

2019 WEATHER REPORT

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Introduction

Air temperature and precipitation have been recorded daily at the Malheur Experiment Station since July 20, 1942. Installation of additional equipment in 1948 allowed for evaporation and wind measurements. A soil thermometer at 4-inch depth was added in 1967. Since 1962, the Malheur Experiment Station has participated in the national cooperative weather station system of the National Weather Service. The daily readings from the station are reported to the National Weather Service forecast office in Boise, Idaho. Starting in June 1997, the daily weather data and the monthly weather summaries have been posted on the Malheur Experiment Station website at: <https://agsci.oregonstate.edu/mes/malheur-experiment-station>.

On June 1, 1992, in cooperation with the U.S. Department of the Interior, Bureau of Reclamation, a fully automated weather station, linked by satellite to the Pacific Northwest Cooperative Agricultural Weather Network (AgriMet) computer in Boise, Idaho, began transmitting data from Malheur Experiment Station. The automated AgriMet station continually monitors air temperature, relative humidity, dew point temperature, precipitation, wind run, wind speed, wind direction, solar radiation, and soil temperature at 8-inch and 20-inch depths. Data are transmitted via satellite to a computer in Boise every 4 hours and are used to calculate daily Malheur County crop water-use estimates. The ground under and around the weather stations was bare until October 17, 1997, when it was covered with turf grass. The AgriMet database can be accessed at <https://www.usbr.gov/pn/agrimet/> and from links on the Malheur Experiment Station web page at <https://agsci.oregonstate.edu/mes>.

Materials and Methods

The manually observed weather data are recorded each day at 8:00 a.m. Consequently, the data in the tables of daily observations refer to the previous 24 hours.

Evaporation is measured from April through October as inches of water evaporated from a standard class A pan (10 inches deep by 4-ft diameter) over 24 hours. Crop evapotranspiration (ET_c) for each crop is calculated by AgriMet using data from the AgriMet weather station and the Kimberly-Penman equation (Wright 1982). AgriMet calculates reference evapotranspiration (ET_r) for a theoretical 12- to 20-inch-tall crop of alfalfa assuming full cover for the whole season. Crop evapotranspiration is calculated for each crop using ET_r and crop coefficients specifically developed for that crop. The crop coefficients for each crop vary throughout the growing season based on the plant growth stage (crop cover and maturity). The crop coefficients are tied to the plant growth stage by three dates: start, full cover, and termination dates. Start dates are the beginning of vegetative growth in the spring for perennial crops or the seedling emergence date for row crops. Termination dates are defined by maturity, expected harvest, frost, or dormancy. Alfalfa mean ET_c is calculated using ET_r and assuming a 15% reduction to account for cuttings.

Wind run is measured by the AgriMet weather station as total wind movement in miles over 24 hours at 9.8 ft above the ground. Weather data averages in the tables, except evapotranspiration, refer to the years preceding and up to, but not including, the current year.

2019 Weather

The total precipitation for 2019 (13.5 inches) was higher than the 10-year (10.4 inches) and 76-year averages (10.1 inches) (Table 1). Precipitation for February, April, May, and September, was at least twice as high as the average.

Total snowfall for 2019 (11.3 inches) was lower than the 76-year average (17.4 inches) (Table 2).

The highest air temperature for 2019 was 100°F on July 23 and August 5 (Table 3). The lowest air temperature for 2019 was 10°F on October 31. The month of January had average maximum and minimum air temperatures substantially higher than average. The month of October had average maximum and minimum air temperatures substantially lower than average.

The average maximum and minimum 4-inch soil temperatures in January were higher than average (Table 4). The average maximum and minimum 4-inch soil temperatures in October were lower than average.

Total monthly wind runs in 2019 were close to the 26-year average (Table 5).

Total pan evaporation in 2019 was close to the 21-year average (Table 6). Total accumulated ET_r in 2019 was lower than the 27-year average (Table 7).

The year 2019 had 3227 growing degree-days (50 to 86°F), lower than the 26-year average of 3317 (Table 8, Figure 1). October had substantially fewer growing degree-days than average. The year 2019 had a lower than average frost-free period (154 days) (Table 9). The last spring frost ($\leq 32^\circ\text{F}$) occurred on May 1, two days later than the 43-year-average date of April 29; the first fall frost occurred on October 2, five days earlier than the 43-year-average date of October 7. Since 1943, the lowest average maximum and minimum air temperatures for October occurred in 2019 (Table 10). Also since 1943, October of 2019 had the lowest minimum air temperature in October (10°F on October 31).

Acknowledgements

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References

Wright, J.L. 1982. New evapotranspiration crop coefficients. Journal of Irrigation and Drainage Division, American Society of Civil Engineers 108:57–74.

Table 1. Monthly precipitation at the Malheur Experiment Station, Oregon State University, Ontario, OR, 1990–2019.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	----- inches -----												
1990	0.44	0.35	0.72	1.52	1.70	0.36	0.04	0.61	0.00	0.49	0.69	0.29	7.2
1991	0.59	0.44	0.88	0.81	1.89	1.09	0.01	0.04	0.35	1.01	1.71	0.43	9.3
1992	0.58	1.36	0.25	0.74	0.21	1.43	0.36	0.01	0.09	0.95	1.15	1.51	8.6
1993	2.35	1.02	2.41	2.55	0.70	1.55	0.18	0.50	0.00	0.80	0.64	0.60	13.3
1994	1.20	0.57	0.05	1.02	1.62	0.07	0.19	0.00	0.15	1.23	2.46	1.49	10.1
1995	2.67	0.28	1.58	1.16	1.41	1.60	1.10	0.13	0.07	0.57	0.88	2.56	14.0
1996	0.97	0.86	1.03	1.19	2.39	0.12	0.32	0.31	0.59	0.97	1.18	2.76	12.7
1997	2.13	0.17	0.25	0.66	0.67	0.86	1.40	0.28	0.40	0.43	1.02	0.94	9.2
1998	2.26	1.45	0.95	1.43	4.55	0.36	1.06	0.00	1.00	0.04	1.07	1.11	15.3
1999	1.64	2.50	0.59	0.23	0.28	1.02	0.00	0.09	0.00	0.40	0.49	0.73	8.0
2000	2.01	2.14	0.97	0.72	0.28	0.26	0.03	0.06	0.39	1.74	0.38	0.66	9.6
2001	1.15	0.41	1.11	0.70	0.37	0.64	0.32	0.00	0.10	0.68	1.33	1.00	7.8
2002	0.77	0.27	0.49	0.77	0.09	0.60	0.14	0.10	0.36	0.29	0.44	1.86	6.2
2003	1.46	0.48	0.99	1.12	1.52	0.24	0.36	0.11	0.15	0.02	0.86	1.47	8.8
2004	1.82	1.54	0.25	0.98	1.70	0.43	0.13	0.64	0.56	2.03	0.93	0.97	12.0
2005	0.41	0.12	1.66	0.80	2.94	1.02	0.22	0.06	0.14	1.38	1.58	3.92	14.3
2006	1.91	0.67	3.33	2.00	0.62	0.45	0.00	0.08	0.55	0.28	1.14	1.76	12.8
2007	0.07	0.95	0.12	0.82	0.47	0.63	0.03	0.15	0.92	0.68	1.07	1.56	7.5
2008	0.50	0.43	0.79	0.14	0.74	0.27	0.43	0.03	1.26	0.44	1.12	1.47	7.6
2009	0.65	0.43	0.86	0.13	1.47	2.27	0.09	1.39	0.02	1.24	0.63	1.82	11.0
2010	2.13	1.19	0.59	1.21	1.18	1.95	0.02	0.86	0.19	1.16	1.09	4.19	15.8
2011	1.05	0.42	2.97	0.44	2.61	0.81	0.19	0.02	0.08	1.59	0.57	0.45	11.2
2012	1.65	0.49	1.36	1.03	0.77	0.45	0.00	0.04	0.1	0.83	1.13	1.25	9.1
2013	0.58	0.34	0.32	0.19	0.37	0.80	0.00	0.11	2.39	0.44	0.90	0.59	7.0
2014	0.69	1.58	1.22	0.92	0.45	0.24	0.02	0.28	0.62	0.52	1.46	3.04	11.0
2015	0.64	0.74	0.77	0.67	1.80	0.18	0.51	0.05	0.50	1.13	1.29	3.21	11.5
2016	0.98	0.38	0.98	0.88	0.95	0.25	0.98	0.01	0.13	0.75	0.58	2.11	9.0
2017	3.02	1.61	1.61	1.27	1.02	0.62	0.00	0.00	0.49	0.45	0.00	0.84	10.9
2018	1.41	0.26	1.12	0.62	0.56	0.47	0.00	0.00	0.01	1.23	0.51	1.13	7.3
2019	1.48	3.38	1.17	1.53	2.27	0.18	0.00	0.09	1.36	0.71	0.14	1.22	13.5
10-yr avg	1.28	0.74	1.18	0.74	1.12	0.80	0.18	0.28	0.45	0.93	0.82	1.86	10.4
76-yr avg	1.27	0.92	0.96	0.79	1.05	0.79	0.22	0.33	0.46	0.74	1.12	1.41	10.1

Table 2. Annual total snowfall (inches) at the Malheur Experiment Station, Oregon State University, Ontario, OR, 1943–2019. Average annual snowfall (1943–2018) is 17.4 inches.

			1943	1944	1945	1946	1947	1948	1949
			24.7	10.3	19.0	8.2	9.1	14.6	9.6
1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
23.9	32.4	22.3	7.5	10.4	40.3	15.6	26.4	9.8	12.1
1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
21.2	9.7	14.8	13.3	32.6	19.6	6.3	11.9	14.9	24.8
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
13.5	17.1	23.7	19.2	20.3	27.3	21.3	21.3	9.3	31.0
1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
11.5	14.5	32.7	35.4	21.0	33.4	13.0	15.5	34.8	25.1
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5.7	7.5	15.5	36.0	32.0	15.0	14.5	5.8	14.6	13.2
2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
13.8	15.5	11.5	4.5	24.0	13.5	12.3	3.8	26.0	13.8
2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
28.0	1.0	4.0	14.0	22.5	14.0	24.5	31.5	3.8	11.3

Table 3. Maximum and minimum air temperatures by month, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

Month		Highest	Lowest	2019 avg	76-yr avg
----- °F -----					
Jan	Max	50	31	41	35
	Min	36	17	25	19
Feb	Max	55	32	42	43
	Min	37	16	28	25
Mar	Max	69	40	54	55
	Min	42	23	29	31
Apr	Max	80	53	64	64
	Min	51	30	40	37
May	Max	87	57	72	74
	Min	58	31	48	45
Jun	Max	92	63	82	82
	Min	65	40	54	52
Jul	Max	100	81	91	92
	Min	69	52	60	58
Aug	Max	100	76	91	90
	Min	68	48	60	56
Sep	Max	97	55	79	80
	Min	64	33	51	46
Oct	Max	71	40	58	65
	Min	42	10	29	37
Nov	Max	34	34	51	48
	Min	18	18	25	28
Dec	Max	50	31	40	37
	Min	35	17	28	22

Table 4. Monthly maximum and minimum soil temperatures at 4-inch depth, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
----- °F -----												
2019 avg	35	34	36	35	42	40	52	50	60	57	69	65
Highest	38	36	39	37	48	46	57	54	67	63	74	69
Lowest	32	31	33	32	37	36	48	46	53	49	63	59
21-yr avg	33	32	36	35	43	41	50	46	60	55	68	62
52-yr avg	33	32	37	34	48	41	58	47	69	57	77	65

Table 5. Daily and monthly wind run, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily	----- miles/day -----											
Mean	85	153	109	150	128	142	123	106	113	109	92	59
Max	355	375	291	380	298	274	231	237	280	338	326	142
Min	36	36	51	45	54	61	71	54	47	39	40	8
Monthly total	----- miles/month -----											
2019	2631	4275	3370	4502	3959	4271	3805	3291	3401	3392	2752	1824
26-yr avg	2802	3282	4180	4624	4179	3697	3378	3283	3174	3265	2997	3234

Table 6. Daily and monthly pan evaporation, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019.

	April	May	Jun	Jul	Aug	Sep	Oct	Total
Daily	----- inches/day -----							
Mean	0.18	0.26	0.37	0.38	0.33	0.21	0.12	
Max.	0.37	0.48	0.59	0.50	0.47	0.36	0.29	
Min.	0.03	0.03	0.18	0.18	0.11	0.05	0.03	
Monthly	----- inches/month -----							
2019	5.46	8.05	11.11	11.88	10.34	6.40	3.42	56.7
21-yr avg	6.37	8.64	10.16	12.39	10.49	7.03	4.10	59.2

Table 7. Total accumulated reference evapotranspiration (ET_r) and estimated crop evapotranspiration (ET_c) (acre-inches/acre) for various crops over the past 28 years, Malheur Experiment Station, Oregon State University, Ontario, OR, 1992–2019.

Year	ET _r	Alfalfa (Mean)	Winter grain	Spring grain	Sugar beet	Onion	Potato	Dry bean	Field corn	Poplar		
										Yr. 1	Yr. 2	Yr. 3 +
1992	53.7	44.4	26.9	27.9	36.1	30.3	28.8	21.3	29.8			
1993	51.9	36.4	21.3	22.7	29.3	24.1	22.8	17.9	23.7			
1994	57.6	40.6	21.3	22.6	34.5	29.5	28.2	21.1	27.7			
1995	49.6	37.1	18.9	22.2	29.0	26.7	23.6	16.7	23.7			
1996	52.8	39.8	22.3	24.1	32.9	27.2	26.3	19.5	25.7			
1997	55.2	41.5	23.8	25.3	33.4	28.0	26.6	19.7	25.1			
1998	55.0	40.7	21.3	23.9	32.4	28.2	26.2	21.0	27.9	23.9	37.1	44.0
1999	58.6	43.9	25.0	26.4	33.7	28.9	26.5	21.7	28.5	24.3	37.8	45.5
2000	58.7	45.5	26.0	25.7	38.3	32.0	29.5	24.1	30.6	24.9	38.9	47.1
2001	57.9	43.8	25.5	27.2	34.8	30.3	27.4	21.4	29.1	23.7	37.0	44.7
2002	58.8	41.7	25.9	28.7	35.2	30.4	27.7	21.9	27.8	23.6	36.7	44.4
2003	54.2	44.1	27.5	31.7	39.1	31.6	31.9	22.4	29.3	24.3	37.9	45.9
2004	52.8	43.5	27.8	30.6	34.3	30.2	27.9	22.1	28.4	23.3	36.3	44.1
2005	53.8	44.5	26.5	27.0	36.0	32.8	30.2	20.0	29.2	24.3	37.8	45.3
2006	57.7	47.9	24.4	31.4	38.5	33.8	29.4	23.9	29.6	26.3	41.0	49.3
2007	59.0	47.2	27.6	26.7	38.9	33.7	29.7	24.5	31.9	25.7	40.1	48.6
2008	58.0	46.4	28.1	30.4	36.4	32.7	30.0	24.0	30.4	23.3	36.5	44.5
2009	58.1	42.5	26.3	28.4	34.7	28.4	27.6	20.3	26.7	22.6	35.2	42.7
2010	51.5	41.9	21.0	26.8	33.4	28.9	27.7	21.1	26.7	22.2	34.5	41.4
2011	51.0	41.9	23.3	25.8	34.4	29.2	27.5	22.8	28.0	23.6	36.8	44.5
2012	57.3	45.3	23.6	27.6	36.4	31.5	31.6	24.0	31.2	25.3	39.4	47.4
2013	59.3	47.8	28.9	30.9	39.2	34.9	32.5	25.9	33.4	25.8	40.2	48.7
2014	59.2	49.0	29.7	32.6	37.5	35.0	34.5	26.6	35.1	26.1	40.8	49.6
2015	61.6	50.3	27.1	29.8	36.2	33.8	32.9	24.7	34.0	25.4	39.5	47.6
2016	60.0	49.7	28.0	31.3	37.0	34.0	31.5	23.4	34.6	26.3	41.1	49.9
2017	53.8	51.7	25.6	27.9	36.2	30.6	29.5	23.9	31.2	23.8	37.1	44.8
2018	59.6	48.9	27.4	29.3	38.8	36.3	31.5	24.8	32.7	25.3	39.5	47.5
2019	53.8	42.8	27.5	34.0	34.8	29.8	28.8	23.1	29.0	22.3	34.9	42.4
Avg												
inch	56.2	44.4	25.2	27.6	35.4	30.8	28.9	22.2	29.3	24.5	38.1	46.1
mm	1427	1127	641	701	900	783	733	565	745	622	969	1170

Table 8. Monthly total growing degree-days (50–86°F), Malheur Experiment Station, Oregon State University, Ontario, OR, 1992–2019.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1992					480	538	647	697	456	273	12	0	
1993	0	0	58	139	451	371	473	556	459	239	17	4	2768
1994	0	5	172	242	398	507	712	695	523	195	7	0	3456
1995	2	60	77	155	330	443	646	566	469	170	16	12	2945
1996	0	19	103	188	286	490	662	614	377	216	37	11	3004
1997	3	10	122	167	447	508	632	665	489	215	35	0	3293
1998	0	4	95	175	268	436	737	690	529	220	40	5	3198
1999	0	9	81	175	320	467	629	651	458	268	69	1	3127
2000	1	13	79	277	380	541	702	684	421	202	8	0	3309
2001	0	0	122	176	433	502	680	712	507	231	62	0	3424
2002	0	4	76	202	375	564	749	620	457	230	37	11	3325
2003	1	11	134	164	370	580	782	714	479	338	27	8	3610
2004	0	0	189	264	322	535	727	657	410	238	7	1	3349
2005	0	19	126	193	342	446	692	685	435	215	6	0	3158
2006	0	18	48	204	406	597	791	647	446	219	60	4	3441
2007	0	20	183	220	441	543	796	644	442	184	50	6	3528
2008	0	2	39	144	389	512	713	665	452	228	36	6	3186
2009	1	7	66	209	415	509	702	644	523	130	34	0	3239
2010	1	5	92	159	248	467	671	605	470	271	50	0	3037
2011	0	11	46	106	272	423	676	699	531	221	11	4	2999
2012	1	8	129	253	353	484	751	694	512	222	56	12	3475
2013	0	8	130	226	407	549	745	717	491	201	18	7	3498
2014	0	22	116	227	424	544	779	685	503	293	36	17	3647
2015	7	71	190	241	427	674	716	700	461	347	33	9	3876
2016	0	42	129	305	405	576	680	683	443	227	78	0	3570
2017	0	0	114	169	380	533	766	706	461	189	19	0	3337
2018	1	28	101	225	471	516	733	683	443	210	36	0	3446
2019	0	4	95	213	372	530	698	691	435	135	53	1	3227
Avg 1993-2018	1	15	108	200	375	512	705	665	469	228	34	4	3317

Table 9. Last and first frost (32°F) dates and number of frost-free days, Malheur Experiment Station, Oregon State University, Ontario, OR, 1990–2019.

Year	Date of last frost		Total frost-free days
	Spring	Fall	
1990	8-May	7-Oct	152
1991	30-Apr	4-Oct	157
1992	24-Apr	14-Sep	143
1993	20-Apr	11-Oct	174
1994	15-Apr	6-Oct	174
1995	16-Apr	22-Sep	159
1996	6-May	23-Sep	140
1997	3-May	8-Oct	158
1998	18-Apr	17-Oct	182
1999	11-May	28-Sep	140
2000	12-May	24-Sep	135
2001	29-Apr	10-Oct	164
2002	8-May	12-Oct	157
2003	19-May	11-Oct	145
2004	16-Apr	24-Oct	191
2005	15-Apr	6-Oct	174
2006	19-Apr	22-Oct	186
2007	4-May	11-Oct	160
2008	2-May	13-Oct	164
2009	13-May	1-Oct	141
2010	7-May	12-Oct	158
2011	4-May	25-Oct	174
2012	29-Apr	4-Oct	158
2013	23-May	5-Oct	135
2014	29-Apr	22-Oct	176
2015	15-Apr	27-Oct	195
2016	28-Mar	12-Oct	198
2017	13-May	10-Oct	150
2018	19-Apr	14-Oct	178
2019	1-May	2-Oct	154
avg 1976-2018	29-Apr	7-Oct	162

Table 10. Record weather events at the Malheur Experiment Station, Oregon State University, Ontario, OR.

Record event	Measurement	Date
----- Since 1943 -----		
Highest annual precipitation	16.87 inches	1983
Lowest annual precipitation	5.16 inches	1949
Highest monthly precipitation	4.55 inches	May 1998
Highest June precipitation	2.27 inches	June 2009
Highest December precipitation	4.19 inches	December 2010
Highest 24-hour precipitation	1.52 inches	September 14, 1959
Highest annual snowfall	40 inches	1955
Greatest snow depth	28 inches	January 17, 2017
Highest 24-hour snowfall	10 inches	November 30, 1975
Earliest snowfall	1 inch	October 25, 1970
Highest air temperature	110°F	July 22, 2003
Total days with maximum air temp. $\geq 100^\circ\text{F}$	18 days	2013
Lowest air temperature	-26°F	Jan 21 and 22, 1962
Total days with minimum air temp. $\leq 0^\circ\text{F}$	35 days	1985
Lowest average maximum air temperature for October	58°F	2019
Lowest average minimum air temperature for October	29°F	2019
Lowest minimum air temperature in October	10°F	October 31, 2019
Longest frost-free period	198 days	2016
----- Since 1967 -----		
Lowest soil temperature at 4-inch depth	12°F	Dec 24, 25, and 26, 1990
----- Since 1993 -----		
Most yearly growing degree-days	3876	2015
Fewest yearly growing degree-days	2768	1993
Fewest growing degree-days in March	39	2008
Fewest growing degree-days in April	106	2011
Most growing degree-days in April	305	2016
----- Since 1992 -----		
Highest reference evapotranspiration	61.6 inches	2015

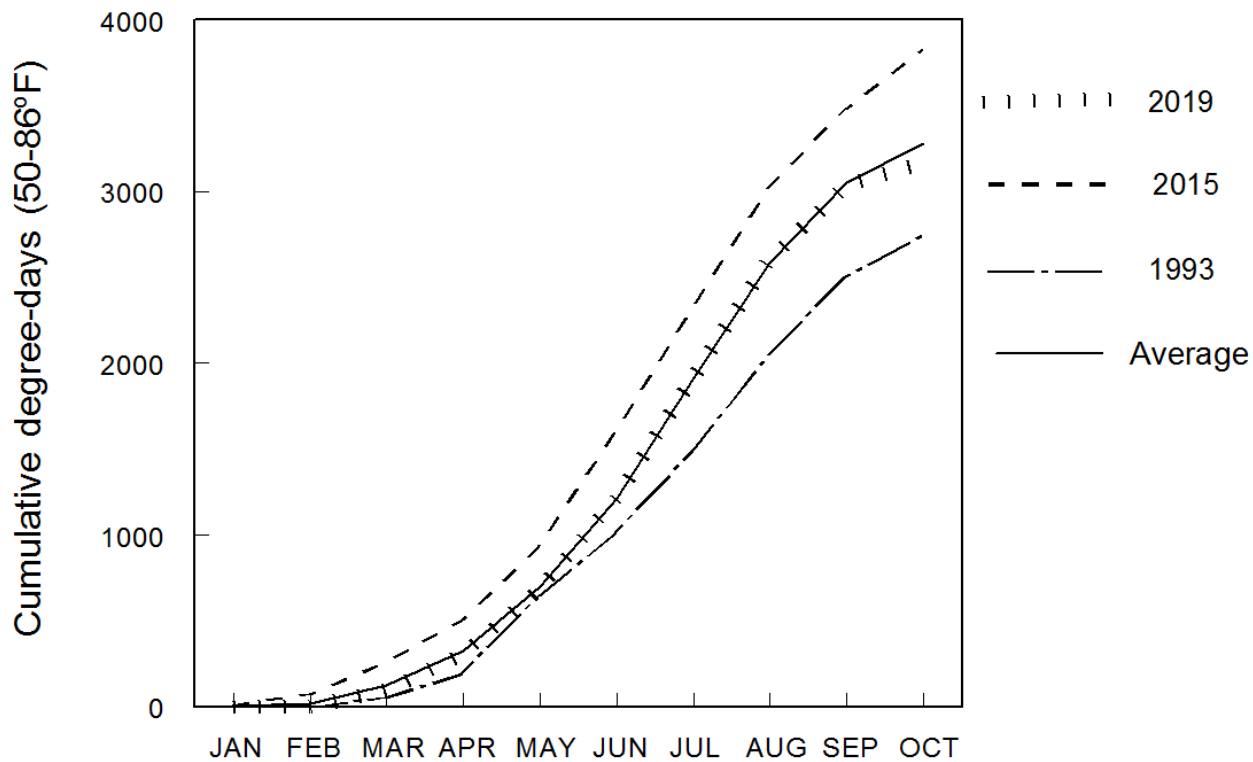


Figure 1. Cumulative growing degree-days (50–86°F) over time for 2019 compared to the years with lowest (1993) and highest (2015) totals since 1993 and to the 26-year average (1993–2018), Malheur Experiment Station, Oregon State University, Ontario, OR. Lines for 2019 and the average overlap.