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Climate of the Palouse Area of Idaho as Indicated By Fifty Years of Climatological Data on the University Farm

K. H. W. KLAGES

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K. H. W. KLAGES*

Introduction

THE relationship of climate and weather to agricultural production has been discussed by many writers. These relationships are so numerous that they cannot be treated in this brief publication. Consequently, no effort will be made here to correlate crop response with climatic manifestations. Such a task will be left to future investigations. The object of this publication is to state the climatic conditions as they were recorded on the University Farm at Moscow, Idaho for the past 50 years. The main purpose of this summary of the data collected over this period of years is to arrive at a reliable description of the climate of this area. While the analysis of the data recorded at Moscow gives a description of only the conditions as they exist at this station, it may be recognized that the salient features of the climate recorded on the University Farm have much in common with general features of the climate of the Palouse area.

Since both the terms "climate" and "weather" are used here, it is well to distinguish between them; they are not interchangeable. The term "weather" refers to the conditions of the atmosphere with respect to its temperature, moisture content, pressure, light conditions, its movements, etc., at any given moment. The term "climate", on the other hand, connotes the average of the weather conditions as experienced in any designated location with the passing of the seasons. It may be stated, then, that the characteristics of a climate are designated by the averages of the factors determining the weather. After these averages, or normals as they often are referred to, have once been established by means of records extending over a period of 10 or more years, they remain fairly constant. The weather changes—the climate remains.

In order to limit the length of this publication, the data will be presented largely in the form of averages. This presentation of averages will then be of help in determining the deviation of any experienced climatic phenomenon from the normal of this area.

Historical

Precipitation data are available for a 51-year period, 1892-1942. Temperature data were not recorded until 2 years later. They are available for a 49-year period, 1894-1942.

The climatological data were collected by Professor J. E. Bonebright, from 1892-1906; by G. A. Crosthwait, from May 1906 to April 1907; by Ralph French, from May 1907 to December 1907;

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*Agronomist, Agricultural Experiment Station.

by G. H. Maughn, to December 1908; by C. G. Horner to July 1909; by C. W. Colver to May 1910; by Walt Lawes to June 1920; by F. L. Burkhart to June 1934; by E. R. Devine to May 1936; and by August Fredrickson, up to date. The climatological data from 1892 to 1937 were summarized by D. E. Corless (2)*, in 1938.

The instruments for the recording of the climatological data were located on the campus of the University of Idaho during the entire period considered here. However, due to building activities on the campus, it was necessary to shift the location of the weather station on several occasions. Since temperatures are readily influenced by changes in elevations and topography, the areas selected for the station were kept at near the same level. Standard instruments and shelters provided by the United States Weather Bureau were used in obtaining the recorded data.

Since the Palouse section is primarily a winter wheat producing area, the climatological data are largely presented on the basis of crop years, that is, from the first of September to the last of August. The use of crop years rather than calendar years provides greater opportunities for correlating observed climatological data with crop responses. Winter wheat begins its cycle of development in the fall and completes its growth during the middle of the following summer.

Precipitation

Definition of Precipitation. The term precipitation includes all measurable forms of moisture. Moisture received in the form of snow or hail is recorded in terms of inches of water contained in such materials.

Total and Monthly Distribution. Table 1 gives the average monthly precipitation and the frequency distribution in ½-inch intervals by months for the 50 crop years, from 1892-93 to 1941-42. A word is in order regarding the frequency distribution in Table 1. It means that in 2 of the 50 years for the month of September, for example, from 4.00-4.49 inches of precipitation were recorded, 18 of the 50 Septembers received from 0.50 to 0.99 inches of precipitation, etc. The particular class in which the average for and designated month happens to fall is indicated. The record precipitation for any one month occurred in January of 1913, when 8.43 inches were received. The second highest was in December 1933 with 8.03 inches. The average annual precipitation for the 50 crop years was 21.75 inches.

Seasonal Distribution. The months of November to February, inclusive, received 48.82 per cent of the total annual precipitation. The growing season months, May to September, inclusive, received only 26.21 per cent, while the months from October to April, inclusive, received 73.79 per cent of the total annual precipitation. The average or normal accumulations of precipitation, with the

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*Reference by number is to "Literature Cited," page 19.

Table 1.—Frequency distribution given in one-half inch class intervals by months for the 50 crop years from 1892-93 to 1941-42. The underlined figures indicate the class in which the averages for the respective months fall.

Frequency classes in inches	Months and frequency distribution of precipitation												Totals for 50 yrs.
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	
8.00-8.49				1	1								2
7.50-7.99													0
7.00-7.49			1										1
6.50-6.99			1										1
6.00-6.49			1	1	1								3
5.50-5.99			2	2	1								5
5.00-5.49			1		2		1						4
4.50-4.99		1	2	1		1	2						7
4.00-4.49	2		3	1	3	1	1		3	1			15
3.50-3.99		2	4	5	7	4	1	2	1		1		27
3.00-3.49	1	3	6	6	3	7	4	1	4	3			38
2.50-2.99	3	1	7	11	9	7	8	6	4	6			62
2.00-2.49	4	8	5	5	9	6	9	4	10	4	1	4	69
1.50-1.99	5	12	7	6	4	9	10	9	5	5	1	1	74
1.00-1.49	8	13	3	11	8	8	10	15	8	12	7	6	109
0.50-0.99	18	6	4		2	3	3	8	10	11	11	9	85
0 -0.49	9	4	3			4	1	5	5	8	29	30	98
Average	1.27	1.69	2.88	2.76	2.84	2.14	2.19	1.55	1.80	1.45	0.58	0.60	21.75
Per cent of Annual	5.84	7.77	13.24	12.69	13.06	9.84	10.07	7.12	8.27	6.67	2.67	2.76	100.0
S. D.	0.96	0.92	1.70	1.47	1.50	1.11	1.08	0.89	1.12	0.99	0.65	0.61	
C. V.	77.1	57.4	59.1	53.1	52.8	52.0	49.2	57.2	62.2	68.3	111.9	102.4	
Av. accumulations for the crop yr.	1.27	2.96	5.84	8.60	11.44	13.58	15.77	17.32	19.12	20.57	21.15	21.75	21.75

advance of the crop year, are presented at the bottom of Table 1. Under normal conditions the total receipts of precipitation up to the end of March should amount to 15.77 inches. Variations for any given crop year can well be stated in the form of deviations from these normal accumulations. Figure 1 gives the normal accumulation of precipitation and the normal mean temperature throughout the crop year.

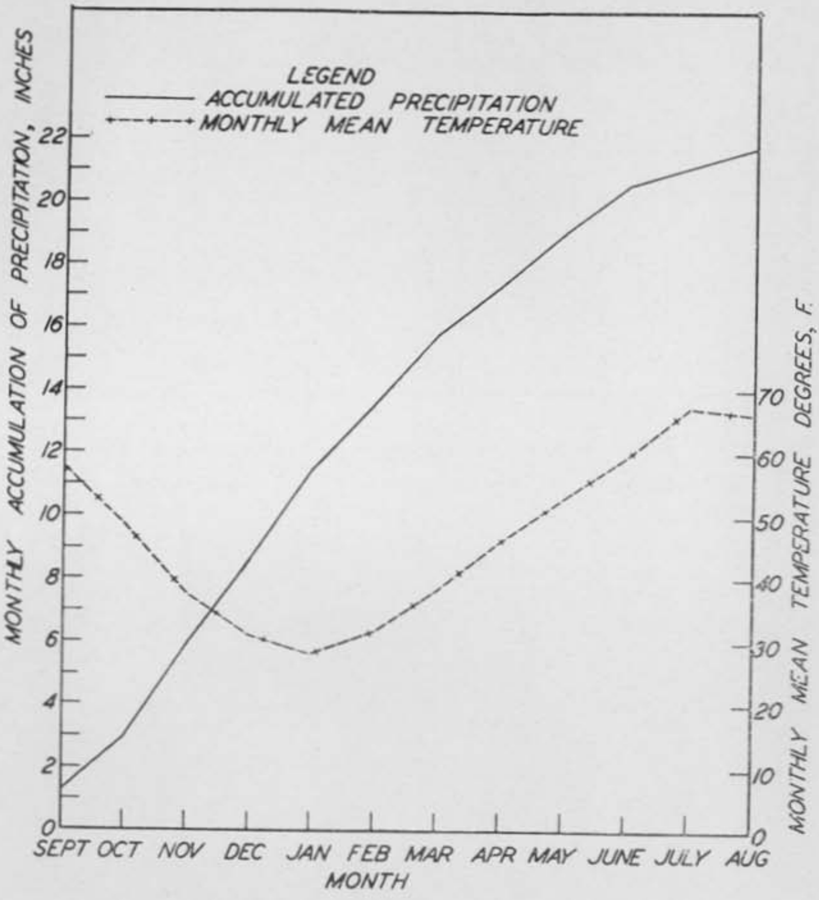

Figure 1.—Monthly normal accumulated precipitation for 50 crop years from 1892-93 to 1941-42, and monthly normal mean temperatures for 48 crop years from 1894-95 to 1941-42.

The fact that the major portion of the moisture received during the crop year comes during the winter months has a decided effect on the type of cropping prevailing in the Palouse area. It accounts for the greater returns obtained from fall than from spring sown cereals. For the same reason, the extensive production of such crops as potatoes and corn, requiring relatively abundant supplies of moisture during the middle of the summer, is precluded. The expected summer droughts do not interfere with the production of winter cereals. These crops and early maturing spring sown crops complete their cycles of development prior to the recurring droughts. In relationship to crop response, Klages (*4*) defined the term drought as "moisture deficiencies deviating sufficiently from the phenological mean to interfere with the normal life processes of plants to the extent that the balance of nutrition is shifted far enough in an unfavorable direction to result in material reductions in crop yields." In the light of this definition, the common lack of moisture during the middle of the summer in the Palouse area must be regarded in a different fashion than is ordinarily the case in the application of the term "drought." The normal recurrence of dry periods during the middle of the summer shapes the cropping systems of the area and influences the selection of crops. However, such expected and common dry periods do not have the disastrous effects on crop plants as in cases where normal expectancies of moisture fail to make their appearances. The latter condition represents a true drought.

Table 2.—Variations in monthly and annual precipitation in inches for the 5 decades of crop years, from 1892-93 to 1941-42. University Farm, Moscow, Idaho.

Decades	Months												Annual
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	
1892-1902	1.43	1.71	3.25	2.60	2.69	2.48	2.04	1.58	2.48	1.26	0.76	0.72	23.00
1902-1912	1.12	1.54	3.28	2.43	2.55	1.97	1.93	1.19	2.17	1.45	0.79	0.92	21.34
1912-1922	1.28	1.61	2.71	2.37	3.32	1.98	2.49	1.90	1.78	1.22	0.47	0.60	21.73
1922-1932	1.19	1.54	2.83	2.92	2.89	2.15	2.36	1.31	1.31	1.55	0.41	0.50	20.96
1932-1942	1.35	2.06	2.34	3.50	2.77	2.13	2.13	1.77	1.28	1.78	0.48	0.27	21.86
50-Yr. Av.	1.27	1.69	2.88	2.76	2.84	2.14	2.19	1.55	1.80	1.45	0.58	0.60	21.75

Trends in Precipitation. Table 2 gives the precipitation by months and for the five decades for the 50 crop years from 1892-93 to 1941-42. Figure 2 gives a graphical presentation of the data for the entire period. It will be observed, both from the tabulated and graphic data, that a slight negative trend is in evidence for the total annual receipts of precipitation. However, this negative trend is largely accounted for by the relatively high moisture receipts of 23.0 inches during the first 10-year period. The average for the next 40 years was 21.47 inches. The average for the whole 50-year period is 21.75 inches. On the basis of straight line trends, calculated by the method of least squares, the equation for the trend line (regression line) for the entire period was $y = 22.49 - 0.029x$. When this line was calculated for the last 40 years of the period, the equation of the regression line becomes $y = 21.60 - 0.007x$. Both of these regression lines are shown in Figure 2. The small average reductions in precipitation of 0.029 inches per year for the 50-year period and 0.007 inches per year for the 40-year period are not large enough to be significant. While seasonal fluctuations in moisture receipts are much in evidence, a general trend extending over a period of years is not indicated by the data available.

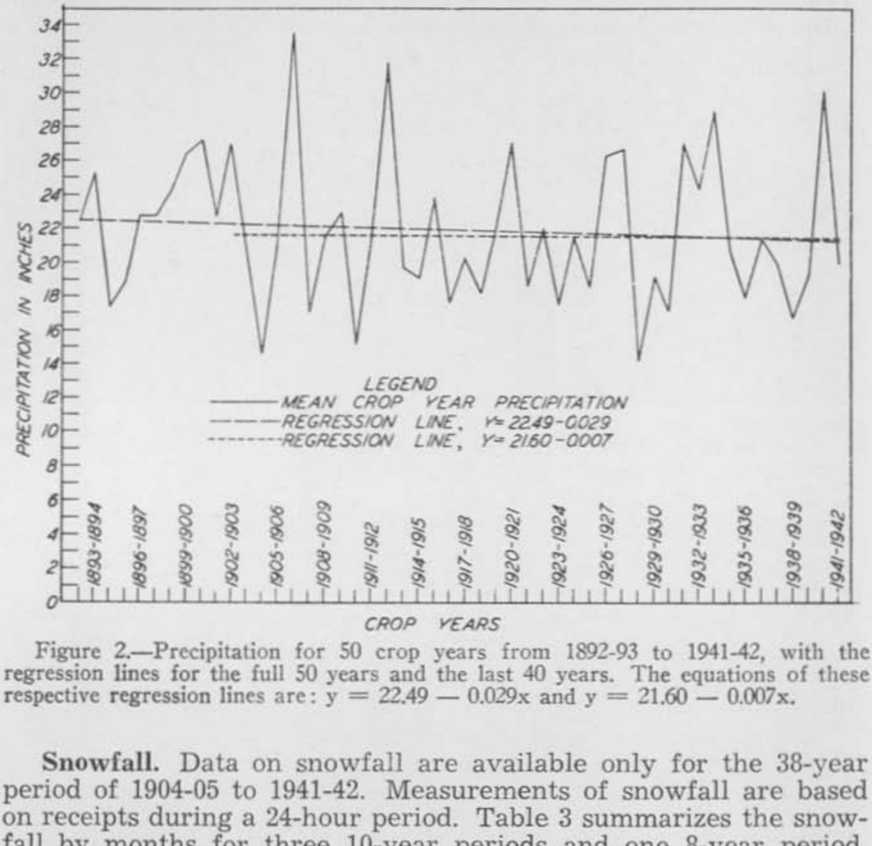

Figure 2.—Precipitation for 50 crop years from 1892-93 to 1941-42, with the regression lines for the full 50 years and the last 40 years. The equations of these respective regression lines are: $y = 22.49 - 0.029x$ and $y = 21.60 - 0.007x$.

Snowfall. Data on snowfall are available only for the 38-year period of 1904-05 to 1941-42. Measurements of snowfall are based on receipts during a 24-hour period. Table 3 summarizes the snowfall by months for three 10-year periods and one 8-year period.

Table 3.—Average snowfall in inches by months for 10-year periods, from 1904-05 to 1941-42. The first period is for 8 years, from 1904-05 to 1911-12.

Periods	Months									Annual average
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	
1904-05 to 1911-12	0.0	1.0	5.2	13.3	12.0	11.1	2.7	0.4	0.3	46.0
1912-13 to 1921-22	0.1	0.9	7.5	11.0	20.1	14.8	8.6	1.1	0.0	64.0
1922-23 to 1931-32	0.0	0.0	6.3	15.0	17.2	7.3	5.2	1.5	0.0	52.6
1932-33 to 1941-42	0.0	0.3	3.2	10.5	16.3	14.3	6.3	0.9	0.0	51.2
38-year average	Tr.	0.5	5.6	12.4	16.6	11.9	5.9	1.0	0.1	54.0

Years of snowfall of more than 100 inches were 1912-13, 1931-32, and 1932-33. Less than 20 inches were recorded in 1904-05, 1925-26, and 1938-39. The highest snowfall recorded for any season was 109.2 inches in 1932-33. The highest snowfall recorded for any one month was January of 1913, when 66 inches fell. It is evident from Table 3 that the greatest snowfall may be expected in January, with December and February close seconds.

Rainfall Intensity. The term "rainfall intensity" refers to the receipts of precipitation during any given time interval, as during a 1-hour or a 24-hour period. Data and charts published by Kincer (*3*) and Yarnell (*6*) show that the Pacific Northwest has the lowest rainfall intensity of any portion of the United States. The fact that the rainfall intensity of the Palouse area is extremely low is brought out in Table 4. The data are represented in the form of frequency distributions for 24-hour periods. By way of explanation, it may be stated that during the 50 crop years, 1892-93 to 1941-42, a trace of rainfall was recorded 78 times in the month of September, and from 0.01-0.09, 105 times, etc. In all, a trace or more of rainfall for any 24-hour period was recorded 369 times in September. For the total period, a trace or more of rainfall was recorded on 6,345 days. This represents 34.76 per cent of the days of the 50-year period. Since only totals were recorded for the last 4 months of 1892, it was necessary to estimate the distribution during these 4 months.

The last two columns of Table 4 are interesting. A trace of precipitation fell on 18.00 per cent of the rainy days; that is, days with a trace or more of precipitation. From 0.01-0.09 was recorded on 31.96 per cent of the rainy days, etc. The last column gives the subtotals of the previous percentages of the respective classes of precipitation. Thus, it will be observed that from a trace to 0.49 inches of precipitation was recorded on 92.23 per cent of the rainy days.

The extremely low intensity of rainfall for this area is of special significance to the agricultural utilization of the region. The very fact that 92.23 per cent of the rains during any 24-hour period amounts to less than ½ inch accounts for the possibility of utilizing land with the slope and type of typography common to this area for crop production without greater soil losses than have been experienced. If this area had as high a rainfall intensity as, for instance, the southern Great Plains region, it would be utterly impossible to utilize the hills of the Palouse area for crop production without incurring ruinous soil erosion losses. This does not mean that soil erosion is not a factor in the utilization of land in the Palouse area. Table 4 shows that high intensities occur at rare intervals. Thus, 2.40 inches per day were recorded three different times, on November 8, 1896; March 24, 1897; and on January 13, 1913. The next highest amount for any 24-hour period, 2.12 inches, was recorded on December 20, 1906.

Table 4.—Rainfall intensity on the University Farm for 50 crop years, 1892-93 to 1941-42, expressed on the basis of frequency distributions by months for 24-hour periods.

Precipitation classes in inches	Months												Total	% of rainy days with indicated amounts of precipitation	Sub-totals of percentages of precipitation
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.			
Trace	78	81	94	106	122	80	131	114	91	89	67	89	1142	18.00	18.00
.01-0.09	105	155	153	223	246	222	231	193	215	138	75	72	2028	31.96	49.96
0.1-0.19	74	95	123	155	160	168	136	96	96	80	29	34	1246	19.64	69.60
0.2-0.29	45	53	94	99	94	65	70	66	50	50	13	29	728	11.47	81.07
0.3-0.39	21	35	49	59	65	42	34	30	45	31	11	7	429	6.76	87.83
0.4-0.49	11	33	36	48	21	23	32	24	17	18	7	9	279	4.40	92.23
0.5-0.59	16	18	23	21	19	15	12	14	17	8	7	3	173	2.73	94.96
0.6-0.69	5	11	23	13	14	7	9	6	5	2	2		97	1.53	96.49
0.7-0.79	4	3	13	11	2	8	11	2	3	5			62	1.00	97.49
0.8-0.89	5	4	4	2	8	2	5	3	5	5		3	46	0.72	98.21
0.9-0.99	1	1	8		5	1		1	7	4	1	1	30	0.48	98.69
1.0-1.09			6	4	7	1	1	2	4	2		2	29	0.46	99.15
1.1-1.19	1		2	1	3	2			1			1	11	0.17	99.32
1.2-1.29	1		3	1	3	1		1			1		11	0.17	99.49
1.3-1.39		1		1		1	1				1	1	6	0.09	99.58
1.4-1.49	1		2	2		1	2	1					9	0.14	99.72
1.5-1.59	1			2									3	0.05	99.77
1.6-1.69					2				1	1			4	0.06	98.83
1.7-1.79		1	1		2		1			1			6	0.09	99.92
1.8-1.89											1		1	0.01	99.93
1.9-1.99		1											1	0.01	99.94
2.0-2.09													0	0.00	99.94
2.1-2.19				1									1	0.01	99.95
2.2-2.29													0	0.00	99.95
2.3-2.39													0	0.00	99.95
2.4-2.49			1		1		1						3	0.05	100.00
Total	369	492	635	749	774	639	677	553	557	434	215	251	6345		
Per cent total by months	5.81	7.75	10.01	11.80	12.20	10.07	10.67	8.72	8.78	6.84	3.39	3.96	100.00		

It is evident from Table 4 that the different months show variations with regard to their respective rainfall intensities. Thus, in November, the frequencies of the first six classifications from trace to 0.49 inches, expressed on a percentage basis, amount to 14.80, 24.09, 19.37, 14.80, 7.72, and 3.62, or 86.45 per cent of the days received less than ½ inch of precipitation. For the month of August, these same figures amount to 35.46, 28.67, 13.55, 11.55, 2.79, and 3.58 per cent, respectively, for each of the first six classes listed in Table 4, or 95.60 of the rainy days of August received less than ½ inch of precipitation.

The relationship of rainfall intensity to probable soil erosion losses is close. One factor of importance, however, is not brought out in the tabulation presented in Table 4; namely, the rate of runoff incurred by melting snow. Such runoff may result in large soil losses on sloping land, especially if the soil is frozen with the surface layer thawed out.

Distribution of Clear and Cloudy Days. Table 5 gives average number of days with recorded rainfall, clear days, partly cloudy, and cloudy days for the 38-year period of 1904-1941. During this period, 30.7 per cent of the days were rainy, 0.01 or more inches of precipitation were recorded; 38.0 per cent of the days were clear; 21.0 per cent partly cloudy; and 40.5 per cent of the days were cloudy. The variations during the season, and for the separate months, are interesting and evident from the tabulated data. The prevailing wind direction is from the west with the exception of the three winter months from December through February, when it is from the east.

Table 5.—Average number of days with recorded rainfall, clear days, partly cloudy days, cloudy days and the prevailing wind direction by months, for the 38-year period of 1904-41, inclusive.

Months	Av. no. of days with 0.01 inches or more of precipitation	Av. no. of clear days	Av. no. of partly cloudy days	Av. no. of cloudy days	Prevailing wind direction
January	14.3	6.2	6.7	18.1	East
February	12.5	6.6	6.0	15.3	East
March	12.4	8.3	6.8	16.0	West
April	9.4	10.6	8.1	11.4	West
May	9.5	11.6	8.5	10.9	West
June	7.5	13.7	7.4	8.8	West
July	3.1	21.6	5.7	3.8	West
August	3.3	20.2	5.6	5.1	West
September	6.2	14.5	6.4	9.1	West
October	8.9	12.2	5.8	13.0	West
November	11.3	7.8	5.0	17.2	West
December	13.7	5.3	5.7	20.0	East
Annual	112.1	138.6	77.7	148.7	
Per cent of annual	30.7	38.0	21.0	40.5	

Temperature

Average Monthly and Annual. Temperature data are available for a 48-year period. Table 6 gives the mean or average monthly and annual temperatures for the 48 crop years from 1894-95 to 1941-42. To show variations, the data are presented by one 8-year and four 10-year periods. The averages for designated periods do not differ significantly from the average of the entire 48 years. The average annual temperature is 47.2 degrees F.

Mean daily temperatures are calculated from the average of the minimum and maximum temperatures for the particular day. The monthly mean represents the average of the mean daily temperatures of the days of the month, while mean annual temperatures represent the average of the twelve monthly means.

Figure 1 gives a graphic presentation of monthly average temperatures.

Table 6.—Mean monthly and annual temperatures in degrees F. by one 8-year and four 10-year periods for the 48 crop years from 1894-95 to 1941-42.

Periods	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Annual
1894-95 to 1901-02	55.5	48.5	37.0	31.8	29.0	33.0	37.0	46.2	52.4	58.2	65.7	64.8	46.6
1902-03 to 1911-12	58.5	49.5	38.8	31.5	29.3	31.4	37.6	46.7	52.8	58.9	66.8	66.1	47.3
1912-13 to 1921-22	57.0	46.7	37.2	28.9	26.7	30.1	37.5	43.9	50.8	58.9	66.7	66.6	45.9
1922-23 to 1931-32	57.9	48.9	37.3	29.0	26.9	32.9	39.3	47.1	54.7	60.3	68.6	67.1	47.5
1932-33 to 1941-42	59.0	48.7	39.1	33.6	29.2	31.7	38.5	48.2	54.3	60.4	68.1	66.4	48.1
48-year average, 1894-95 to 1941-42	57.7	48.7	37.9	30.9	28.2	31.8	38.5	46.5	53.0	59.4	67.2	66.3	47.2

Variations in Temperatures. Tables 7, 8, and 9 give the average minimum, maximum, and mean temperatures for a 48-crop-year period in the form of frequency distributions for each of the 12 months of the year. In order to limit the tabulations, a rather wide range of class intervals, 5 degrees F., was selected. Nevertheless, the variations of the different seasons are significant.

The variations shown by the average monthly minimal, maximal, and mean temperatures for the year are interesting. These variations are shown in Tables 7, 8, and 9 by the standard deviations, (S. D.), and the coefficients of variability, (C. V.). Since the magnitudes of the various standard deviations are definitely influenced by the means of the separate months, the coefficient of variability offers the most reliable measure of variability. Figure 3 gives a graphic presentation of the magnitudes of these coefficients for the minima, maxima, and means by months. The greatest variation is shown by the minimum temperatures, the least by the maxima, while the mean temperatures occupy an intermediate position. All three, however, show the same seasonal trend; namely, they are low during the summer, increase in fall, reach a peak during the winter months, and then again decrease in the spring.

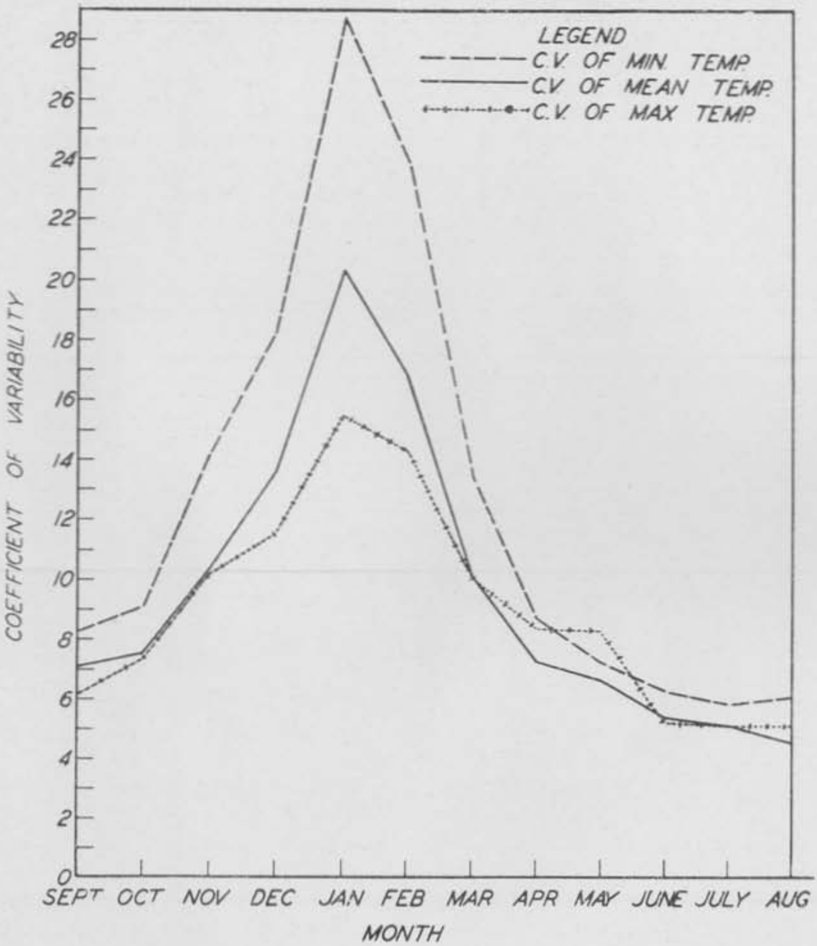

Figure 3.—Variability of mean minimum, mean, and mean maximum temperatures by months as expressed by the coefficient of variability for monthly means for the 48 crop years from 1894-95 to 1941-42.

The coefficients of variability attain their greatest magnitudes during the month of January. In other words, the average monthly minimum, maximum, and mean temperatures are far more variable during the winter than during the summer months.

Table 7.—Frequency distributions of monthly average minimum temperatures, and the monthly averages, standard deviations, and coefficients of variability for these temperatures for the period of 48 crop years from 1894-95 to 1941-42. The underlined figures indicate the class in which the averages for the respective months fall.

Class limits in degrees F.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Totals
55.0-59.9											7	3	10
50.0-54.9	3									6	$\underline{30}$	$\underline{33}$	72
45.0-49.9	18								4	$\underline{31}$	11	10	74
40.0-44.9	$\underline{25}$	16						4	$\underline{32}$	11		2	90
35.0-39.9	1	$\underline{24}$	8				5	$\underline{24}$	11				73
30.0-34.9	1	8	$\underline{22}$	6	3	9	$\underline{23}$	20	1				93
25.0-29.9			15	$\underline{21}$	12	17	17						82
20.0-24.9			2	13	$\underline{20}$	$\underline{13}$	2						50
15.0-19.9			1	8	7	6	1						23
10.0-14.9					3	2							5
5.0- 9.9					2	1							3
0.0- 4.9					1								1
Average	44.7	38.2	30.7	25.2	22.2	24.8	30.3	36.1	41.4	47.0	52.1	51.3	37.0
S. D.	3.71	3.47	4.37	4.61	6.38	5.92	4.09	3.15	3.03	2.96	3.07	3.13	
C. V.	8.30	9.08	14.23	18.29	28.74	23.87	13.50	8.73	7.32	6.30	5.89	6.10	

Table 8.—Frequency distributions of monthly average maximum temperatures and the monthly averages, standard deviations, and coefficients of variability for these temperatures for the period of 48 crop years from 1894-95 to 1941-42. The underlined figures indicate the class in which the averages for the respective months fall.

Class limits in degrees F.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
90.0-94.9											1		1
85.0-89.9											9	6	15
80.0-84.9	1									1	$\underline{28}$	$\underline{30}$	60
75.0-79.9	6								2	7	8	8	31
70.0-74.9	$\underline{23}$								5	$\underline{25}$	1	3	57
65.0-69.9	13	5						3	16	14	1	1	53
60.0-64.9	5	16						12	$\underline{17}$	1			51
55.0-59.9		$\underline{18}$					2	$\underline{16}$	7				43
50.0-54.9		9	8			1	10	15	1				44
45.0-49.9			$\underline{18}$	1		4	$\underline{21}$	2					46
40.0-44.9			16	7	3	17	12						55
35.0-39.9			6	$\underline{28}$	22	$\underline{15}$	3						74
30.0-34.9				8	$\underline{15}$	9							32
25.0-29.9				4	5	1							10
20.0-24.9					2	1							3
15.0-19.9					1								1
Average	70.8	59.3	45.1	36.6	34.2	38.7	46.6	56.8	64.6	71.7	82.3	81.3	57.2
S. D.	4.35	4.39	4.59	4.25	5.29	5.63	4.71	4.78	5.36	3.77	4.25	4.16	
C. V.	6.14	7.40	10.17	11.61	15.47	14.25	10.11	8.42	8.30	5.26	5.16	5.16	

Table 9.—Frequency distributions of monthly mean temperatures, and the monthly averages, standard deviations, and coefficients of variability for these temperatures for the period of 48 crop years from 1894-95 to 1941-42. The underlined figures indicate the class in which the averages for the respective months fall.

Class limits in degrees F.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
70.0-74.9											9	3	12
65.0-69.9	1									2	28	30	61
60.0-64.9	14									18	10	14	56
55.0-59.9	22	1							14	26	1	1	65
50.0-54.9	10	18						8	24	2			62
45.0-59.9	1	22					2	25	10				60
40.0-44.9		9	17			2	13	15					56
35.0-39.9			18	6	3	10	24						61
30.0-34.9			13	23	18	21	9						84
25.0-29.9				14	16	9							39
20.0-24.9				5	7	5							17
15.0-19.9					2	1							3
Average	57.7	48.7	37.9	30.9	28.2	31.8	38.5	46.5	53.0	59.4	67.2	66.3	47.2
S. D.	4.11	3.68	3.93	4.21	5.74	5.39	3.91	3.42	3.55	3.23	3.48	3.05	
C. V.	7.12	7.56	10.37	13.62	20.35	16.95	10.16	7.35	6.70	5.44	5.18	4.60	

High and Low Temperatures. Table 10 gives the frequency of occurrence of maximum temperatures of 90 degrees F., or above, by months, and the number of times per year that minimum temperatures of zero or below were recorded during the 48-year period from 1894-1941, inclusive. It will be observed that days with maximum temperatures of 90 or more are quite rare. By way of explanation of the tabulated materials in Table 10, it may be stated that during 43 of the months of May, no maximum temperatures of 90 or above were recorded, in 3 of the months the temperature of 90 or more was reached only once, while in 2 of the months in the 48-year period considered, 90 degrees F. or above was recorded twice. For July, 7 months had maximum temperatures of 90 degrees F. or above 8 times, or on 8 separate days. In determining the totals for the entire period, it was necessary to summarize the product of the number of months during which the various designated frequencies were recorded by their respective frequencies.

Temperatures above 100 degrees F. are extremely rare. The highest temperature ever recorded was 105 degrees F., on July 26, 1928. The lowest temperature recorded was 30 degrees F. below zero, on January 20, 1937. Prior to that time the lowest minimum on record was 20 degrees F. below zero, on February 26, 1933.

Length of Growing Season. The length of the growing season is expressed in days representing the interval in time between the last killing frost in spring and the first killing frost in fall. Table 11 gives the length of the growing season for one 9-year and four 10-year periods. The averages for these periods show significant differences. The average occurrence of the last killing frost in spring falls on May 6, while the average of the first killing frost in autumn may be expected around October 5. Table 11 also shows the extremes in the occurrence of these dates.

Table 10.—Frequency distributions by months of number of times maximum temperatures of 90 degrees F. or more were recorded over a period of 48 years from 1894 to 1941, and number of times per year when minimum temperatures of zero or below were recorded.

Frequencies in days of maximum temperatures of 90 degrees F. or above or 0 degrees F. or below	Number of months with maximum temperatures of 90 degrees F. or above with designated frequencies					Total	Number of years with minimum temperature of 0 degrees F. or below
	May	June	July	Aug.	Sept.		
0	43	27	1	1	30	102	12
1	3	8	3	1	11	26	8
2	2	8	2	8	2	22	4
3		1	4	4	2	11	5
4		1	5	2	2	10	5
5		2	3	7	1	13	1
6		1	5	5		11	1
7			3	5		8	3
8			7	1		8	1
9			2	4		6	
10			5	3		8	3
11			6	2		8	1
12			1	3		4	1
13							
14				1		1	2
15				1		1	1
16							
17							
18							
19			1			1	
Totals, 90 degrees or above, zero or below	7	47	326	298	34	712	187
Annual average	0.1	1.0	6.8	6.2	0.7	14.8	4.9

Table 11.—Length of growing season and dates of last killing frosts in spring and first in fall, with averages for 10-year periods from 1894 to 1942. The first period is for 9 years, 1894-1902.

Period	Last frost in spring	First frost in fall	Length of growing season in days
1894-1902	May 11	October 3	145.22
1903-1912	May 3	October 14	163.50
1913-1922	May 9	October 4	147.80
1923-1932	May 8	October 4	148.40
1933-1942	April 28	October 2	157.70
49-year average	May 6	October 5	152.67
Extremes	April 6[1]	August 16[3]	
Extremes	May 30[2]	November 7[4]	

[1] Earliest date of last frost in spring, 1936.
[2] Latest date of last frost in spring, 1895, 1898, 1902, 1920, 1926.
[3] Earliest date of first frost in fall, 1935.
[4] Latest date of first frost in fall, 1903.

Table 12 gives the variations in the length of the growing season and the occurrences of the last killing frost in the spring and the first killing frost in the fall. The variation in the length of the growing or frost-free season is great; the range extends from 83 days in 1935 to 201 days in 1940. It also will be observed that the occurrence of the last frost in spring is somewhat less variable than the occurrence of the first killing frost in fall. The standard deviations for these respective dates are 14.96 and 16.45.

Table 12.—Variations in total length of growing season, occurrence of last frost in spring and first frost in fall for the 49-year period of 1894 to 1942.

Total growing season		Last frost in spring		First frost in fall	
Classes in days	Frequency	Classes in dates	Frequency	Classes in dates	Frequency
80- 89	1	Apr. 6-Apr. 12	2	Aug. 16-Aug. 22	1
90- 99	0	Apr. 13-Apr. 19	7	Aug. 23-Aug. 29	0
100-109	1	Apr. 20-Apr. 26	3	Aug. 30-Sept. 5	0
110-119	1	Apr. 27-May 3	13	Sept. 6-Sept. 12	3
120-129	3	May 4-May 10	7	Sept. 13-Sept. 19	1
130-139	4	May 11-May 17	4	Sept. 20-Sept. 26	12
140-149	9	May 18-May 24	4	Sept. 27-Oct. 3	6
150-159	13	May 25-June 1	9	Oct. 4-Oct. 10	9
160-169	5			Oct. 11-Oct. 17	5
170-179	6			Oct. 18-Oct. 24	6
180-189	3			Oct. 25-Oct. 31	1
190-199	2			Nov. 1-Nov. 7	5
200-209					
Averages	152.67	May 6		Oct. 5	
S. D.	23.21		14.96		16.45

Evaporation

Data on growing season evaporation are available for only 4 years as shown in Table 13. A standard evaporation station was established in 1939. The evaporation data presented indicate evaporation from a free water surface.

Table 13.—Growing season evaporation in inches by months.

Year	May	June	July	Aug.	Sept.	Oct.
1939	....	5.32	8.12	7.72	5.18	2.49
1940	5.13	7.56	7.14	6.93	3.74	2.24
1941	3.98	4.53	7.49	5.34	2.64	....
1942	3.09	4.79	7.71	7.07	3.55	....

Summary

THE climate of the Palouse area represents a transition between the true grassland and woodland climates. It has many of the characteristics of the grassland climate; namely, limited precipitation, but precipitation abundant enough to keep the surface layers of the soil moist during spring and early summer; moderate temperatures during the period of vegetative growth, followed by relatively high day temperatures during the middle and later portion of the summer. The climate of this area differs from the true grassland climate in that a high percentage of the moisture comes during the winter months, the humidity during the winter is relatively high, and above all the area is favored with relatively calm, moist air during the winter months. The absence of cold, drying winds so common to the true grassland is indeed a fortunate circumstance and greatly influences the crop producing potentialities of this area. The climate of the Palouse area, being transitional in nature between those of the true grassland and woodland climates, does not have the extreme moisture fluctuations so common to regions with true grassland and definitely continental types of climates. Consequently, this area is relatively free from the damage of extreme droughts and high fluctuations in crop yields. This accounts for the stability of agricultural production in this area.

While the precipitation of the Palouse area is fairly low, 21.75 inches per annum, the efficiency of moisture utilization is high. This is manifested by the high average crop yields attained in the area. Baker and Klages (*1*) report average winter wheat yields in excess of 50 bushels per acre on some of the better rotation systems on the University Farm. These high average yields of wheat and of other crops under systems of continuous cropping without the use of summer fallow over a period of 28 years attest a high efficiency in the use of moisture. The attainment of high crop yields demands not only favorable climatic conditions but also favorable soil relationships such as a high level of fertility and moisture-absorbing and moisture-holding ability. The fact that a high percentage of the moisture receipts of this area arrive during the winter and early spring months demands that a considerable amount of the water utilized by crop plants must be stored in the soil during the period of the year when temperatures are too low for the growth of crops. Koppen (*5*) ascribes a higher efficiency of precipitation to regions with winter concentrations of precipitations than to areas with uniform distributions or with summer concentrations of rainfall. The high efficiency of moisture utilization in the Palouse area supports Koppen's thesis. However, this could be the case only in areas favored with soil conditions suitable for the storage of moisture received during the winter months. The low intensity of precipitation common to this area definitely enters into the capacity of soils to absorb winter and early spring precipitations. Furthermore, the relatively low temperatures and the absence of drying winds during the major portion of the growing season contribute to the efficient use of moisture by the crop plants of the area.

In conclusion, it is well to state that a combination of favorable climatic and soil conditions provide the basis for the establishment and maintenance of a prosperous and well-balanced agriculture.

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