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Effects of 1954 Drouth on Corn

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COLUMBIA, MISSOURI

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M. S. ZUBER AND W. L. DECKER*

INTRODUCTION

The possibilities of drouth have been a constant source of concern to Missouri farmers. Drouths vary geographically and are more common on certain soil types. However, in years like 1954, drouth becomes a real threat to the economy of all farmers. Corn, probably more than any other cash crop, shows a pronounced effect of a general drouth.

Corn yields were generally low in central Missouri as a result of the severe drouth of 1954. Temperatures in excess of 110° F. occurred on three days during July, and temperatures of 100° F. or higher were reported on 22 days during the three summer months. Very little rain fell from June 10 to July 31. Figure 1 shows the rainfall distribution at Columbia during the summer period. Corn normally flowers in central Missouri during the latter half of this period. It is the purpose of this paper to discuss the reaction of corn to this protracted hot, dry period in 1954.

The study consisted of two parts. The first part was concerned with the influence, if any, of temperature and humidity on seed sets. The second part** was an investigation of the influence of irrigation levels, plant populations, and levels of nitrogen on the timing between tasseling and silking, tassel blasting and barren plants, and environmental temperatures and humidities.

PREVIOUS INVESTIGATIONS

Recently Bates (1955) reported on the climatic factors and corn yields in the Texas Blacklands. He correlated various climatic factors with corn yields for a 41-year period. A close correlation was found between corn yields and the mean maximum temperature, mean relative humidity, and evaporation during the month of June, when corn usually pollinates in that

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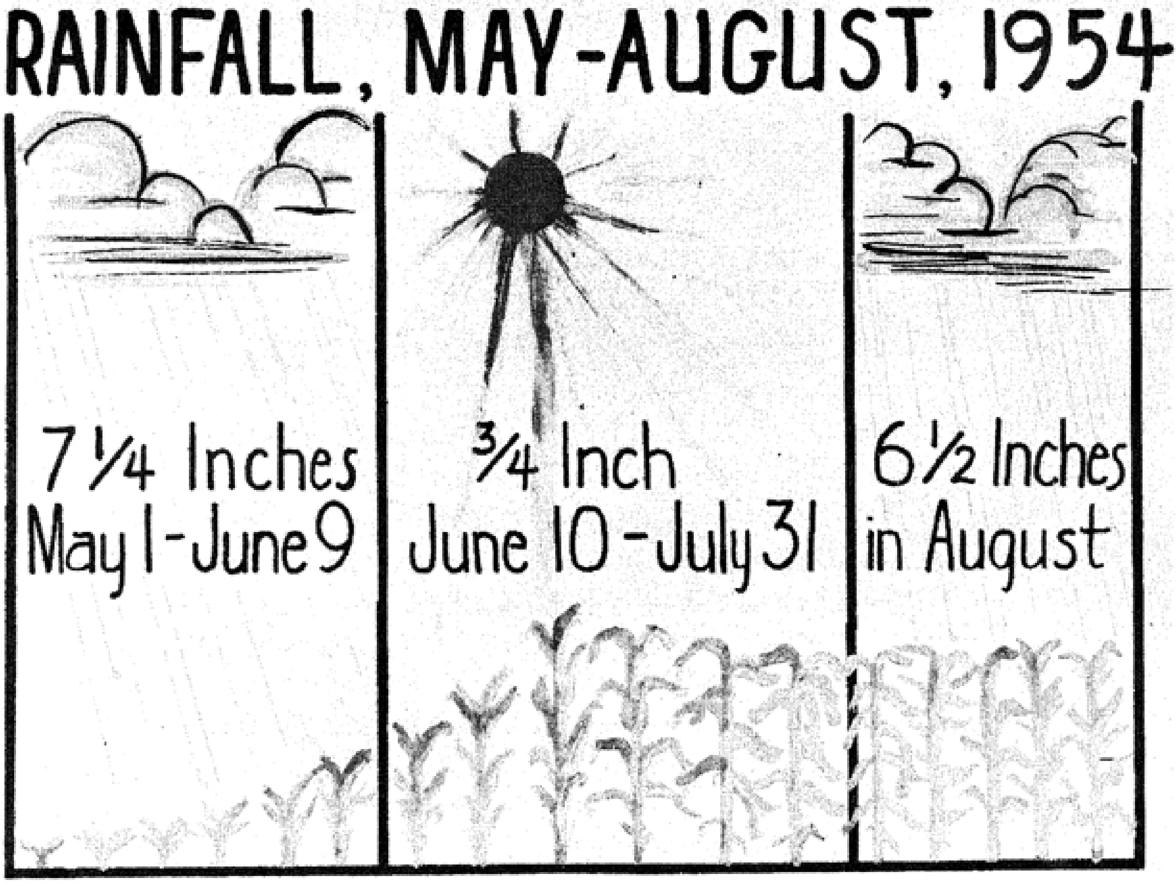

Fig. 1—Rainfall distribution at Columbia, Mo., during 1954.

part of Texas. He also found these three factors to be closely correlated with each other. Each of these factors was more closely correlated with corn yields than was rainfall at any period of the year. However, the June rainfall had a higher correlation than the total rainfall for any other period of the year. The number of cloudy days in June was not closely correlated with yield. Numerous other workers have studied the climatic effects on corn. Jenkins and Richey[2] observed differences between inbred lines and their reaction to drouth in 1930, which suggested the possibility of breeding a more drouth resistant corn. Jenkin's[3] data on a number of inbred lines and crosses showed a differing response among lines and crosses to the hot, dry weather of 1930. Ten crosses of one line were completely free from leaf burning whereas crosses of another line ranged from a few to many plants with burned leaves. These data indicated that much might be accomplished in the breeding of corn for drouth resistance. Lonnquist and Jugenheimer[4] studied the factors affecting seed sets during the summer of 1940 and 1941 in Kansas. They found negative correlations between high temperatures and seed sets of inbreds when self pollinated. Some lines were better than others. Maximum seed sets were received when silks were exposed two days after emergence and declined rapidly thereafter. Lines resistant to top-firing set more seed and silks remained receptive longer than did the susceptible lines.

Adequate soil moisture provided by irrigation, together with higher humidity and lower temperatures, was effective in prolonging silk receptivity. Tatum and Kehr[5], working in Kansas, found a very close relationship between the success of pollination and the temperatures and relative humidities which prevailed at the time the pollinations were made. They suggested that these two factors influenced pollination indirectly through their effects on evaporation and transpiration and, in turn, the internal water supply or turgidity of the corn plant. There was some indication that a lack of sufficient moisture in the silks to germinate pollen may be more important in causing poor seed sets than the lack of viable pollen.

Robins and Domingo[6] found when soil moisture depletion reached the wilting percentage during the flowering stage, marked reduction in corn yields resulted. Deficits for one to two days during tasseling or pollinating resulted in as much as 22 percent yield reduction and periods from six to eight days gave up to 50 percent reduction in yield. Shaw and Thom[7] studied the number of days from planting to emergence, tasseling, first pollen shed, and silking in Iowa. They found in the warm, dry year of 1947 there was a rapid rate of tasseling but a slower rate of silking, whereas in the cooler, more moist year of 1948 there was a slower rate of tasseling but a more rapid rate of silking. Kiesselbach[8] reported that under Nebraska growing conditions over a 47 year period that for each rise of 1° F. in mean seasonal temperature during June, July, and August there was a 6.75 bushel decrease in yield. On the other hand, a 1-inch increase in July, seasonal, and annual (crop-year) rainfall resulted in increases in yield of 5.15, 3.32, and 2.08 bushels per acre, respectively. For each additional inch of evaporation from a free-water surface during the three-month growing season, there was a reduction of 3.24 bushels. An increase of 1 percent mean seasonal relative humidity gave an increase of 2.73 bushels per acre. Seasonal increases of sunshine and mean daily solar radiation reduced yields 1.53 and 0.42 bushels, respectively.

Attempts have been made to measure the temperature and humidity variations within various types of covers. Geiger[9] summarized many of the early observations, and reported differences in temperature and humidities which were too small for biological significance. Waggoner[10] measured temperatures within and above a growing potato cover. He concluded that the small temperature differences were biologically trivial. Thornthwaite[11] reported the results of humidity observations taken within lima bean and corn covers. He found average differences in the dew point temperature about 0.9° F. within the lima beans and from 3.5° to 5.5° F. within a cover of tasseled corn. Thornthwaite's observations indicated that the highest dew point temperatures are found near the soil surface, and that they decrease with increasing height. Shaw and Waggoner[12] reported that the standard deviation of the mid-day dew point temperature observation was of the order of 1° F. within a corn field. This indicates that the random variability of the humidity at a given height is small.

MATERIALS AND METHODS

Part I

Seed sets resulting from the hand pollination of single cross parents for making double cross seed were recorded. This group involved approximately 64 single crosses of 30 plants each grown on non-irrigated Missouri River bottom loam of high fertility. The soil was adequately fertilized before planting and side dressed with nitrogen when the plants were about two feet high. Soil moisture, due to a higher water table, is usually more favorable on this type of bottom land than on most upland soils. These single crosses represented a maturity range from midseason (110-115 days) to late (125-135 days). The seed sets from pollinations made on specific dates were grouped without regard to pedigrees or previously known reaction to drouth. Seed sets for any one date were classified as none, poor (10-20% seed set), fair (20-40% seed set), and good (40-80% seed set). The maximum temperature in degrees fahrenheit and the relative humidity for 6 a.m. and 12.00 noon were recorded each day for the period of July 8 to July 23 during which time these hand pollinations were made. These records were otbained from the U. S. Weather Bureau Station located near Columbia, approximately nine air miles from the corn breeding nursery.

Part II

The timing of tasseling and silking was obtained from an irrigation experiment in 1954 at the Midwest Claypan Experimental Farm located near McCredie, Mo. The experiment was planted to hybrid US523W on May 10, and the variables consisted of two plant populations (7,100 and 14,200 plants per acre), two levels of nitrogen (120 and 240 pounds of N per acre), and three levels of irrigation (none, 7 inches, and 8½ inches). Tasseling and silking data were taken from all of the plants of two replications for each combination of the three irrigation levels, two plant populations, and two levels of nitrogen, or from a total of 12 different treatment combinations. Each treatment combination represented two replications of 20 plants each for the low plant population and 40 plants each for the larger plant population. A plant was recorded as tasseled when the first 25 percent of the staminate inflorescence appeared and as silked when a brush of 1 inch was first evident.

An aspirating psychrometer was employed to obtain the environmental temperature and humidity observations for these investigations. This psychrometer, which is pictured in Figure 2 is ventilated by maintaining a con-

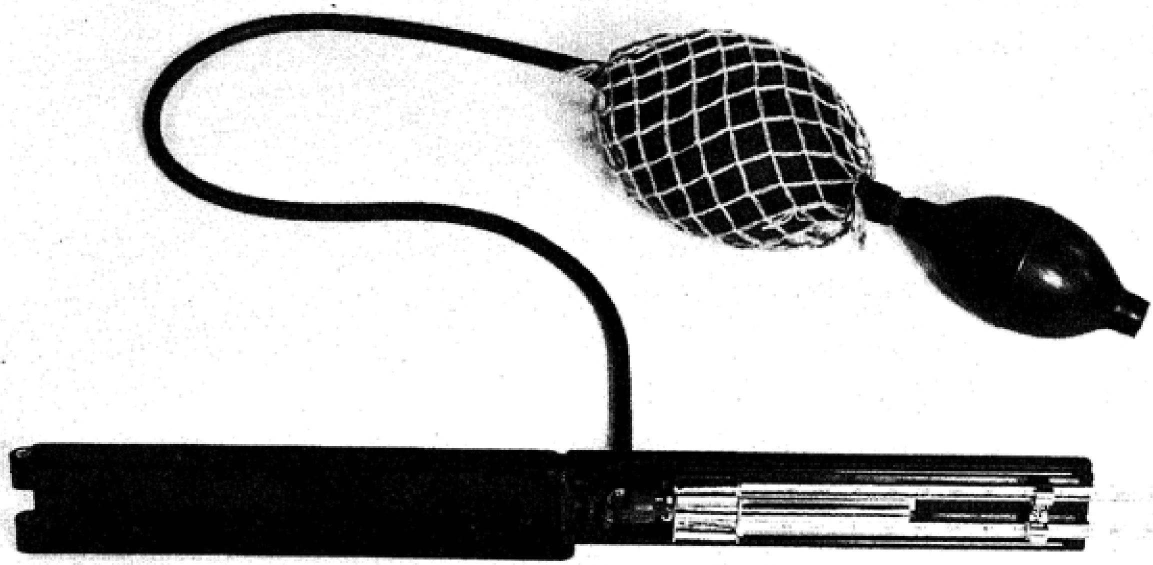

Fig. 2—An aspiration psychrometer used in obtaining the environmental temperature and humidity observations.

stant pressure in the rubber bulb. The pressure from this rubber bulb induces air movement across the thermometer bulbs. From the readings obtained from the two thermometers, temperature and humidity observations at different heights were obtained.

By a sampling procedure one temperature and humidity observation was taken in the center of each plot. Since each irrigation treatment was applied to two levels of nitrogen, it was possible to take two observations from both irrigation treatments and the non-irrigated treatment. Hourly temperature and humidity observations at each location were taken at 1, 3, 5, and 7 feet above the soil surface. During the period of observations the non-irrigated corn was approximately 5 feet high, while the irrigated corn measured about 7 feet tall. The order of taking the observations was randomized for each hour so that unbiased comparisons between treatments could be obtained.

Using these sampling procedures, four hourly observations of temperature and humidity were obtained for the irrigated corn, i. e., two from each irrigation treatment, and two hourly observations of temperature and humidity were obtained from the non-irrigated corn. These observations were taken during the mid-day periods (11 a.m. to 3 p.m.) from July 21 through July 31, except that no observations were taken on Sunday, July 24.

EXPERIMENTAL RESULTS

Part I

Data are given in Table 1 on the success of hand pollinations in the 1954 Missouri corn breeding nursery.

TABLE 1 -- RECORDS OF SEED SETS OBTAINED FROM THE DOUBLE CROSSING NURSERY IN 1954 TOGETHER WITH THE DAILY MAXIMUM TEMPERATURE AND RELATIVE HUMIDITY PERCENTAGES.

Pollination Date	Percentage Ears Seed Set				Maximum Temp. Degrees	Relative Humidity %	
	None	Poor	Fair	Good		6:00 A.M.	12:00 Noon
July 8	--	--	--	100	88	46	23
July 9	25	--	--	75	93	67	28
July 10	--	--	--	100	84	61	38
July 11	--	--	--	100	101	55	36
July 12	46	18	4	32	113	53	18
July 13	41	16	6	36	107	72	24
July 14	60	18	13	9	113	55	19
July 15	28	20	5	47	93	59	28
July 16	15	18	5	62	94	49	30
July 17	20	11	3	66	108	41	29
July 18	43	28	8	22	111	48	21
July 19	--	--	--	---	106	53	25
July 20	40	29	9	22	105	61	32
July 21	63	--	--	38	95	78	59
July 22	13	4	4	79	99	87	48
July 23	8	8	15	69	89	79	43

For the period of July 8 to July 23, maximum temperatures exceeded 100° F. during 8 of the 16 days. No rainfall occurred during this period nor had rain of any significance fallen since June 10. On July 12 when the temperature reached 113°, the percent of ears with good seed sets was 32. The following day, July 13, the maximum temperature was 107° and the ears with good seed sets increased slightly to 36 percent. However, on July 14 when the temperature again reached 113°, the ears with good seed sets declined to 9 percent. The poor seed sets might be explained by the low internal water supply of the plants after three successive days of high temperatures which in turn resulted in the silks having such a low moisture content that they could neither germinate pollen grains nor maintain pollen tube growth when sufficient silk moisture was available to induce germination. The percentage of ears with good seed sets that resulted the days following this period show that tassels from plants grown under the conditions of this experiment had the ability to produce viable pollen after maximum temperatures of 113°. These results appear to confirm the suggestion of Tatum and Kehr (5) regarding the internal moisture supply of the plant as being the most important factor in seed setting.

Part II

The summary of results obtained for the timing of tasseling and silking reported in Table 2 was taken from the data for each treatment plot given in Table 7 in the Appendix.

The number of days from planting to tasseling was influenced most by irrigation, second most by different plant populations, and least by increas-

TABLE 2 -- SUMMARY OF THE RESULTS OBTAINED FROM THE 1954 IRRIGATION EXPERIMENT CONDUCTED AT THE MISSOURI CLAYPAN EXPERIMENTAL FARM LOCATED NEAR McCREDIE, MISSOURI.

	Number of Days			
	Planting to Tasseling	Planting to Silking	% Sterile Tassels	% Plants Without Silks
1. Nitrogen Level				
120 lb. N	74.8	77.4	14.5	37.4
240 lb. N	74.3	76.7	9.7	33.6
2. Plant Population				
7,100	73.9	76.6	6.6	26.7
14,200	75.2	77.8*	17.6	44.2
3. Water Applied				
8.5 in. Irrigation	73.9	76.0	4.2	11.4
7.0 in. Irrigation	73.8	76.7	4.5	9.7
None	76.0	79.8*	27.7	85.4

*This figure may be biased since it included some plots with a large percentage of plants that never silked.

ing nitrogen levels. Application of water compared with no supplemental water caused tasseling about two days sooner; whereas, the smallest population tasseled about 1.3 days before the larger populations. Only a half day difference existed between the two nitrogen levels.

An application of 120 pounds of nitrogen was the lowest used in this experiment. It is probable that even on the irrigated area this amount was in excess of crop requirements, with other factors being more limiting. To assess the effect of nitrogen under growing conditions such as these would require tests with much lower rates of application.

The difference in number of days from planting to silking was 3.8 days for the 8.5-inch irrigation level versus non-irrigated plots and 3.1 days for the 7.0-inch irrigation level versus non-irrigated plots. The two plant populations differed by only 1.2 days, and the two nitrogen levels differed by 0.7 days.

Correlation coefficients were calculated between the number of days from planting to tasseling and the number of days from planting to silking for each plant within a treatment level (see Appendix, Table 7). A highly significant correlation coefficient does not necessarily mean the best timing occurred but with each r value, the average or mean number of days from planting to tasseling and planting to silking must be taken into consideration. For example, an r value of 0.9 might be obtained when mean values for tasseling and silking differ by only a few days (timing good) or ten days (timing very poor). Actually the r value represents the consistency of the relationship between tasseling with silking of the different plants within a particular treatment, whether the mean or average spread between tasseling and silking is two, five, or ten days.

The best timing occurred with the highest level of irrigation, highest nitrogen application, and the smallest plant population. This treatment also had the most consistent timing ($r = 0.85$), followed very closely by the same irrigation level and plant population but with 120 pounds of nitrogen. The poorest timing existed for the non-irrigated plots where the number of plants that silked was small and correlation coefficient would not have had a great deal of meaning. From these data, it appears that water was the most important factor for best timing. When plots were not irrigated, changes in population or nitrogen levels were of little benefit.

Data were also obtained on the percentage of "burned" or "blasted" tassels. These tassels were classified as sterile since they produced little, if any, viable pollen. The largest percentage of sterile tassels occurred in the non-irrigated plots with an average of 27.7 percent. One of these non-irrigated plots, the plot with highest plant population and 120 pounds of nitrogen, had 53.0 percent sterile tassels.

From the summary (Table 2), next to the lack of water, the largest percentage of sterile tassels occurred with the largest plant population, followed by the lowest nitrogen treatment. Some of the non-irrigated plots in this experiment had as many as 99.1 percent of the plants without silks (Table 7). The average of all non-irrigated plots showed 85.4 percent of the plants were without silks, and the smallest percentage (9.7 to 11.4%) occurred when the plots were irrigated (Table 2). The application of additional nitrogen decreased the percentage of plants without silks from 37.4 to 33.6 percent; whereas, doubling the plant population from 7,100 to 14,200 plants per acre increased this percentage from 26.7 to 44.2 percent. The non-irrigated corn yielded about 2 to 4 bushels per acre while the irrigated corn yielded from 60 to 85 bushels. The low yields of corn on the non-irrigated plots can be accounted for largely by the lack of shoot and silk production.

Tasseling and silking declined to such an extent that notes were last taken on July 31. On the first and second of August, 2 to 3 inches of rain fell. After this date many of the plants that were previously recorded as not silked started growing a secondary ear at the ear bearing node, and on August 18 or 100 days from the time of planting, the percentage of plants with viable silks was recorded (see Appendix, Table 7). This included most of the plants that had been previously recorded without silks. Since viable pollen was not available these plants did not set seed. If viable pollen had been available the amount of seed set probably would have been of such a small quantity that its effect on final yields would have been small as there were few silks per ear. The interesting part of this observation is the persistence of these barren corn plants to reproduce when favorable environmental conditions reappeared.

The average temperatures and relative humidities during the 11 a.m. to 3 p.m. period of each day for the irrigation experiment are listed in Table 3.

On most days there was a decrease in temperature with increase in height in all plots. The average temperatures at the four heights for both irrigated and the non-irrigated plots are plotted in Figure 3. In both cases the average temperatures were about 2° F. cooler at 7 feet than at 1 foot above the surface. There was no apparent difference in the average temperatures of the two irrigated plots. The average temperatures in the non-irrigated plots exceeded those in the irrigated plots by 0.6° F. at the 7-foot level and by 1.2° F. at the 1-foot level. Although these temperature differences were biologically insignificant, they indicate that more heat was absorbed within the sparse cover of the non-irrigated plots. A possible explanation is that in the irrigated corn there was a dissipation of heat by the increased transpiration rate, and the larger corn plants in the irrigated plots prevented absorption of solar energy by soil surface by shading.

The amount of heat transferred through a layer of the atmosphere is directly proportional to the rate of temperature decrease with height. This temperature decrease has been evaluated by 2-foot layers within the corn cover, and the average temperature decreases for each hour are shown in Table 4. The temperature decrease with height was greater for the non-irrigated than the irrigated plots. This indicates that there was a greater heat

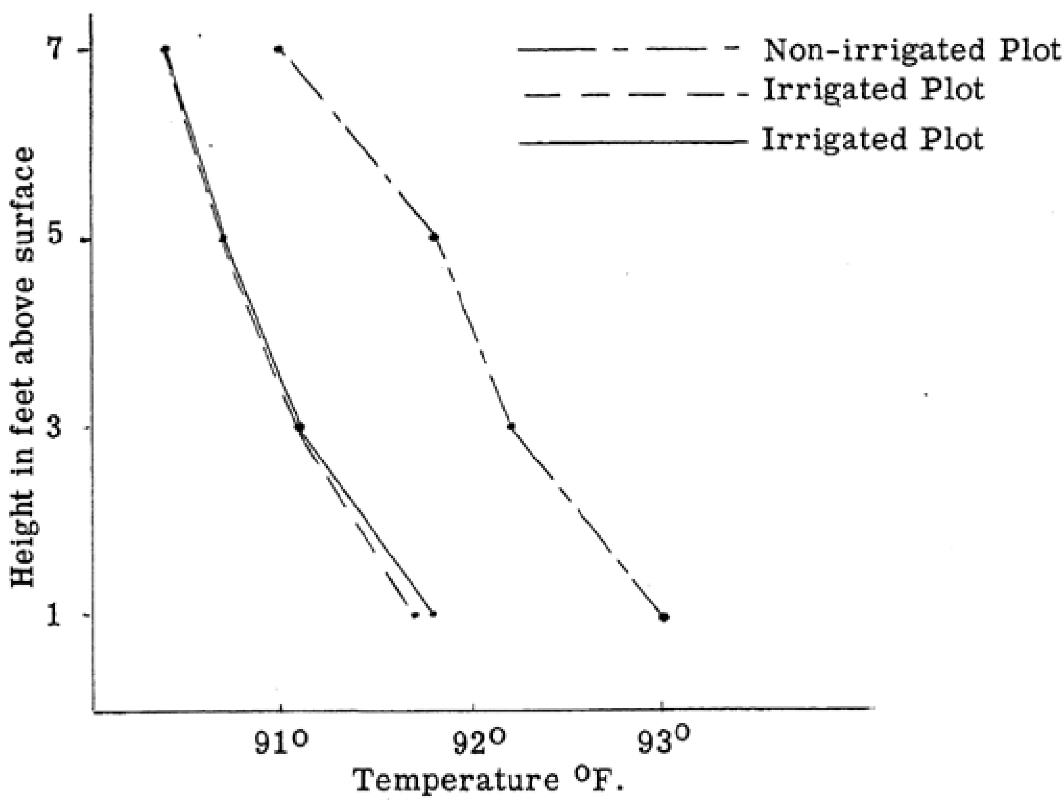

Figure 3 -- Average mid-day temperatures at 1, 3, 5, and 7 feet above the surface in irrigated and non-irrigated plots.

TABLE 4 -- AVERAGE TEMPERATURE DECREASE IN DEGREES F. WITH HEIGHT BY TWO-FOOT INTERVALS WITHIN IRRIGATED AND NON-IRRIGATED CORN PLOTS.

Heights	Treatment	Hour 9 A.M.	10 A.M.	11 A.M.	12 Noon	1 P.M.	2 P.M.	3 P.M.	4 P.M.	Average
1 to 3 feet	Non-irrigated	.2	1.4	.8	1.0	.5	.8	.8	.8	.8
	Irrigated	.2	.8	.4	.8	.8	.9	.6	.2	.6
3 to 5 feet	Non-irrigated	.6	.4	.1	.6	1.0	.6	.2	.2	.5
	Irrigated	.2	.3	.5	.4	.4	.2	.3	.1	.3
5 to 7 feet	Non-irrigated	.3	.5	.7	.8	.9	.7	.6	.2	.6
	Irrigated	.4	.6	.4	.2	.6	.4	.2	0.0	.4
1 to 7 feet	Non-irrigated	1.1	2.3	1.6	2.4	2.4	2.1	1.6	1.2	1.9
	Irrigated	.8	1.7	1.3	1.4	1.8	1.5	1.1	.3	1.3

TABLE 3 -- THE AVERAGE TEMPERATURE AND RELATIVE HUMIDITIES FOR THE DAILY PERIOD 11 A.M. to 3 P.M. WITHIN IRRIGATED AND NON-IRRIGATED CORN

	Non-Irrigated								Irrigated							
	1 Foot		3 Feet		5 Feet		7 Feet		1 Foot		3 Feet		5 Feet		7 Feet	
Date	Temp.	Rel. Hum.	Temp.	Rel. Hum.	Temp.	Rel. Hum.	Temp.	Rel. Hum.	Temp.	Rel. Hum.	Temp.	Rel. Hum.	Temp.	Rel. Hum.	Temp.	Rel. Hum.
July 21	87.2	67.8	86.7	67.4	86.1	67.3	85.6	67.9	87.2	69.9	86.8	70.0	86.2	70.0	85.8	69.4
July 22	97.5	51.9	96.1	51.5	95.7	50.8	94.9	51.9	95.2	57.8	94.8	56.8	94.4	56.4	94.6	55.6
July 23	89.8	44.7	89.1	43.7	88.8	45.0	88.5	44.1	88.7	48.1	88.2	48.2	87.8	48.9	87.6	47.6
July 24	80.2	72.0	79.4	71.8	79.3	72.0	78.2	72.4	79.6	75.2	79.0	74.8	79.2	74.0	78.4	74.2
July 26	93.4	20.0	92.5	29.0	91.6	29.9	90.8	30.1	91.7	34.6	91.0	34.2	90.4	33.2	90.3	30.1
July 27	95.6	29.4	95.0	28.1	94.2	28.1	92.2	27.6	94.1	34.5	92.9	33.6	92.4	32.4	91.3	30.6
July 28	94.9	40.9	94.6	40.9	94.3	41.2	94.1	40.2	94.2	43.8	93.6	43.8	93.6	43.8	93.6	42.6
July 29	98.8	35.3	98.0	32.6	97.4	33.4	96.8	31.9	96.9	36.8	95.8	36.8	95.5	37.0	95.1	35.2
July 30	98.2	36.8	96.9	35.7	96.9	34.9	96.5	34.3	97.4	38.3	96.4	38.1	96.0	38.6	95.8	38.2
July 31	94.8	48.6	94.2	48.5	93.5	48.7	92.8	49.1	92.9	51.8	92.4	52.2	92.0	52.4	91.6	51.0

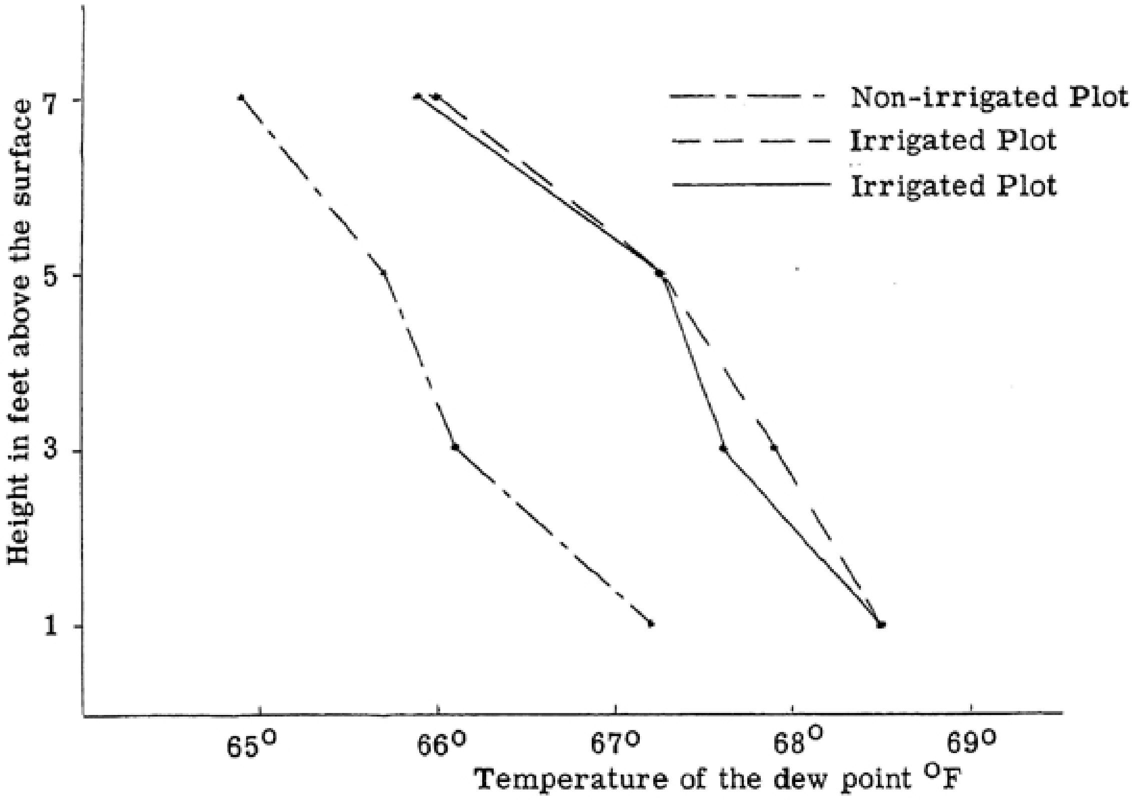

Figure 4a -- Average mid-day dew point temperatures at 1, 3, 5, and 7 feet above the surface in irrigated and non-irrigated plots.

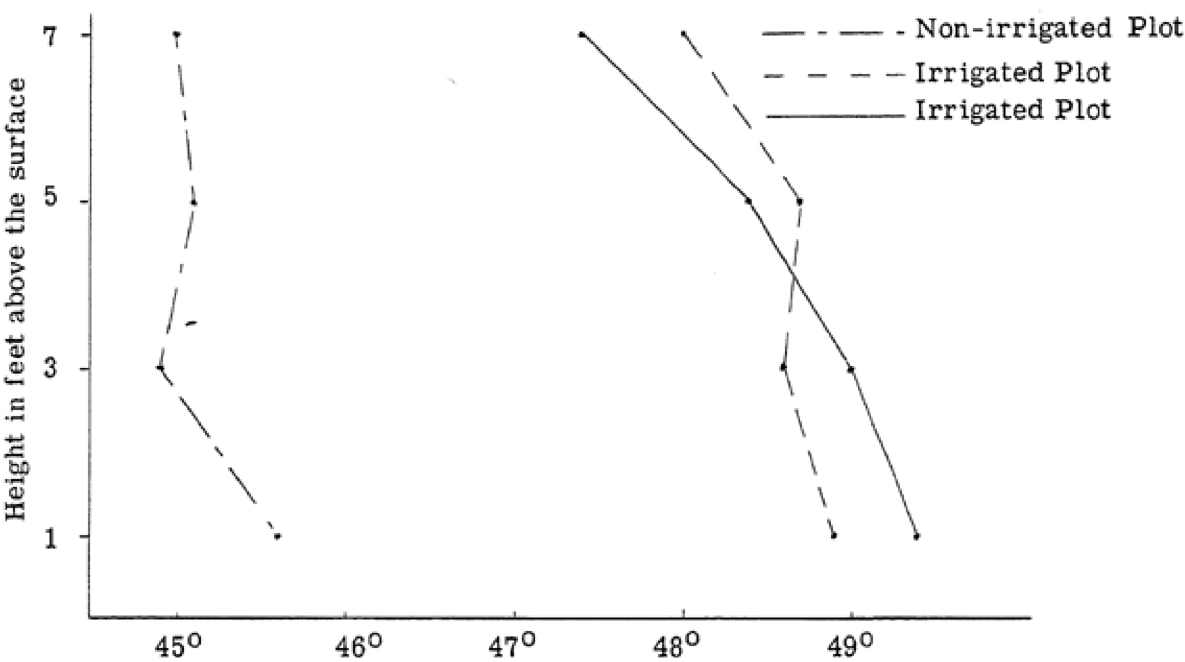

Figure 4b -- Average mid-day relative humidities at 1, 3, 5, and 7 feet above the surface in irrigated and non-irrigated plots.

exchange through the atmospheric layers within the non-irrigated plots. The greatest heat exchange occurred during the hours of greatest solar intensity, and in the layer of air nearest the soil surface.

Humidity measurements were obtained for the 1, 3, 5, and 7-foot levels within the irrigated and non-irrigated corn plots. Shown in Figure 4a are the average dew point temperatures at each height; Figure 4b shows the average relative humidities.

There did not appear to be any difference in the average moisture content of the air in the two irrigated corn plots. The air within the non-irrigated plot averaged drier than that within the irrigated plots. When the moisture content was expressed as the average relative humidity, the humidity was from 3.0 to 3.5 percent lower in the non-irrigated plots. These humidity differences were small because the irrigated plots were small and the atmosphere within the plant cover was unstable. In spite of this, larger differences were experienced on days when irrigation water was applied. Table 5 shows the average of the relative humidity observations for days when irrigation water was applied. The beneficial effects of adding irrigation water were not confined to the increases in soil water levels. Advantage was also gained through an increase in the moisture content of the air around the plant, which reduced the stress associated with hot and dry conditions.

TABLE 5 -- AVERAGE RELATIVE HUMIDITIES FOR IRRIGATED AND NON-IRRIGATED PLOTS ON DAYS WHEN IRRIGATION WATER WAS APPLIED

Treatment	Date	Heights (Feet)			
		1'	3'	5'	7'
		(Percent)			
Irrigated	July 22	58.2	57.1	56.6	55.5
Non-irrigated	July 22	51.9	51.5	50.8	51.9
Difference		6.3	5.6	5.8	3.6
Irrigated	July 26	35.5	34.7	33.3	29.8
Non-irrigated	July 26	29.0	29.0	29.0	30.1
Difference		6.5	5.7	3.4	-.3
Average Difference		6.4	5.6	4.6	1.6

ADDITIONAL METEOROLOGICAL DATA

Detailed weather data were taken during the 10-day period from July 22 through July 31. Temperatures were recorded from an instrument shelter located near the plots, and wind velocities were taken at a height of 6 feet above the surface. A summary of these data is given in Table 6.

DISCUSSION

The effects of drouth on the yield of corn are very complicated since a large number of inter-related factors are involved. This study took into consideration only the factors that could be directly measured, quantitatively, such as air temperatures, relative humidity, and the application of irrigation water. Many other related factors are involved but these could not be measured nor controlled in this study.

Under the conditions of this study, the effect of high temperatures on seed sets indicated functional pollen was produced after a maximum tem-

TABLE 6 -- SUMMARY OF WEATHER AT McCREDIE FARM DURING PERIOD JULY 22 TO JULY 31, 1954.

Date	Average 11 A.M. to 3 P.M. Temperature, Humidity and Wind				Daily Temperatures		Remarks
	Temperature °F.	Dew Point Temperature °F.	Relative Humidity %	Wind mph	Maximum	Minimum	
July 21	82.6	----	----	3.7	92	72	Overcast skies with E winds until midmorning. Clouds became scattered by late afternoon while winds shifted to S. Light rain occurred just prior to midnight, 0.7".
July 22	95.8	75.8	52.4	4.3	99	71	Scattered clouds with easterly winds.
July 23	88.4	69.4	54.2	5.5	90	69	Broken to overcast skies throughout the day, NE wind.
July 24	78.4	69.0	73.8	4.6	82	68	Overcast skies and trace of rain before noon. Clearing during the afternoon. Wind E.
July 26	92.0	60.0	35.0	5.2	95	60	Scattered clouds during the day. Wind NE.
July 27	93.6	59.2	32.8	5.0	98	57	Mostly fair with southerly winds.
July 28	95.0	67.6	39.4	5.1	99	68	Broken clouds with southerly winds.
July 29	97.8	62.2	31.8	6.4	102	72	Mostly fair with westerly winds.
July 30	97.2	66.2	35.8	5.7	102	68	Scattered clouds and southerly winds.
July 31	93.8	70.2	46.6	7.5	98	76	Broken to overcast skies. Wind shifting from south to north in early afternoon.

perature of 113° Fahrenheit. Further investigation should be undertaken to determine the maximum temperature to which mature pollen grains can be subjected and still be functional. Involved in such a study should be not only maximum temperatures but also different lengths of time of such temperatures at different relative humidities. The amount of seed set in these studies might have been quite different if the soil moisture had been less

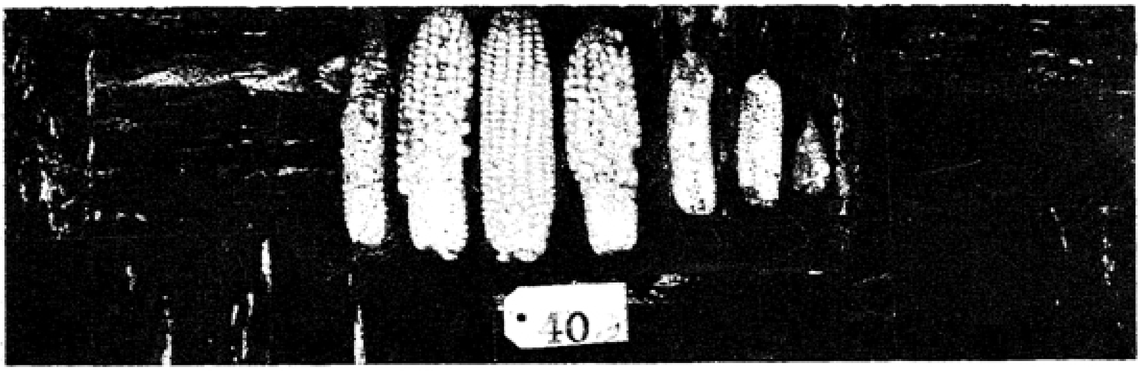

Fig. 5—Harvested ears from a 20-plant plot with no irrigation; 7,100 plants per acre and 120 pounds of nitrogen applied.

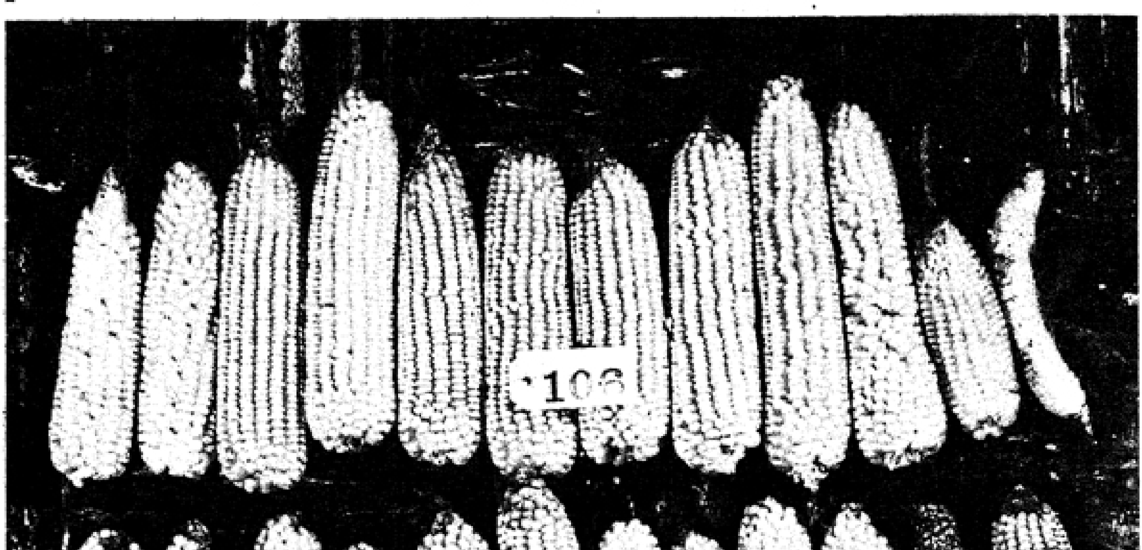

Fig. 6—Harvested ears from a 20-plant plot with 8.5 inches irrigation water; 7,100 plants per acre and 120 pounds of nitrogen applied.

or if transpiration rates had been higher because of some other factor such as a greater wind movement. More knowledge on these aspects is needed. The internal moisture gradient from the base of the corn plant to its uppermost leaves should be determined under different levels of soil moisture, air temperature, and relative humidity. These internal moisture conditions should be correlated with the amount of moisture in the silks in order to

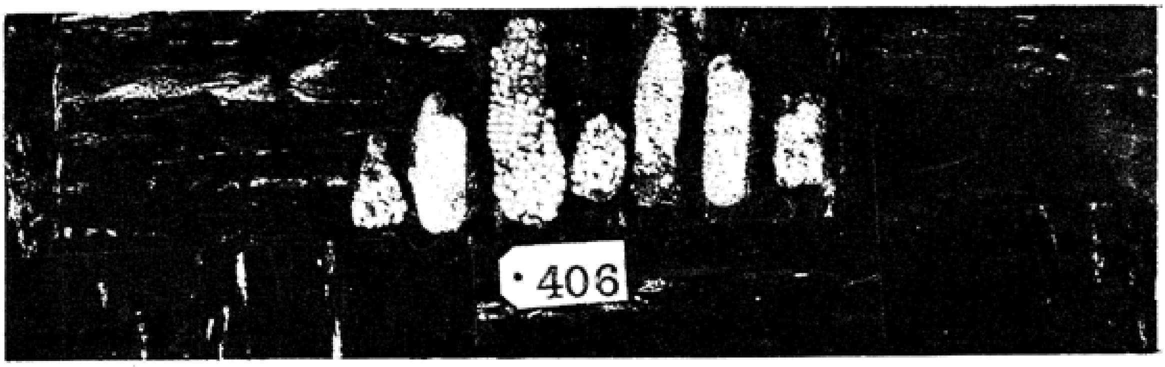

Fig. 7—Harvested ears from a 40-plant plot with no irrigation; 14,200 plants per acre and 120 pounds of nitrogen applied.

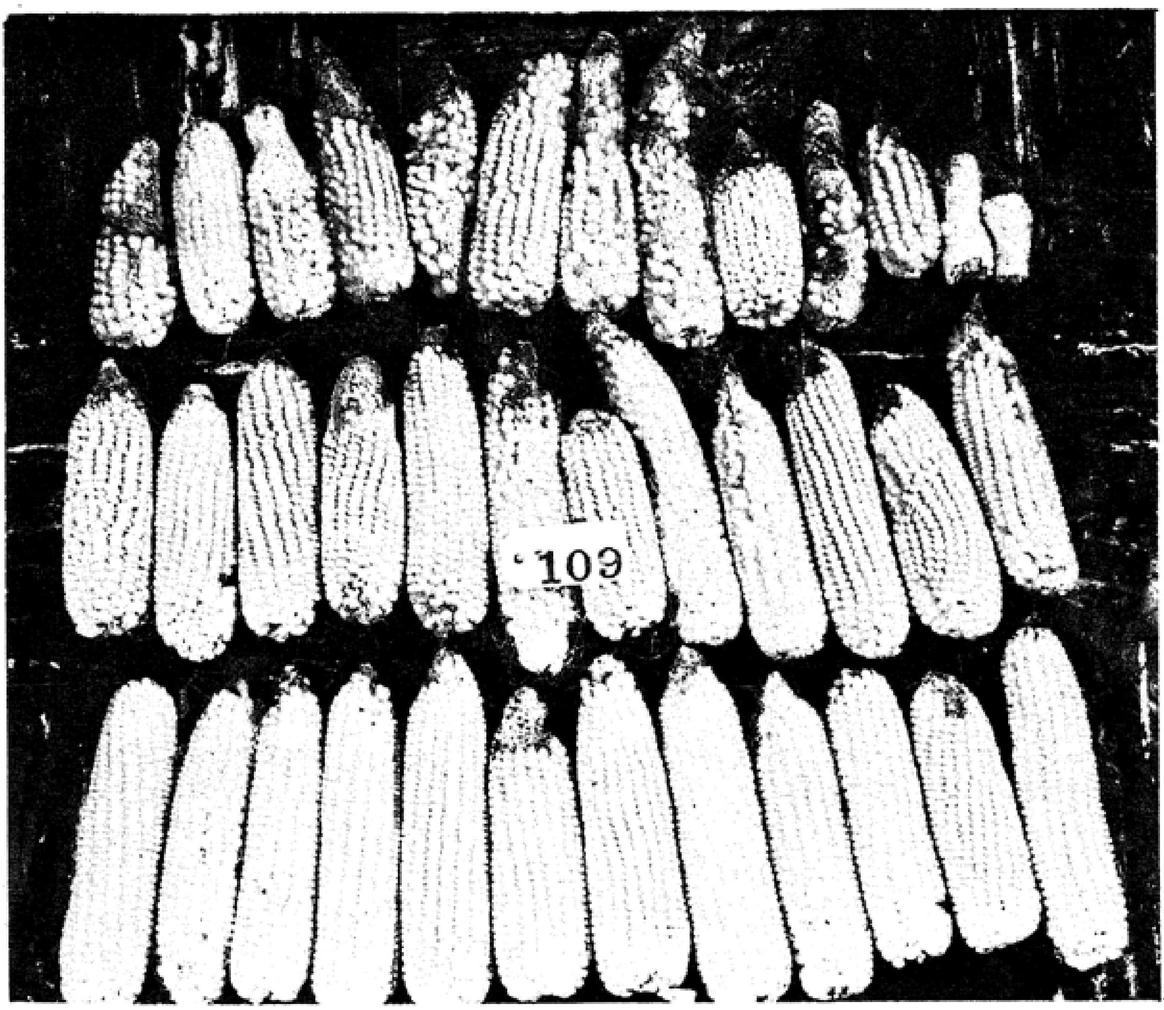

Fig. 8—Harvested ears from a 40-plant plot with 8.5 inches irrigation water, 14,200 plants per acre and 120 pounds of nitrogen applied.

determine the levels of silk moisture at which pollen grains cease to germinate and grow.

The means by which the application of irrigation water increases corn yields is of particular interest. This study shows that the decrease in the number of barren plants contributed most to the higher yields. This decrease in barren plants was associated with better timing between tasseling and silking and a smaller number of sterile tassels in the irrigated plots. However, the number of sterile tassels (53%, maximum in one plot) is believed to have had little effect on yield since there were enough fertile tassels present in the non-irrigated plots to produce adequate pollen. The comparative yields received from non-irrigated and irrigated corn can be illustrated best by the ears harvested from some of the individual plots as shown in Figures 5, 6, 7 and 8, respectively.

The effect of the addition of irrigation water on the environmental conditions appears to be worth investigating. Changes in air temperature at various heights surrounding the corn plant in the irrigated versus the non-irrigated plots did not appear great enough to account for the differences in the response of the plant. The average relative humidities were increased by irrigation, although the magnitude of these increases was not as great as might be expected. The relationship between the environmental changes and the internal-water supply of the plant was not established but is a problem certainly worth investigating.

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TABLE 7 -- NUMBER OF DAYS FROM PLANTING TO TASSELING, PLANTING TO SILKING, PERCENT PLANTS WITH STERILE TASSELS, PERCENT PLANTS WITHOUT SILKS, PLUS CORRELATION COEFFICIENTS FOR TASSELING VS. SILKING, TASSELING VS. EAR WEIGHT, AND SILKING VS. EAR WEIGHT FROM AN IRRIGATION EXPERIMENT CONDUCTED ON THE MISSOURI CLAYPAN EXPERIMENTAL FARM LOCATED NEAR McCREDIE, MISSOURI.

Nit. Level	Plant Pop.	Water Applied	Number of Days: Planting to Tasseling	Number of Days: Planting to Silking	% Sterile Tassels	% Plants Without Silks	% Plants with Viable Silks 100 Days after Planting	Correlation between Tasseling and Silking	Correlation between Tasseling Date and Ear Wt.	Correlation between Silking Date and Ear Wt.
120#N	14,200	8 1/2"	75.3 ± 2.8	78.5 ± 2.7	7.8	25.0	21.7	0.61**	0.05	-0.21*
120#N	7,100	8 1/2"	73.3 ± 2.3	74.6 ± 2.7	None	3.7	3.7	0.84**	0.13	0.04
120#N	14,200	7"	74.6 ± 2.2	78.5 ± 2.0	4.3	20.7	19.0	0.47**	0.18	-0.31**
120#N	7,100	7"	73.3 ± 2.1	75.8 ± 2.5	9.0	3.7	3.7	0.58**	0.02	0.02
120#N	7,100	None	75.5 ± 2.5	79.7 ± 2.9	12.7	72.7	70.9	------	------	-------
120#N	14,200	None	76.7 ± 2.7	---------	53.0	98.3	88.7	------	------	-------
240#N	7,100	8 1/2"	73.1 ± 2.6	74.4 ± 3.1	5.3	7.1	7.1	0.85**	0.11	0.20
240#N	14,200	None	76.5 ± 2.9	---------	36.0	99.1	86.5	------	-------	-------
240#N	14,200	8 1/2"	73.7 ± 2.0	76.5 ± 2.9	3.6	9.8	7.1	0.68**	-0.29**	-0.27*
240#N	14,200	7"	74.1 ± 2.0	77.5 ± 2.1	0.9	12.5	9.8	0.55**	0.02	-0.18
240#N	7,100	7"	73.0 ± 1.9	75.1 ± 2.1	3.6	1.8	1.8	0.76**	-0.20	0.23
240#N	7,100	None	75.1 ± 2.3	79.9 ± 2.0	8.9	71.4	69.6	0.53*	0.04	-0.59*

* Correlation Coefficient Significant at 5% level
** Correlation Coefficient Significant at 1% level

SUMMARY AND CONCLUSIONS

1. Under the conditions of these studies, the two most important factors causing lower corn yields in a drouth year were lack of silk production (barren plants) and the poor timing between pollen production and silking. The lack of viable pollen caused by the "burning" and "blasting" appeared to be of lesser importance. When sufficient soil moisture was available, corn plants produced functional pollen following days with maximum temperatures of 113° F.

2. The importance of adequate soil moisture in a drouth year is indicated by the results of an irrigation experiment. Irrigated corn, compared with non-irrigated corn, tasseled earlier, silked earlier, produced fewer sterile tassels, had better timing between tasseling and silking, and had fewer plants without silks.

3. As the amount of water applied was reduced, the smaller plant population when compared to the larger plant population gave a better timing between tasseling and silking and had fewer plants without silks.

4. The lowest nitrogen level (120 lb. per acre) was considered excessive to the crop requirements on the irrigated area in 1954, other factors being more limiting. Although, the highest nitrogen level (240 lb. per acre) plots tasseled and silked slightly earlier, had fewer sterile tassels, and had fewer plants without silks than the plots with the lower nitrogen levels, the magnitude of these differences was not large. On the non-irrigated corn, little differences existed between the two nitrogen levels.

5. Air temperatures within the non-irrigated corn were slightly higher than within the irrigated corn, but it is believed these differences were of little biological significance.

6. Relative humidity averaged 3.0 to 3.5 percent lower in the non-irrigated corn with larger differences existing on the days irrigation water was applied.

7. The results of these studies suggest investigations should be undertaken to determine the internal-water supply and moisture gradient within the corn plant from the base to the tassel when grown under conditions of limited moisture with varying amounts of water being applied. The relationship of the internal-water supply of the plant to the moisture content of silks and, in turn, to various silk moisture levels, should be studied to determine at what moisture level pollen grains fail to germinate and discontinue growth after germination. More information is needed to determine the effect of external climatic factors on the internal moisture supply of the corn plant.