2015 WEATHER REPORT

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Summary

While rainfall during 2015 was near normal, both growing degree-days and reference evapotranspiration set new record highs. The heat in the Treasure Valley also occurred high in the watershed, limiting water runoff for irrigation. Water shortages made it infeasible to fully utilize the long favorable growing season.

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.

A biophenometer to monitor degree-days and pyranometers to monitor total solar and photosynthetically active radiation were added in 1985. Starting in June 1997, the daily weather data and the monthly weather summaries have been posted on the Malheur Experiment Station web site at www.cropinfo.net.

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 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 AgriMet database can be accessed at www.usbr.gov/pn/agrimet and from links on the Malheur Experiment Station web page at www.cropinfo.net.

Materials and Methods

The ground under and around the weather stations was bare until October 17, 1997, when it was covered with turfgrass. The grass is irrigated by subsurface drip irrigation. 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. Evapotranspiration (ET_c) for each crop is calculated by the AgriMet computer using data from the AgriMet weather station

and the Kimberly-Penman equation (Wright 1982). Agrimet calculates reference evapotranspiration (ET_0) for a theoretical 12- to 20-inch-tall crop of alfalfa assuming full cover for the whole season. Evapotranspiration for all crops is calculated using ET_0 and crop coefficients for each crop. These crop coefficients vary throughout the growing season based on the plant growth stage (crop cover). 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 emergence date for row crops. Full cover dates are typically when plants reach full foliage. Termination dates are defined by harvest, frost, or dormancy. Alfalfa mean ET_c is calculated for an alfalfa crop using ET_0 and assuming a 15% reduction to account for cuttings.

Wind run is measured as total wind movement in miles over 24 hours at 24 inches above the ground. The wind run data for 2015 in this report were collected by the AgriMet weather station and were measured 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.

2015 Weather

The total precipitation for 2015 (11.49 inches) was close to the 10-year (11.0 inches) and 71-year (10.1 inches) averages (Table 1). Total snowfall for 2015 (14 inches) was close to the 10-year average (13.9 inches), and lower than the 70-year average (17.7 inches) (Table 2). The highest air temperature for 2015 was 106°F on June 29. The lowest temperature for the year was 2°F on January 1 and December 26 (Table 3). The average monthly maximum and minimum 4-inch soil temperatures for all months were higher than the 10-year average, except for July, August, and September (Table 4).

Total wind runs for the months of February, April, July, August, November, and December were higher than the 22-year average (Table 5). Total pan evaporation for April, June, August, and October in 2015 was higher than the 10-year and 67-year averages (Table 6). Total accumulated reference evapotranspiration (ET_o) was the highest since records began in 1992 (Table 7).

The year 2015 had 3,876 growing degree days (50 to 86°F) the highest total since records began in 1993 (Tables 8 and 9, Fig. 1). The last spring frost (≤32°F) occurred on April 15, 15 days earlier than the 39-year-average date of April 29; the first fall frost occurred on October 27, 21 days later than the 39-year-average date of October 7 (Table 10).

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, 1990-2015.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	---------- inches ----------												
1990	0.44	0.35	0.72	1.52	1.7	0.36	0.04	0.61	0	0.49	0.69	0.29	7.21
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	9.25
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	8.64
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	13.30
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	10.05
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	14.01
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	12.69
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	9.21
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	15.28
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	7.97
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	9.64
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	7.81
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	6.18
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	8.78
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	11.98
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	14.25
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	12.79
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	7.47
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	7.62
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	11.00
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	15.76
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	11.20
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	9.10
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	7.03
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	11.04
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	11.49
10-yr avg	1.17	0.67	1.29	0.87	1.40	0.85	0.15	0.34	0.40	0.97	1.01	1.89	11.00
72-yr avg	1.28	0.93	0.95	0.79	1.06	0.82	0.22	0.35	0.44	0.74	1.15	1.38	10.12

Table 2. Annual snowfall totals (inches) at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2001-2015.

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	10-yr avg	72-yr avg
15.5	11.5	4.5	24.0	13.5	12.3	3.8	26.0	13.8	28.0	1.0	4.0	14.0	22.5	14.0	13.9	17.7

Table 3. Maximum and minimum air temperatures by month, Malheur Experiment Station, Oregon State University, Ontario, OR, 2015.

Month		Highest	Lowest	2015 avg	72-yr avg
		---------- °F ----------			
Jan	Max	51	19	36	35
	Min	31	2	25	19
Feb	Max	65	40	54	43
	Min	42	19	31	25
Mar	Max	73	47	61	55
	Min	48	19	34	31
Apr	Max	80	53	65	64
	Min	47	25	37	37
May	Max	86	61	75	74
	Min	62	37	48	45
Jun	Max	106	76	91	82
	Min	77	46	58	52
Jul	Max	104	79	92	92
	Min	72	44	59	58
Aug	Max	105	82	93	90
	Min	68	44	56	56
Sep	Max	95	65	80	80
	Min	55	38	46	46
Oct	Max	86	49	71	65
	Min	54	31	42	37
Nov	Max	68	24	48	48
	Min	41	14	28	28
Dec	Max	55	20	38	37
	Min	42	2	23	22

Table 4. Monthly soil temperature at 4-inch depth, Malheur Experiment Station, Oregon State University, Ontario, OR, 2015.

	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
	---------- °F ----------																							
2015 avg	34	34	41	40	45	43	51	48	61	57	70	66	72	69	70	67	63	61	58	56	45	44	38	36
Highest	37	37	44	44	51	47	61	53	68	64	77	75	76	74	73	71	66	65	62	60	54	53	42	42
Lowest	32	31	37	37	39	37	46	44	54	52	66	63	68	65	67	64	61	59	52	51	35	35	34	33
10-yr avg	32	31	35	34	43	40	49	46	59	54	67	62	74	68	72	68	66	62	55	52	44	42	34	33
48-yr avg	33	32	37	34	49	40	59	47	71	57	80	66	87	73	85	72	75	63	60	51	44	39	34	33

Table 5. Daily and monthly wind-run. Malheur Experiment Station, Oregon State University, Ontario, OR, 2015.

Daily	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	---------- miles/day ----------											
Mean	57	117	115	163	128	121	117	113	95	97	138	123
Max	166	268	317	365	327	222	287	207	202	358	525	370
Min	10	43	53	68	72	57	55	59	53	32	52	36
Monthly total	---------- miles/month ----------											
2015	1776	3268	3577	4892	3965	3640	3623	3493	2840	3010	4141	3809
22-yr average	2907	3193	4220	4591	4171	3669	3336	3274	3160	3320	2953	3252

Table 6. Daily and monthly pan-evaporation, Malheur Experiment Station, Oregon State University, Ontario, OR, 2015.

Totals	April	May	Jun	Jul	Aug	Sep	Oct	Total
Daily	---------- inches/day ----------							
Mean	0.24	0.26	0.40	0.39	0.35	0.22	0.15	
Max.	0.47	0.48	0.62	0.54	0.52	0.49	0.53	
Min.	0.11	0.03	0.23	0.20	0.18	0.09	0.00	
Monthly	---------- inches/month ----------							
2015	7.21	8.03	12.06	12.12	10.87	6.72	4.71	61.72
10-yr avg	6.40	8.82	10.07	12.84	10.51	7.06	3.98	59.68
67-yr avg	5.76	7.89	9.14	11.42	9.77	6.43	3.39	53.79

Table 7. Total accumulated reference evapotranspiration (ET_0) and estimated crop evapotranspiration (ET_c) (acre-inches/acre), Malheur Experiment Station, Oregon State University, Ontario, OR, 1992-2015.

Year	ET_o	Alfalfa (Mean)	Winter Grain	Spring Grain	Sugar Beet	Onion	Potato	Dry Bean	Field Corn	Poplar Yr. 1	Poplar Yr. 2	Poplar 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	30.3	26.3	41.0	49.3
2007	59.0	47.2	27.6	26.7	38.9	33.7	29.7	24.5	30.5	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	33.9	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
Avg												
inch	55.7	43.4	24.9	27.2	35.1	30.4	28.4	21.9	28.6	24.3	37.9	45.7
mm	1415	1101	633	692	893	771	722	556	726	617	962	1162

Table 8. Monthly total growing degree-days (50-86°F), Malheur Experiment Station, Oregon State University, Ontario, OR, 1993-2015.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
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
Avg 1993-2014	1	14	108	196	370	508	703	661	471	230	33	5	3273

Table 9. 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	Dec 2010
Highest 24-hour precipitation	1.52 inches	Sep 14, 1959
Highest annual snowfall	40 inches	1955
Highest 24-hour snowfall	10 inches	Nov 30, 1975
Earliest snowfall	1 inch	Oct 25, 1970
Highest air temperature	110°F	July 22, 2003
Total days with maximum air temp. ≥100°F	18 days	2013
Lowest air temperature	-26°F	Jan 21 and 22, 1962
Total days with minimum air temp. ≤0°F	35 days	1985
Longest frost-free period	195 days	2015
---------- Since 1967 ----------		
Lowest soil temperature at 4-inch depth	12°F	Dec 24, 25, and 26, 1990
---------- Since 1993 ----------		
Most yearly growing degree-days	3,876 degree-days	2015
Fewest yearly growing degree-days	2,768 degree-days	1993
Fewest growing degree-days in March	39	2008
Fewest growing degree-days in April	106	2011
---------- Since 1992 ----------		
Highest reference evapotranspiration	61.6 inches	2015

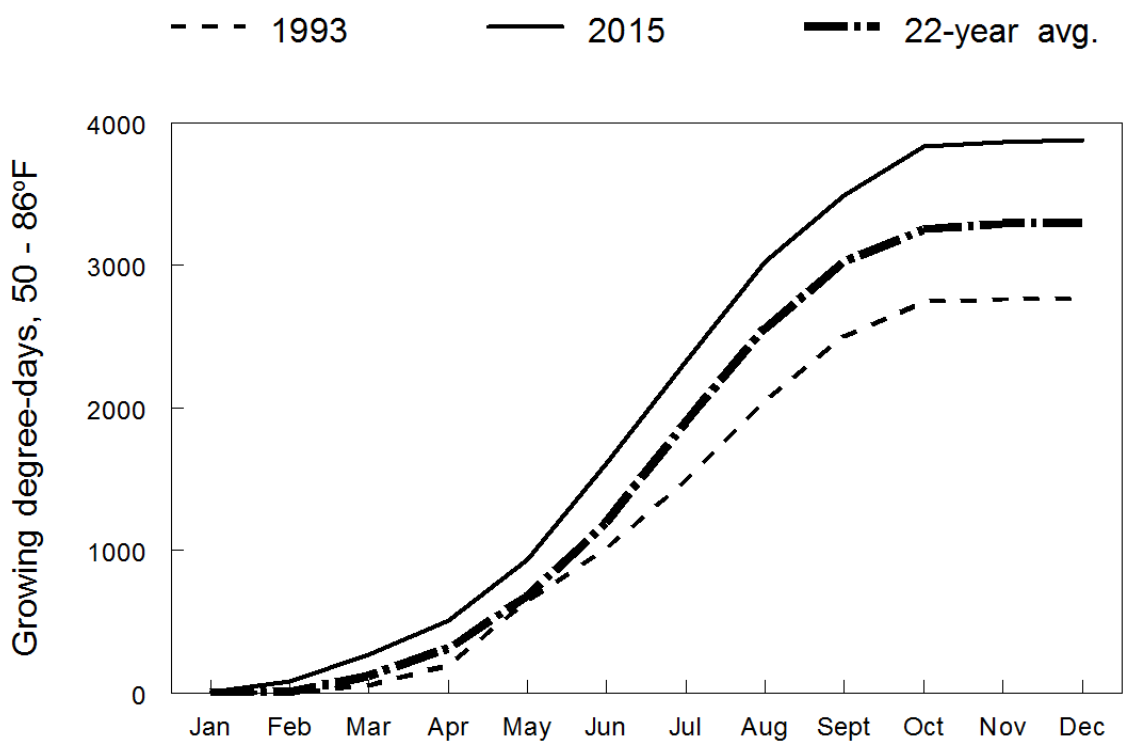

Figure 1. Cumulative growing degree-days (50-86°F) over time for 2015 compared to the years with lowest (1993) totals since 1993 and to the 22-year average (1993-2014), Malheur Experiment Station, Oregon State University, Ontario, OR, 2015. 2015 had the highest cumulative growing degree-days since 1993.

Table 10. Last and first frost (32°F) dates and number of frost-free days, Malheur Experiment Station, Oregon State University, Ontario, OR, 1990-2015.

Year	Date of last frost Spring	Date of first frost Fall	Total frost-free days
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	0ct 22	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
avg 1976-2014	29-Apr	7-Oct	161