The Temperature Factor in Corn Production in Tippecanoe County, Indiana

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Abstract

The ten best years for corn production in Tippecanoe County, Indiana, were compared with the ten poorest years using the period of 1923 through 1966 in the selection. Weekly comparisons of air and soil temperatures showed that the best corn yields occurred in years when temperatures averaged above normal during the establishment period and below normal during the grand growth and reproduction periods.

The reduction of weather factors to an equation and a set of numbers concurrent with the yield of a crop such as corn, continues to be a challenge to agricultural scientists. This analysis considers the weekly average of daily maximum temperature of the ten poorest years for corn production in Tippecanoe County, Indiana, with the ten best years.

Literature

Most studies in the past concerning Indiana corn yield and temperatures have utilized either state or area averages. L. M. Thompson (3) in his analysis of the climatic factors among the corn belt states, concluded that August temperatures in Indiana need to be lower than average for highest corn yields. He also concluded that higher than average May temperatures might adversely affect Indiana corn yields. There may be considerable differences in optimum climate for corn across Indiana considering the high temperatures and evapotranspiration of the south compared to those in the cool, more cloudy, northeast area.

John Rose (2; 7, p. 412-425) in 1932 studied the effect of weather on corn yields for five well distributed Indiana counties, namely, St. Joseph, Huntington, Tippecanoe, Rush and Knox. He correlated monthly precipitation and temperature for the central months of the growing season with the respective seasonal corn yields. The correlation coefficients for the several climatic factors he studied and corn yields ranged (for the five Indiana counties) from .64 in Rush County to .91 in Huntington. Tippecanoe County cofficient was .71. Rose believed that Indiana climatic factors for optimum corn production were quite varied considering the cool northeast versus the warm southwest with the inter-relations between factors varying considerably.

Data and Procedure

In this investigation air temperatures were related to Tippecanoe County average corn yields to estimate the optimum temperatures through the season for good corn growth. Corn yields per acre for the period of 1923 through 1966 were obtained from the Agricultural

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Statistician, Statistical Reporting Service, U.S.D.A. Average yields ranged from 25.7 bushels per acre in 1930 to 105.2 bushels per acre in 1965.

To estimate optimum temperatures for corn, other climate factors such as moisture stress, were minimized when a group of best years for corn growth were selected. Figure 1 shows crop yields in Tippecanoe County, Indiana, beginning with 1923. The "best years" were arbitrarily selected by taking every new highest yield after 1923 through 1966. This resulted in ten "best years," circled in Figure 1. Years of lowest yield were selected by taking the lowest producing year starting backwards from 1966. This method provided nine "poorest years," but in order to have ten for comparative purposes, 1930 was also selected which was within 1.4 bushels of the absolute low yield established in 1934, Figure 1.

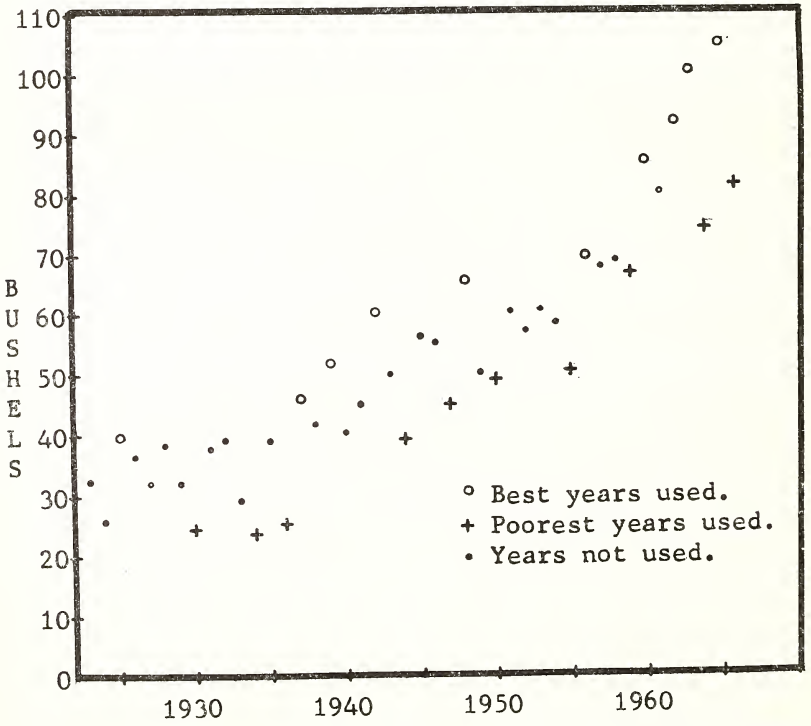

Figure 1. Average corn yields in bushels per acre in Tippecanoe County, Indiana, and the best and poorest years selected for comparison.

Favorable corn progress in the selected ten best years was substantiated by a review of reports at the time (5, 6). In all of the selected "best years," the seasons and the growth periods within the seasons seemed close to ideal with one possible exception. In 1925 the corn was planted in dry soil and while subsequent rains after the first week of June brought the corn along nicely, the fall was

rainy, corn ripening was slow, and there was reported loss from a delayed harvest.

It was assumed that the ten worst years resulted from any, all, or a composite of growth inhibiting effects such as, too much rain at planting or harvesting time, too little rain with hot weather, or cool, wet conditions.

The temperature argument used was the daily maximum temperature. This measurement was used throughout whether for a weekly average or a growth period. It is commonly accepted that the high temperature of the day is more representative of solar radiation and effective temperature than either the daily low temperature, usually occurring at the earily morning hours, or the mean temperature obtained by averaging the maximum and minimum temperatures for the day.

The daily high temperatures for each week of the growing season were averaged for both the "best years" and "poorest years" for corn in Tippecanoe County. Climatological weeks were used; thus week number 1 was March 1-7 every year, March 8-14 was the second week, etc.

The weekly averages were pooled to approximate the five growth periods of corn described by Blair (1), namely, the germination period of May 1-12, the establishment period of May 18-June 12, the grand growth period of June 15-July 19, the reproduction period of July 20-August 15, and the maturity period of August 15-October 1.

The average daily maxima for each week of the growing season for all twenty years are shown in Table 1. In order to compare the temperatures of the ten best years with the ten poorest years, ten-year weekly means were calculated for both groups. The results are shown in Figure 2. The greatest differences occurred in the reproduction period of the last two weeks of July and the first week in August. The average daily maximum temperatures of the ten best years averaged 4 or 5 degrees lower than those of the ten poorest years. The grand growth period in the last half of June and early July showed mean daily maximum temperatures of 84°F. in the best years while the poor years averaged 86°F.

The ten best years favored a warm establishment period occurring in the last week of May and the first two weeks of June. In the germination period, the first two weeks of May, there was no clear-cut indication of consistent temperature differences.

To examine the idea that one or two years may have dominated the averages, the frequency of each week above or below the 20-year mean was computed. Some results are shown in Figure 3. The weekly mean exceeded the 20-year mean in seven of the ten poorest years in the period of June 28 to July 11, and generally more than half the years in the eight week period from June 21 to August 15. In the week of June 28-July 4 there were eight years out of the ten best years when temperatures were below the 20-year average. The ten best years also produced nine years out of ten when the weekly temperatures averaged below the 20-year mean in the period of July 26 through August

TABLE 1

Average Daily Maximum Temperature by Weeks

Year*	Weeks with ending dates of																				
	4/25	5/2	5/9	5/16	5/23	5/30	6/6	6/13	6/20	6/27	7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	9/19
1925	77	66	64	75	80	74	93	89	86	83	86	90	87	84	78	85	86	86	89	94	90	81
1930	54	59	82	73	70	72	84	75	82	91	84	91	88	94	93	93	86	82	89	83	82	82
1934	64	65	86	73	87	81	96	85	90	94	99	90	91	106	92	92	92	84	75	79	75	76
1936	69	68	58	68	68	75	76	79	80	78	90	89	89	88	94	89	96	98	92	82	91	82
1937	68	64	70	70	75	85	85	76	80	87	81	94	87	87	86	89	89	90	89	87	81	71
1939	63	67	76	72	84	87	84	78	86	88	86	91	88	85	86	86	87	85	85	88	90	92
1942	73	82	66	74	70	80	91	83	76	79	87	84	90	88	90	86	90	80	84	90	71	70
1944	68	69	60	81	84	87	85	82	89	87	91	95	89	88	88	94	95	84	76	83	79	81
1947	61	64	58	75	74	70	74	83	71	80	85	81	87	78	89	94	91	95	90	86	87	81
1948	76	69	67	67	75	78	85	83	82	86	83	90	88	83	86	81	86	86	95	85	81	88
1950	62	54	73	75	77	77	77	82	75	85	76	85	83	82	86	82	82	81	84	79	78	75
1955	71	66	77	66	77	73	76	65	76	87	89	87	86	84	85	83	86	88	92	85	84	70
1956	56	62	67	77	72	72	71	86	87	87	84	78	80	80	85	86	87	80	83	83	75	80
1959	57	68	79	67	76	77	79	85	76	89	89	87	86	84	85	83	86	88	92	85	84	70
1960	72	67	64	59	72	75	80	77	75	79	82	78	81	86	83	83	81	81	85	90	83	75
1962	66	79	73	74	88	79	80	78	84	86	86	84	81	80	78	85	78	84	83	83	74	80
1963	60	63	74	72	67	71	83	85	81	83	91	81	85	86	85	85	80	74	81	78	81	80
1964	64	63	79	73	84	74	72	86	85	87	90	79	80	89	87	91	76	83	79	86	87	73
1965	66	65	56	78	81	75	78	82	77	84	83	81	83	85	81	81	81	85	79	74	79	80
1966	68	63	65	56	72	77	76	80	79	90	92	92	90	86	87	82	78	83	80	89	80	78
Ave.	66	66	70	71	77	77	81	81	81	85	87	86	86	86	87	87	85	85	85	84	81	79

* Bold years were best years for corn in Tippecanoe County. Other years were poorest years.
Temperature observations from Agronomy Farm near Lafayette, Indiana, and earlier from Campus of Purdue University.

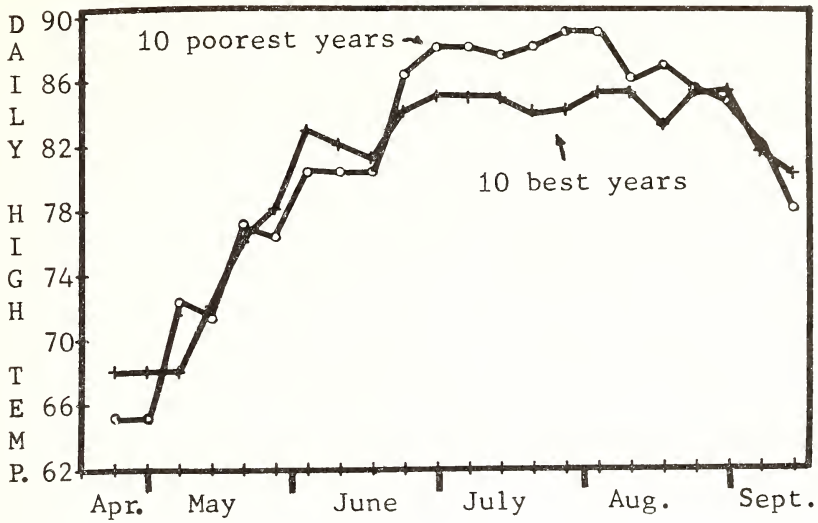

Figure 2. Weekly averages of daily high temperatures of the 10 best years is compared to the 10 poorest years for growing corn in Tippecanoe County, Indiana.

8. Generally more than half the years were below the mean from June 28 to August 8. Differences between the ten best years and the ten poorest years were less and not too consistent for other periods.

Further consolidation of the data was done by combining the weeks into the five periods of corn growth, germination, establishment, grand growth, reproduction, and maturity. The resulting averages are shown in Table 2. A serious shortcoming is that the same calendar weeks were used every year although any particular season may progress one or two weeks ahead or behind the average. Germination may

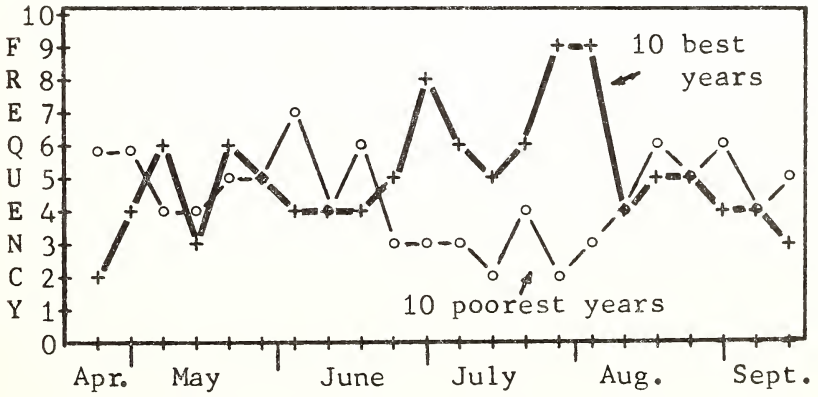

Figure 3. Frequency of the mean weekly daily high temperature averaging below the 20-year mean which occurred 9 years out of 10 in the best years in late July and early August.

TABLE 2

Average Daily Maximum Air Temperatures

Group	Germination (5/3-5/16)	Establishment (5/17-6/13)	Grand Growth (6/14-7/19)	Reproduction (7/19-8/15)	Maturity (8/16-9/26)
10 Best Years	70	81	84	84	82
10 Poorest Years	71	78	86	88	82

occur late in May due to weather factors, changing technology and farming practices since the 20's. Within the same season crop progress may also accelerate to make up for the tardy beginning. Average temperatures in the germination period, defined as the first two weeks in May, were practically the same for the ten best and the ten poorest years. In the establishment period the ten best years were 3 degrees warmer than the ten poorest years but 2 degrees cooler in the grand growth stage. The most outstanding differences were shown in the reproduction period of July 19 to August 15 with the ten best years 4 degrees cooler than the ten poorest years which averaged 88 degrees.

This supports the idea that the number one deterrent to maximum yield is the dry, hot weather often experienced in the grand growth and reproduction periods. But temperature cannot be considered an independent deterrent. If moisture is adequate, more solar radiation is converted into vapor and less sensible heat but when soils are dry more energy is converted to heat and higher temperatures.

Conclusions

For best corn yields in west central Indiana or Tippecanoe County, temperatures should average above normal in the establishment period. Highest corn yields were obtained when temperatures averaged a little below normal during the grand growth and reproduction periods from June 14 through August 15. It appears that high daily maximum temperatures limit corn production more than low daily maximum temperatures and normal daily maximum temperatures are too high for optimum growth in mid-summer.

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