureate certificate in science. Attended the American University of Beirut and in 1954 transferred to the College of Agriculture, University of Baghdad. Graduated from Baghdad Agriculture College in 1957 with a Bachelor Degree in Agronomy. Attended the Graduate School of Oklahoma State University, 1963 to 1965.

Experience: Six months employment by a British Contracting Company in Iraq as an assistant soil surveyor and crop sampler, 1958. Assistant specialist in agriculture in the Field Crops Division, Ministry of Agriculture, Iraq, 1958 to 1963. Three months training in the Central Indian Cotton Committee Laboratory, Bombay, India, in cotton fiber testing, 1959-1960.