Northwestern Agricultural Research Center
of the
Department of Research Centers
Montana Agricultural Experiment Station
Montana State University

ANNUAL REPORT
2020 CROP YEAR

Seventy-second annual report

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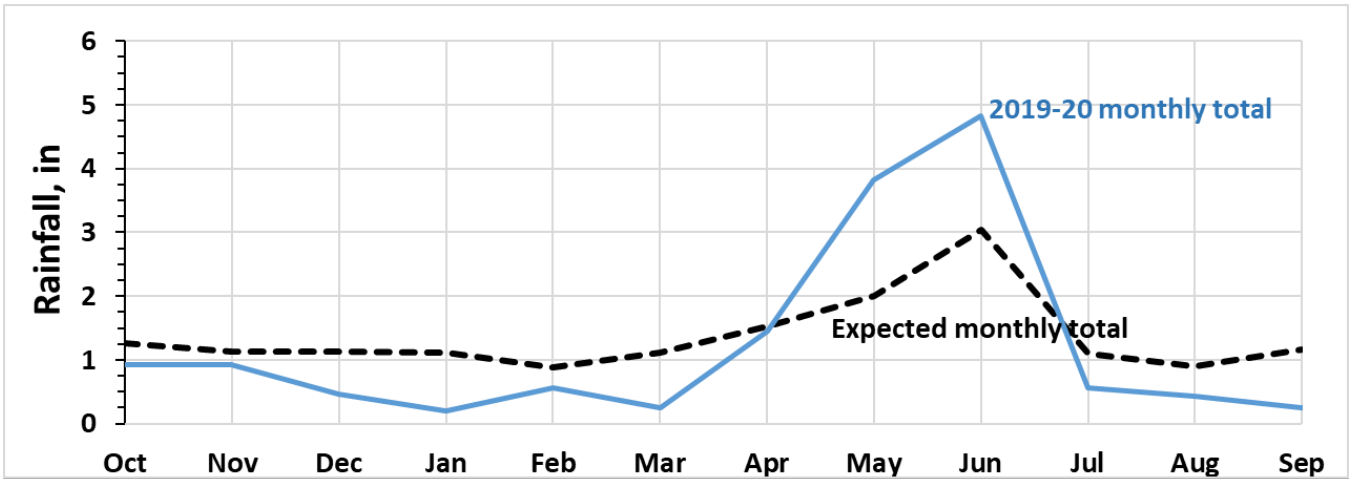
Jane Spain

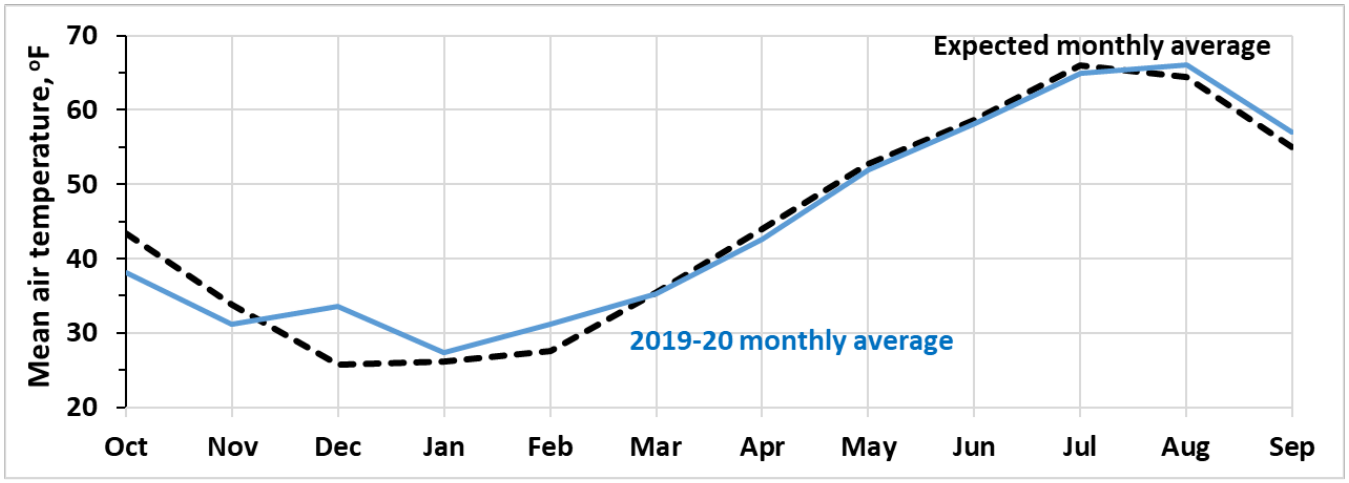
Ben Cluka

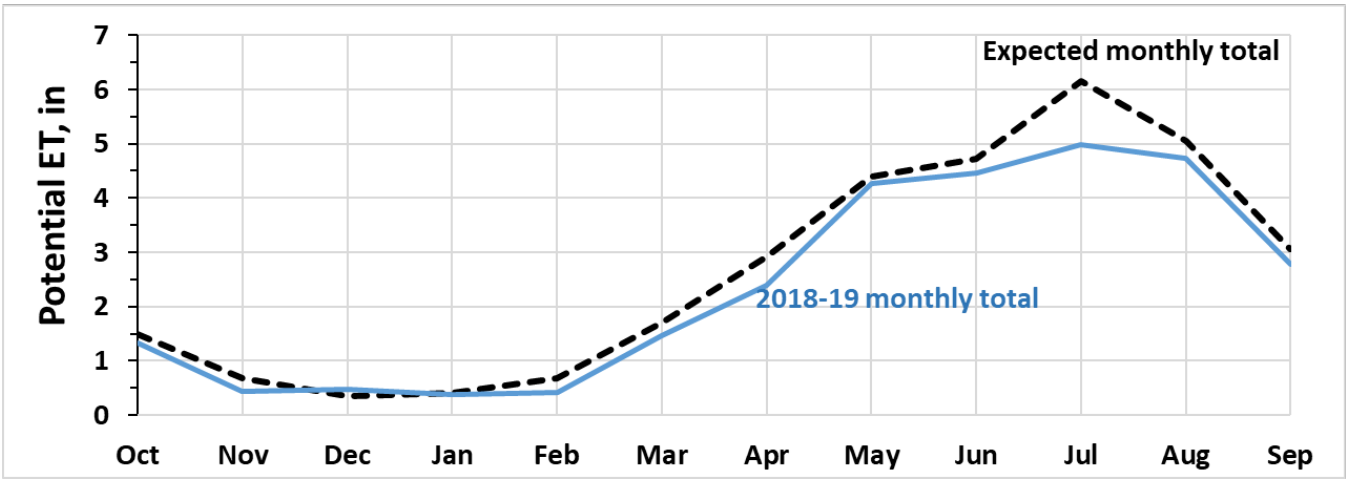
CLIMATOLOGY

Weather information as recorded at the Northwestern Agricultural Research Center, Kalispell, Montana.

*ET, potential evapotranspiration (grass-referenced)







Summary of climatic data for the 2020 crop year: September, 2019 – August 31, 2020

Northwestern Agricultural Research Center, Creston, Montana

Month Year	SEPT 2019	OCT 2019	NOV. 2019	DEC. 2019	JAN. 2020	FEB. 2020	MAR. 2020	APR. 2020	MAY 2020	JUNE 2020	JULY 2020	AUG. 2020	
Precipitation (in.)													**Total**
Current Year	2.5	1.12	0.9	0.48	1.59	0.61	0.1	1.53	3.44	5.39	1.22	0.41	19.29
Average (1980-2019)	1.39	1.23	1.28	1.74	2.33	3.33	1.47	1.04	1.58	1.41	1.59	1.48	19.85
Difference	1.11	-0.11	-0.38	-1.26	-0.74	-2.72	-1.37	0.49	1.86	3.98	-0.37	-1.07	-0.56
Mean Temperature (°F)													**Average**
Current Year	56.1	37.4	30.8	31.2	28.8	30.4	34.3	40.6	50.5	57.8	63.25	65.5	43.9
Average (1980-2019)	53.9	42.3	32.7	24.4	24.5	26.8	34.8	42.8	51.6	58.0	64.5	63.7	43.3
Difference	2.2	-4.9	-1.9	6.8	4.3	3.6	-0.5	-2.2	-1.1	-0.2	-1.2	1.8	0.6

Last killing frost in spring*

Spring, 2020: May 10 (31 °F)
Average (1980-2019): May 19 (31°F)

First killing frost in fall*

Fall, 2019: September 8 (28°F)
Average (1980-2019): September 19 (30 °F)

Frost-free period

2020: 121 days
Average (1980-2019): 123 days

Maximum summer temperature: 97°F (August 1st, 2020)
Minimum winter temperature: 1°F (January 16th, 2020)

Growing degree days (base 50)
May 1st – September 30th, 2020: 1750 GDD
Average (2017-2020): 1778 GDD

*32 °F is considered a killing frost

Summary of Temperature Data at the Northwestern Agricultural Research Center
On a Crop Year Basis September 1980 - August 31, 2020
AVERAGE TEMPERATURE BY YEAR AND MONTH

In degrees Farenheit

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	MEAN
1980-81	54.1	45.3	35.8	32.2	30.1	31.3	38.5	44.5	52.5	53.8	62.8	66.4	45.6
1981-82	55.3	43.2	36.0	27.0	21.6	24.5	37.5	39.4	49.8	59.8	61.1	63.0	43.2
1982-83	53.4	41.0	29.1	25.9	30.3	33.8	37.9	42.4	51.9	57.6	59.6	65.4	44.0
1983-84	50.4	42.9	36.6	11.1	27.6	32.4	38.3	42.2	48.7	56.4	65.3	64.6	43.0
1984-85	49.5	40.0	32.6	20.6	19.2	19.0	30.8	44.8	53.7	57.6	68.3	60.2	41.4
1985-86	47.8	40.8	18.6	18.3	25.4	25.6	40.6	43.8	53.7	63.9	59.9	66.1	42.0
1986-87	50.2	43.0	30.3	24.9	22.2	27.9	35.0	47.8	55.6	61.6	62.9	59.8	43.4
1987-88	56.1	43.3	35.3	25.4	20.5	30.3	37.8	45.7	51.4	60.9	63.7	63.9	44.5
1988-89	53.4	43.4	36.3	23.3	27.5	12.4	28.8	44.2	49.6	59.8	65.4	61.9	42.2
1989-90	52.7	42.7	35.8	25.3	30.5	24.5	34.8	45.2	49.8	57.2	65.2	64.8	44.0
1990-91	59.1	41.9	36.1	16.5	18.3	34.6	32.8	42.4	50.3	55.1	64.0	65.2	43.0
1991-92	54.4	40.6	32.1	29.3	28.7	34.5	39.7	45.1	53.5	55.5	61.2	61.8	44.7
1992-93	51.1	44.7	33.1	19.4	14.7	18.4	33.7	43.6	56.0	56.5	56.6	59.7	40.6
1993-94	51.4	44.4	25.0	27.4	32.9	20.6	37.5	45.4	54.0	57.3	66.4	63.0	43.8
1994-95	56.3	42.8	29.7	27.1	23.6	33.7	33.1	42.6	51.6	56.3	63.1	59.5	43.3
1995-96	54.9	41.1	34.9	26.7	17.4	24.0	29.0	43.2	46.6	58.5	65.4	62.5	42.0
1996-97	52.3	42.1	27.3	19.8	19.8	28.0	32.3	38.3	52.3	57.8	62.8	63.8	41.4
1997-98	55.6	43.7	33.0	27.9	25.1	33.0	34.9	44.5	54.1	56.0	68.4	65.6	45.2
1998-99	59.7	42.3	37.0	27.4	30.4	32.2	37.5	41.6	48.8	55.8	60.9	65.5	44.9
1999-00	51.3	42.9	38.1	31.0	25.8	26.3	36.9	43.4	50.4	56.2	63.9	63.4	44.1
2000-01	52.0	33.5	27.5	18.4	24.0	20.6	33.6	40.5	53.4	54.8	63.1	64.6	40.5
2001-02	57.3	42.0	36.6	27.0	27.2	25.7	25.0	41.6	47.5	57.7	67.2	60.4	42.9
2002-03	54.4	37.5	32.6	30.6	28.8	28.1	33.4	44.5	50.5	60.1	69.1	66.9	44.7
2003-04	55.5	46.3	27.3	24.2	21.1	27.6	39.5	45.1	51.0	57.3	66.0	64.0	43.7
2004-05	52.3	43.4	33.8	29.4	20.6	30.6	36.1	43.9	51.8	55.3	62.6	62.8	43.6
2005-06	51.0	43.6	32.6	18.1	33.2	24.2	35.5	43.9	52.6	60.7	69.1	63.8	44.0
2006-07	53.5	44.0	32.5	24.1	22.1	28.3	37.7	42.7	52.6	59.0	72.0	62.3	44.2
2007-08	53.6	40.3	32.6	26.2	19.7	30.2	32.9	37.8	47.0	55.6	65.1	63.6	42.1
2008-09	52.4	41.7	33.3	18.0	21.5	24.5	26.2	41.8	53.3	59.2	67.1	66.1	42.1
2009-10	60.1	38.9	35.3	18.0	26.4	31.4	37.9	41.2	47.1	56.0	61.9	61.4	43.0
2010-11	51.9	43.9	29.0	23.8	24.3	19.5	34.7	38.7	48.7	53.5	61.9	64.4	41.2
2011-12	56.2	43.3	31.6	28.0	26.4	28.2	36.7	45.2	48.8	54.9	65.2	63.1	44.0
2012-13	55.4	41.9	35.8	28.5	23.9	32.6	35.3	40.4	52.4	58.5	67.2	66.0	44.8
2013-14	57.2	39.6	31.4	21.9	26.6	17.1	33.2	42.3	51.8	55.9	66.6	65.1	42.4
2014-15	54.2	48.0	28.8	25.0	22.6	32.4	38.6	43.6	52.7	63.7	65.7	64.3	45.0
2015-16	52.8	46.6	31.2	27.4	27.0	33.2	37.2	47.8	51.4	58.4	62.6	62.7	44.9
2016-17	52.0	43.5	38.4	17.3	12.5	22.1	35.8	40.4	52.6	59.6	68.0	64.3	42.2
2017-18	54.0	41.4	35.4	28.9	33.8	26.6	37.0	43.6	58.4	59.7	66.3	65.5	45.9
2018-19	55.5	44.7	37.3	29.0	25.6	11.3	25.5	43.9	53.5	59.4	63.4	64.8	42.8
2019-20	56.1	37.4	30.8	31.2	28.8	30.4	34.3	40.6	50.5	57.8	63.3	65.5	43.9
MEAN	53.9	42.3	32.7	24.5	24.7	26.8	34.8	43.0	51.5	57.8	64.5	63.7	43.4

Mean temperature for all years = 43.4

Precipitation by Day for Crop Year September 2019- August 2020
Northwest Agriculture Research Center, Kalispell Montana

DAY	SEPT. 2019	OCT. 2019	NOV. 2019	DEC. 2019	JAN. 2020	FEB. 2020	MAR. 2020	APR. 2020	MAY 2020	JUNE 2020	JULY 2020	AUG. 2020
1	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.21	0.01	0.74	0.59	0.00
2	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.03	0.03	0.01	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.14	0.00	0.00	0.00
4	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.04	0.00
5	0.00	0.03	0.00	0.00	0.00	0.10	0.00	0.06	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.04	0.00	0.25	0.00	0.00
7	0.02	0.00	0.00	0.00	0.32	0.08	0.00	0.00	0.66	0.81	0.22	0.33
8	0.00	0.19	0.00	0.02	0.20	0.12	0.00	0.00	0.01	1.04	0.08	0.00
9	0.93	0.00	0.00	0.03	0.00	0.08	0.00	0.00	0.00	0.38	0.00	0.00
10	1.01	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00
11	0.06	0.00	0.00	0.07	0.00	0.01	0.00	0.00	0.00	0.04	0.04	0.00
12	0.00	0.00	0.00	0.03	0.00	0.03	0.04	0.00	0.01	0.00	0.00	0.00
13	0.00	0.00	0.16	0.22	0.16	0.00	0.00	0.00	0.53	0.00	0.00	0.00
14	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00
15	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.36	0.01	0.01	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
17	0.00	0.00	0.00	0.00	0.15	0.02	0.00	0.00	0.00	0.00	0.00	0.00
18	0.03	0.03	0.15	0.00	0.05	0.00	0.00	0.00	0.26	0.35	0.00	0.01
19	0.05	0.18	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01
20	0.00	0.05	0.54	0.05	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.04
21	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.10	0.00	0.01
22	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.24	0.00	0.00
23	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.11	0.00	0.00	0.00	0.00
25	0.00	0.08	0.00	0.01	0.08	0.10	0.00	0.06	0.02	0.13	0.00	0.00
26	0.01	0.32	0.00	0.00	0.06	T	0.00	0.00	0.18	0.00	0.00	0.00
27	0.20	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.11	0.00	0.00	0.08	0.00	0.00	0.04	0.00	0.00	0.00	0.00
29	0.05	0.04	0.00	0.02	0.05	0.00	0.00	0.00	0.00	0.01	0.00	0.00
30	0.00	0.00	0.00	0.01	0.00		0.01	0.00	0.00	1.12	0.00	0.00
31		0.00		0.01	0.00		0.05		0.00		0.00	0.01
TOTAL	2.50	1.12	0.90	0.48	1.59	0.61	0.10	1.53	3.44	5.39	1.22	0.41

Year to date 19.29

Summary of Precipitation at the Northwestern Agricultural Research Center On a Crop Year Basis

Total Precipitation in Inches by Year and Month

YEAR	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	TOTAL
1980-81	1.20	0.83	0.78	2.58	1.81	1.85	2.17	1.75	3.86	4.70	1.17	0.96	23.66
1981-82	0.77	0.56	1.49	1.91	2.38	1.48	1.16	1.60	1.25	2.41	2.06	1.17	18.24
1982-83	2.37	0.75	1.39	1.60	0.93	0.85	1.71	2.41	1.20	2.96	3.66	1.16	20.99
1983-84	1.70	1.13	1.96	2.57	0.80	2.19	1.81	1.93	2.91	2.07	0.31	0.55	19.93
1984-85	2.15	2.25	1.40	1.29	0.31	1.28	0.90	1.31	2.81	1.89	0.35	1.62	17.56
1985-86	5.35	1.55	1.61	0.51	2.39	2.33	0.50	1.34	2.92	1.83	2.09	0.81	23.23
1986-87	3.63	0.80	1.78	0.63	0.38	0.46	3.47	1.15	1.89	1.95	4.85	0.98	21.97
1987-88	0.81	0.12	0.91	1.18	0.98	1.03	0.77	1.36	3.60	1.98	1.07	0.13	13.94
1988-89	2.30	0.62	1.39	1.69	1.39	1.48	2.29	1.09	2.70	2.05	2.70	3.69	23.39
1989-90	1.50	2.29	3.75	1.92	0.96	1.00	1.76	1.63	3.74	2.68	2.34	2.44	26.01
1990-91	T	2.32	1.37	2.60	1.41	0.41	0.72	1.21	2.72	5.36	0.77	1.15	20.04
1991-92	0.80	0.75	2.26	0.58	1.17	0.61	0.83	1.18	1.65	5.34	2.24	0.94	18.35
1992-93	1.21	1.07	2.37	1.53	1.68	0.60	0.73	3.77	2.22	4.00	7.00	1.19	27.37
1993-94	1.54	0.83	1.23	1.27	1.43	1.49	0.11	2.01	1.79	2.59	0.10	0.23	14.62
1994-95	0.46	2.12	1.89	1.07	1.17	0.90	2.33	2.25	1.44	5.63	1.91	1.47	22.64
1995-96	1.21	2.75	2.33	1.91	2.22	1.18	1.19	3.32	4.58	2.05	0.95	0.80	24.49
1996-97	2.67	1.58	3.99	3.52	1.50	1.62	1.18	1.69	2.62	3.41	0.99	1.94	26.71
1997-98	2.36	0.94	0.33	0.42	0.77	0.33	2.64	1.80	5.14	4.64	1.18	0.72	21.27
1998-99	1.48	0.71	1.11	1.47	1.05	1.18	0.90	0.55	1.32	2.74	1.63	1.93	16.07
1999-00	0.36	1.72	2.33	1.08	1.46	1.81	1.30	2.21	0.89	1.80	0.84	0.35	16.15
2000-01	1.40	1.23	0.62	1.23	0.75	1.54	1.03	2.62	0.57	3.29	0.91	0.54	15.73
2001-02	0.32	1.80	1.44	0.59	1.21	1.66	1.48	0.91	2.72	2.39	1.45	1.44	17.41
2002-03	1.18	0.25	0.87	1.67	1.63	1.01	2.32	2.23	1.78	1.57	0.05	0.35	14.91
2003-04	2.56	1.29	0.59	1.04	2.02	0.42	0.57	2.23	1.97	1.31	1.24	3.60	18.84
2004-05	1.89	1.62	0.84	1.49	1.38	0.01	1.41	2.21	1.73	8.44	0.26	0.56	21.84
2005-06	2.28	2.20	1.45	1.42	3.04	1.14	0.55	2.12	2.89	5.50	0.51	0.24	23.34
2006-07	1.95	1.10	2.28	0.95	0.39	2.26	0.54	1.62	3.29	1.35	0.75	0.23	16.71
2007-08	1.28	1.11	1.02	1.13	1.31	0.76	0.61	0.90	2.33	3.65	3.80	1.15	19.05
2008-09	1.57	0.61	1.71	2.37	1.72	1.59	1.43	0.98	1.62	1.98	2.44	0.99	19.01
2009-10	0.04	1.72	0.37	2.66	1.42	0.66	0.72	3.47	2.45	5.03	1.25	1.35	21.14
2010-11	1.71	0.74	2.77	1.69	2.43	1.61	0.87	2.25	3.20	4.48	0.99	0.24	22.98
2011-12	0.91	2.46	0.46	0.40	1.08	1.15	1.16	1.35	2.11	7.11	1.41	0.56	20.16
2012-13	0.75	2.46	1.66	1.84	0.67	0.20	0.66	2.12	3.29	2.76	0.03	0.93	17.37
2013-14	2.65	0.36	2.00	0.99	1.36	1.66	2.32	0.76	1.17	6.39	0.51	1.73	21.90
2014-15	0.75	2.13	2.84	2.66	2.52	1.04	1.43	0.30	0.43	1.02	0.63	0.19	15.94
2015-16	0.96	0.79	1.00	2.16	1.42	1.01	0.97	1.50	2.78	2.07	1.55	1.11	17.32
2016-17	0.97	5.48	1.06	1.66	0.84	2.80	2.99	2.33	0.71	2.62	0.07	0.19	21.72
2017-18	0.99	1.28	1.69	2.98	1.17	2.14	0.42	1.54	1.78	2.63	0.30	0.22	17.14
2018-19	0.59	1.17	1.52	0.46	1.37	1.79	0.98	1.19	1.63	1.96	1.12	0.65	14.43
2019-20	2.50	1.12	0.90	0.48	1.59	0.61	0.10	1.53	3.44	5.39	1.22	0.41	19.29
MEAN	1.57	1.42	1.57	1.53	1.39	1.23	1.28	1.74	2.33	3.33	1.47	1.02	19.82
	SEPT	OCT	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	TOTAL

Mean monthly precipitation for all crop years = 1.66

YEAR 2020 - GROWING DEGREE DAYS JANUARY THROUGH OCTOBER
CALCULATED AT BASE 50, BASE 40, AND BASE 32
Page 1: January - May

January

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	39	30	0.0	0.0	3.5
2	40	31	0.0	0.0	4.0
3	37	29	0.0	0.0	2.5
4	41	30	0.0	0.5	4.5
5	42	27	0.0	1.0	5.0
6	36	30	0.0	0.0	2.0
7	36	30	0.0	0.0	2.0
8	39	33	0.0	0.0	4.0
9	41	28	0.0	0.5	4.5
10	31	13	0.0	0.0	0.0
11	25	13	0.0	0.0	0.0
12	34	8	0.0	0.0	1.0
13	34	8	0.0	0.0	1.0
14	18	8	0.0	0.0	0.0
15	14	3	0.0	0.0	0.0
16	28	1	0.0	0.0	0.0
17	28	16	0.0	0.0	0.0
18	30	16	0.0	0.0	0.0
19	36	16	0.0	0.0	2.0
20	27	15	0.0	0.0	0.0
21	36	18	0.0	0.0	2.0
22	40	25	0.0	0.0	4.0
23	37	32	0.0	0.0	2.5
24	38	32	0.0	0.0	3.0
25	43	32	0.0	1.5	5.5
26	39	31	0.0	0.0	3.5
27	35	32	0.0	0.0	1.5
28	42	28	0.0	1.0	5.0
29	36	29	0.0	0.0	2.0
30	38	26	0.0	0.0	3.0
31	41	29	0.0	0.5	4.5

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
35.0	22.5	0.0	5.0	72.5

February

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	50	30	0.0	5.0	9.0
2	55	29	2.5	7.5	11.5
3	37	12	0.0	0.0	2.5
4	30	12	0.0	0.0	0.0
5	29	11	0.0	0.0	0.0
6	32	24	0.0	0.0	0.0
7	37	27	0.0	0.0	2.5
8	37	30	0.0	0.0	2.5
9	35	13	0.0	0.0	1.5
10	30	12	0.0	0.0	0.0
11	36	22	0.0	0.0	2.0
12	34	21	0.0	0.0	1.0
13	34	21	0.0	0.0	1.0
14	41	21	0.0	0.5	4.5
15	40	26	0.0	0.0	4.0
16	38	31	0.0	0.0	3.0
17	38	28	0.0	0.0	3.0
18	34	24	0.0	0.0	1.0
19	34	11	0.0	0.0	1.0
20	32	11	0.0	0.0	0.0
21	35	12	0.0	0.0	1.5
22	42	17	0.0	1.0	5.0
23	48	30	0.0	4.0	8.0
24	44	31	0.0	2.0	6.0
25	36	26	0.0	0.0	2.0
26	40	26	0.0	0.0	4.0
27	40	24	0.0	0.0	4.0
28	54	24	2.0	7.0	11.0
29	56	28	3.0	8.0	12.0

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
38.9	21.9	7.5	35.0	103.5

March

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	45	28	0.0	2.5	6.5
2	42	30	0.0	1.0	5.0
3	43	34	0.0	1.5	6.5
4	53	38	1.5	6.5	13.5
5	45	22	0.0	2.5	6.5
6	47	24	0.0	3.5	7.5
7	54	28	2.0	7.0	11.0
8	49	21	0.0	4.5	8.5
9	40	21	0.0	0.0	4.0
10	41	22	0.0	0.5	4.5
11	46	26	0.0	3.0	7.0
12	49	21	0.0	4.5	8.5
13	41	13	0.0	0.5	4.5
14	32	5	0.0	0.0	0.0
15	22	6	0.0	0.0	0.0
16	29	9	0.0	0.0	0.0
17	43	14	0.0	1.5	5.5
18	52	15	1.0	6.0	10.0
19	48	21	0.0	4.0	8.0
20	44	19	0.0	2.0	6.0
21	50	19	0.0	5.0	9.0
22	56	21	3.0	8.0	12.0
23	52	25	1.0	6.0	10.0
24	53	27	1.5	6.5	10.5
25	44	29	0.0	2.0	6.0
26	45	23	0.0	2.5	6.5
27	45	25	0.0	2.5	6.5
28	43	32	0.0	1.5	5.5
29	48	35	0.0	4.0	9.5
30	55	34	2.5	7.5	12.5
31	48	33	0.0	4.0	8.5

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
45.3	23.2	12.5	100.5	219.5

April

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	48	18	0.0	4.0	8.0
2	30	15	0.0	0.0	0.0
3	31	16	0.0	0.0	0.0
4	42	26	0.0	1.0	5.0
5	43	27	0.0	1.5	5.5
6	46	29	0.0	3.0	7.0
7	54	36	2.0	7.0	13.0
8	57	26	3.5	8.5	12.5
9	59	25	4.5	9.5	13.5
10	64	27	7.0	12.0	16.0
11	62	30	6.0	11.0	15.0
12	39	13	0.0	0.0	3.5
13	39	15	0.0	0.0	3.5
14	44	17	0.0	2.0	6.0
15	56	32	3.0	8.0	12.0
16	46	21	0.0	3.0	7.0
17	48	25	0.0	4.0	8.0
18	62	32	6.0	11.0	15.0
19	51	29	0.5	5.5	9.5
20	55	29	2.5	7.5	11.5
21	66	29	8.0	13.0	17.0
22	70	34	10.0	15.0	20.0
23	65	39	7.5	12.5	20.0
24	53	31	1.5	6.5	10.5
25	56	34	3.0	8.0	13.0
26	58	40	4.0	9.0	17.0
27	62	31	6.0	11.0	15.0
28	56	31	3.0	8.0	12.0
29	65	36	7.5	12.5	18.5
30	71	41	10.5	16.0	24.0

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
53.3	27.8	96.0	210.0	338.5

May

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	58	42	4.0	10.0	18.0
2	61	28	5.5	10.5	14.5
3	70	36	10.0	15.0	21.0
4	55	36	2.5	7.5	13.5
5	59	28	4.5	9.5	13.5
6	68	35	9.0	14.0	19.5
7	55	36	2.5	7.5	13.5
8	49	36	0.0	4.5	10.5
9	60	32	5.0	10.0	14.0
10	64	31	7.0	12.0	16.0
11	58	38	4.0	9.0	16.0
12	56	38	3.0	8.0	15.0
13	48	38	0.0	4.0	11.0
14	53	41	1.5	7.0	15.0
15	63	38	6.5	11.5	18.5
16	50	36	0.0	5.0	11.0
17	64	38	7.0	12.0	19.0
18	70	42	10.0	16.0	24.0
19	62	48	6.0	15.0	23.0
20	70	48	10.0	19.0	27.0
21	56	46	3.0	11.0	19.0
22	55	42	2.5	8.5	16.5
23	52	40	1.0	6.0	14.0
24	56	43	3.0	9.5	17.5
25	59	39	4.5	9.5	17.0
26	67	37	8.5	13.5	20.0
27	69	39	9.5	14.5	22.0
28	72	39	11.0	16.0	23.5
29	76	45	13.0	20.5	28.5
30	79	49	14.5	24.0	32.0
31	88	41	18.0	23.5	31.5

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
62.0	38.9	186.5	363.5	575.0

YEAR 2020 - GROWING DEGREE DAYS JANUARY THROUGH OCTOBER
CALCULATED AT BASE 50, BASE 40, AND BASE 32
Page 2: June - October

JUNE

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	64	38	7.0	12.0	19.0
2	62	43	6.0	12.5	20.5
3	71	48	10.5	19.5	27.5
4	73	49	11.5	21.0	29.0
5	68	40	9.0	14.0	22.0
6	73	49	11.5	21.0	29.0
7	59	44	4.5	11.5	19.5
8	54	43	2.0	8.5	16.5
9	55	43	2.5	9.0	17.0
10	58	46	4.0	12.0	20.0
11	65	42	7.5	13.5	21.5
12	78	48	14.0	23.0	31.0
13	80	46	15.0	23.0	31.0
14	75	45	12.5	20.0	28.0
15	60	44	5.0	12.0	20.0
16	61	45	5.5	13.0	21.0
17	67	45	8.5	16.0	24.0
18	66	49	8.0	17.5	25.5
19	65	50	7.5	17.5	25.5
20	71	50	10.5	20.5	28.5
21	66	48	8.0	17.0	25.0
22	70	45	10.0	17.5	25.5
23	77	49	13.5	23.0	31.0
24	81	53	17.0	27.0	35.0
25	82	47	16.0	24.5	32.5
26	79	52	15.5	25.5	33.5
27	84	48	17.0	26.0	34.0
28	76	47	13.0	21.5	29.5
29	70	49	10.0	19.5	27.5
30	62	48	6.0	15.0	23.0

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
69.1	46.4	288.5	533.5	772.5

JULY

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	57	48	3.5	12.5	20.5
2	57	40	3.5	8.5	16.5
3	66	39	8.0	13.0	20.5
4	81	47	15.5	24.0	32.0
5	79	44	14.5	21.5	29.5
6	76	44	13.0	20.0	28.0
7	80	53	16.5	26.5	34.5
8	69	52	10.5	20.5	28.5
9	69	41	9.5	15.0	23.0
10	76	50	13.0	23.0	31.0
11	73	46	11.5	19.5	27.5
12	83	45	16.5	24.0	32.0
13	74	44	12.0	19.0	27.0
14	72	41	11.0	16.5	24.5
15	76	49	13.0	22.5	30.5
16	81	50	15.5	25.5	33.5
17	83	55	19.0	29.0	37.0
18	77	46	13.5	21.5	29.5
19	81	47	15.5	24.0	32.0
20	80	52	16.0	26.0	34.0
21	84	50	17.0	27.0	35.0
22	85	51	18.0	28.0	36.0
23	90	52	19.0	29.0	37.0
24	84	45	17.0	24.5	32.5
25	82	42	16.0	22.0	30.0
26	79	44	14.5	21.5	29.5
27	84	45	17.0	24.5	32.5
28	91	51	18.5	28.5	36.5
29	92	54	20.0	30.0	38.0
30	90	54	20.0	30.0	38.0
31	94	56	21.0	31.0	39.0

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
78.9	48	428.0	677.0	916.5

AUGUST

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	97	60	28.0	33.0	41.0
2	94	58	26.0	32.0	40.0
3	92	53	22.5	29.5	37.5
4	86	49	18.0	27.5	35.5
5	84	49	17.0	26.5	34.5
6	90	50	20.0	28.0	36.0
7	82	49	16.0	25.5	33.5
8	72	45	11.0	18.5	26.5
9	72	47	11.0	19.5	27.5
10	80	43	15.0	21.5	29.5
11	81	47	15.5	24.0	32.0
12	71	43	10.5	17.0	25.0
13	71	41	10.5	16.0	24.0
14	71	41	10.5	16.0	24.0
15	79	43	14.5	21.0	29.0
16	86	46	18.0	26.0	34.0
17	92	55	23.5	30.5	38.5
18	95	57	26.0	31.5	39.5
19	90	57	23.5	31.5	39.5
20	89	52	20.5	29.0	37.0
21	77	48	13.5	22.5	30.5
22	88	47	19.0	26.5	34.5
23	81	40	15.5	20.5	28.5
24	87	46	18.5	26.0	34.0
25	83	48	16.5	25.5	33.5
26	81	48	15.5	24.5	32.5
27	82	48	16.0	25.0	33.0
28	82	43	16.0	22.5	30.5
29	82	42	16.0	22.0	30.0
30	82	43	16.0	22.5	30.5
31	73	49	11.5	21.0	29.0

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
83.0	48.0	520.0	741.5	981.5

SEPTEMBER

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	59	49	4.5	14.0	22.0
2	82	58	20.0	30.0	38.0
3	82	51	16.5	26.5	34.5
4	85	43	17.5	24.0	32.0
5	88	46	18.0	26.0	34.0
6	89	50	18.0	28.0	36.0
7	87	36	18.0	23.0	29.0
8	64	28	7.0	12.0	16.0
9	61	31	5.5	10.5	14.5
10	72	31	11.0	16.0	20.0
11	78	38	14.0	19.0	26.0
12	82	41	16.0	21.5	29.5
13	84	40	17.0	22.0	30.0
14	69	42	9.5	15.5	23.5
15	63	44	6.5	13.5	21.5
16	73	39	11.5	16.5	24.0
17	72	39	11.0	16.0	23.5
18	72	39	11.0	16.0	23.5
19	71	54	12.5	22.5	30.5
20	63	41	6.5	12.0	20.0
21	66	36	8.0	13.0	19.0
22	73	37	11.5	16.5	23.0
23	58	41	4.0	9.5	17.5
24	74	43	12.0	18.5	26.5
25	63	43	6.5	13.0	21.0
26	56	36	3.0	8.0	14.0
27	57	32	3.5	8.5	12.5
28	61	33	5.5	10.5	15.0
29	66	32	8.0	13.0	17.0
30	76	35	13.0	18.0	23.5

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
71.5	40.3	326.5	513.0	717.0

OCTOBER

Day	Temperatures		Growing Degree Days		
	MAX	MIN	Base 50	Base 40	Base 32
1	73	34	11.5	16.5	21.5
2	67	35	8.5	13.5	19.0
3	71	36	10.5	15.5	21.5
4	72	36	11.0	16.0	22.0
5	75	41	12.5	18.0	26.0
6	75	40	12.5	17.5	25.5
7	81	39	15.5	20.5	28.0
8	78	36	14.0	19.0	25.0
9	73	39	11.5	16.5	24.0
10	74	39	12.0	17.0	24.5
11	60	38	5.0	10.0	17.0
12	55	40	2.5	7.5	15.5
13	57	33	3.5	8.5	13.0
14	49	35	0.0	4.5	10.0
15	52	29	1.0	6.0	10.0
16	52	30	1.0	6.0	10.0
17	52	36	1.0	6.0	12.0
18	55	27	2.5	7.5	11.5
19	41	26	0.0	0.5	4.5
20	39	27	0.0	0.0	3.5
21	48	26	0.0	4.0	8.0
22	48	20	0.0	4.0	8.0
23	33	22	0.0	0.0	0.5
24	30	2	0.0	0.0	0.0
25	25	-1	0.0	0.0	0.0
26	23	1	0.0	0.0	0.0
27	26	9	0.0	0.0	0.0
28	36	23	0.0	0.0	2.0
29	37	23	0.0	0.0	2.5
30	58	23	4.0	9.0	13.0
31	52	26	1.0	6.0	10.0

AV MAX	AV MIN	Total Base 50	Total Base 40	Total Base 32
53.8	28.1	140.0	243.5	378.0

Julian Date Calendar for Year 2020

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	32	61	92	122	153	183	214	245	275	306	336
2	2	33	62	93	123	154	184	215	246	276	307	337
3	3	34	63	94	124	155	185	216	247	277	308	338
4	4	35	64	95	125	156	186	217	248	278	309	339
5	5	36	65	96	126	157	187	218	249	279	310	340
6	6	37	66	97	127	158	188	219	250	280	311	341
7	7	38	67	98	128	159	189	220	251	281	312	342
8	8	39	68	99	129	160	190	221	252	282	313	343
9	9	40	69	100	130	161	191	222	253	283	314	344
10	10	41	70	101	131	162	192	223	254	284	315	345
11	11	42	71	102	132	163	193	224	255	285	316	346
12	12	43	72	103	133	164	194	225	256	286	317	347
13	13	44	73	104	134	165	195	226	257	287	318	348
14	14	45	74	105	135	166	196	227	258	288	319	349
15	15	46	75	106	136	167	197	228	259	289	320	350
16	16	47	76	107	137	168	198	229	260	290	321	351
17	17	48	77	108	138	169	199	230	261	291	322	352
18	18	49	78	109	139	170	200	231	262	292	323	353
19	19	50	79	110	140	171	201	232	263	293	324	354
20	20	51	80	111	141	172	202	233	264	294	325	355
21	21	52	81	112	142	173	203	234	265	295	326	356
22	22	53	82	113	143	174	204	235	266	296	327	357
23	23	54	83	114	144	175	205	236	267	297	328	358
24	24	55	84	115	145	176	206	237	268	298	329	359
25	25	56	85	116	146	177	207	238	269	299	330	360
26	26	57	86	117	147	178	208	239	270	300	331	361
27	27	58	87	118	148	179	209	240	271	301	332	362
28	28	59	88	119	149	180	210	241	272	302	333	363
29	29	60	89	120	150	181	211	242	273	303	334	364
30	30		90	121	151	182	212	243	274	304	335	365
31	31		91		152		213	244		305		366

CEREALS

Project Title: 2020 Intrastate Forage Barley Trial

Objective: To evaluate the performance of selected barley varieties in northwestern Montana

Personnel: J.A. Torrion, Amanda Shine, Jamie Sherman, Eeusha Nafi

Summary:

Twenty-five barley varieties/lines were planted in spring, and managed under rainfed condition (Table 1). A total of 11.2 inches rainfall was received during the growing period (April-Aug.).

On average, the forage yield was 6.1 t/A, and ranging from 8.4t/A for MT18F00507 to 4.9 t/A for MT18F00117. Grain yield averaged 98.9 bu/A, ranging from 79 bu/A for MT18F00410 to 110.4 bu/A for MT18F00607 (Table 2). Average grain protein content was 9.7%; MT18F00410 had the highest protein content at 12.1%, whereas Hays had the lowest protein content at 8.8%. The tallest variety was MT18F01104 at 41.1 inches and the shortest on was MT18F00805 at 29.5 inches, while the average height over the varieties was 33.5 inches. Grain test weight (TWT) averaged 49.8 lbs/bu, ranging from 52.8 lbs/bu for MT18F01104 to 47 lbs/bu for MT18F00117. Plump percentages were clustered within the 84.9%-96.6% range, with the average at 92.4%.

Table 1. Management information

Seeding date:	4/21/2020	Field Location:	P2
Julian date:	112	Harvest date:	Forage: 7/13, Grain 8/18
Seeding rate:	n/a	Julian dates:	195, 230
Previous crop:	Winter wheat	Soil type:	Creston silt loam
Herbicide:	6/1: Cleansweep M & Axial	Tillage:	Conventional
Insecticide:	None	Soil residual nutrient (NO_3-, P, K lb/A):	Fall, 2019: 122-20-376
Fungicide:	None	Nutrient fertilizer applied (N, P_2O_5, K_20 lb/A):	4/8/20: 84-10-35 (10 S)

Table 2. Agronomic performance of the forage barley entries

Variety	Forage yield t/A	Grain yield (bu/A)	Grain Protein (%)	Height (inch)	TWT (lbs/bu)	Plump (%)
MT18F00507	8.4	99.8	9.4	30.3	49.2	87.0
MT18F00410	8.3	79.0	12.1	37.7	47.3	95.9
MT18F00503	7.4	97.0	9.4	34.1	50.6	95.2
Lavina	7.0	110.3	9.5	31.6	50.3	87.2
MT18F00502	6.7	102.2	9.8	33.3	49.1	95.5
MT18F01104	6.7	95.5	10.4	41.1	52.8	96.6
MT16F02410	6.5	102.5	9.5	29.6	50.2	90.3
Hays	6.3	103.2	8.8	29.8	50.7	90.7
MT16F01601	6.3	103.2	9.8	31.9	50.9	93.2
MT18F01003	6.3	94.0	9.5	38.6	51.6	96.4
MT18F00110	6.2	98.8	9.6	36.0	50.7	95.9
MT18F01010	6.2	97.1	9.1	30.8	50.3	94.2
MT18F00403	6.0	101.8	9.6	33.5	48.6	91.4
MT16F02408	6.0	101.2	10.1	34.4	52.4	95.1
MT18F01012	6.0	99.2	9.2	34.4	49.7	92.2
MT18F00411	5.7	95.5	10.7	33.1	47.6	90.1
Haymaker	5.6	96.0	9.8	32.5	50.5	89.1
MT18F00607	5.5	110.4	8.8	32.4	48.8	90.7
MT16F01603	5.3	96.2	9.8	31.6	49.6	92.7
MT17F01611	5.1	103.1	9.2	32.9	50.5	93.9
MT16F02902	5.1	99.8	9.4	32.4	50.8	93.3
MT18F00805	5.1	95.9	9.9	29.5	48.5	89.2
MT16F02910	5.0	101.6	9.6	37.5	49.1	93.6
MT18F00206	5.0	90.8	10.2	36.0	48.3	94.7
MT18F00117	4.9	98.1	9.9	33.1	47.0	84.9
Mean	6.1	98.9	9.7	33.5	49.8	92.4
CV	28.1	7.5	3.8	7.4	0.8	1.6
LSD	2.4	10.2	0.5	4.1	0.6	2.5

TWT = test weight; test weight and yield standardized to 12% moisture levels

Project Title: 2020 Preliminary Yield Trial Spring Forage Barley

Objective: To evaluate the performance of selected barley varieties northwestern Montana

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi, Jamie Sherman, Greg Lutgen

Summary:

Forty-five barley varieties/lines were planted in spring, and managed under rainfed conditions (Table 1). A total of 11.2 inches of rainfall was received during the growing period (April-Aug.).

On average, the barley forage yield was 6.3 t/A, and ranging from 9.6 t/A for MT19_F05_03 to 3.9 t/A for MT19_F01_02. Acid detergent fiber (ADF) averaged 33.5%, ranging from 39.3% for MT18F00309 to 27.3% for MT19_F05_03. On the other hand, MT18F00309 had the highest neutral detergent fiber (NDF) at 62.4% and MT19_F07_05 had the lowest NDF at 41% with an average at 54.3%.

Grain yield averaged 102.5 bu/A, ranging from 134.7 bu/A for Hays to 74.3 bu/A for MT19_F07_02 (Table 2). Average grain protein content was 10.3%; MT19_F06_03 had the highest protein content at 12.5% while MT19_F02_02 had the lowest protein content at 8.7%. Grain test weight (TWT) averaged 46.4 lbs/bu, ranging from 50.9 lbs/bu for Hays to 39.2 lbs/bu for MT19_F06_05. Lodging among the varieties averaged at 7.2%, while 79% of the lodging was recorded for MT19_F04_04.

Table 1. Management information

Seeding date:	4/21/2020	Field:	P2
Julian date:	112	Harvest date:	Forage: 7/13, Grain: 8/17
Seeding rate:	n/a	Julian dates:	195, 230
Previous crop:	Winter wheat	Soil type:	Creston silt loam
Herbicide:	6/1: Cleansweep M & Axial	Tillage:	Conventional
Insecticide:	None	Soil residual nutrient (NO_3^-, P, K lb/A):	Fall, 2019: 122-20-376
Fungicide:	None	Nutrient fertilizer applied (N, P_2O_5, K_20 lb/A):	4/8/20: 84-10-35 (10 S)

Table 2. Agronomic performance of the forage barley entries

Entries	Forage yield (tons/A)	ADF (%)	NDF (%)	Grain yield (bu/A)	Lodging (%)	Test weight (lbs/bu)	Grain protein (%)
MT19_F05_03	9.6	27.3	44.9	105.2	0	47.5	10
MT19_F03_05	9.2	32.6	53.8	109.3	1	46.5	9.5
MT19_F06_02	9.1	33.7	55.6	94.7	0	45.4	10.2
MT19_F04_03	8.6	31.6	50.9	101.5	3	49.4	9.8
MT19_F07_04	8.1	30.3	46.7	102.3	3	46.2	10.2
MT19_F03_04	7.5	37.7	61.7	123.7	6	47.2	10.6
MT19_F06_01	7.4	31.9	52.9	83.5	3	41.1	10.9
MT18F00309	7.4	39.3	62.4	82	43	46.7	10.5
MT19_F03_02	7.3	34.3	56.9	101.8	1	47.6	9.2
MT19_F03_06	7	34	55	97.7	3	47.2	8.8
Lavina	6.9	36	58.9	114.7	3	50.1	10.1
MT19_F03_01	6.9	34.6	57.7	112.3	24	46.1	10.6
MT19_F04_02	6.8	29.3	46.5	102.4	0	45.9	9.9
MT18F00508	6.8	31.3	50.2	91.8	0	40.8	10.5
MT19_F05_04	6.7	31.8	52.3	106.2	3	47.1	8.8
MT19_F03_03	6.4	33	54.4	107	1	46.1	10.3
MT19_F07_03	6.4	34.5	57.8	97.9	3	42.9	10.9
MT19_F02_03	6.4	35.9	56.3	97.3	10	45.2	11.1
MT19_F01_05	6.4	34.6	55.2	87.7	3	47.8	10.1
MT19_F07_02	6.4	31.3	49.8	74.3	1	48.7	12.2
Hays	6.3	36.4	60.1	134.7	7	50.9	9.9
MT19_F04_04	6.3	31.9	51.3	109.6	79	47.4	10.5
MT17F02406	6.3	31.8	51.5	109	0	49.3	8.8
MT18F00803	6.2	31.5	50.8	118.5	15	46.2	10.5
MT19_F04_05	6.2	31.7	51.8	93.6	0	48.5	10
MT19_F01_01	6.1	32.3	52.2	113.2	1	48.4	10.5
Haybet	6	37.2	61.8	92.2	40	49.9	11.2
MT19_F06_05	5.9	34	57.5	98.7	3	39.2	11
MT19_F04_01	5.7	32.4	51.5	109.2	1	47.7	10.3
MT19_F01_03	5.7	36.9	58.5	101.9	1	47.5	10.4
MT19_F07_01	5.6	32.5	50.9	100.7	1	46.1	11.2
MT19_F06_04	5.4	28.8	47.1	101.4	3	45.6	9.3

MT18F00811	5.4	32.2	52.3	75.8	3	42.2	11.8
MT19_F05_01	5.3	32.7	53	116.7	0	47.8	9.4
MT19_F02_01	5.3	32.9	52.5	112.3	1	45.8	9.6
MT19_F06_03	5.2	33	54.6	85	1	42.7	12.5
MT18F00310	5	37.3	59.4	122.3	3	48.1	9
MT19_F05_05	4.9	36.6	60.6	128	1	46.9	8.7
MT19_F01_04	4.9	35.9	56.4	114.7	3	47.6	11
MT18F00509	4.8	34.5	56.9	88.1	1	41.1	11.2
MT19_F02_02	4.5	34.6	56	99.9	15	46.6	8.7
MT19_F05_02	4.5	34.5	57	94	53	48.2	10.5
MT19_F07_05	4.5	27.9	41.1	83.8	3	46.7	10.1
MT19_F02_04	4.4	36.4	59.1	94.2	1	44.5	10.5
MT19_F01_02	3.9	36.2	58.3	120.1	6	47.4	11.7
Mean	6.3	33.5	54.3	102.5	7	46.4	10.3
CV	32.2	20.6	21.0	22.1	347.9	20.1	22.4
LSD	3.5	12.0	19.9	39.5	43.5	16.3	4.0

ADF = Acid detergent fiber, NDF = neutral detergent fiber

Project Title: 2020 Spring Wheat Off-Station Trial

Objective: To evaluate the performance of selected spring wheat varieties in a production environment in northwestern Montana

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi, Hwa-young Heo, Jason Cook

Summary:

The off-station spring wheat trial was planted on April 22, 2020, and irrigated with 2.75 inches. See Table 1 for detailed management information.

Yields ranged from 124.8 (Corbin) to 155.9 (Duclair) bu/A, with an overall average of 142.9 bu/A (Table 2). The average test weight was 62.5 lb/bu. MT1053/MO8/3-4 had the lowest test weight whereas, SY Ingmar being the highest. The average protein content was at 14%. The NS Presser CLP had the highest protein content (15.8%), whereas WB Gunnison and MT1274/RB07 had the lowest protein (12.9%). Fortuna was the tallest plant (45 in.), whereas both SY Soren and Brennan were the shortest (34 in.). The average falling number (FN) for this trial was 430 seconds. Both Duclair and Alum had the fastest FN (both 371 sec.). The slowest FN was the NS Presser CLP (511 sec), which also had the highest protein content amongst the cultivars tested.

From seeding to harvest, this nursery received 9.7 inches of rain.

Table 1. Management information

Seeding date:	4/22/2020	Field Location:	R5
Julian date:	113	Harvest date:	8/26/20
Seeding rate:	-	Julian date:	239
Previous crop:	Alfalfa	Soil type:	Fine sandy loam
Herbicide:	Axial/Cleansweep (6/1)	Tillage:	Conventional
Insecticide:	None	Soil residual nutrient (NO_3^{-1}, P, K, lb/A):	124-8-220
Fungicide:	None	Nutrient fertilizer applied (N, P_2O_5, K_20, lb/A):	94-15-80-10(S)

Table 2. Agronomic performance of the Off-Station spring wheat.

ID/ Name	Cultivar/ Pedigree	Yield bu/A	TWT lb/bu	Protein %	HDDT Julian	Height in.	Rust %	FN sec.
LIMAGR143	LCS Pro	62.5	62.7	14.5	170	30.6	6.0	377.8
WSCIA	ALUM	61.6	62.9	14.3	174	29.0	1.0	416.8
MT 1621	MT1148/MT1133	61.1	62.1	14.7	169	26.9	7.7	405.0
PI660981	DUCLAIR	61.0	61.3	14.6	170	29.8	2.0	393.2
PI 676978	LANNING	59.5	62.2	15.4	170	26.0	2.0	391.8
MT 1716	MT1274/RB07	59.1	61.5	14.6	170	27.8	16.7	406.8
PI633974	CHOTEAU	58.9	61.2	14.6	171	26.7	6.7	387.2
MT 1767	12SR225/12F5 827	58.7	60.5	14.5	169	27.3	9.3	390.2
MT 1673	Duclair x McNeal/Glupro, +, fam 72-17	56.8	60.3	15.6	169	28.1	0.0	397.2
PI642366	VIDA	54.3	61.6	14.2	176	27.0	3.0	368.8
PI 679964	NS PRESSER CLP	53.1	61.4	13.7	176	28.3	36.7	392.2
BZ996434	CORBIN	52.7	62.4	14.2	169	28.1	9.3	391.5
CI 13596	Fortuna	52.1	61.2	14.8	172	32.1	5.3	399.3
BZ92413R	WB GUNNISON	51.6	62.6	14.1	174	26.6	8.3	437.0
WB9879CLP	WB9879CLP	49.7	61.1	14.9	172	25.9	5.3	417.5
AGRIPR141	SY INGMAR	49.5	63.0	16.3	172	27.1	1.0	451.6
ND 695	REEDER	49.2	62.7	14.1	175	27.3	3.0	392.5
PI 671855	EGAN	46.4	60.9	16.7	175	28.6	0.0	463.9
AGRIPR14	SY SOREN	45.6	62.2	16.1	170	24.4	7.7	429.4
AGRIPR10	BRENNAN	42.1	62.1	15.7	169	23.5	5.3	439.2
	MEAN	54.3	61.8	14.9	171.6	27.6	6.8	407.5
	LSD (0.05)	9.9	0.4	0.3	2.3	3.2	10.4	21.6
	CV%	11.1	0.4	1.3	0.8	7.0	92.7	3.2

Cultivar/Line	Yield bu/A	TWT lb/bu	Protein %	HDDT Julian	Height in.	Rust %	FN sec.	TKW g.
DUCLAIR	155.9	61.8	13.9	181	35	1	371	37.8
DAGMAR	155.7	63.0	14.6	181	38	0	446	44.7
ALUM	153.6	62.8	13.5	184	37	0	371	39.2
WB9879CLP	153.4	62.6	13.8	182	39	1	467	34.4
MT1053/MO8/3 -4	149.9	61.1	13.9	186	42	1	415	37.7
LANNING	149.3	62.4	13.7	180	37	0	435	38.9
LCS PRO	148.8	63.1	13.8	181	42	1	395	43.7
VIDA	146.0	61.9	13.6	181	38	0	406	37.4
CHOTEAU	144.9	61.9	13.7	182	37	0	400	35.8
EGAN	144.2	62.0	15.7	184	39	0	503	38.4

SY SOREN	142.1	63.4	14.0	181	34	0	408	33.6
REEDER	139.9	62.7	14.3	181	42	0	436	38.4
MT1274/RB07	139.7	62.8	12.9	181	38	1	431	29.6
NS PRESSER CLP	139.7	62.1	15.8	184	39	0	511	37.1
SY INGMAR	139.2	63.6	14.0	183	36	0	414	34.1
WB GUNNISON	138.1	62.3	12.9	182	37	3	442	43.1
BRENNAN	135.4	63.7	14.2	181	34	0	456	36.2
Vida*4/Conan	131.7	61.4	14.1	182	41	0	429	37.2
FORTUNA	126.4	62.6	13.6	183	45	0	427	38.4
CORBIN	124.8	62.0	14.0	181	38	0	427	40.5
Mean	142.9	62.5	14.0	182	38.4	0.4	429.5	37.9
LSD (0.05)	13.4	0.7	0.5	2	2.2	1.2	22.5	2.3
CV%	5.7	0.7	2	0.7	3.5	172.4	3.2	3.8
Pr>F	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001

TWT = test weight, HDDT = heading date, FN = falling number, TKW = thousand kernel weight

Project Title: 2020 Off-Station Winter Wheat Nitrogen Management

Objective: To evaluate the performance of the rates and split-application of nitrogen in rainfed winter wheat production environment in northwestern Montana

Personnel: J.A. Torrion, Eeusha Nafi

Summary:

The off-station winter wheat nitrogen (N) trial was planted under no-till rainfed ground with row-spacing 12-in apart on Sept. 23, 2019. See Table 1 for detailed management information.

The nitrogen rates applied were: 1) 0 as control, 2) 40, 3) 80, 4) 80 split-applied, 5) 120, and 6) 120 split-applied lbs N/A. Urea was used as an N fertilizer source. The soil had a 25 lbs/A residual nitrate and 10 lbs N drilled with the seeds at planting.

The highest yield response was recorded at the 120 lbs/A rate at either N-applied in early spring or split (early spring + heading). There were no significant differences in yield between these two treatments. There was also no statistical yield difference between the 80 lbs/A N application in the spring or split in the spring + heading application. We observed a similar trend in the grain protein (Figure 2) as the grain yield with N application rates. The plant height, test weights, and the falling number increased at 80 lbs/N and plateaued after that (data not presented).

In the spring, this nursery received 9.7 inches of rain.

Table 1. Management Information

Seeding date:	9/23/2019	Field Location:	Big Mahugh
Julian date:	267	Harvest date:	Aug. 3, 2020
Seeding rate:	90 lbs/A	Julian date:	216
Previous crop:	Peas	Soil type:	Flathead very fine sandy loam
Herbicide:	5/5: Beyond	Tillage:	No-till
		Variety	Brawl CL
Insecticide:	None	Soil residual nutrient (NO_3^-, P, K lb/A):	25-18-172
Fungicide:	None	Nutrient fertilizer applied (N, P_2O_5, K_20 lb/A):	10-35-45 (10 S, 1 Zn) - drilled N applied varied, see N treatment

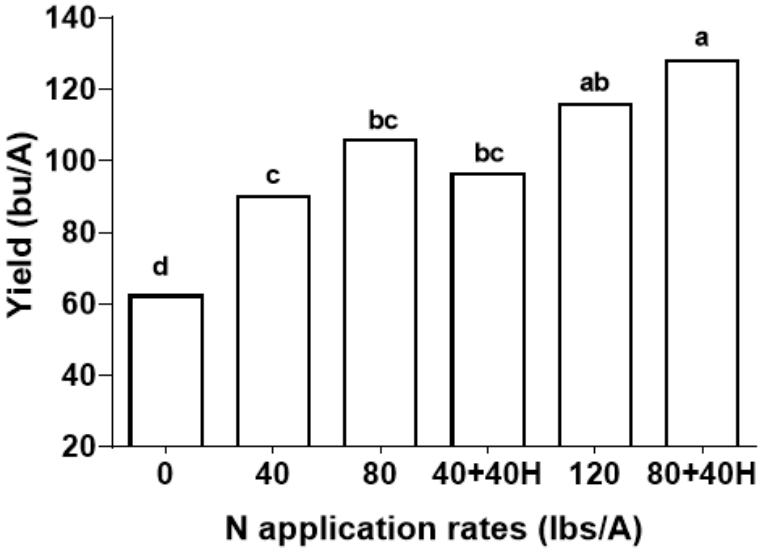


Figure 1. Yield response to nitrogen (N) application rates and timing (split-applied at heading). The first application was in early spring. The split (second) application is indicated by a '+' sign and H (at Heading). The application rates specified did not include the residual N (25 lbs/A) and the amount drilled with the seeds (10 lbs/A). The same letter assignment indicates nonsignificance at *P*<.05.

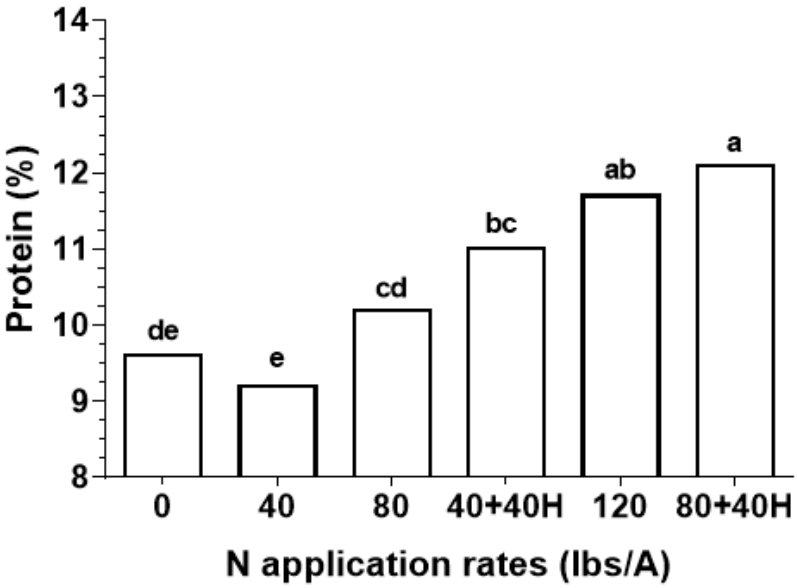


Figure 2. Protein response to nitrogen (N) application rates and timing (split-applied at heading). The first application was in early spring. The split (second) application is indicated by a '+' sign and H (at Heading). The application rates specified did not include the residual N (25 lbs/A) and the amount drilled with the seeds (10 lbs/A). The same letter assignment indicates nonsignificance at *P*<.05.

Project Title: 2020 Intrastate Winter Wheat Trial

Objective: To evaluate the performance of selected winter wheat in northwestern Montana

Personnel: Amanda Shine, J.A. Torrion, Eeusha Nafi, Jim Berg, Phil Bruckner

Summary:

Forty-nine (49) winter wheat varieties/lines were planted in fall 2019, and managed under rainfed condition (Table 1). A total of 16.5 inches rainfall was received during the growing period (Sept. 2019 -Aug. 2020).

On average, the grain yield was 153 bu/a, and ranging from 122 bu/a for SY 517 CL2 to 173.5 bu/a for WB4792. Grain test weight (TWT) averaged 62.2 lbs/bu, ranging from 58.6 lbs/bu for MTS18149 to 64.8 lbs/bu for SY 517 CL2 (Table 2). The average day for heading was 166 with the earliest heading at 156 for CP7909 and the latest was at 171 for both Loma and MTS1831. The average plant height was 37.2 inches. The tallest variety was AAC Wildfire and the shortest was SY 517 CL2. Thousand kernel weight (TKW) averaged 43.5 g, ranging from 35.6.8 g for WB4418 to 56.5 g for Mpress (SWW). Falling no. averaged 326 sec., and ranging from 258.5 sec. for Loma to 426.4 sec. for MT1848. Average grain protein content was 10.2%; Brawl CL Plus had the highest protein content at 11.4%, whereas Incline AX had the lowest protein content at 8.9%.

Table 1. Management Information

Seeding date:	9/24/2019	**Field Location:**	Y2
Julian date:	267	**Harvest date:**	8/11/2020
Seeding rate:	Unknown	**Julian date:**	224
Previous crop:	Canola	**Soil type:**	Creston silt loam
Herbicide:	5/5: Huskie/Axial	**Tillage:**	Conventional
Insecticide:	None	**Soil residual nutrient (NO_3^-, P, K lb/A):**	60-12-260
		Nutrient fertilizer applied (N, P_2O_5, K_2O lb/A)	9/19/19: 13.5-45-80-11.25S-1.13Zn
Fungicide:	None		4/10/20: topdress 100-0-0

Table 2. Agronomic performance of the winter wheat entries

Entry	Cultivar/Line	Yield (bu/a)	TWT (lbs/bu)	Heading (Julian d)	Height (inch)	TKW (g.)	FN (Sec.)	Protein (%)
19	WB4792	**173.5**	62.2	167.0	37.4	41.6	372.7	9.2
20	LCS Jet	**171.1**	61.5	167.0	33.9	49.6	346.4	9.6
29	Mpress (SWW)	**170.7**	60.8	168.3	37.0	**56.5**	299.7	9.5
48	MT1867	**168.1**	62.5	167.0	39.0	42.1	318.5	9.7
4	Keldin	**167.6**	62.9	167.0	37.4	50.5	350.5	9.8
34	MT1745	**166.8**	62.5	167.0	41.0	45.2	401.7	10.2
32	MT1642	**166.2**	62.3	167.0	40.3	47.9	401.6	10.1
41	MTS1831	**166.1**	59.5	171.3	35.6	39.1	311.0	10.2
7	Northern	**164.0**	61.1	167.7	40.8	44.3	377.6	10.2
8	Loma	**162.8**	61.2	171.3	38.8	42.5	258.5	10.5
6	SY Clearstone 2CL	**162.1**	61.9	167.0	40.5	47.1	391.1	9.7
26	Langin	**161.9**	61.4	161.0	35.9	42.6	323.6	9.2
2	Yellowstone	**161.6**	61.4	167.0	40.5	46.2	388.7	10.2
45	MT1848	**159.8**	62.1	167.0	35.9	39.9	**426.4**	**11.1**
10	Flathead	**159.6**	63.4	161.0	36.8	46.9	379.1	10.1
23	LCS15ACC-8-21 (LCS Helix AX)	**159.3**	63.2	163.3	37.7	44.6	347.7	9.7
38	MTCL1732	**158.7**	61.5	167.0	36.6	43.2	354.4	10.5
27	Byrd CL Plus	**158.7**	62.2	163.3	40.3	44.3	321.9	9.0
33	MT1683	**158.5**	62.2	167.0	39.3	48.1	376.8	10.1
28	AAC Wildfire	156.9	59.1	169.7	42.4	47.9	355.8	10.2
15	SY Wolverine	156.9	63.6	161.0	35.9	40.3	334.0	10.2
39	MTCL1737	156.7	61.2	168.3	35.2	42.5	344.0	10.4
42	MTS18116	156.0	60.6	169.0	35.0	39.5	318.9	9.9
47	MT1866	155.1	62.6	167.0	36.3	42.5	366.0	9.8
24	Long Branch	155.0	63.1	161.0	36.5	45.0	357.9	9.7
49	MT1872	154.8	63.5	167.0	36.9	49.9	353.5	10.1
46	MT1855	153.6	62.5	167.7	39.0	39.0	339.0	10.3
25	Incline AX	150.5	61.1	167.0	38.5	43.1	329.2	8.9
22	LCS-18-7071	150.4	61.5	167.0	40.2	41.8	353.7	9.6
31	StandClear CLP	149.3	63.7	167.0	36.6	42.9	390.2	10.5
17	WB4311	148.9	62.6	167.0	32.9	47.5	367.4	10.3
40	MTS1810	148.6	62.0	167.7	38.7	44.3	392.2	**11.2**
35	MT1746	146.6	63.6	167.0	37.7	38.1	372.6	10.4
43	MTS18149	146.6	58.6	170.3	37.5	44.5	347.6	10.5
3	Judee	146.3	**64.0**	167.0	38.0	44.1	333.9	10.4
18	WB4418	145.8	60.1	165.0	36.2	35.6	318.5	10.2
12	SY Monument	145.2	61.9	167.0	35.7	42.3	362.5	10.3
44	MT1845	145.2	62.3	165.0	37.2	42.5	**409.5**	**11.2**

Continues on next page

Table 2. Continued

Entry	Cultivar/Line	Yield (bu/a)	TWT (lbs/bu)	Heading (Julian d)	Height (inch)	TKW (g.)	FN (Sec.)	Protein (%)
16	WB4269	144.7	63.6	161.0	35.8	36.6	363.0	10.3
9	FourOsix	143.7	62.8	167.0	34.7	44.1	380.2	9.8
14	SY Legend CL2	141.9	63.6	161.0	35.8	44.1	**406.3**	10.2
36	MT1787	140.8	62.7	167.0	36.0	42.6	386.3	10.7
11	Bobcat	139.5	**63.8**	167.0	36.4	42.5	373.8	10.2
1	Warhorse	138.5	62.1	167.0	39.2	41.7	393.3	**10.9**
37	MT1793	138.0	62.0	163.0	36.1	38.4	380.4	10.4
5	Brawl CL Plus	135.6	63.5	161.0	34.5	43.6	386.4	**11.4**
21	LCS Photon AX	123.7	**64.5**	163.0	38.5	40.7	**423.0**	10.7
30	CP7909	122.5	63.5	156.0	33.8	40.6	359.0	9.7
13	SY 517 CL2	122.0	**64.8**	161.0	32.4	39.3	**407.9**	10.7
	Average	152.6	62.2	165.8	37.2	43.5	362.0	10.2
	LSD (0.05)	15.2	1.1	2.2	3.1	1.7	22.7	0.6
	CV (%)	6.1	1.1	0.8	5.1	2.4	3.9	3.2
	***P*-value**	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*<.0001*

bold = indicates highest value within a column

bold = indicates varieties with values equal to highest variety within a column based on Fisher's Protected LSD (*p* =0.05)

TWT = test weight, FN = falling no.; test weight and yield standardized to 12% moisture levels

OIL CROPS

Project Title: 2020 Spring Canola Variety Trial

Objective: To evaluate the performance of selected spring canola varieties in northwestern Montana

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi, Simon Fordyce, Pat Carr

Summary:

Twenty different varieties of spring canola were planted on April 28, 2020 managed under dryland conditions (Table 1). There was minimal lodging and shattering in the trial.

The average grain yield this year was 2,985 lb/A that was 57% higher compared with last year (1898 lb/A). InVigor L345PC had the highest average yield of 3,544.3 lb/A and CS2300 had the lowest yield (2,430.7 lb/A) as shown in Table 2. The tallest variety was CS2300 (64.5 in.) and the shortest was DKTFLL21SC at 52.9 in. Average height across the trial was 57.8 in. Test weights were relatively consistent among all varieties, with an average of 51.8 lb/bu. DKTF96SC had the highest test weight (52.5 lb/bu), and CS2300 had the lowest, at 51.2 lb/bu. CP930RR had the highest oil content of 52.5% and NCC101S had the lowest (47.2 %). Average oil content across all varieties was 50.5%. Average days to flowering was 177 (julian) ranging from 174 days to 178 days.

Table 1. Management information

Seeding date:	4/28/20	Field Location:	Y4
Julian date:	119	Harvest date:	9/11/20
Seeding rate:	12 plants/ft^2	Julian date:	255
Previous crop:	Barley	Soil type:	Creston Silt loam
Herbicide:	6/2, Stinger	Tillage:	Conventional
Insecticide:	6/25, Lambda-CY-AG	Soil residual nutrient (NO_3^{-1}, P, K lb/A):	115-18-302
Fungicide:	None	Nutrient fertilizer applied (N, P_2O_5, K_20, S lb/A):	94-20-35-10

Table 2. Performance of the canola varieties.

Entry	Yield* (lbs/A)	TWT (lb/bu)	OIL (%)	FLDT (julian)	Height (in)
InVigor L345PC	3544.3	51.9	49.9	178	57.6
InVigor L233P	3355.4	51.5	51.0	178	59.7
DKTF96SC	3346.2	52.5	49.4	177	56.9
DG 760TM	3174.1	51.6	51.0	177	57.4
Experimental #1	3138.5	51.7	50.3	178	59.8
CP930RR	3106.4	51.5	52.5	175	53.9
DG 200CL	3091.4	51.3	50.9	178	59.0
DKTFLL21SC	3070.9	51.5	50.8	176	52.9
BY 6204TF	3041.6	51.8	48.8	178	58.5
DKTF91SC	3041.4	51.9	50.6	176	56.9
DG 761TM	2968.4	51.8	51.3	178	60.1
CS2600CR-T	2928.9	51.9	50.3	177	59.0
CS2500CL	2927.3	51.9	51.7	178	58.7
CP9978TF	2912.9	51.9	50.3	176	58.7
NCC101S	2876.1	52.4	47.2	174	54.6
CP955RR	2853.5	51.8	51.4	176	57.3
CS2100	2795.8	51.9	50.5	177	58.2
CP9919RR	2538.2	51.7	49.2	174	53.2
BY19-6284CL	2533.8	51.5	51.3	178	59.5
CS2300	2430.7	51.2	52.2	178	64.5
Mean	2984.5	51.8	50.5	177	57.8
LSD (0.05)	475	0.6	1.4	1	5.3
CV %	11.2	0.8	1.9	0.4	6.4
Pr > F	<0.01	<0.01	<0.001	<0.001	<0.05

*Yield adjusted to 8.5% moisture

TWT= test weight, FLDT=flowering date

Project Title: 2020 Soybean Planting Date Study

Objective: To evaluate the effect of planting date and maturity group on soybean grain yield and quality in northwestern Montana

Personnel: J.A. Torrion, E. Nafi

Summary:

Five different maturity groups (MG) of soybeans were planted on different dates, starting from late-April to late-May (Table 2) dryland conditions. Damage due to vegetative consumption by deer was observed in the late part of the season (prior to harvest, primarily) but did not contribute to the variability in yields. There was minimal lodging and shattering in the trial.

No significant interaction between planting date and MG was recorded for soybean measured traits except seed oil content. The average grain yield across the trail was 36.6 bu/A. the highest yield (42.9 bu/A) was observed when soybean was planted in May 6th and the lowest (33.6 bu/A) was recorded with delayed planting (Figure 1). The MG 0.08 had higher yields (39.0 bu/A) and increasing MG beyond 0.08 did increase yield any further (Figure 2). The caveat is that for longer MG beyond 0.08, drying down time of the pods and stems is a major concern for timely harvesting.

The highest seed protein content was observed under the delayed-planted and early maturing soybean varieties (Table 3). As planting was delayed, thousand kernel weight (TKW) and test weight (TWT) increased (Table 3). The lowest TKW (34.5 g) and TWT (57.3 lbs/bu) was found for early-planted soybean. The average TKW and TWT were 35.8 g and 57.7 lbs/bu, respectively. Late maturing soybean varieties also showed the greatest TKW (except 0.4) and TWT compared with the early maturing ones (Table 4). Seed oil content topped out at 22.1% for early-planted soybean, and decreased as planting was delayed. Oil content was inconsistent with the maturity groups, ranging from 20.7% to 21.9%.

Table 1. Management information

Seeding rate (plants/acre): 150,000	Field location: X1
Previous crop: Corn	Soil type: Creston silt loam
Herbicide: 6/3: Basagran	Tillage: Conventional
Insecticide: None	Soil residual nutrient
Fungicide: None	(NO_3^-, P, K lb/A): 190-12-258
Inoculant: Verdesian N-Dure	Nutrient fertilizer applied
	(N, P_2O_5, K_20 lb/A): 0-30-0

Table 2. Harvesting dates of the respective soybean planting dates

Planting dates	Harvesting dates
April-27	October-2
May-06	October-2
May-18	October-8
May-29	October-8

Table 3. Planting date (individual) effects on soybean quality

Planting dates	Protein (%)	TKW (g.)	TWT (lbs/bu)	Oil (%)
April-27	37.1b	34.5b	57.3b	22.1a
May-06	36.9b	35.5b	57.8ab	21.2b
May-18	38.2a	34.9b	58.2a	20.7c
May-29	38.3a	36.6a	58.0a	20.6c
Mean	37.6	35.6	57.8	21.2
CV%	4.8	11.9	1.9	4.8
Pr > F	0.006	0.04	0.02	<0.001

Table 4. Maturity group (individual) effects on soybean quality

Maturity groups	Protein (%)	TKW (g.)	TWT (lbs/bu)	Oil (%)
0.02	39.9a	33.8bc	57.4ab	20.7c
0.06	37.9b	36ab	57.3b	21.9a
0.08	37.2bc	35.9ab	57.9a	21.1bc
0.2	36.8bc	38.7a	57.8ab	21.3b
0.4	37.1c	32.4c	58.4a	20.7c
Mean	37.8	35.4	57.7	21.3
CV%	4.5	10.8	1.8	4.7
Pr > F	<0.001	<0.001	0.02	0.0008

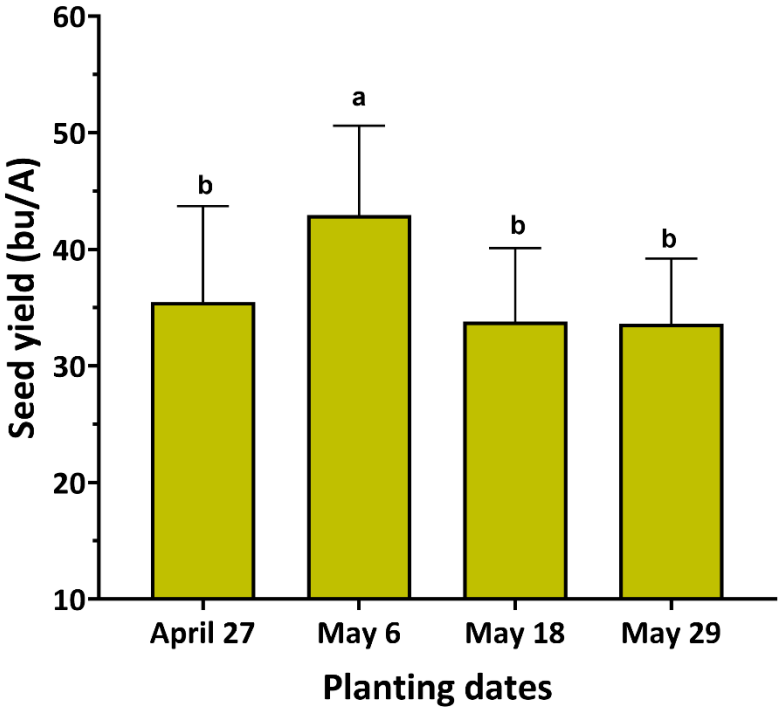


Figure 1. Soybean seed yield with planting dates. Same letter assignment denotes no statistical difference (α = 0.05).

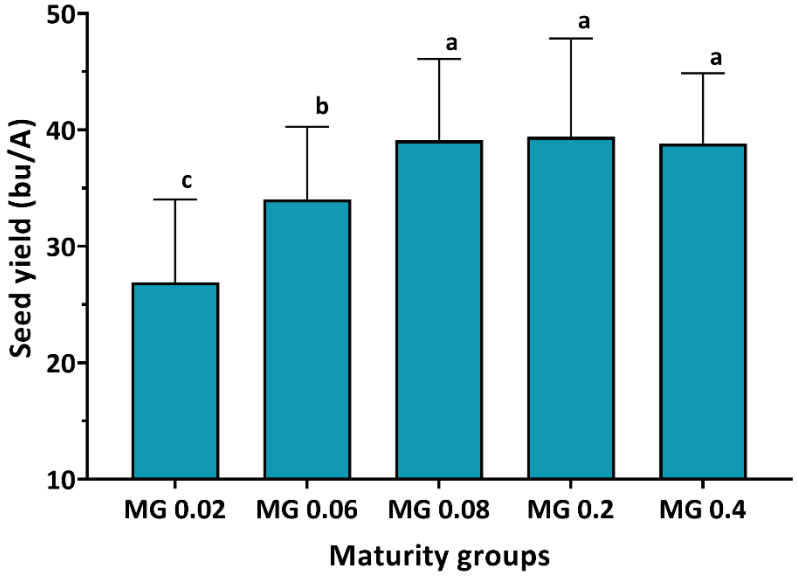


Figure 2. Soybean seed yield with maturity groups. Same letter assignment denotes no statistical difference (α = 0.05).

FORAGES

Project Title: Alfalfa Planting Density Trial

Objective: To evaluate alfalfa yield under different planting densities.

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi

Summary:

The trial was conducted under rainfed conditions on a fine sandy loam soil and received seven inches of precipitation from planting to final harvest (Table 1). Alfalfa (var. Rugged) was planted at five different seeding densities (Table 2) to assess the impact of planting density on yield and persistence.

In the 2nd year of establishment, the actual live plants/ft^2 increased with increased seeding up to 9 lbs/A pure live seeds (Figure 1a) and stagnated beyond 9 lbs/A. The actual stems/ft^2 also increased with increased seeding rate (Figure 1b). Importantly, the number of stems per plant only increased from 4 to 6 lbs/A seeding rate. Increased seeding rate beyond 6 lbs/A decreased the number of stems per plant significantly (Figure 1c). The ability of sparser plant density to produce more stems than the denser density led to the no significant forage yields among the various seeding rates (Figure 2).

Table 1. Management information

Seeding date:	5/23/19	Field:	R8
Emergence:	5/30/19	Previous crop:	Barley
Seed Treatment:	None	Harvest dates:	6/23; 8/3; 9/15
Seeding rate:	Various		
Inoculant:	PreVail (Verdesian)	Soil type:	Fine sandy loam
Herbicide:	None	Tillage:	Conventional
Insecticide:	None	Soil residual nutrient (NO_3^{-1}, P, K lb/A):	22-15-19 (2019)
Fungicide:	None	Nutrient fertilizer applied (N, P_2O_5, K_20 lb/A):	21-60-100-10S (2019)

Table 2. Planting density treatments

Treatment	Target planting density (plants/ft^2)	lbs/A PLS*
1	16	4
2	24	6
3	36	9
4	48	12
5	60	15

*PLS = pure live seed

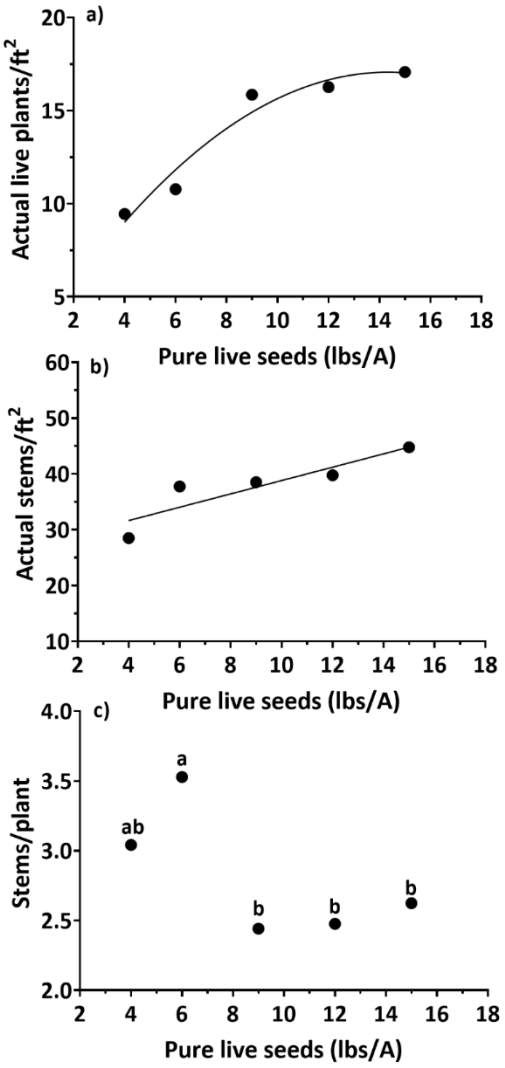


Figure 1. Relationship between seeding rate and: a) actual live plants/ft^2, b) stems/ft^2, and c) stems/plant

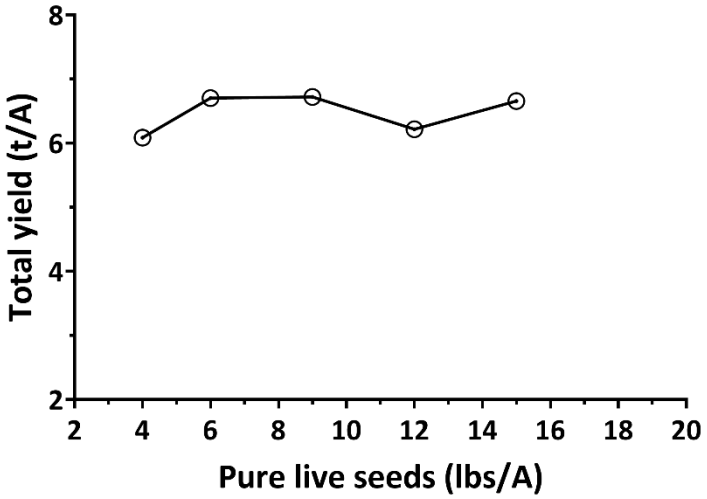


Figure 2. Total yield (two cuttings) for each of the planting density treatments. There was no significant forage yield impact on the second (2020) year of establishment across seeding rates.

Project Title: Assessing alfalfa yield and quality under different irrigation strategies to increase production efficiencies (third year)

Objective: To evaluate yields of alfalfa of various fall dormancy under differing moisture

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi

Summary:

These results presented are from the third-year (2020) of alfalfa trial established in 2018. Specific management information is provided in Table 1. The six alfalfa varieties of three fall dormancies (FD): 2, 3, and 6, were managed under three water regime environments: rainfed, 50% evapotranspiration (50ET), and 100% evapotranspiration (100ET).

As expected, yield increased significantly with increase in water availability (from rainfed to irrigation). However, there was an observed interaction with the alfalfa varieties and total water availability (Figure 1). For example, FSG229CR - an FD 2, outperformed the other varieties under rainfed condition. Also, the less dormant Cisco II- an FD 6, performed better under both irrigated conditions. However, another less dormant FD 6 – Hi gest 660 (low-lignin variety) did not perform well compared with its counterpart FD-6 (Cisco II) and the rest of the varieties across moisture regime this year. Total yield of Maxi graze- an FD 2 decreased by 11.5%, while its counterpart FD-2 (FSG229CR) increased by 5.4% under full irrigation condition compared with deficit irrigation.

The cultivar-specific yield response to water regimes this year means that each variety does have different water productivity values. Overall, the deficit irrigation treatment (50ET) consistently showed the highest water use efficiency (aka water productivity) shown in Table 2.

Table 1. Management information

Planted:	5/21/2018	Field Location:	R7
Emerged:	5/28/2018	Cutting dates (2020):	6/27-28 (1st cut); 7/30-31 (2nd cut); 9/4, 9/11, 9/115 (3rd cut)
Seeding rate:	25 seeds/ft^2	Total irrigation (50 ET):	4.8 inches
Previous crop:	Barley	(100 ET):	9.95 inches
Herbicide:	7/2: Pursuit	Total precipitation:	9.7 inches (4/15-9/25)
Insecticide:	None	Soil type:	Creston silt loam
Fungicide:	None	Soil residual nutrient (NO_3^-, P, K lb/A):	23-20-190 (fall, 2018)
Weed control:	Manual weeding	Nutrient fertilizer applied (N, P_2O_5, K_20 lb/A):	4/29/20: 100 lbs K_2O on 50 and 100 ET blocks

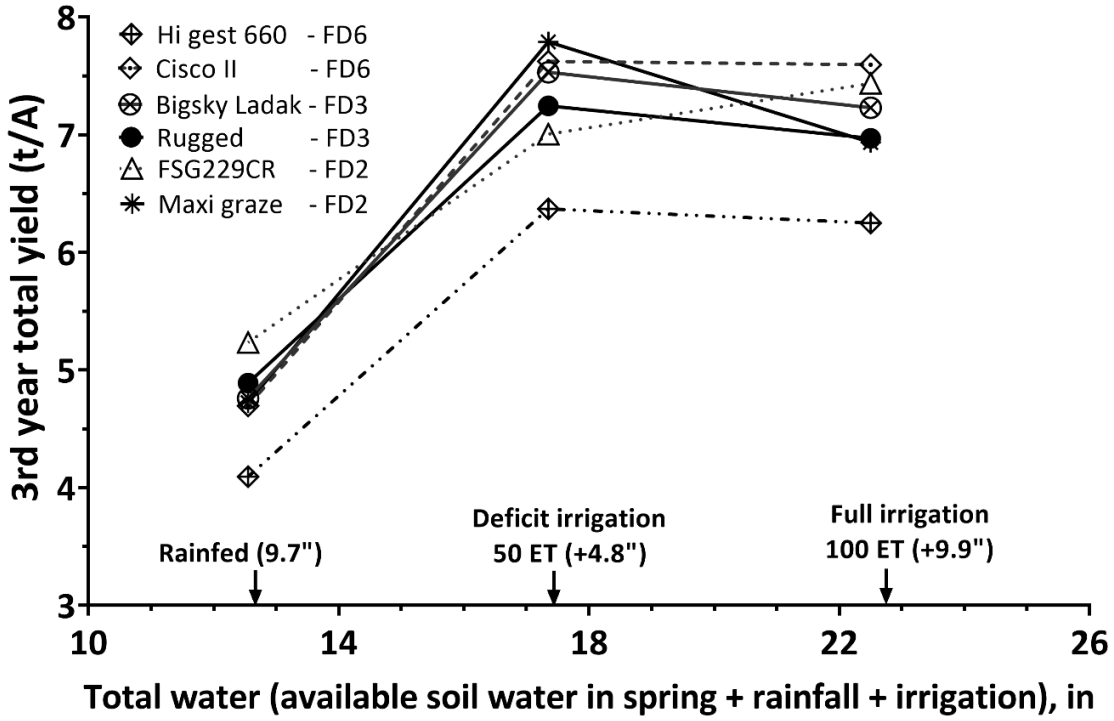


Figure 1. Moisture regime interaction with alfalfa varieties. Irrigation application in the 50% evapotranspiration (50ET) occurred at the same time with the 100ET. Specifically, the 50ET received half of what was applied under 100ET per irrigation event.

Table 2. Water productivity of the rainfed and the irrigated treatments based on evapotranspiration demand (ET). Total water productivity includes initial soil moisture in spring + rainfall + irrigation.

Water regimes	**Total water**	**Applied irrigation water**
	----------tons/inch water----------	
Rainfed	0.37	-
Deficit irrigation	0.41	0.52
Full irrigation (100ET)	0.32	0.24
Mean	**0.37**	**0.38**

Project Title: Phosphorus and potassium fertilization of dormant to semi-dormant alfalfa

Objective: To evaluate the performance of alfalfa varieties with differing P and K fertility in rainfed and irrigated environments.

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi, Maryse Bourgault, Emily Meccage, Peggy Lamb

Summary:

This experiment was carried out on May 2019 and continued in 2020 under three environments: 1) rainfed in Creston, 2) irrigated in Creston, and 3) rainfed in Havre. Tables 1 and 2 specify management information for Creston and Havre sites, respectively. Five rates of different phosphorus (P) and potassium (K) fertilization combinations were applied (Table 3) as the main plot factor. Six alfalfa varieties of varying fall dormancy (FD) ratings were used as the subplot factor (Table 4). Soil residual K level at Havre was initially high, thus no supplemental K was applied in 2019. Urea was added to all plots in an amount equal to that of the N present in the monoammonium phosphate used for P fertilizer.

The overall mean yield (cumulative 1st, 2nd, and 3rd cuttings) of irrigated environment was 36% greater than the rainfed environment in Creston. This year we had environment and fertility level interaction for total yield in Creston (Figure 1) and forage P and K content (Figure 3). No significant difference among the fertility levels were found under irrigated environment. Whereas, under rainfed environment, 1-1 and 1-0.5, P-K (lbs/A) fertility levels showed has higher yield compared with the rest of the treatments. Overall, forage P and K content was relatively higher under irrigated environment compared with rainfed environment for all the treatments except 1-0.5, P-K (lbs/A) fertility level (Figure 3). Higher forage P content was found for the 1-1, P-K (lbs/A) fertility level under both environments while, 0-1 and 1-1, P-K (lbs/A) fertility levels had the higher forage K content.

In Creston, we found a significant variety effect (fall dormancy, FD, Figure 2) on total yield, and % P and crude protein (CP) in forage. Among the varieties, Cisco (FD 6) had the highest total yield while, rest of the varieties showed similar yield pattern. The highest forage CP and P was found in Maxi-Graze (2).

No effects of variety or fall dormancy on yield or forage quality was found in Havre. Fertility levels affected total yield and forage P content in Havre (Figure 4). 1-0.5, P-K (lbs/A) showed the highest forage yield compared with the other fertility levels. Higher forage P content was found when both P and K were applied.

Table 1. Management information, Creston, MT

Seeding date:	5/22/19	Field:	R8
Emergence:	5/29/19	2020 cutting dates:	June 23-26 July 29-Aug 3 Sept 9-Oct. 8
Seed Treatment:	Apron XL + pre-treat		
Seeding rate:	30 plants/ft^2		
Previous crop:	Barley	Soil type:	Fine sandy loam
Herbicide:	Raptor (6/18/2019)	Tillage:	Conventional
Insecticide:	None	Soil residual nutrient (NO_3^{-1}, P, K lb/A):	22-15-19 (spring 2019)
Fungicide:	None	Inoculant:	PreVail (Verdesian)

Table 2. Management information, Havre, MT

Seeding date:	5/15/19	Field:	H
Emergence:	5/25/19	Previous crop:	Pea/barley forage mix
Seed Treatment:	Apron XL + pre-treat	2020 cutting dates:	June 19-20 July 30
Seeding rate:	30 plants/ft^2	Julian date:	214
Previous crop:	Pea/barley forage mix	Soil type:	Clay loam
Herbicide:	None	Tillage:	No-till
Insecticide:	None	Soil residual nutrient: NO_3^{-1}, P, K (lb/A):	50-11-319 (2019)
Fungicide:	None	Inoculant:	PreVail (Verdesian)

Table 3. Nutrients applied in 2019

ID	**P_2O_5 rates**	**K_2O rates**	**Creston**			**Havre**		
			----------lbs/A----------					
			P_2O_5	**K_2O**	**N**	**P_2O_5**	**K_2O**	**N**
1	0	0	0	0	8.5	0	0	12.7
2	0	1	0	170	8.5	0	0	12.7
3	0	0.5	0	85	8.5	0	0	12.7
4	1	1	40	170	8.5	60	0	12.7
5	1	0.5	40	85	8.5	60	0	12.7

Table 4. Alfalfa varieties used in the study

Varieties	**Fall dormancy**
Maxi-Graze	2
Rugged	3
Alphatron	4
Saltiva	5
Cisco II	6
Magna	7

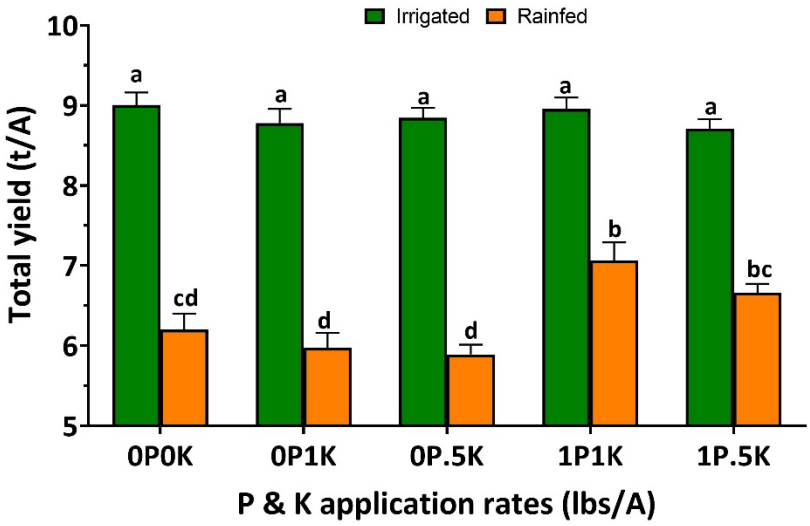


Figure 1. Total yields (3 cuttings) with fertility levels at Creston, MT. Same letter assignment denotes no statistical difference (α = 0.05).

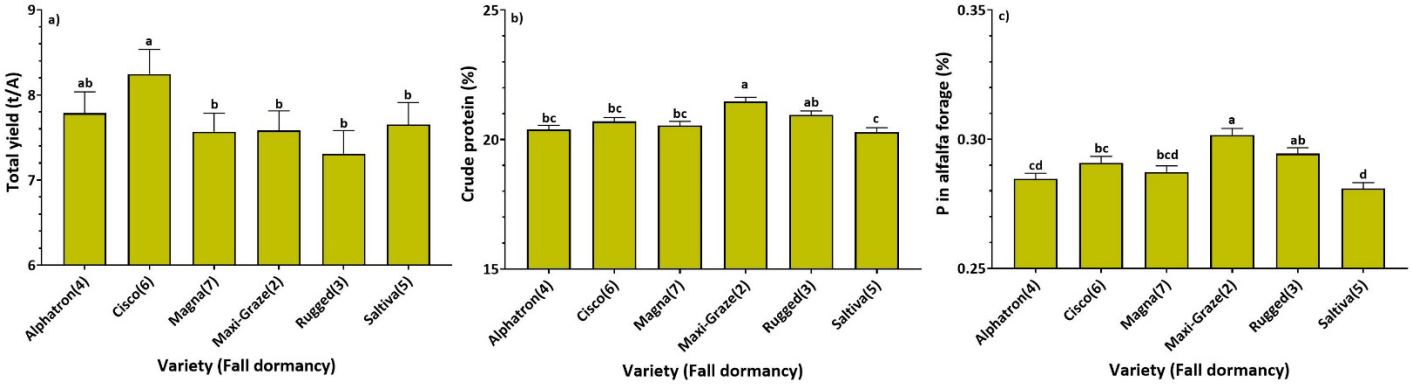


Figure 2. Total yields (a), forage crude protein (b), and P (c) with variety (fall dormancy) at Creston, MT. Same letter assignment denotes no statistical difference (α = 0.05).

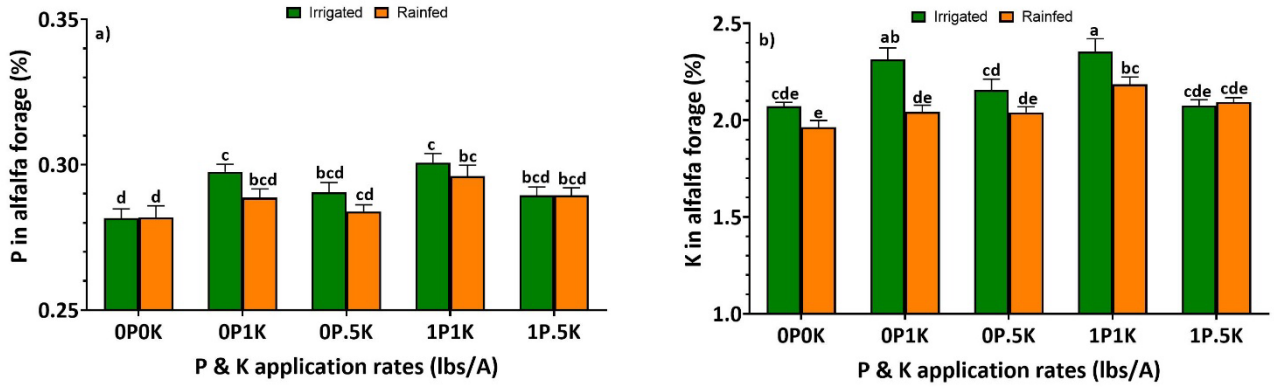


Figure 3. Forage P (a), and K (b) content with fertility levels at Creston, MT. Same letter assignment denotes no statistical difference (α = 0.05).

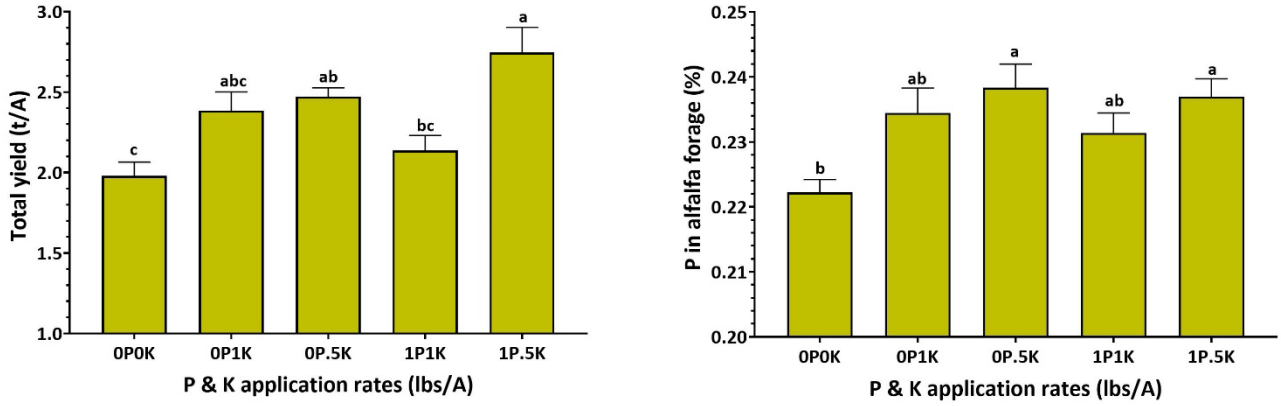


Figure 4. Forage total yield (a), and P content (b) with fertility levels at Havre, MT. Same letter assignment denotes no statistical difference (α = 0.05).

Project Title: Cool-season and Warm-season Forage grass Trial

Objective: To evaluate the performance of selected grass forages in northwestern Montana

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi

Summary:

Fourteen cool season and two warm season forage grasses were planted on April 22, 2020 to evaluate their performance (yield and quality) and suitability for production in northwest Montana. Specific management information is provided in Table 1. This trial was under rainfed condition.

Yield results were reported as summation one to two cuttings (Table 2). Whereas, forage quality results were presented as per cuttings and mean of two cuttings where applicable. Total yield averaged 2.3 t/A and ranged from 1.7 t/A for dryland tall fescue to 3.3 t/A for teff grass. Although having only one cutting, smooth brome and creeping wheatgrass contributed to relatively high yield, 2.7 and 2.4 t/A, respectively.

Water-soluble carbohydrates (WSC) averaged 14% and 15.9% in 1st and 2nd cutting, respectively. In the 1st cutting, perennial ryegrass 1 had the highest WSC at 18%, while Meadow fescue had the highest WSC content (20.4%) in the 2nd cutting. Forage lignin content was 3% on average of two cuttings. Creeping wheatgrass had the highest lignin content at 3.2% in the 1st cutting, and in the 2nd cutting, both meadow brome and teffgrass had the highest lignin content (3.9%). The lowest lignin content the meadow fescue_2 at 1% in the 1st cutting and both meadow fescue 1 and tall fescue had the lowest lignin content at 2.4% in the 2nd cutting. Crude protein (CP) content averaged 10.9% in the 1st cutting, ranged from 8.4% for smooth brome to 14.3% for dryland mix_2. In the 2nd cutting, CP averaged 10.2%, ranging from 7.9% for meadow brome to 14.7% for tall fescue or meadow fescue mix. Relative forage quality (RFQ) did not significantly differ between the two cuttings. RFQ, on average of the cuttings, was 154.5. The highest RFQ was found for meadow fescue_1 for 1st and 2nd cutting, 180.7 and 192, respectively. Both smooth brome and creeping wheatgrass had the lowest RFQ (137) in the 1st cutting, while teffgrass had the lowest RFQ in the 2nd cutting at 124.7.

Table 1. Management information

Seeding date:	4/22/2020	Field Location:	P2
Julian date:	113	Harvest date:	7/17-10/15, depending on varieties; some had two cuttings
Seeding rate:	Variety-dependent		
Previous crop:	Winter wheat	Soil type:	Creston Silt Loam
Herbicide:	7/10: Shredder	Tillage:	Conventional
Insecticide:	None	Soil residual nutrient (NO_3^-, P, K lb/A):	122-20-376
Fungicide:	None	Nutrient fertilizer applied (N, P_2O_5, K_20 lb/A):	4/8: 84-10-35-10(S)

Table 2. Forage yields of cool-season and warm-season

Variety	No. of cuttings	Forage yield (tons/A)
Cool season		
Orchardgrass	2	2.8
Smooth brome	1	2.7
Creeping wheatgrass	1	2.4
Meadow brome	2	2.4
Meadow fescue_2	2	2.4
Dryland mix_2	2	2.4
Tall fescue/meadow fescue mix	2	2.3
Meadow fescue_1	2	2.3
Dryland orchardgrass	2	2.2
Dryland mix_1	2	2.2
Perennial ryegrass_2	1	2.1
Perennial ryegrass_1	1	1.9
Tall fescue	2	1.9
Dryland tall fescue	2	1.7
Warm season		
Teff	2	3.3
Crabgrass	1	1.9
Overall Mean:		2.3
CV (%):		23.9
LSD		0.9
Pr > F		<0.01

Table 3. Quality performance per cuttings of the various forage varieties

Entries	Water Soluble Carbohydrates		Lignin		Crude Protein		Relative Feed Quality	
	Cut 1	Cut 2	Cut 1	Cut 2	Cut 1	Cut 2	Cut 1	Cut 2
Cool season								
Dryland mix_1	12.6	14.8	2.1	3.6	13.6	10.3	161.3	148.0
Dryland mix_2	12.0	15.3	2.2	3.6	14.3	10.2	156.3	149.7
Dryland orchardgrass	12.3	18.7	2.1	3.8	9.9	10.3	139.3	159.0
Dryland tall fescue	15.3	19.1	1.9	3.6	12.9	10.0	171.3	153.3
Meadow brome	11.8	14.1	2.3	3.9	12.3	7.9	151.7	138.0
Meadow fescue_1	16.2	20.1	1.1	2.4	11.3	13.5	180.7	192.0
Meadow fescue_2	15.0	20.4	1.0	2.7	10.6	10.2	173.0	172.0
Orchardgrass	13.9	20.3	1.9	3.8	9.2	8.4	145.0	150.0
Tall fescue	14.7	17.5	1.4	2.4	12.9	13.0	173.0	174.0
Tall fescue/meadow fescue mix	16.2	19.2	1.4	2.6	11.4	14.7	176.0	191.0
Teffgrass	10.2	9.4	3.0	3.9	13.8	9.4	145.3	124.7
Crabgrass	12.2	-	3.0	-	11.7	-	143.0	-
Creeping wheatgrass	15.0	-	3.2	-	9.1	-	137.0	-
Perennial ryegrass_1	18.0	-	1.2	-	10.6	-	178.7	-
Perennial ryegrass_2	15.8	-	1.6	-	8.4	-	154.0	-
Smooth brome	13.1	-	2.6	-	8.7	-	137.0	-
Warm season								
Teffgrass	10.2	9.4	3.0	3.9	13.8	9.4	145.3	124.7
Crabgrass	12.2	-	3.0	-	11.7	-	143.0	-
Mean	14	15.9	2.5	3.5	10.9	10.2	157.7	151.4
Mean (cuts)	*14.9*		*3*		*10.5*		*154.5*	
CV (%)	8.5	4.2	29.7	8.2	17.3	11.3	4.5	5.3
LSD	1.9	1.2	1.2	0.5	3.1	2.1	11.8	14.6
Pr > F	<.001	<.001	<.001	<.001	<.001	<.005	<.001	<.001

Project Title: 2020 Cool Season Forage Production Trial

Objective: To evaluate the yield and quality of five perennial cool-season grasses (2nd year of study)

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi

Summary:

Five cool season forage grasses were planted on May 2019 and continued in 2020 to evaluate their performance (yield and quality) and suitability for production in northwest Montana. Seeding rates used in this study followed the industry recommendation. Other management information is provided in Table 1.

Weed pressure within plots was low, and hand-weeding was performed throughout the growing season. No irrigation and fertilizer were applied in 2020 growing season. Results are reported based on two cuttings.

The average total yield (cumulative 1st and 2nd cuttings) was 4.3 t/A. Among the varieties, dry land mix grasses had the highest yield at 5.4 t/A and Timothy had the lowest, at 2.9 t/A. In both cuttings, dry land mix grasses had the highest yield whereas Timothy is the lowest. Crude protein (CP) averaged 9.4% in the 1st cutting, ranging from 10.9% for Oahe and 7% for Timothy. Except for Timothy, the second cut had lower CP in the second cut compared with the first cut. Average water soluble carbohydrates (WSC) increased over the cuttings, ranging from 8.9% (1st cutting) to 11.5% (2nd cutting). Regardless of cuttings, orchard grass had the highest WSC content (11% and 14.7%) and Luna had the lowest WSC content (7.6% and 9.5%). Relative forage quality (RFQ) averaged 119.4 in the 1st cutting, ranging from 114.8 for both dryland mix and Luna, and 125.5 for Oahe. In the 2nd cutting, dryland mix (95) had the lowest RFQ and Timothy (143.3) had the highest with an average RFQ of 112.4.

Table 1. Management Information

Seeding date:	5/29/2019	Field Location:	R8
Julian date:	149	2020harvest date:	6/11; 8/11 (2nd cut Luna & Timothy); 9/29 (2nd cut orchard grass & dryland mix)
Seeding rate:	Various	Julian date:	163; 224; 273
Previous crop:	Barley	Soil type:	Fine sandy loam
Herbicide:	None	Tillage:	Conventional
Insecticide:	None	Soil residual nutrient (NO_3^-, P, K lb/A):	(Spring, 2019), 22-15-99
Fungicide:	None		
Irrigation:	2019, minimal for establishment 2020, none	Nutrient fertilizer applied (N, P_2O_5, K_20 lb/A):	(Spring, 2019): 100-20-60 (spring, 2020): none

Table 2. Quality and yield performance of forages

Forage*	CP		WSC		RFQ		Yield		
	--------%---------		--------%---------				----------t/A----------		
	1st Cut	2nd Cut	1st Cut	2nd Cut	1st Cut	2nd Cut	1st Cut	2nd Cut	Total
Dryland Mix	8.7	4.9	8.6	10.2	114.8	95.0	3.6	1.7	5.4
Oahe	10.9	8.1	8.7	9.5	125.5	113.8	3.5	1.7	5.2
Luna	10.5	7.7	7.6	9.5	114.8	103.5	3.3	1.7	5.0
Orchard grass	10.1	4.5	11.0	14.7	118.8	106.3	2.2	1.1	3.3
Timothy	7.0	9.0	8.5	13.4	123.0	143.3	2.1	0.8	2.9
Mean	9.4	6.8	8.9	11.5	119.4	112.4	2.9	1.4	4.3
LSD	3.1	1.3	1.9	1.5	ns	10.7	0.9	0.7	1.4
CV (%)	14.4	8.7	9.3	5.6	5.7	4.2	14.6	21.8	14.5
Pr > F	<0.01	<0.001	<0.001	<0.001	ns	<0.001	<0.001	<0.01	<0.001

*Forage species
Dryland Mix: tall fescue, intermediate wheatgrass, smooth brome, Alaska brome, meadow brome
Oahe: intermediate wheatgrass
Luna: pubescent wheatgrass
CP = Crude protein; WSC = Water soluble carbohydrates; RFQ = Relative Forage Quality

Project Title: Determining Optimal Nitrogen Fertilization of Selected Warm Season Grasses for Yield and Quality

Objective: To evaluate the nitrogen response of seven warm season grasses under different levels of nitrogen fertility and contrasting moisture regimes.

Personnel: Jessica A. Torrion, Amanda Shine, Eeusha Nafi

Summary:

This trial was planted on May 28-29, 2020. Specific management information is provided in Table 1. Five different nitrogen (N) fertilization treatments were applied (Table 2) as the main plot factor with seven grass species (Table 3) as the sub-plot factor. The study was duplicated under two moisture regime environments: rainfed and irrigated. A total 5.8 inches of water was applied under the irrigated environment. The rainfed environment received a total of 6.7 inches of rainfall.

As expected, greater forage yield was attained under irrigated condition (6.2 t/A) compared with rainfed condition (4.1 t/A). Forage yield did not increase with total N levels (Figure 1) due to the high initial soil nitrate residuals and the previous crop alfalfa credit. Forage yield averaged 5.1 t/A, ranging from 7.8 t/A for sorghum-sudan grass to 3.4 t/A for teff grass. Although forage yield was significantly lower under rainfed condition, yield patterns were similar under both environments for the grass species (Figure 2).

Grass crude protein content interacted with species and environment (Figure 3) where Tiffleaf 3 had the highest crude protein when planted under rainfed. Crude protein content averaged 15.3% and ranged from 9.8% for sorghum-sudan grass to 18.4% for teff grass species. Further, crude protein content followed similar pattern in either environments. Forage nitrate content increased with increased nitrogen levels and irrigation application. Irrigation application resulted in increased nitrogen availability (greater uptake) to the plants (Figure 4). Although pearl millet had the highest forage nitrate content (2575 ppm), sorghum-sudan grass species also had a significant amount of forage nitrate content compared other species. Sudangrass had the lowest forage nitrate content (751 ppm) among other species (data not shown).

Table 1. Management information

Seeding date:	5/28-29	Field Location:	R5
Seeding rate:	Species-dependent	Harvest date:	Species-dependent (7/28-9/29)
Previous crop:	Alfalfa	Soil type:	Creston Silt Loam
Herbicide:	Shredder	Tillage:	Conventional
Fertilizer applied	Applied N-40-80	Soil residual nutrient	
(N, P_2O_5, K_20 lb/A):		(NO_3^-, P, K lb/A):	78-26-37

Table 2. Nutrients levels in 2020. The total nitrogen (N) was the total N supply from the initial soil residual nitrates down to 2-ft depth + N from applied urea, monoammonium phosphates + N credit from previous alfalfa crop.

Treatments	**Applied N**	**Total N**	**Applied P_2O_5**	**Applied K_20**
	----------lbs/A----------			
N0	0	108	40	80
N1	38	146	40	80
N2	63	171	40	80
N3	88	196	40	80
N4	113	221	40	80

Table 3. Species, seeding rates, and entry names. Sorghum-Sudan entries are variety not stated.

Entry	**Species**	**Seeding rate (Seeds/ft^2)**
Tifleaf 3	Pearl Millet	15
Piper	Sudangrass	25
Corvallis	Teff	10
20BAR_ET	Teff	10
SS_01	Sorghum-Sudan	25
SS_02	Sorghum-Sudan	25
SS_04	Sorghum-Sudan	25

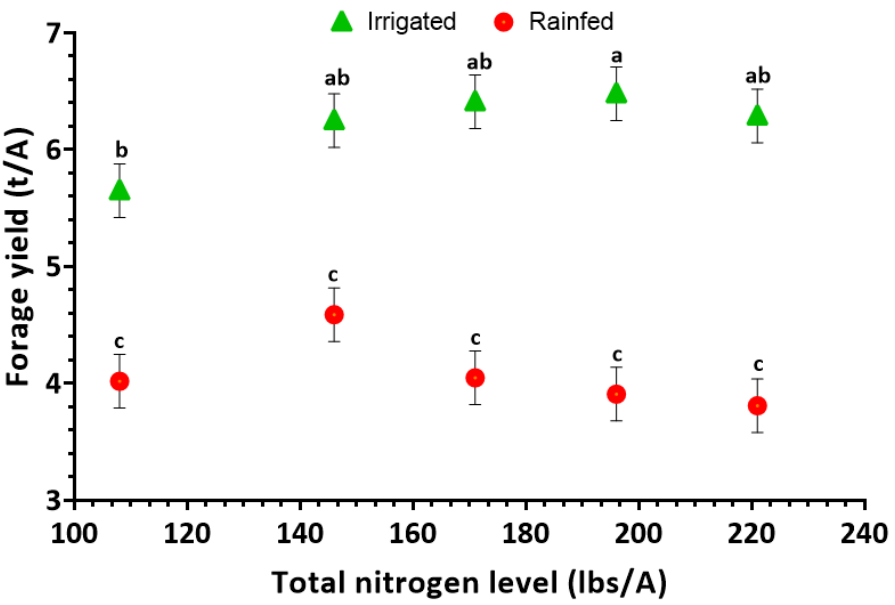


Figure 1. Environment x total nitrogen level interaction means of forage yield (t/A). Error bars are the standard error of the difference between N supply across environments. Same letter denotes nonsignificance within environment at α= 0.05. The total nitrogen (N) was the total N supply from the initial soil residual nitrates down to 2-ft depth + N from applied from urea, monoammonium phosphates + N credit from previous alfalfa crop.

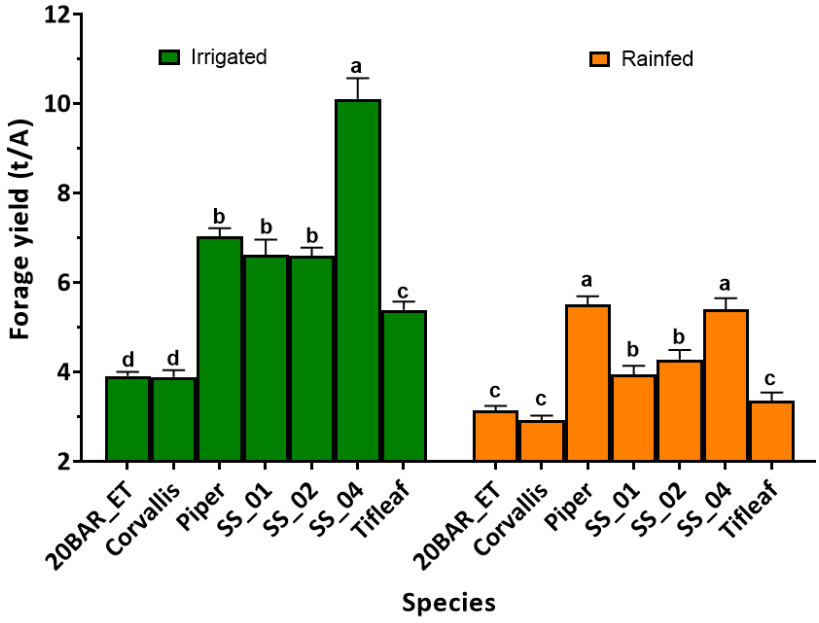


Figure 2. Environment x species interaction means of forage yield (t/A). Error bars are the standard error of the difference between species within an environment. Same letter denotes nonsignificance within environment at α= 0.05.

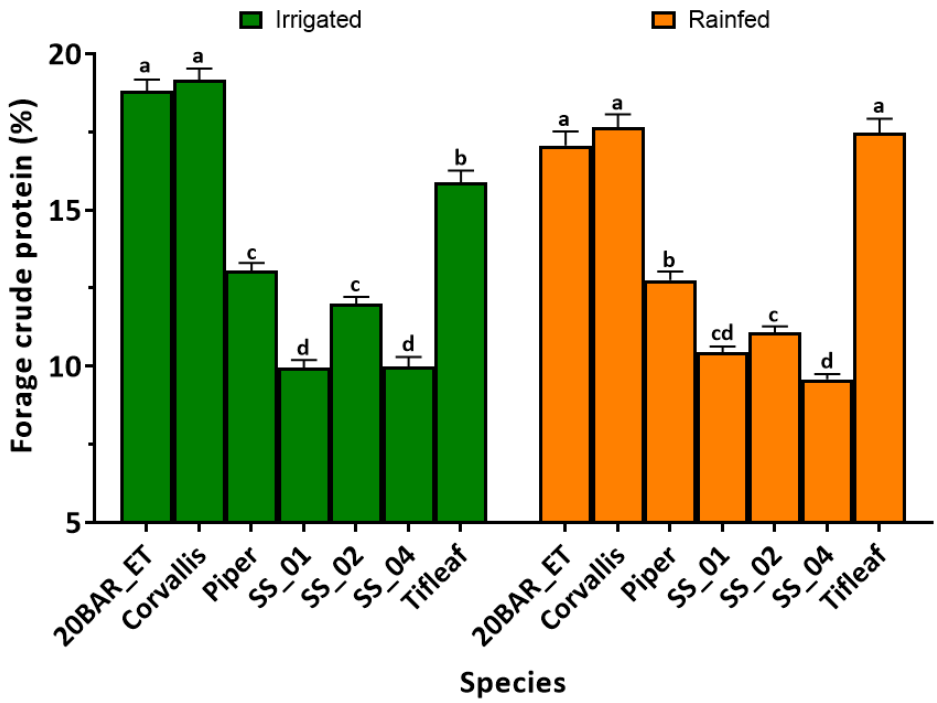


Figure 3. Environment x species interaction means of forage crude protein content (%). Error bars are the standard error of the difference between species within an environment. Same letter denotes nonsignificance within environment at α= 0.05.

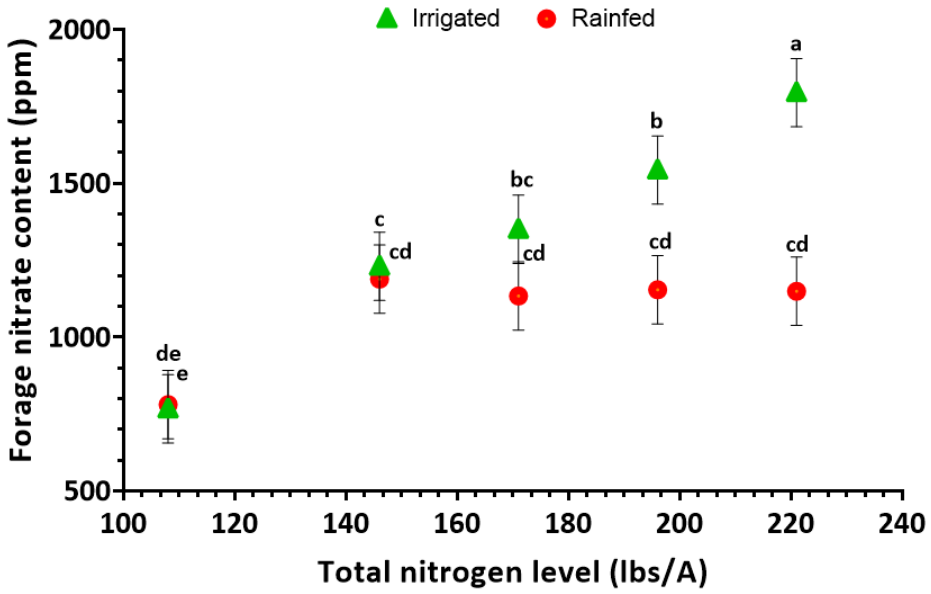


Figure 4. Environment x total nitrogen level interaction means of forage nitrate content (ppm). Error bars are the standard error of the difference between N supply across environments. Same letter denotes nonsignificance within environment at α= 0.05. The total nitrogen (N) was the total N supply from the initial soil residual nitrates down to 2-ft depth + N from applied from urea, monoammonium phosphates + N credit from previous alfalfa crop.

Project Title: 2020 Winter Cereal Forage Trial

Objective: To evaluate the performance of selected forage wheat and triticale in northwestern Montana

Personnel: J.A. Torrion, Amanda Shine, E. Nafi, Simon Fordyce, Pat Carr

Summary:

This trial was planted on a silt loam ground with known subsurface moisture recharge. Other manageme **b.** ormation is provided in Table 1.

The average forage yield (on a dry matter basis) was 9.6 t/A which was 20% more than last year. The FX 1001 triticale had the highest yield at 11.5 t/A and Ray wheat had the lowest, at 5.9 t/A (Table 2). Days to heading averaged 171 days, ranging from 167 days for MTF 20187 wheat to 178 days for Willow Creek wheat. The tallest variety was FX 1001 triticale at 73 inch and the shortest one was 47.4 inch Ray wheat. The FX 1001 also had the greatest relative feeding value (RFV) at 102%. On the other hand, MTF 20187 wheat had the lowest RFV of 81%. However, RFV values amongst all entries did not vary with each other (Table 2).

Grain yield averaged 121 bu/A and ranged from only 88 bu/A (Willow Creek wheat) to 155 bu/A (Ray **c.**). Grain protein averaged 12.6% and ranged from 11.3% for Ray wheat to 13.7% Willow Creek wheat.

Table 1. Management information

Seeding date:	9/24/2019	Field Location:	Y2
Julian date:	267	Harvest date:	7/7 (forage) 8/26 (grain)
Seeding rate:	16 plants/ft^2	Julian date:	188 and 238
Previous crop:	Canola	Soil type:	Creston Silt loam
Herbicide:	5/5: Huskie	Tillage:	Conventional
Insecticide:	None	Soil residual nutrient (NO_3^-, P, K lb/A):	60-12-260
Fungicide:	None	Nutrient fertilizer applied (N, P_2O_5, K_20 lb/A):	Pre-plant: 201-45-80 (10S) 4/10: Spring topdress 100-0-0

Table 2. Agronomic performance of wheat and triticale forage entries.

Species	Cultivar	Heading	Height	Forage			Grain	
				Moisture	RFV	Yield	Yield	Protein
		Julian	in	----------%---------		tons/ac	bu/ac	%
Triticale	FX 1001	169	73.0	65	102	11.5	123	12.7
Wheat	MTF 20188	168	57.1	65	93	10.3	127	12.7
Wheat	MTF 20189	169	59.3	67	94	10.0	114	13.1
Wheat	Willow Creek	178	63.5	66	93	9.9	88	13.7
Wheat	MTF 20186	174	57.0	67	90	9.3	122	12.3
Wheat	MTF 20187	167	50.7	65	81	8.9	118	12.3
Wheat	Ray	177	47.4	67	91	7.0	155	11.3
Mean		171	58.3	66.0	92	9.6	121	12.6
CV%		0.7	3.9	3.5	9.5	10.2	7.5	4.5
LSD 0.05		1.9	37	NS	NS	1.7	13.5	0.8
P-value		<0.001	<0.001	NS	NS	<0.01	<0.001	<0.001

Height = height at forage harvest, NS = not significant

*Forage yield on a dry matter basis and grain yield at 13% moisture.

PULSES

Project Title: Faba Variety Trial – 2020

Objective: To evaluate Faba for yield and agronomic performance in Northwestern Montana

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi

Summary:

The nursery was planted under rainfed conditions with known subsurface moisture on silt loam soil. Weeds were controlled via pre-plant incorporated Triflurex and weeded manually during the season. Detailed agronomic management is shown in Table 1.

Significant differences were observed for all measured traits, except for number of live plants, days to maturity, and lodging. Average yield was 2960.1 lb/A with a range from 1517.6 to 4349.3 lb/A. Average protein was 29.9%, with the lowest at 27.7% and the highest at 32.3%. Thousand seed weight ranged from 227 to 622 grams. Average days to flowering after planting was 63 days with a range from 60 days to 66 days. Days to maturity after planting ranged from 119 days to 127 days. Plant height at maturity ranged from 30.7 to 46.5 inches. Lodging was observed only for one variety, ranging from 2-8%.

(Detailed yield and agronomic data are not shown)

Table 1. Management information

Seeding date:	4/27/2020	Harvest date:	9/4/2020
Julian date:	118	Julian date:	248
Seeding rate:	4 plants/ft^2	Soil nutrient residual (NO_3^-, P, K lbs/A):	190-12-258
Previous crop:	Corn	Nutrient fertilizer applied (N, P_2O_5, K_20 lbs/A):	0-30-0
Tillage:	Conventional	Insecticide:	6/11: Warrior
Irrigation:	None	Herbicide:	6/11: Varisto
Soil type:	Creston Silt Loam	Inoculant:	Verdesian N-Dure

OTHER CROPS

Project Title: Corn planting date experiment

Objective: To evaluate the effect of planting date and cultivar on silage production and kernel yield and quality

Personnel: J.A. Torrion, Jordan Penney, Amanda Shine, Ben Hoesl

Summary:

Two corn varieties, P8034R (80 days) and H2512 (75 days) were sown on three planting dates (April 27, May 6, and May 18). Table 1 shows detailed agronomic and management information. Silage and kernel yields were recorded.

Overall, kernel yield loss was observed with later planting dates (Table 2). Although caution should be noted when planting early. There is a chance of lowered soil temperature in the last week of April (Figure 1).

The production challenge observed was predatory birds. The negative grain yield impact due to birds is related to planting date and corn maturity (Figure 2). The later-planted and the 80-day corn is more prone to grain yield loss due to predatory birds than the earlier-planted and the 75-day corn (Table 2). Yield reduction due to predatory birds on 80-day corn is greater than the 75-day corn (Table 3), although the actual yield was significantly higher for 80-day corn compared with 75-day corn.

The takeaways, from two-year (2019-2020) of data, are: 1) yield reduction with delayed planting (3rd week of May, see also economic loss in Figure 3), 2) higher yield potential with 80-day corn than 75-day, but the 80-day is prone to wildlife feeding and also delayed harvest, 3) planting date had no negative impact if corn is planted only for silage, and 4) the 80-day corn performed better as silage.

Table 1. Management information

Seeding date:	4/27, 5/6, 5/18	Field Location:	X2
Julian date:	118/127/139	Harvest date:	Silage: 9/9 Grain: 1/19/21
Seeding rate:	28,000 plants/A	Julian date:	253/19
Previous crop:	Peas	Soil type:	Silt loam
Herbicide:	5/4: Roundup 5/28: Buccaneer 5 6/25: Buccaneer 5	Tillage:	Conventional
Insecticide:	None	Soil residual nutrient (NO_3-, P, K lb/A):	185-24-316
Fungicide:	None	Nutrient fertilizer applied (N, P_2O_5, K_20, S lb/A):	125-40-80-10

Table 2. Influence of planting date to grain yield. Same letter assignment denotes no statistical difference (*P* = 0.05).

Planted	----------(bu/A@15% moisture)----------	
	Estimated with the absence of predatory birds	Actual grain yield with the predatory birds
April 27	155a	132a (-15%)
May 06	149a	111ab (-26%)
May 18	148a	91b (-39%)

Table 3. Influence of relative maturity to grain yield and silage. Same letter assignment denotes no statistical difference (*P* = 0.05).

Relative Maturity	----------(bu/A@15% moisture)----------		Tons/A@ 60% moisture
	Absence of predatory birds	Actual grain yield with the predatory birds	Silage
80 days (P8034R)	172a	124a (-28%)	28.6 a
75 days (H2512)	130b	99b (-24%)	25.8 b

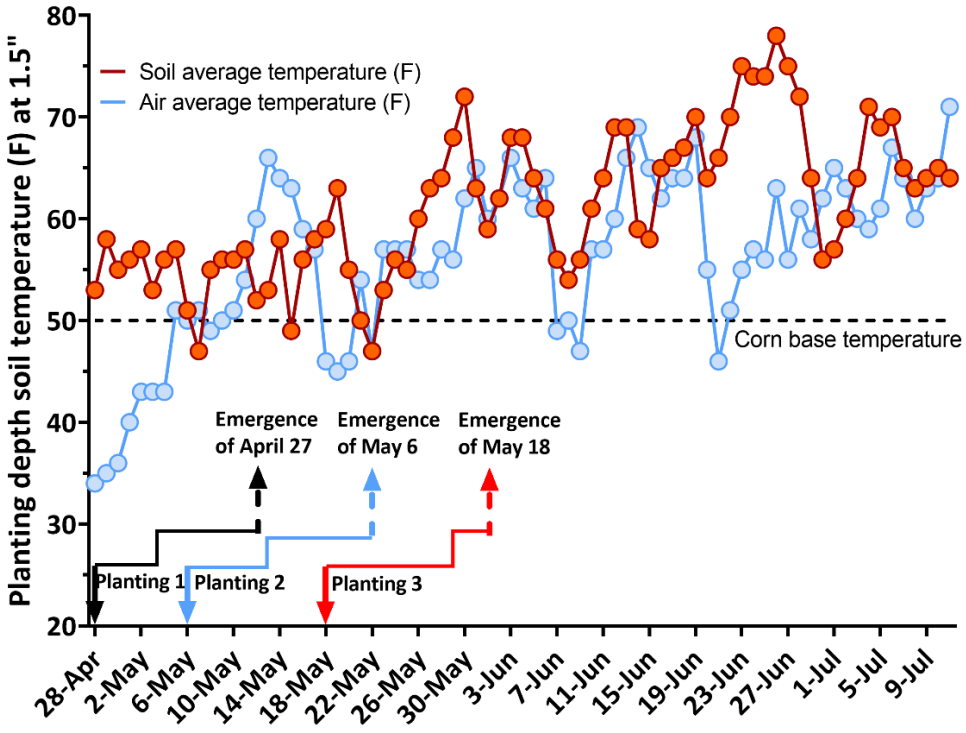


Figure 1. Trend of the soil and air temperatures with the corn planting dates and their corresponding day of emergence.

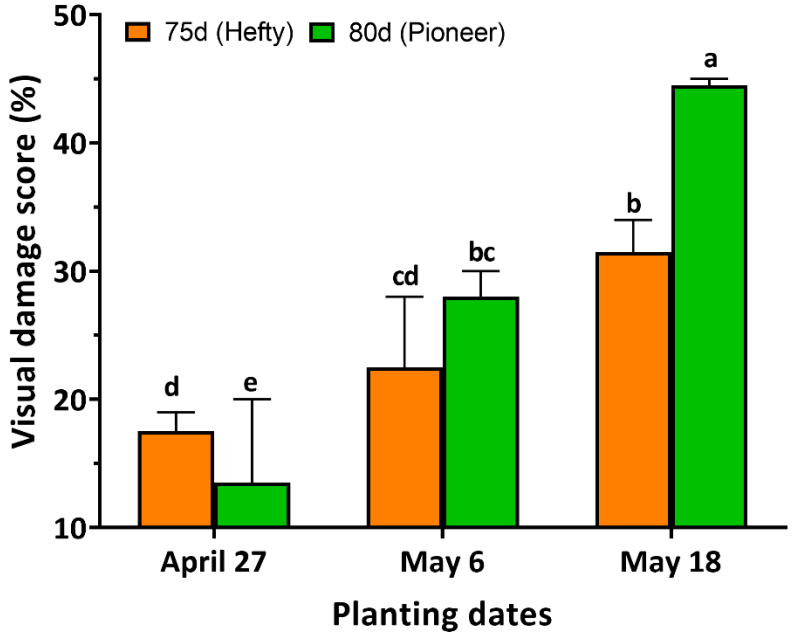


Figure 2. Percent damage to predatory birds with planting dates and relative maturity of corn. Same letter assignment denotes no statistical difference (*P* = 0.05).

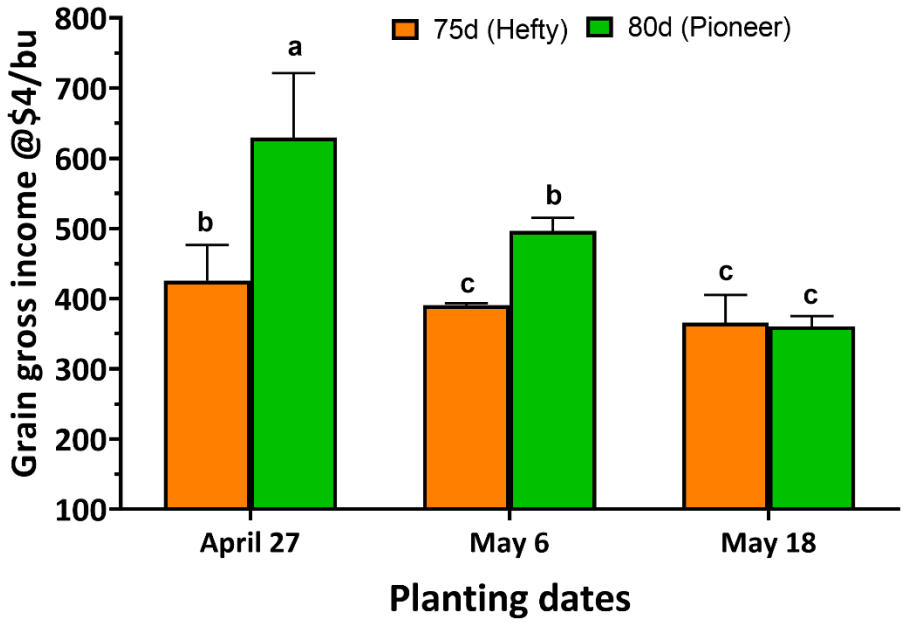


Figure 3. Grain gross adjusted income with planting dates and relative maturity of corn. Same letter assignment denotes no statistical difference (*P* = 0.05).

Project Title: Kernza planting date study

Objective: To evaluate the performance of kernza varieties with different planting dates

Personnel: J.A. Torrion, Amanda Shine, Eeusha Nafi, Jacob Jungers

Summary:

Kernza is perennial intermediate wheatgrass known for its extensive root system that uses nutrients more efficiently than wheat. This is the first experiment about kernza conducted at the research center.

Four kernza entries, C3, C4, Clearwater, and Rush were planted in the fall of 2019 on three planting dates (20-Sept., 27-Sept., and 04-Oct.) through the spring of 2020 on two planting dates (17-Apr. and 01-May). Kernza was planted at a seeding rate of 4 live seeds/ft^2 at 0.5-inch depth with 3.28-ft row spacing. Table 1 specify other kernza management information.

Kernza planted in 20-September resulted in both higher grain yield (707.6 lbs/A) and biomass (3.3 t/A) production compared with later planted kernza (Table 2). In terms of biomass, there was no interaction between planting dates and kernza entries. We found yield reduction of kernza biomass as planting was delayed (Table 2) across the kenza entry (Table 3). Among the kernza varieties, Clearwater had the highest biomass production (2.4 t/A). Regardless of planting dates, Rush had lowest biomass production.

We found a significant interaction between planting dates and kernza varieties on grain yield. While there is a general trend of lowered grain as planting was delayed, Clearwater showed yield advantage with planted early (e.g., sept 20-27, 2019). C3, on the other hand, showed a grain yield advantage when planted later in spring (April 17 and May 1, 2020).

Table 1. Management information

Seeding rate:	4 live seeds/ft2	**Field Location:**	X5
Previous crop:	Canola	**Soil type:**	Silty loam
Herbicide:	None	**Tillage:**	Conventional
Nutrient fertilizer applied (N, P_2O_5, K_20 lb/A):	(Fall, 2019):45-80-0-(10S)	**Soil residual nutrient (NO_3^-, P, K lb/A):**	59-16-260

Table 2. Planting date effect on kernza aboveground biomass

Planting dates	**Biomass (t/A)**
20-Sep-19	3.3a
27-Sep-19	2.2b
04-Oct-19	2.3b
17-Apr-20	1.7c
01-May-20	1.2d
Mean	2.2
P-value	<0.001

Table 3. Varietal effects on kernza biomass

Varieties	**Biomass (t/A)**
Clearwater	2.4a
C4	2.1b
C3	2.0b
Rush	1.9b
Mean	2.1
P-value	<0.001

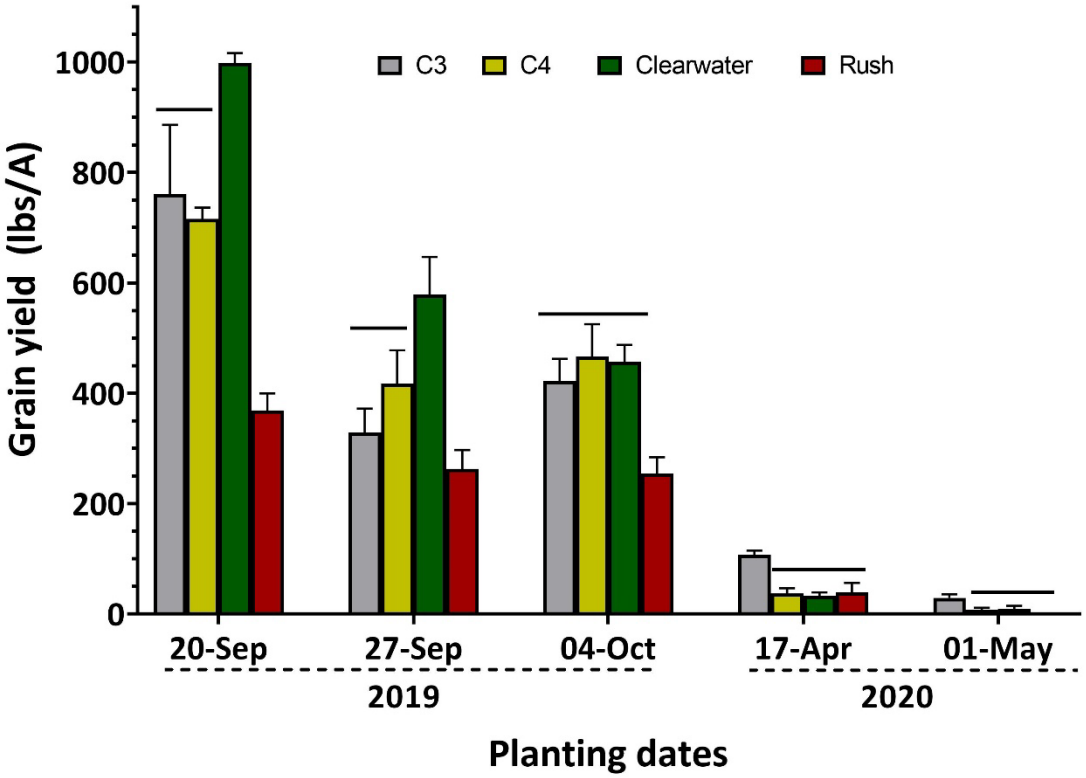


Figure 1. Interaction of planting date and variety for grain yield. Horizontal line denotes no statistical difference (α = 0.05) within a planting date.