Orchardgrass Variety Trial

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Introduction

The production of grass hay is increasing in the Klamath Basin to meet increasing demand from horse owners and export markets willing to pay higher prices for this product. This hay primarily consists of cool-season grasses, sometimes mixed with a legume such as clover or alfalfa. Most of this hay is baled in two- or three-string bales (less than 100 lb each) that are easier to handle than the 0.5-ton or 1.0-ton round or square bales commonly used in alfalfa hay production. Orchardgrass is the predominant grass species grown for hay. However, fields of quackgrass, endophyte-free tall fescue, annual and perennial ryegrass, or timothy are also common because each of these cool-season grasses is well adapted to Klamath Basin climatic conditions.

Timothy and orchardgrass are the most desired grass species for the horse industry due to higher palatability and perceived value. Timothy has the least acreage and lowest yields in the Klamath Basin, but sometimes commands the highest price, even though orchardgrass generally produces higher quality forage.

To learn more about these forages and to identify varieties of orchardgrass that are well-suited to the Klamath Basin, a trial was established by Dr. Don Clark, the previous agronomist at the Klamath Experiment Station (KES), in the spring of 2002 to evaluate 16 orchardgrass varieties in pure stands. The trial was set up to allow measurement of yield and quality for several cutting dates to determine which varieties might perform better during various times in the growing season. The 2005 crop year marked the end of the data collection period for this study, although the planting will not be removed until the space is needed for another study.

Procedures

The orchardgrass variety trial was established in June 2002 at the KES on a Fordney loamy fine sand soil. The field was ripped to a depth of 12-18 inches, followed by moldboard plowing, disking, and harrowing. A Brillion packer (Brillion Farm Equipment) was pulled behind the harrow on the last pass to form a smooth, firm seedbed.

All plots were 4.5 ft wide and 20 ft long. In the orchardgrass variety trial, seed was planted at 0.25- to 0.5-inch depth, at a seeding rate of 12 lb/acre. All plots were seeded with a Kincaid (Kincaid Equipment Manufacturing) experimental plot drill, which planted 9 rows at a 6-inch spacing per row. This trial was arranged in a randomized complete block design with four replications.

As part of field preparation, the trial area received preplant incorporated additions of elemental (popcorn) sulfur (S) at 300 lb/acre S, and 10-34-0 liquid at 400 lb/acre to supply phosphorus at 136 lb/acre P_2O_5 and nitrogen (N) at 40 lb/acre N. At planting, the area also

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received 310 lb/acre of 16-20-0-13, (supplying 50 lb/acre N, 62.5 lb/acre P_2O_5, and 41 lb/acre S). In 2002 and 2003, additional N and S applications were made following each harvest.

In 2004 the orchardgrass variety trial area received 80 lb/acre N as ammonium sulfate at 390 degree days (March 22, about when the grass started to actively grow). The same fertilizer rate and material was also applied after the first and second cutting dates. The trial area did not receive any herbicide prior to or during the 2004 season.

In 2005, the trial area received 84 lb/acre N as ammonium sulfate on April 25, soon after the grass started to actively grow. After first cutting, the trial area received 71 lb/acre N as ammonium sulfate on June 2. After second cutting, the trial area received 75 lb/acre N as ammonium sulfate on July 20. The trial area did not receive any herbicide prior to or during the 2005 season.

Irrigation water deliveries to KES were not interrupted for any significant time periods in 2005. All forage trials were irrigated with solid-set sprinklers to meet crop needs based upon crop evapotranspiration (Et), and were monitored with Watermark (Irrometer Co, Inc.) moisture sensors at 6-, 12-, and 24-inch soil depth. Water was applied when tensiometer readings were at 50 kPa for the 12-inch depth sensor. This generally coincided with Et requirements for irrigation. Irrigation rate for all forage trials was based upon alfalfa needs since most of the field was devoted to alfalfa test plots, and there was no practical way to irrigate the alfalfa trials separate from the orchardgrass or orchardgrass/alfalfa plantings. The trial area received one irrigation in April (0.64 inch), none in May, five irrigations between first and second cutting (4.45 inch total), five irrigations between second and third cutting (6.15 inch total), and five irrigations between third cutting and the end of September (4.24 inch total), for a seasonal total of 15.48 inches of irrigation water applied in 2005.

In addition to irrigation, a total of 4.51 inches of precipitation fell during the April-September growing season. This amount was greater than typical, and was due to an unusually wet spring, where 1.80 inches of precipitation fell during April, and another 2.24 inches fell from May 1 to May 18. Thus only one small irrigation application (in April) was needed before the first cutting on May 27. Only 0.47 inches of precipitation fell the remainder of the season (May 19- September 30). No rain fell in August, and only 0.02 inches fell in July, resulting in excellent harvest and hay curing weather, especially for the second and third cuttings. After the unusually wet spring, the 2005 growing season was somewhat warmer than 2004 (especially in mid-summer), and ended up being fairly typical for the Klamath Basin, providing good growing conditions for most of the summer, as well as excellent harvest conditions (see the Weather and Crop Summary section of this annual report for further weather details).

The orchardgrass variety trial was harvested three times, on May 27, July 20, and August 26. Prior to each harvest, 5.5-ft strips were cut between plot rows for separation. Forages were harvested with a Carter (Carter Manufacturing Co., Inc.) power take-off powered flail harvester with a 3-ft-wide cutting width. Residue in border areas was removed with a Mathews (Mathews Co.) flail chopper after plot harvests.

After the cut material from each plot was weighed, random samples were collected from the chopped plot material, weighed, and then oven dried to determine dry matter content and calculate dry matter yield. Dried samples were ground to pass a 2-mm sieve in a Wiley Mill (Arthur H. Thomas Co.) and then to pass a 1-mm-sieve size in a Udy Mill (Udy Corp.). The ground samples were then analyzed in a near infrared spectrophotometer (NIRS, NIRSystems) to determine forage quality expressed as crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), relative feed value (RFV), and relative forage quality (RFQ), with equations developed by FOSS North America, Minneapolis, Minnesota; the NIRS Consortium, Madison, Wisconsin; or by KES.

Statistics on yield and quality data were calculated using SAS® for Windows, Release 9.1 (SAS Institute, Inc.) software. Treatment significance was based on the F test at the $P = 0.05$ level. If this analysis indicated significant treatment effects, least significant difference (LSD) values were calculated based on the student's *t* test at the 5 percent level.

To assist interpretation of forage quality data, the USDA grass hay quality guidelines are included in this report (Table 1). KES grass hay quality ratings are reported on 100 percent dry matter and are based upon USDA guidelines. Ratings for total digestible nutrients (TDN), ADF, NDF, RFV, and RFQ are not included in USDA grass hay quality grading guidelines at this time, but are included in this report as another means that growers and companies might find useful to help assess differences in forage quality between trial entries.

Results and Discussion

There were significant differences in yield among the 16 orchardgrass varieties for all three cuttings, as well as the annual yield totals (Table 2). First-cutting yields ranged from 2.3 to 3.1 ton/acre, with a mean of 2.7 ton/acre. Second-cutting yields ranged from 0.9 to 1.3 ton/acre, with a mean of 1.1 ton/acre. Third-cutting yields ranged from 1.6 to 2.0 ton/acre, with a mean of 1.8 ton/acre. Total yields ranged from 5.3 to 6.1 ton/acre, with a mean of 5.6 ton/acre. The lowest-yielding varieties had a similar total yield in 2004 and 2005, but the yields of the highest yielding varieties were clearly lower in 2005. This difference was mainly due to the lower second cutting yields in 2005. Growing conditions were nearly ideal for cool-season grasses in 2004, especially in mid-summer, whereas the hotter mid-summer weather typically seen (as was experienced in 2005) tends to reduce biomass production at that time.

As in 2004, the lowest yielding entries tended to be late-maturing types, and except for Amba, these late-maturing types occupied the lowest 9 ranks in total yield. As in 2004, the early and medium types tended to have higher yields, and occupied the top six ranks in 2005. There were not as many dramatic changes in rank from 2004 to 2005 as there had been the previous year, but there were a few interesting trends. Stampede continued its relative improvement, moving up 4 ranks in 2005 after improving by 5 ranks in 2004. Satin also continued to improve. After producing the lowest yield in the entire trial in 2003, it improved by 6 ranks in 2004 and another 3 in 2005, becoming the highest yielding of the late-maturing

group of varieties in 2005. In contrast, Amba continued its slide, dropping by 7 ranks in 2005 in addition to the drop of 3 it exhibited in 2004. Pennlate also continued to fall relative to the others, dropping 7 ranks in 2005 after dropping 2 in 2004. Two varieties (Mammoth and Potomac) have consistently yielded well all 3 years, whereas Sparta continues to remain near the bottom of the list for the third year in a row.

Significant variety differences were observed in CP for the second cutting only (Table 3). For every variety, CP values increased as the season progressed to the second and third cuttings. Due to maturity and other variety differences, it is unusual for a particular variety to have a higher CP than the others for all three cuttings. The relative ranking values indicate Sparta, Amba, and Quantum were the only varieties to rank among the top half in CP value for all three cuttings, but as was shown previously, those were also the three lowest yielding varieties in the entire trial in 2005. At the other extreme, Pizza was the only variety with below-average CP for all three cuttings. All entries were below premium grade (less than 13 percent CP) for the first cutting, but were above 13 percent for the second cutting, and well above 13 percent CP by the third cutting. The main difference between 2004 and 2005 occurred at the second cutting, where the 2004 mean was 17.6 percent, compared to the 2005 mean of 13.8 percent.

There was a significant difference between variety means for ADF, NDF, and RFV on the second cutting date only (Tables 4-6). As in the case of yield and CP, this response indicates some differential response of varieties to their growing conditions between May 27 and July 20.

Unlike the RFV results, RFQ results did show a significant difference between varieties for all three cutting dates (Table 7). Although RFV and RFQ calculations are both designed to differentiate between hay of different quality grades, they do not use the same factors in the calculation. RFV is derived from ADF and NDF, whereas RFQ is a more complicated calculation derived from nonfibrous carbohydrate, CP, fatty acids, nitrogen-free NDF, 48-hour *in vitro* digestibility, and NDF (Undersander and Moore 2002). Because RFQ uses additional factors representing animal assimilation (e.g., digestible fiber and nonfibrous carbohydrate), it is thought by some to be a more accurate predictor of actual animal performance on a particular forage. This improved ability to predict animal performance is thought to be especially true for grass forages. Thus, in most cases RFV and RFQ will provide similar predictions of forage quality, but when they do not, it is helpful to remember how the two values are calculated and therefore how they might best be used by hay growers and buyers, depending on the planned end-use of the forage.

As was true for CP, most varieties had relatively high ADF, NDF, RFV, and RFQ values for one or two cuttings, but not all three. Exceptions to that pattern included Comet and Mammoth (consistently high ADF and NDF, but low RFV), Orion (consistently low ADF), Satin and Amba (consistently low NDF, but high RFV), Athos (consistently high RFQ), and Comet (consistently low RFQ).

The consistently high ADF and NDF and low RFV for Mammoth is not too surprising given its consistently high yield for all cutting dates, indicating a maximizing of biomass production and

advanced maturity for this early-maturing variety by the time of each harvest.

A comparison of the annual yield of each entry for all years of the study, as well as the cumulative total yield, is shown in Table 8. The relative persistence and production of each entry over time can be observed and compared. A few varieties produced very good yields relative to the other entries every year of the study, including Mammoth, Hallmark, and Potomac, and thus they were among the highest in total cumulative yield for the trial. In contrast, Pizza and Sparta produced low yields every year of the study, and thus their total cumulative yields were the lowest in the trial. Some entries dramatically increased or decreased their relative performance during the course of the trial. Icon had a relatively low yield the first year, but improved dramatically to the first or second position for the last two years, resulting in a second place cumulative yield. On the other hand, Quantum had the highest yield the first year, but then dropped to near the bottom the last 2 years.

References

Undersander, D., and J.E. Moore. 2002. Relative forage quality. Focus on Forage, Vol. 4, No. 5. Univ. of Wisconsin Extension, Madison. 2 pp.

Table 1. USDA quality guidelines for grass hay[1].

Quality Grade[2]	Crude Protein %
Premium	>13
Good	9-13
Fair	5-9
Low	<5

[1]For the latest hay market report contact: USDA Livestock and Grain Market News, 1498 S. Pioneer Way, Moses Lake, WA 98837; Phone: 509/765-3611; Fax: 509/765-0454.

[2]Hay quality designation--physical description.

Supreme	Very early maturity, prebloom, soft fine stemmed, extra leafy. Factors indicative of very high nutritive content. Hay is excellent color and free of damage.
Premium	Early maturity, preheading, extra leafy and fine stemmed. Factors indicative of high nutritive content. Hay is green and free of damage.
Good	Early to average maturity, early head, leafy, fine to medium stemmed, free of damage other than slight discoloration.
Fair	Late maturity, head, moderate or below leaf content, generally coarse stemmed. Hay may show light damage.
Utility	Hay in very late maturity, mature head, coarse stemmed. Includes hay with excessive damage and heavy weed content or mold. Defects will be identified in market reports when using this category.

Table 2. 2005 yield results for the orchardgrass variety trial planted in spring 2002 at the Klamath Experiment Station, Klamath Falls, OR.

Variety	Maturity rating	Cut 1 May 27	Cut 2 July 20	Cut 3 Aug 26	Total yield	2005 rank	Rank change from 2004
		ton/acre					
Mammoth	early	3.1	1.1	1.8	6.1	1	2+
Icon	medium	2.9	1.1	2.0	6.1	2	1-
Stampede	early/med	3.0	1.2	1.9	6.0	3	4+
Hallmark	early	2.9	1.1	1.8	5.8	4	2-
Comet	medium	2.9	1.1	1.8	5.8	5	1+
Potomac	early	2.8	1.1	1.8	5.7	6	2-
Satin	late	2.7	1.0	2.0	5.6	7	3+
Baridana	late	2.7	1.0	1.9	5.6	8	3+
Latar	late	2.7	1.1	1.7	5.5	9	6+
Pizza	late	2.5	1.3	1.7	5.5	10	3+
Orion	late	2.7	0.9	1.8	5.5	11	3-
Pennlate	late	2.7	1.0	1.8	5.5	12	7-
Athos	late	2.3	1.3	1.8	5.4	13	1-
Quantum	late	2.5	1.2	1.8	5.4	14	=
Sparta	late	2.6	0.9	1.8	5.3	15	1+
Amba	early	2.7	1.0	1.6	5.3	16	7-
Mean		2.7	1.1	1.8	5.6		
P value		0.004	0.002	0.017	0.008		
LSD (0.05)		0.3	0.2	0.2	0.5		
CV (%)		8.7	12.0	7.2	5.7		

Table 3. 2005 crude protein results for the orchardgrass variety trial planted in spring 2002 at the Klamath Experiment Station, Klamath Falls, OR.

Variety	Maturity rating	Cut 1	Rank	Cut 2	Rank	Cut 3	Rank
				Crude protein %			
Comet	medium	11.8	16	13.6	12	17.6	5
Hallmark	early	12.0	13	14.2	3	17.3	12
Orion	late	12.0	9	14.0	6	17.6	6
Potomac	early	12.2	3	12.7	16	17.3	14
Icon	medium	12.3	1	13.6	11	17.2	15
Pizza	late	12.0	10	13.1	15	17.5	10
Latar	late	12.0	11	13.6	10	17.5	7
Pennlate	late	12.0	14	13.6	9	17.9	2
Satin	late	11.8	15	13.7	8	18.1	1
Sparta	late	12.2	5	14.9	1	17.5	8
Athos	late	12.2	2	13.5	13	16.9	16
Amba	early	12.2	6	14.4	2	17.7	4
Mammoth	early	12.0	12	14.2	4	17.4	11
Quantum	late	12.1	8	14.1	5	17.7	3
Stampede	early/med	12.1	7	13.4	14	17.3	13
Baridana	late	12.2	4	13.9	7	17.5	9
Mean		12.0		13.8		17.5	
P value		0.192		0.004		0.907	
LSD (0.05)		NS		0.9		NS	
CV (%)		6.0		4.4		4.4	

Table 4. 2005 acid detergent fiber results for the orchardgrass variety trial planted in spring 2002 at the Klamath Experiment Station, Klamath Falls, OR.

Variety	Maturity rating	Cut 1	Rank	Cut 2	Rank	Cut 3	Rank
		Acid detergent fiber %					
Comet	medium	36.0	1	38.0	2	37.0	4
Hallmark	early	35.4	7	37.7	5	36.1	14
Orion	late	35.3	10	36.6	14	36.0	15
Potomac	early	35.1	12	37.3	10	36.8	5
Icon	medium	35.5	6	36.5	15	35.6	16
Pizza	late	35.5	5	37.5	8	36.8	6
Latar	late	35.6	3	37.2	12	36.4	10
Pennlate	late	35.6	4	36.8	13	36.5	9
Satin	late	34.9	14	37.2	11	36.8	7
Sparta	late	35.4	8	35.7	16	36.6	8
Athos	late	35.3	11	37.7	6	37.0	3
Amba	early	35.4	9	37.4	9	36.4	12
Mammoth	early	35.9	2	38.2	1	37.1	1
Quantum	late	35.0	13	37.9	4	37.0	2
Stampede	early/med	34.5	15	37.6	7	36.2	13
Baridana	late	34.2	16	38.0	3	36.4	11
Mean		35.2		37.3		36.5	
P value		0.088		0.008		0.295	
LSD (0.05)		NS		1.2		NS	
CV (%)		2.8		2.2		2.1	

Table 5. 2005 neutral detergent fiber results for the orchardgrass variety trial planted in spring 2002 at the Klamath Experiment Station, Klamath Falls, OR.

Variety	Maturity rating	Cut 1	Rank	Cut 2	Rank	Cut 3	Rank
				Neutral detergent fiber %			
Comet	medium	61.2	1	60.7	3	59.3	2
Hallmark	early	60.4	2	60.6	4	58.1	8
Orion	late	60.3	3	58.5	13	57.8	13
Potomac	early	59.0	11	59.5	7	58.3	5
Icon	medium	59.2	9	58.3	15	58.1	10
Pizza	late	59.2	8	59.2	9	57.6	15
Latar	late	59.1	10	59.4	8	58.1	7
Pennlate	late	59.8	4	58.6	12	58.1	9
Satin	late	59.0	12	58.4	14	57.7	14
Sparta	late	59.4	5	57.7	16	58.3	6
Athos	late	59.3	7	60.1	5	58.7	3
Amba	early	58.7	13	59.0	11	57.6	16
Mammoth	early	59.3	6	61.2	2	59.6	1
Quantum	late	57.9	14	61.3	1	57.9	12
Stampede	early/med	56.4	16	59.2	10	58.5	4
Baridana	late	56.7	15	60.1	6	58.0	11
Mean		59.0		59.5		58.2	
P value		0.112		<0.001		0.181	
LSD (0.05)		NS		1.6		NS	
CV (%)		3.3		1.9		1.6	

Table 6. 2005 relative feed value results for the orchardgrass variety trial planted in spring 2002 at the Klamath Experiment Station, Klamath Falls, OR.

Variety	Maturity rating	Cut 1	Rank	Cut 2	Rank	Cut 3	Rank
				Relative feed value			
Comet	medium	93	16	91	14	94	15
Hallmark	early	94	15	91	13	97	5
Orion	late	95	14	96	3	98	1
Potomac	early	97	6	94	10	96	13
Icon	medium	96	7	97	2	98	2
Pizza	late	96	10	94	8	97	6
Latar	late	96	9	94	7	97	9
Pennlate	late	95	13	96	4	97	8
Satin	late	97	4	95	5	97	4
Sparta	late	96	11	98	1	96	12
Athos	late	96	8	92	11	95	14
Amba	early	97	5	94	6	98	3
Mammoth	early	96	12	90	16	94	16
Quantum	late	99	3	90	15	96	11
Stampede	early/med	103	1	94	9	97	10
Baridana	late	102	2	92	12	97	7
Mean		97		94		97	
P value		0.094		0.001		0.475	
LSD (0.05)		NS		4		NS	
CV (%)		4.5		2.8		2.6	

Table 7. 2005 relative forage quality results for the orchardgrass variety trial planted in spring 2002 at the Klamath Experiment Station, Klamath Falls, OR.

Variety	Maturity rating	Cut 1	Rank	Cut 2	Rank	Cut 3	Rank
			Relative forage quality				
Comet	medium	120	16	117	14	93	15
Hallmark	early	124	12	123	11	106	1
Orion	late	125	10	126	5	100	7
Potomac	early	126	6	126	6	98	11
Icon	medium	124	14	130	2	104	2
Pizza	late	124	11	122	12	99	9
Latar	late	124	13	128	4	99	8
Pennlate	late	125	9	130	3	99	10
Satin	late	130	2	123	10	88	16
Sparta	late	129	4	131	1	95	14
Athos	late	130	3	125	7	102	4
Amba	early	126	7	124	9	101	6
Mammoth	early	123	15	117	15	101	5
Quantum	late	126	8	121	13	97	12
Stampede	early/med	129	5	125	8	103	3
Baridana	late	132	1	115	16	96	13
Mean		127		124		99	
P value		0.020		0.005		0.032	
LSD (0.05)		9		8		9	
CV (%)		5.0		4.6		6.1	

Table 8. 2003, 2004, 2005, and cumulative yield totals for the orchardgrass variety trial planted in spring 2002 at the Klamath Experiment Station, Klamath Falls, OR.

		2003		2004		2005		Total	
Variety	Maturity rating	Yield ton/acre	Rank	Yield ton/acre	Rank	Yield ton/acre	Rank	Yield ton/acre	Rank
Mammoth	early	4.3	2	6.5	3	6.1	1	16.9	1
Icon	medium	3.9	10	6.6	1	6.1	2	16.6	2
Hallmark	early	4.1	5	6.5	2	5.8	4	16.5	3
Potomac	early	4.2	3	6.5	4	5.7	6	16.4	4
Comet	medium	3.9	11	6.5	6	5.8	5	16.2	5
Pennlate	late	4.1	4	6.5	5	5.5	12	16.1	6
Stampede	early/med	3.8	12	6.2	7	6.0	3	16.0	7
Quantum	late	4.4	1	6.0	14	5.4	14	15.8	8
Baridana	late	4.0	8	6.1	11	5.6	8	15.7	9
Amba	early	4.0	7	6.2	9	5.3	16	15.5	10
Latar	late	4.1	6	5.9	15	5.5	9	15.5	11
Orion	late	3.7	13	6.2	8	5.5	11	15.4	12
Athos	late	4.0	9	6.0	12	5.4	13	15.4	13
Satin	late	3.6	16	6.1	10	5.6	7	15.3	14
Pizza	late	3.7	14	6.0	13	5.5	10	15.2	15
Sparta	late	3.7	15	5.5	16	5.3	15	14.5	16
Mean		4.0		6.2		5.6		15.8	
P value		0.775		0.003		0.008		0.003	
LSD (0.05)		NS		0.5		0.5		1.0	
CV (%)		13.9		5.6		5.7		4.5	