



Research Report

Winter Cereal Variety Evaluation at Maricopa, 2020

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Summary

Winter cereals for forage were evaluated in small plots at the University of Maricopa Agricultural Center. The crop types evaluated were triticale, barley, wheat and oats. The trial was irrigated up on December 18, 2019. The forage was sampled at the boot and soft dough stages. In addition, the triticale was sampled between each irrigation for a total of eight sampling times. Forage yield was measured along with percent leaf, stem, and head, plant height, head moisture and growth stage.

Forage quality was measured by NIRS for samples taken at the boot and soft dough stages.

Introduction

Winter cereals for forage are displacing durum for grain in many areas of Arizona due to the demands of the dairy and beef cattle industry. The University of Arizona has only sporadically tested winter cereals for forage. This trial was initiated at the request of the dairy industry and may be conducted in the future depending on demand for this information and available funding.

Procedure

Winter cereal forage varieties were evaluated at Maricopa Agricultural Center. The seed was planted with a cone planter in plots 20 ft long in 10 rows spaced 7 inches apart. The seeding rate was approximately 130 lbs/acre. The experimental design was a randomized complete block with 3 replications and 15 triticale, 5 barley, 3 oat, and 1 wheat variety. Growing conditions are listed in Table 1.

The plots were sampled for yield when each variety reached the boot and soft dough stages. Forage yield was measured from 2 rows (7 inch spacing) x 18 inches length. Forage quality was measured by NIRS.

In addition, the triticale varieties were sampled between each irrigation for a total of eight sampling times. The following data was collected: forage yield (72% moisture basis), leaf, stem, and head percentage of the plant, plant height, head moisture (as an indication of maturity), and growth stage. The growth stage numeric code is presented in Table 2. Forage quality was measured by NIRS for samples taken at the boot and soft dough stages. Forage yield was measured from 2 rows (7 inch spacing) x 18 inches length. The percentage of leaf, stem, and head was determined from 10 plants.

Discussion

Yield and plant characteristics of the varieties are presented in Table 3 for the boot stage, Table 4 for the soft dough stage, and Table 5 for the triticale varieties which were sampled eight times. Forage quality is presented in Table 6 for the boot stage and Table 7 for the soft dough stage. Abbreviations used for the quality parameters are presented in Table 8. Several locations and years are needed to accurately assess variety performance. The results of this trial are most useful when combined with data from previous years. Nevertheless, the results show that winter cereal forage of high yield and quality can be grown in Arizona.

Acknowledgments

The technical assistance of Said Attalah and Alex Kohlenberg is greatly appreciated.

Table 1. Cultural practices for the small grains variety trial at Maricopa, 2020.

Cultural information	Maricopa (UA)
Previous crop	Fallow
Soil texture	Sandy loam
Planting date	12/18/19
Irrigation dates and amounts	12/18: 7.18 in 2/5: 3.96 in 2/28: 4.33 in 3/18: 4.34 in 4/2: 2.60 in 4/16: 4.64 in 4/30: 3.14 in SUM = 30.19 in
Nitrogen application dates and amounts	2/5: 101 lbs N/A as 46-0-0 2/28: 51 lbs N/A as 46-0-0 3/18: 36 lbs N/A as 46-0-0 4/2: 35 lbs N/A as 32-0-0 4/16: 34 lbs N/A as 46-0-0 SUM = 257 lbs N/A
Phosphorus application date and amount	None
Pesticides	None

Table 2. Growth stage numeric code.

Numeric code	Growth stage
1	1 leaf
2	2 leaf
3	3 leaf
4	4 leaf
5	5 leaf
6	6 leaf
7	Early jointing
8	Mid jointing
9	Flag leaf visible
10	Flag leaf collar visible
11	Boot
12	Heading
13	Flowering
14	Kernel watery
15	Kernel milky
16	Soft dough
17	Hard dough
18	Physiological maturity
19	Harvest ripe

Table 3. Boot stage forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020. The following varieties were sampled at heading instead of boot due to rain at the boot stage: 770,001, Swift 77, and Solum. A description of the numeric growth stage codes can be found in Table 2.

Crop	Source	Entry	Date	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage	
				T/A	%	%	%	inches	%		
Triticale	APB	470, 285	3/25	12.0	40	60	0	35	.	11.0	
		470, 113	4/08	16.5	34	66	0	33	.	11.0	
		470, 133	3/25	12.9	41	59	0	27	.	11.0	
		470, 249	3/25	12.1	42	58	0	28	.	11.0	
		470, 269	3/25	14.8	41	59	0	29	.	11.0	
			470, 298	3/22	13.2	42	58	0	28	.	11.0
			470, 308	3/22	12.4	40	60	0	30	.	11.0
			770, 001	3/17	10.3	35	53	12	29	.	11.7
			770, 113	3/25	13.1	39	61	0	35	.	11.0
		NAB	SY 115T	4/01	15.3	35	65	0	30	.	11.0
	SY 158T		3/25	12.8	41	59	0	30	.	11.0	
	Merlin Max		4/18	25.2	25	75	0	51	.	11.0	
	Legend		4/08	17.6	35	65	0	33	.	11.0	
	Swift 77		3/17	10.0	35	46	19	30	.	12.0	
		Goldrush 91	3/22	10.6	39	62	0	27	.	11.0	
Wheat	BSI	PR 1404	4/01	15.1	30	70	0	33	.	11.0	
Barley	HSG	Chowford	3/25	14.5	39	61	0	40	.	11.0	
		Eureka	3/25	14.3	38	62	0	48	.	11.0	
		Pronto	3/17	8.9	37	63	0	30	.	12.0	
		HO315-354	4/01	11.9	38	62	0	33	.	11.0	
		USDA	Solum	3/17	12.6	26	74	0	42	.	12.0
Oat	BSI	UC125	4/14	21.9	33	67	0	47	.	11.0	
		UC132	4/01	22.2	34	66	0	44	.	11.0	
		APB	Wildcat 60	4/21	21.2	32	68	0	58	.	11.0
Avg		Avg	3/28	14.6	36	62	1	35	.	11.2	
LSD.05				4.2	5	5	3	3		0.2	
CV (%)				17.4	8.4	5.1	162.8	5.8		1.1	

Table 4. Soft dough stage forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020. A description of the numeric growth stage codes can be found in Table 2. Head moisture is a more precise indicator of maturity than the visual growth stage reported in this table. Soft dough begins at an approximate head moisture of 55% and ends at an approximate head moisture of 45%.

Crop	Source	Entry	Date	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage
				T/A	%	%	%	inches	%	
Triticale	APB	470, 285	4/28	33.9	15	40	45	47	53	16.0
		470, 113	5/05	28.7	16	38	46	39	57	16.0
		470, 133	4/28	27.2	16	37	47	36	54	16.0
		470, 249	4/28	26.9	17	38	45	38	56	16.0
		470, 269	4/28	31.7	17	35	48	38	54	16.0
		470, 298	4/28	29.5	15	39	46	41	54	16.0
		470, 308	4/28	31.9	14	38	48	41	53	16.0
		770, 001	4/28	31.9	14	39	47	43	52	16.0
		770, 113	4/28	28.8	15	43	41	50	52	16.0
		NAB	SY 115T	5/05	27.7	15	32	52	36	55
SY 158T	4/28		27.2	17	36	48	38	53	16.0	
Merlin Max	5/12		35.3	11	53	36	54	44	16.0	
Legend	5/05		28.2	17	43	40	41	55	16.0	
Swift 77	4/28		31.0	12	31	57	42	50	16.0	
Goldrush 91	4/28		29.6	15	33	52	38	53	16.0	
Wheat	BSI		PR 1404	4/28	28.3	16	39	45	42	48
Barley	HSG	Chowford	4/21	26.9	22	42	36	45	54	16.0
		Eureka	4/21	29.0	22	47	32	49	55	16.0
		Pronto	4/14	23.7	16	42	42	41	52	16.0
		HO315-354	4/28	27.7	22	28	49	37	47	16.0
	USDA	Solum	4/14	29.2	12	28	61	40	48	16.0
Oat	BSI	UC125	5/12	33.5	23	.	.	52	.	16.0
		UC132	4/28	42.8	20	.	.	47	.	16.0
		APB	Wildcat 60	5/12	37.4	21	.	.	61	.
Avg		Avg	4/28	30.3	17	38	40	43	52	16.0
LSD.05				4.6	2	3	3	2	3	0.0
CV (%)				9.2	7.1	3.8	5.2	3.5	3.0	0.0

Table 5. Triticale forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020 at eight sampling dates. A description of the numeric growth stage codes can be found in Table 2.

Date	Source	Entry	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage
			T/A	%	%	%	inches	%	
2/04	APB	470, 285	0.42	100	0	0	7.0	.	3.9
		470, 113	0.50	100	0	0	6.4	.	3.6
		470, 133	0.43	100	0	0	7.4	.	3.8
		470, 249	0.47	100	0	0	7.3	.	3.9
		470, 269	0.39	100	0	0	7.5	.	3.8
		470, 298	0.48	100	0	0	8.2	.	3.9
		470, 308	0.46	100	0	0	8.3	.	3.8
		770, 001	0.47	100	0	0	7.1	.	3.7
		770, 113	0.34	100	0	0	3.8	.	3.9
	NAB	SY 115T	0.15	100	0	0	5.8	.	4.0
		SY 158T	0.47	100	0	0	7.7	.	3.9
		Merlin Max	0.34	100	0	0	6.1	.	3.8
		Legend	0.44	100	0	0	6.8	.	3.5
		Swift 77	0.53	100	0	0	9.0	.	4.0
		Goldrush 91	0.27	100	0	0	6.2	.	4.2
		Average	0.41	100	0	0	7.0	.	3.8
LSD.05			0.18	.	.	.	2.0	.	NS
CV (%)			26.4	0.0	.	.	16.5		5.5

Table 5. (con'd) Triticale forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020 at eight sampling dates. A description of the numeric growth stage codes can be found in Table 2.

Date	Source	Entry	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage
			T/A	%	%	%	inches	%	
2/26	APB	470, 285	2.73	70	30	0	14	.	8.9
		470, 113	2.41	76	24	0	14	.	8.9
		470, 133	3.26	70	30	0	13	.	9.2
		470, 249	2.83	70	30	0	14	.	9.5
		470, 269	2.82	67	33	0	15	.	9.7
		470, 298	3.15	67	33	0	15	.	9.8
		470, 308	3.65	66	34	0	16	.	9.8
		770, 001	3.17	65	35	0	15	.	9.7
		770, 113	2.61	72	28	0	13	.	9.2
	NAB	SY 115T	1.20	82	18	0	11	.	8.9
		SY 158T	2.42	70	30	0	14	.	9.1
		Merlin Max	3.02	75	25	0	13	.	8.9
		Legend	2.91	77	23	0	14	.	9.2
		Swift 77	2.72	57	43	0	18	.	9.8
		Goldrush 91	2.98	69	31	0	13	.	9.8
		Average	2.79	70	30	0	14	.	9.4
LSD.05			0.93	4	4	0	1	.	0.7
CV (%)			19.9	3.1	7.4	.	6.0		4.4

Table 5. (con'd) Triticale forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020 at eight sampling dates. A description of the numeric growth stage codes can be found in Table 2.

Date	Source	Entry	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage
			T/A	%	%	%	inches	%	
3/17	APB	470, 285	9.02	49	51	0	27	.	10.0
		470, 113	8.45	55	45	0	22	.	8.0
		470, 133	8.22	48	52	0	22	.	10.3
		470, 249	8.18	50	50	0	24	.	10.3
		470, 269	8.59	48	52	0	24	.	10.5
		470, 298	8.67	46	54	0	28	.	10.7
		470, 308	8.79	43	57	0	27	.	10.7
		770, 001	10.25	35	53	12	29	.	11.7
		770, 113	10.73	46	54	0	27	.	10.5
	NAB	SY 115T	7.44	55	45	0	21	.	8.3
		SY 158T	9.63	49	51	0	26	.	10.5
		Merlin Max	8.29	49	51	0	25	.	8.0
		Legend	7.94	59	41	0	22	.	8.0
		Swift 77	10.02	35	46	19	30	.	12.0
		Goldrush 91	8.38	42	58	0	25	.	10.7
		Average	8.84	47	51	2	25	.	10.0
LSD.05			1.6	5	5	4	3	.	0.5
CV (%)			10.5	5.7	6.4	128.5	6.9		2.7

Table 5. (con'd) Triticale forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020 at eight sampling dates. A description of the numeric growth stage codes can be found in Table 2.

Date	Source	Entry	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage
			T/A	%	%	%	inches	%	
4/01	APB	470, 285	17.2	27	54	19	42	72	12.0
		470, 113	15.7	39	61	0	28	.	10.5
		470, 133	15.0	27	50	23	33	73	12.0
		470, 249	16.3	27	51	22	33	73	12.0
		470, 269	16.8	28	50	22	36	70	12.0
		470, 298	17.0	27	52	22	38	72	12.0
		470, 308	17.3	24	54	22	41	72	13.0
		770, 001	20.8	22	57	21	43	68	13.0
		770, 113	18.6	24	58	19	43	74	12.0
	NAB	SY 115T	15.3	35	65	0	30	.	11.0
		SY 158T	16.2	28	49	23	35	73	12.0
		Merlin Max	20.2	36	64	0	36	.	10.0
		Legend	17.5	41	59	0	28	.	10.5
		Swift 77	15.9	21	56	22	40	67	13.0
		Goldrush 91	16.5	23	53	24	35	65	13.0
		Average	17.1	29	55	16	36	71	11.9
LSD.05			2.2	3	3	1	3	3	0.0
CV (%)			7.5	5.8	2.9	5.6	4.5	2.6	0.0

Table 5. (con'd) Triticale forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020 at eight sampling dates. A description of the numeric growth stage codes can be found in Table 2.

Date	Source	Entry	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage
			T/A	%	%	%	inches	%	
4/14	APB	470, 285	22.1	20	55	25	48	65	13.0
		470, 113	19.0	26	49	26	39	70	13.0
		470, 133	20.3	20	51	29	37	66	13.0
		470, 249	22.6	22	52	26	36	65	13.0
		470, 269	24.4	21	50	29	40	66	13.0
		470, 298	21.7	19	52	29	42	66	14.0
		470, 308	24.7	18	53	29	43	65	13.0
		770, 001	27.3	18	53	29	45	66	13.0
		770, 113	24.6	19	57	24	52	68	13.0
	NAB	SY 115T	24.1	24	52	24	38	68	13.0
		SY 158T	22.4	21	51	29	39	66	13.0
		Merlin Max	26.1	26	74	0	48	.	10.7
		Legend	22.1	27	54	19	37	73	14.0
		Swift 77	24.0	17	50	34	42	65	14.0
		Goldrush 91	22.5	17	50	33	36	65	13.0
		Average	23.2	21	54	26	41	67	13.0
LSD.05			NS	3	2	3	3	2	0.1
CV (%)			14.1	8.0	2.7	6.4	4.6	1.9	0.6

Table 5. (con'd) Triticale forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020 at eight sampling dates. A description of the numeric growth stage codes can be found in Table 2.

Date	Source	Entry	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage
			T/A	%	%	%	inches	%	
4/28	APB	470, 285	33.9	15	40	45	47	53	16.0
		470, 113	25.5	20	42	38	40	63	14.0
		470, 133	27.2	16	37	47	36	54	16.0
		470, 249	26.9	17	38	45	38	56	16.0
		470, 269	31.7	17	35	48	38	54	16.0
		470, 298	29.5	15	39	46	41	54	16.0
		470, 308	31.9	14	38	48	41	53	16.0
		770, 001	31.9	14	39	47	43	52	16.0
		770, 113	28.8	15	43	41	50	52	16.0
	NAB	SY 115T	29.5	19	41	41	37	62	14.0
		SY 158T	27.2	17	36	48	38	53	16.0
		Merlin Max	30.3	22	59	19	57	65	13.0
		Legend	28.2	23	46	31	40	64	14.0
		Swift 77	31.0	12	31	57	42	50	16.0
		Goldrush 91	29.6	15	33	52	38	53	16.0
		Average	29.5	17	40	43	42	56	15.4
LSD.05			NS	2	2	4	3	3	0.0
CV (%)			11.8	7.3	3.7	5.2	4.7	3.1	0.0

Table 5 (con'd). Triticale forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020 at eight sampling dates. A description of the numeric growth stage codes can be found in Table 2.

Date	Source	Entry	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage
			T/A	%	%	%	inches	%	
5/12	APB	470, 285	37.8	8	32	60	45	14	18.7
		470, 113	32.4	11	35	54	40	32	18.0
		470, 133	33.5	8	30	62	35	25	18.0
		470, 249	37.2	9	29	61	35	23	18.0
		470, 269	34.6	7	30	62	38	21	18.0
		470, 298	36.1	7	31	61	42	23	18.0
		470, 308	36.2	6	31	63	40	20	18.0
		770, 001	34.0	6	35	59	45	14	18.3
		770, 113	38.0	7	37	56	48	11	19.0
	NAB	SY 115T	37.4	10	29	61	36	36	17.3
		SY 158T	37.4	9	29	62	36	25	18.0
		Merlin Max	35.3	11	53	36	54	44	16.0
		Legend	31.8	13	38	49	42	37	16.0
		Swift 77	34.6	6	27	67	41	12	18.7
		Goldrush 91	32.3	8	28	64	36	7	19.0
		Average	35.2	9	33	58	41	23	17.9
LSD.05			4.0	2	2	2	3	6	0.7
CV (%)			6.8	12.0	3.8	2.5	3.9	16.6	2.3

Table 5 (con'd). Triticale forage yield (at 72% moisture) and other characteristics of a winter cereal forage variety trial at the Maricopa Agricultural Center, 2020 at eight sampling dates. A description of the numeric growth stage codes can be found in Table 2.

Date	Source	Entry	Forage yield	Leaf	Stem	Head	Plant height	Head moisture	Growth stage
			T/A	%	%	%	inches	%	
5/26	APB	470, 285	31.4	9	31	61	45	4	19.0
		470, 113	30.3	10	29	61	39	5	19.0
		470, 133	31.9	8	26	66	36	4	19.0
		470, 249	30.2	8	26	66	36	4	19.0
		470, 269	37.0	8	25	67	38	4	19.0
		470, 298	35.5	6	27	68	40	4	19.0
		470, 308	31.4	7	30	63	40	4	19.0
		770, 001	36.8	7	29	64	43	3	19.0
		770, 113	33.0	8	34	58	46	4	19.0
	NAB	SY 115T	30.2	8	29	64	36	5	19.0
		SY 158T	29.6	8	28	63	35	4	19.0
		Merlin Max	28.5	11	49	40	56	4	19.0
		Legend	26.7	13	32	55	39	5	19.0
		Swift 77	38.1	8	24	67	40	4	19.0
		Goldrush 91	24.5	8	27	64	35	3	19.0
		Average	31.7	9	30	62	40	4	19.0
LSD.05			7.9	3	4	6	3	NS	0.0
CV (%)			15.0	23.1	8.9	6.1	4.9	22.7	0.0

Table 6. Boot stage forage quality (except for three varieties) for winter cereal forage varieties at the Maricopa Agricultural Center, 2020. See Table 5 for quality parameter abbreviations. The following varieties were sampled at heading instead of boot due to rain at the boot stage: 770,001, Swift 77, and Solum.

Crop	Entry	DM	Moist	Ash	NDF	ADF	CP	RFV	TDN	RFQ	NEL	Fat
		%	%	%	%	%	%		%		Mcal/lb DM	%
Triticale	470, 285	96.3	3.74	9.24	58.3	37.2	17.3	96	65.8	91	0.68	2.13
	470, 113	95.9	4.13	9.32	61.0	37.4	12.7	91	63.9	87	0.66	2.22
	470, 133	95.6	4.41	9.24	57.7	36.6	17.0	97	66.1	93	0.68	2.14
	470, 249	95.6	4.42	9.00	56.7	36.4	18.5	99	66.9	95	0.69	2.18
	470, 269	95.7	4.29	9.32	57.3	36.1	18.9	99	66.4	94	0.68	2.15
	470, 298	94.3	5.69	9.04	55.8	35.0	20.9	103	67.4	98	0.70	2.13
	470, 308	94.6	5.36	9.07	56.5	36.1	18.2	100	67.0	96	0.69	2.10
	770, 001	94.1	5.92	8.99	56.6	36.9	19.2	99	66.9	94	0.69	2.07
	770, 113	96.0	3.99	9.06	58.4	38.0	17.9	95	65.7	90	0.68	2.14
	SY 115T	93.7	6.32	9.21	53.8	35.3	19.5	106	68.8	102	0.71	2.07
SY 158T	94.6	5.42	9.18	57.9	36.2	18.6	98	66.0	93	0.68	2.11	
	Merlin Max	96.8	3.21	9.54	66.6	42.8	7.2	78	60.1	74	0.61	2.04
	Legend	96.4	3.59	9.37	60.8	38.3	13.0	90	64.0	86	0.66	2.24
	Swift 77	94.1	5.88	9.06	54.7	34.3	21.0	106	68.2	101	0.70	2.13
	Goldrush 91	94.7	5.29	9.23	56.4	36.5	18.6	100	67.0	95	0.69	2.08
Wheat	PR 1404	94.9	5.09	9.38	57.8	36.2	13.3	98	66.1	93	0.68	2.12
Barley	Chowford	95.1	4.94	9.42	59.8	39.2	14.5	91	64.7	86	0.66	2.07
	Eureka	95.1	4.93	9.58	60.6	40.0	13.3	89	64.2	84	0.66	1.99
	Pronto	94.5	5.50	9.36	58.0	37.8	17.1	95	65.9	91	0.68	1.99
	HO315-354	94.8	5.19	9.20	58.6	37.8	15.3	94	65.5	90	0.67	2.07
	Solum	94.6	5.44	9.60	56.9	35.7	17.1	100	66.7	95	0.69	2.07
Oat	UC125	95.3	4.75	9.56	63.8	40.7	8.3	83	62.0	79	0.63	1.96
	UC132	95.1	4.94	9.49	60.3	39.3	11.7	90	64.4	86	0.66	2.16
	Wildcat 60	95.5	4.48	9.62	63.5	39.9	10.6	85	62.2	81	0.64	1.97
Avg	Avg	95.1	4.87	9.30	58.7	37.5	15.8	95	65.5	91	0.67	2.10

Table 6 (con'd). Boot stage forage quality (except for three varieties) for winter cereal forage varieties at the Maricopa Agricultural Center, 2020. See Table 5 for quality parameter abbreviations. The following varieties were sampled at heading instead of boot due to rain at the boot stage: 770,001, Swift 77, and Solum.

Crop	Entry	Ca	K	Mg	S	K	Na	Cl	Fe	Mn	Cu	Zn
		%	%	%	%	%	%	%	ppm	ppm	ppm	ppm
Triticale	470, 285	0.31	0.35	0.25	0.26	4.32	0.01	1.18	149	78	7.72	48.6
	470, 113	0.31	0.35	0.26	0.24	3.97	0.01	0.93	176	75	9.60	48.1
	470, 133	0.31	0.36	0.27	0.25	4.37	0.01	1.05	159	86	8.80	48.6
	470, 249	0.31	0.38	0.28	0.25	4.46	0.01	1.08	153	88	7.73	48.3
	470, 269	0.31	0.37	0.27	0.27	4.40	0.01	1.05	161	94	8.63	48.8
	470, 298	0.31	0.38	0.27	0.26	4.45	0.01	1.05	174	100	9.82	48.9
	470, 308	0.31	0.37	0.27	0.24	4.39	0.01	1.01	187	103	9.66	48.9
	770, 001	0.31	0.41	0.27	0.25	4.65	0.01	0.96	179	103	10.40	49.4
	770, 113	0.31	0.39	0.27	0.25	4.60	0.01	1.08	171	77	7.85	48.8
	SY 115T	0.31	0.35	0.27	0.26	4.28	0.01	1.06	153	85	8.84	48.5
SY 158T	0.31	0.36	0.27	0.24	4.20	0.01	0.99	176	91	10.05	48.9	
Merlin Max	0.30	0.26	0.21	0.22	4.01	0.01	1.10	137	55	8.60	45.0	
Legend	0.31	0.35	0.25	0.24	4.06	0.01	1.03	168	72	8.47	47.3	
Swift 77	0.31	0.36	0.27	0.28	4.38	0.01	0.97	166	78	10.01	48.4	
Goldrush 91	0.30	0.34	0.26	0.26	4.19	0.01	1.08	185	73	9.31	48.9	
Wheat	PR 1404	0.31	0.32	0.26	0.24	4.02	0.01	1.02	175	75	8.61	48.1
Barley	Chowford	0.30	0.38	0.27	0.23	4.32	0.01	1.07	121	97	7.47	48.0
	Eureka	0.31	0.34	0.24	0.23	4.31	0.01	1.17	93	79	3.86	45.6
	Pronto	0.31	0.38	0.26	0.24	4.43	0.01	1.08	127	97	9.49	48.6
	HO315-354	0.31	0.37	0.27	0.23	4.20	0.01	1.03	152	92	9.12	49.0
	Solum	0.31	0.31	0.26	0.23	3.96	0.01	1.07	125	92	7.18	47.2
Oat	UC125	0.30	0.32	0.24	0.22	3.91	0.01	1.17	105	91	5.51	46.5
	UC132	0.30	0.35	0.24	0.22	4.15	0.01	1.15	111	89	5.72	47.5
	Wildcat 60	0.30	0.33	0.24	0.23	3.92	0.01	1.13	111	87	6.09	46.6
Avg	Avg	0.31	0.35	0.26	0.24	4.25	0.01	1.06	151	86	8.27	48.0

Table 6 (con'd). Boot stage forage quality (except for three varieties) for winter cereal forage varieties at the Maricopa Agricultural Center, 2020. See Table 5 for quality parameter abbreviations. The following varieties were sampled at heading instead of boot due to rain at the boot stage: 770,001, Swift 77, and Solum.

Crop	Entry	SP	ADF-CP	NDF-CP	UIP	Lignin	Starch	NFC	Carbo	Sugar
		%	%	%	% of CP	%	%	%	%	%
Triticale	470, 285	47.0	0.88	2.42	28.3	8.33	3.14	18.7	7.12	6.01
	470, 113	44.9	0.86	2.31	30.0	7.21	3.88	18.8	5.44	5.04
	470, 133	45.8	0.92	2.47	29.5	8.32	4.95	18.7	7.04	4.63
	470, 249	45.8	0.92	2.54	29.5	8.55	1.61	18.5	6.93	5.35
	470, 269	45.7	0.90	2.60	28.2	8.29	4.60	18.1	7.07	4.87
	470, 298	44.2	0.92	2.73	29.0	7.34	3.60	18.9	7.34	4.91
	470, 308	45.6	0.91	2.55	28.5	7.50	3.73	19.7	7.08	5.26
	770, 001	44.9	0.97	2.61	28.8	7.91	0.90	19.8	6.58	5.64
	770, 113	44.4	0.91	2.61	30.4	8.44	3.65	16.0	6.26	4.74
	SY 115T	48.4	0.91	2.41	27.0	6.60	1.29	21.3	8.37	6.70
	SY 158T	44.2	0.93	2.64	30.1	7.22	2.74	18.9	6.75	4.80
	Merlin Max	45.3	0.87	2.06	33.9	8.58	6.25	17.5	3.66	4.04
	Legend	45.1	0.88	2.39	29.5	8.01	4.22	19.9	5.23	4.24
	Swift 77	48.0	0.90	2.38	26.5	6.60	3.97	21.7	8.19	4.80
	Goldrush 91	46.3	0.89	2.53	28.4	6.77	2.56	19.3	7.49	5.98
Wheat	PR 1404	47.8	0.84	2.45	28.4	6.70	8.01	20.2	7.56	5.08
Barley	Chowford	41.6	0.89	2.71	29.8	8.15	4.53	17.1	5.35	5.28
	Eureka	43.7	0.90	2.60	30.7	7.43	5.53	18.6	5.83	5.40
	Pronto	45.0	0.91	2.49	29.8	7.31	2.77	19.3	6.79	6.22
	HO315-354	44.9	0.89	2.58	29.0	6.89	4.30	17.7	6.11	5.20
	Solum	46.7	0.89	2.50	28.8	6.84	3.31	20.6	8.45	5.96
Oat	UC125	44.9	0.88	2.09	32.0	7.40	7.06	18.0	4.07	4.53
	UC132	46.9	0.89	2.25	28.1	7.16	5.44	19.4	5.81	5.02
	Wildcat 60	43.6	0.88	2.29	32.3	7.26	4.98	18.1	4.91	4.00
Avg	Avg	45.4	0.90	2.47	29.4	7.53	4.04	18.9	6.48	5.15

Table 6 (con'd). Boot stage forage quality (except for three varieties) for winter cereal forage varieties at the Maricopa Agricultural Center, 2020. See Table 5 for quality parameter abbreviations. The following varieties were sampled at heading instead of boot due to rain at the boot stage: 770,001, Swift 77, and Solum.

Crop	Entry	IVTDM D24	IVTDM D30	IVTDM D48	NDF D24	NDF D30	NDF D48	Lys	Met	AA	LA	Kd
		%	%	%	% of NDF	% of NDF	% of NDF	%	%	%	%	% NDF/hour
Triticale	470, 285	66.3	71.9	76.8	39.9	54.9	66.4	0.47	0.18	2.02	2.42	4.46
	470, 113	59.0	64.6	77.0	34.0	53.1	66.0	0.39	0.16	1.96	2.14	3.06
	470, 133	65.2	71.2	77.0	39.3	55.6	66.7	0.47	0.18	2.03	1.56	4.36
	470, 249	67.0	72.3	76.8	43.7	57.6	66.8	0.49	0.19	2.30	1.39	5.55
	470, 269	66.7	72.0	76.3	40.1	55.6	67.4	0.52	0.19	2.02	1.81	4.54
	470, 298	62.9	68.5	78.0	38.2	55.5	69.1	0.52	0.20	1.90	2.26	3.89
	470, 308	62.6	68.1	79.5	36.4	54.6	67.8	0.47	0.18	2.16	2.02	3.68
	770, 001	60.5	66.7	79.8	37.8	57.6	69.7	0.43	0.17	2.35	1.56	4.01
	770, 113	66.8	72.1	74.7	45.0	57.2	67.1	0.46	0.18	2.41	0.90	5.56
	SY 115T	61.9	67.8	82.9	37.0	54.6	68.7	0.51	0.19	2.08	2.16	3.55
SY 158T	61.1	67.1	78.6	37.0	54.4	67.3	0.47	0.18	2.05	2.26	3.58	
Merlin Max	52.6	58.1	72.1	31.1	45.3	60.0	0.24	0.11	1.45	2.16	2.84	
Legend	60.4	66.4	76.4	34.4	53.1	66.7	0.40	0.16	1.88	2.08	3.33	
Swift 77	64.0	69.6	81.3	34.2	55.0	69.8	0.56	0.21	2.27	2.48	3.13	
Goldrush 91	61.9	67.5	80.6	37.9	53.0	68.0	0.46	0.18	2.05	2.41	3.63	
Wheat	PR 1404	64.4	69.7	80.1	37.3	53.6	66.3	0.39	0.16	2.08	2.77	3.46
Barley	Chowford	58.1	65.1	72.5	36.7	53.9	66.3	0.39	0.16	1.79	1.74	3.75
	Eureka	58.4	64.6	75.1	36.5	49.1	64.1	0.38	0.16	1.59	2.09	3.47
	Pronto	60.4	66.7	78.8	39.3	54.5	66.3	0.41	0.17	1.78	2.07	3.94
	HO315- 354	58.4	64.8	76.2	36.5	54.3	65.7	0.42	0.17	1.84	1.99	3.38
	Solum	61.0	66.9	81.2	37.4	51.2	66.0	0.46	0.18	1.82	2.71	3.55
Oat	UC125	58.2	63.6	72.0	37.1	46.5	61.7	0.31	0.13	1.56	2.11	3.44
	UC132	60.0	65.7	75.1	37.0	50.1	64.8	0.39	0.16	1.81	2.37	3.48
	Wildcat 60	55.0	60.6	72.9	31.9	48.0	63.2	0.37	0.16	1.65	2.06	2.75
Avg	Avg	61.4	67.1	77.2	37.3	53.3	66.3	0.43	0.17	1.95	2.06	3.77

Table 7. Soft dough stage forage quality for winter cereal forage varieties at the Maricopa Agricultural Center, 2020. See Table 5 for quality parameter abbreviations.

Crop	Entry	DM	Moist	Ash	NDF	ADF	CP	RFV	TDN	RFQ	NEL	Fat
		%	%	%	%	%	%		%		Mcal/lb DM	%
Triticale	470, 285	95.4	4.61	9.84	54.2	33.8	9.3	107	68.5	103	0.05	2.02
	470, 113	97.5	2.51	9.92	57.2	34.9	9.3	100	66.5	96	0.05	2.03
	470, 133	94.5	5.51	9.89	54.1	34.3	8.4	107	68.6	102	0.05	1.99
	470, 249	95.4	4.62	9.82	54.8	34.4	9.9	105	68.1	101	0.05	2.02
	470, 269	94.8	5.19	9.87	53.1	33.6	9.7	110	69.3	105	0.05	2.01
	470, 298	95.8	4.18	9.72	55.4	34.5	10.4	104	67.7	99	0.05	2.06
	470, 308	95.7	4.35	9.97	55.4	34.5	8.7	104	67.7	99	0.05	1.96
	770, 001	95.3	4.66	10.10	52.8	32.7	10.1	112	69.4	107	0.05	1.93
	770, 113	95.4	4.62	10.04	53.6	33.1	10.0	110	68.9	105	0.05	2.02
	SY 115T	96.3	3.68	9.66	53.1	32.9	10.5	111	69.3	106	0.05	2.10
SY 158T	94.5	5.54	10.38	47.8	30.2	10.7	127	72.8	122	0.05	1.95	
	Merlin Max	97.7	2.34	9.96	60.1	36.8	9.8	93	64.5	89	0.05	1.96
	Legend	97.6	2.38	9.85	57.6	35.2	9.7	99	66.2	95	0.05	2.09
	Swift 77	94.9	5.15	9.87	53.2	33.0	10.7	110	69.2	106	0.05	1.98
	Goldrush 91	96.7	3.32	9.88	57.0	35.0	9.1	101	66.6	96	0.05	2.03
Wheat	PR 1404	94.5	5.46	9.87	52.0	31.7	12.1	115	70.0	110	0.05	2.00
Barley	Chowford	96.5	3.52	9.80	58.7	37.0	9.5	95	65.5	91	0.05	1.99
	Eureka	95.8	4.23	9.94	58.4	37.9	7.1	95	65.7	90	0.05	1.98
	Pronto	94.6	5.40	10.00	53.5	34.2	9.0	108	69.0	103	0.05	1.92
	HO315-354	97.2	2.77	9.85	59.2	38.1	6.7	93	65.2	89	0.05	1.95
	Solum	94.1	5.92	9.89	52.9	33.6	8.3	110	69.4	105	0.05	1.94
Oat	UC125	97.3	2.75	9.72	60.3	39.0	7.9	90	64.4	86	0.05	2.06
	UC132	96.4	3.58	9.60	61.8	38.0	9.0	89	63.4	85	0.05	1.99
	Wildcat 60	97.0	3.00	9.86	60.8	38.7	6.5	90	64.0	85	0.05	1.95
Avg	Avg	95.9	4.14	9.89	55.7	34.9	9.3	104	67.5	99	0.05	2.00

Table 7 (con'd). Soft dough stage forage quality for winter cereal forage varieties at the Maricopa Agricultural Center, 2020. See Table 5 for quality parameter abbreviations.

Crop	Entry	Ca	K	Mg	S	K	Na	Cl	Fe	Mn	Cu	Zn
		%	%	%	%	%	%	%	ppm	ppm	ppm	ppm
Triticale	470, 285	0.31	0.23	0.26	0.20	2.67	0.01	1.14	145	96	4.36	45.4
	470, 113	0.31	0.25	0.24	0.22	2.85	0.01	1.08	138	70	4.15	45.3
	470, 133	0.31	0.26	0.25	0.20	2.81	0.01	1.23	150	95	5.49	46.2
	470, 249	0.31	0.26	0.26	0.20	2.80	0.01	1.19	146	97	5.24	45.1
	470, 269	0.31	0.24	0.26	0.21	2.84	0.01	1.10	152	96	5.56	45.1
	470, 298	0.31	0.27	0.26	0.21	3.05	0.01	1.12	148	108	5.26	46.3
	470, 308	0.31	0.22	0.26	0.20	2.61	0.01	1.13	165	95	5.18	44.8
	770, 001	0.31	0.19	0.23	0.22	2.83	0.01	1.08	144	97	4.32	77.5
	770, 113	0.31	0.24	0.27	0.20	2.81	0.01	1.13	145	123	6.77	44.6
	SY 115T	0.31	0.26	0.27	0.19	3.13	0.01	1.09	138	121	6.86	45.3
SY 158T	0.31	0.12	0.23	0.20	2.62	0.01	1.07	143	104	3.77	92.0	
Merlin Max	0.31	0.25	0.25	0.20	3.29	0.01	1.09	144	85	8.31	43.0	
Legend	0.31	0.26	0.25	0.21	3.01	0.01	1.02	139	111	5.09	45.0	
Swift 77	0.31	0.27	0.28	0.21	3.06	0.01	1.12	141	120	7.07	44.3	
Goldrush 91	0.31	0.24	0.24	0.19	2.96	0.01	1.08	136	96	5.13	44.8	
Wheat	PR 1404	0.31	0.23	0.26	0.21	3.08	0.01	1.03	171	96	7.26	44.0
Barley	Chowford	0.31	0.30	0.26	0.20	3.74	0.01	1.14	110	113	6.62	45.9
	Eureka	0.31	0.25	0.24	0.18	3.25	0.01	1.22	94	86	4.35	43.8
	Pronto	0.31	0.27	0.27	0.19	3.38	0.01	1.22	124	123	6.01	45.6
	HO315-354	0.31	0.27	0.26	0.17	3.53	0.01	1.21	129	120	6.39	44.1
	Solum	0.32	0.19	0.24	0.19	3.01	0.01	1.18	107	89	4.23	43.2
Oat	UC125	0.31	0.27	0.25	0.20	3.47	0.01	1.06	93	79	3.86	45.6
	UC132	0.30	0.32	0.28	0.22	3.28	0.01	1.17	154	92	7.95	43.8
	Wildcat 60	0.31	0.28	0.25	0.20	3.43	0.01	1.14	134	88	5.65	44.0
Avg	Avg	0.31	0.25	0.26	0.20	3.06	0.01	1.13	137	100	5.62	48.1

Table 7 (con'd). Soft dough stage forage quality for winter cereal forage varieties at the Maricopa Agricultural Center, 2020. See Table 5 for quality parameter abbreviations.

Crop	Entry	SP	ADF-CP	NDF-CP	UIP	Lignin	Starch	NFC	Carbo	Sugar
		%	%	%	% of CP	%	%	%	%	%
Triticale	470, 285	41.5	0.82	2.17	30.0	7.10	8.35	24.5	8.66	5.92
	470, 113	43.5	0.81	2.07	30.9	7.37	8.51	24.5	6.71	5.02
	470, 133	43.6	0.84	2.15	30.4	6.95	8.79	25.5	9.70	8.48
	470, 249	42.6	0.83	2.14	30.6	7.03	9.65	25.2	9.15	7.63
	470, 269	42.2	0.83	2.24	29.5	6.74	11.33	29.0	10.03	6.58
	470, 298	42.6	0.83	2.20	30.4	7.17	8.79	24.1	8.24	6.03
	470, 308	42.5	0.80	2.18	31.2	7.12	10.61	23.9	9.89	7.85
	770, 001	39.7	0.82	2.28	28.2	7.07	9.19	27.4	8.93	6.60
	770, 113	38.3	0.77	2.27	30.1	6.47	10.45	24.3	8.20	6.09
	SY 115T	41.7	0.76	2.19	29.1	6.44	8.53	23.9	8.55	5.35
SY 158T	37.0	0.78	2.32	28.0	6.63	12.37	31.3	11.55	6.96	
Merlin Max	40.7	0.79	2.18	32.9	7.37	5.59	19.9	4.96	4.20	
Legend	43.0	0.81	2.07	30.3	7.26	8.27	23.3	6.31	5.59	
Swift 77	40.7	0.78	2.21	30.0	6.44	9.39	24.8	7.87	5.25	
Goldrush 91	41.0	0.81	2.15	30.6	7.34	7.47	23.3	6.40	5.42	
Wheat	PR 1404	38.7	0.76	2.48	28.8	6.12	11.38	25.5	8.60	5.70
Barley	Chowford	39.8	0.81	2.24	32.6	7.81	6.71	20.3	5.88	5.18
	Eureka	45.2	0.84	2.02	32.6	7.39	7.72	25.3	9.90	7.32
	Pronto	43.1	0.78	2.08	31.3	6.15	8.20	23.6	9.74	9.12
	HO315-354	40.0	0.79	2.14	33.8	7.61	8.15	18.9	5.43	4.79
	Solum	44.2	0.84	2.15	31.2	6.87	12.42	30.0	10.77	6.56
Oat	UC125	45.1	0.83	1.75	32.3	7.51	8.91	24.5	5.60	3.43
	UC132	39.5	0.77	1.79	31.7	7.24	9.76	20.0	2.07	2.98
	Wildcat 60	43.1	0.80	1.85	31.9	7.12	6.65	20.9	4.06	3.96
Avg	Avg	41.6	0.80	2.14	30.8	7.01	9.05	24.3	7.80	5.92

Table 7 (con'd). Soft dough stage forage quality for winter cereal forage varieties at the Maricopa Agricultural Center, 2020. See Table 5 for quality parameter abbreviations.

Crop	Entry	IVTDM D24	IVTDM D30	IVTDM D48	NDF D24	NDF D30	NDF D48	Lys	Met	AA	LA	Kd
		%	%	%	% of NDF	% of NDF	% of NDF	%	%	%	%	% NDF/hour
Triticale	470, 285	62.1	68.0	76.3	39.7	50.0	60.4	0.31	0.13	1.77	2.07	4.13
	470, 113	60.8	66.5	73.8	37.5	49.3	58.4	0.30	0.13	1.65	2.17	3.73
	470, 133	63.4	67.6	80.3	40.9	50.0	61.8	0.27	0.12	1.51	2.49	4.27
	470, 249	63.5	68.5	79.3	40.6	49.7	59.8	0.28	0.12	1.56	2.42	4.21
	470, 269	65.6	70.5	77.7	42.9	50.4	62.5	0.29	0.12	1.85	2.56	4.57
	470, 298	62.7	67.7	77.3	38.6	51.3	61.3	0.31	0.13	1.84	2.28	3.92
	470, 308	61.5	66.9	80.1	39.6	49.0	60.8	0.25	0.11	1.50	2.37	4.04
	770, 001	64.5	69.9	73.5	46.6	49.7	61.0	0.30	0.13	1.79	1.94	5.52
	770, 113	65.6	70.7	73.6	43.5	50.5	61.4	0.23	0.11	1.81	2.31	4.51
	SY 115T	61.3	66.8	76.8	37.6	51.6	61.9	0.29	0.13	1.84	2.08	3.60
SY 158T	67.6	73.2	74.7	48.4	50.6	61.7	0.28	0.13	1.79	2.32	6.17	
Merlin Max	54.1	59.2	73.2	31.3	44.8	56.7	0.26	0.12	1.48	2.22	2.79	
Legend	61.4	66.4	71.4	37.8	49.7	59.0	0.29	0.12	1.78	2.05	3.72	
Swift 77	63.7	68.8	76.3	38.0	50.5	60.2	0.29	0.12	2.01	2.09	3.65	
Goldrush 91	59.9	65.2	72.3	37.7	47.7	58.2	0.29	0.12	1.83	2.00	3.78	
Wheat	PR 1404	65.7	71.0	74.5	43.1	51.6	63.2	0.28	0.13	1.91	2.42	4.37
Barley	Chowford	59.5	65.4	69.9	38.6	49.7	61.2	0.27	0.13	1.32	1.89	3.98
	Eureka	58.7	64.5	78.3	38.0	47.7	61.4	0.29	0.13	1.11	2.42	3.75
	Pronto	64.4	69.9	80.7	39.7	51.1	61.6	0.27	0.12	1.41	2.32	3.79
	HO315-354	59.4	65.1	65.2	37.4	49.1	57.9	0.20	0.11	1.28	1.62	3.72
	Solum	65.1	70.1	78.5	44.0	46.9	61.7	0.35	0.14	1.36	2.21	4.86
Oat	UC125	56.9	61.8	70.9	30.9	45.2	59.0	0.30	0.13	1.37	2.05	2.76
	UC132	59.2	64.3	71.9	34.9	44.1	56.2	0.28	0.13	1.90	1.83	3.17
	Wildcat 60	55.3	60.9	72.5	33.3	45.1	59.2	0.28	0.13	1.53	1.75	2.96
Avg	Avg	61.7	67.0	75.0	39.2	49.0	60.3	0.28	0.12	1.63	2.16	4.00

Table 8. Abbreviations used for forage quality parameters.

Abbreviation	Parameter	Abbreviation	Parameter
DM	DM	SP	Soluble Protein
Moist	Moisture	ADF-CP	ADF CP
Ash	Ash	NDF-CP	NDF CP
NDF	NDF	UIP	UIP
ADF	ADF	Lignin	Lignin
CP	Crude Protein	Starch	Starch
RFV	RFV	NFC	NFC
TDN	TDN	Carbo	Soluble Carbohydrate
RFQ	RFQ	Sugar	Simple Sugar
NEL	NEL	IVTDMD24	IVTDMD24
Fat	Fat	IVTDMD30	IVTDMD30
Ca	Calcium	IVTDMD48	IVTDMD48
K	Phosphorus	NDFD24	NDFD 24
Mg	Magnesium	NDFD30	NDFD 30
S	Sulfur	NDFD48	NDFD 48
K	Potassium	Lys	Lysine
Na	Sodium	Met	Methionine
Cl	Chloride	AA	Acetic Acid
Fe	Iron (ppm)	LA	Lactic Acid
Mn	Manganese (ppm)	Kd	NDF digestion rate
Cu	Copper (ppm)		
Zn	Zinc (ppm)		



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