

TEFF HAY: RECENT OBSERVATIONS IN THE SOUTHWEST

Mark A. Marsalis¹ and Leonard M. Lauriault²

ABSTRACT

Teff is a warm-season annual grass that has gained popularity among horse owners and hay producers looking for alternative hay crops to improve marketing opportunities and to fit into low-water situations. In recent years, water shortages have threatened the sustainability of irrigated agriculture in dry environments of the western U.S. Hay producers across the West have experienced reduced irrigation allocations, increased pumping costs, and subsequently lower yields and profitability in their operations. Teff offers a high-quality hay option that fits well into alfalfa rotations, while maximizing limited water and fertilizer resources. Research and producer observations have mixed results; however, enough consistencies exist that make choosing teff a viable alternative under certain conditions. This article summarizes research in New Mexico and some farmer experiences with teff in the region.

Key Words: teff, irrigation, nitrogen, management, nutritive value

INTRODUCTION

As declining water availability continues to threaten irrigated agriculture sustainability, alternative forage sources must be utilized that reduce water inputs and allow for flexibility in extreme climatic conditions (e.g., drought). Teff [*Eragrostis tef* (Zucc.) Trotter], originally utilized as a cereal grain crop in Africa, has developed a reputation as a rapidly growing, drought-tolerant, high-quality forage crop in the U.S. Multiple studies in several western states and extensive promotion among companies in the hay industry have touted the benefits of teff for several classes of livestock and for use in challenging growing conditions. The forage is suited to a broad range of environments in the Southwest, can be cut multiple times, and offers flexibility to the hay producer. The primary utilization potential for teff, however, appears to be in the small bale horse market, and in areas where other suitable annual grass hays are not available to feed to horses. Horse owners have had favorable experiences with teff hay, and demand for the hay has increased significantly in the region. Several producers have attempted to take advantage of the demand by growing all different bale sizes and varieties of teff. As with any crop, both positive and negative opinions have emerged from the varied experiences of farmers with teff. Poor establishment is the most often cited complaint among producers in the region. Growing conditions and hay production challenges are very different in the warmer and often drought-stricken regions of the Southwest than in other more northern, western US regions.

¹ M.A. Marsalis, Extension Forage Specialist, New Mexico State University, Agricultural Science Center at Los Lunas, 1036 Miller Rd, Los Lunas, NM 87031; Email: (marsalis@nmsu.edu); ² L.M. Lauriault, Forage Crop Management Scientist, New Mexico State University, Agricultural Science Center at Tucumcari, 6502 Quay Rd. AM 5, Tucumcari, NM 88401 **In:** Proceedings, 2015 Western States Alfalfa and Forage Symposium, Reno, NV, 2-4 December, 2015. UC Cooperative Extension, Plant Sciences Department, University of California, Davis, CA 95616. (See <http://alfalfa.ucdavis.edu> for this and other alfalfa conference Proceedings.)

Little information exists on management of teff in the Southwest, particularly under water-restricted conditions.

YIELDS AND QUALITY

Teff has been reported from western states to produce anywhere from 1.5 to over 8.5 tons/ac of total seasonal yield, depending on location, length of growing season, cutting schedule, and irrigation and fertilizer inputs. About 1.0 to 2.0 tons/ac are common per cutting. Over 3 years at the NMSU Agricultural Science Center at Los Lunas, teff has yielded between 2.6 and 4.0 tons/ac for the season (Table 1). Yields of 2.1 to 3.3 tons/ac have been reported at Tucumcari, NM. At both locations, these yields were obtained with approximately half the water applied to 'fully irrigated' alfalfa and yields are similar to those reported by farmers in the region utilizing varying irrigation techniques and amounts. They are also similar to yields observed in neighboring states. Typical water scheduling at Los Lunas is a rotation every 21-28 days. Approximately 1.5 tons/ac of hay can be made in 45-60 days in the Middle Rio Grande region of New Mexico, utilizing flood irrigation. However, this is dependent on time of year and on nitrogen fertilizer applications. For example, in 2013, higher yields resulted on the subsequent cuttings when 50 lbs of urea fertilizer was applied after the June 18 and August 8 harvests (Table 1).

Table 1. Teff hay yields in three different years at the NMSU Agricultural Science Center at Los Lunas, NM.

Year (Planting Date)	Hay Cuttings	# Bales/ac	Ton/ac*
2007 (June 8)	July 24	60	1.8
	August 24	27	0.7
	October 15	38	1.1
	Total Yield	125	3.6
2013 (May 3; cool Spring)	June 18	6	0.2
	July 12	49	1.5
	August 8	24	0.7
	October 10	53	1.6
	Total Yield	132	4.0
2014 (May 30)	August 20	48	1.4
	October 27	40	1.2
	Total Yield	88	2.6

*Assumes a 60-lb bale weight.

Water requirement appears to be more than that reported for sorghum forages (e.g., *Sorghum* sp.; haygrazer or forage sorghums), but water use is often lower than typical alfalfa usage, based on

producer reports and researcher observations. Sorghum sudangrass has been shown to yield more than teff with similar water and fertilizer applied. In other locations, teff has exhibited similar irrigation efficiency to sorghums, at about 3-4 inches of water to produce 1 ton of hay. More irrigation studies are needed to determine precisely relative water-use efficiency of teff compared with other forages, particularly in the Southwest.

Another advantage of teff is the fine-stemmed nature of the hay, which not only makes a more palatable feed, but also improves the ability to make a tight, heavy bale, which can be a challenge with other grass forages. Bale weights of 2-string small squares of over 60 lbs are easily achievable with teff. Drying teff hay in the windrow is usually very rapid in the Southwest due to its fine-stemmed nature, combined with normal dry, hot weather.

Teff nutritive value has been described as similar to timothy (*Phleum pratense* L.) and orchardgrass (*Dactylis glomerata* L.) hay and full-bloom alfalfa. Studies and producer experiences have shown mixed results when determining horse and other livestock preference of the different hays. However, many horse owners report improved preference and less waste of teff when feeding it. Teff is marketed as a low starch and soluble carbohydrate hay compared to other forages, and this trait may make it a suitable component in the diet of horses with equine metabolic syndrome or related disorders. Our bale sampling, as well as research at Tucumcari, reveal that teff soluble sugars (non-fiber carbohydrates; NFC) are lower than most alfalfa hays, but can be higher than other grasses (>18% NFC; Table 2).

Crude protein (CP) of teff is dependent upon available nitrogen and improves with additional N fertilizer applications. Crude protein ranges from 7 to 17%, but CP is usually between 10 and 15% with N fertility of 30 to 100 lbs/ac that is commonly applied. Although teff may have high fiber values (e.g., NDF) as indicated by our sampling and other studies, digestibility (i.e., neutral detergent fiber digestibility; NDFD) shows that the fiber component is highly digestible (Table 2). Hence, ranking indicators such as RFQ may give better representation of actual feed value of teff than the historical system of RFV. As with most hays, the nutritive value parameter in question will determine which hay is superior to another when comparing for a particular class of livestock. If using digestible energy (DE) for estimation for horses, then teff is similar to or better than other grasses (e.g., fescue and bermudagrass; Table 2) and lower quality alfalfa. Studies have shown that teff is capable of meeting 90-97% of the DE and other nutrient requirements of an average horse.

Table 2. Nutritive value analysis of various hay bale samples taken in 2013-14. LL = bales produced at the NMSU Los Lunas Agricultural Science Center.

Sample ID	Source	Notes	CP	DE (Horse)	NFC	Ca	P	ADF	NDF	NDFD 48	TDN 1x	RFQ
			% of DM	Mcals/lb	% of DM	% of DM	% of DM	% of DM	% of DM	% aNDF	% of DM	
teff	LL - Baled	After Frost	10.8	0.91	19.0	0.47	0.18	41.1	66.9	53.3	55.3	91
teff	LL - Baled	Mid-Summer	8.1	0.92	17.2	0.32	0.18	38.7	58.8	57.0	58.4	101
alfalfa	Purchased 3-string		14.1	0.86	25.5	0.87	0.27	46.9	56.5	40.5	52.9	86
alfalfa	Purchased 2-string		21.7	1.04	28.4	1.36	0.32	37.8	46.3	49.3	61.4	135
bermuda	Purchased 3-string		12.0	0.87	16.6	0.34	0.23	42.2	65.2	49.3	53.1	85
alfalfa	LL - Baled		19.6	1.11	37.1	1.43	0.27	31.3	39.7	47.4	65.1	164
alfalfa	LL - Baled		15.8	1.00	23.1	0.9	0.26	41.4	51.0	44.0	56.0	93
alfalfa	LL - Baled Cut 2	Rained On	14.3	0.86	12.4	1.1	0.13	51.5	64.7	38.0	48.0	53
alfalfa	LL - Baled Cut 3		15.5	0.99	22.7	0.95	0.29	42.4	51.5	41.0	54.0	85
fescue	LL - Baled Cut 2	Max Q	13.4	1.35	31.0	0.42	0.29	24.1	43.7	87.1	76.9	244
fescue	LL - Baled Cut 3	Max Q	14.2	0.92	14.6	0.38	0.17	33.8	57.1	74.0	65.0	147
fescue	LL - Baled Cut 2	Blend	12.6	0.90	13.7	0.43	0.23	36.0	60.6	68.0	62.0	135

NITROGEN FERTILITY

Recommendations for fertilizing teff with nitrogen are quite variable and are to add anywhere from 50 to 120 lbs of N/ac for the year, but most sources agree that about 30 to 60 lb N/ac at-plant and in between cuttings is optimum. Little yield advantage has been observed with nitrogen applications greater than 50 lb N/ac per cutting.

To verify this for more southerly locations in the West, a 2-year study was conducted at the NMSU Agricultural Science Center at Tucumcari, New Mexico to test the effects of nitrogen rates and timing on teff yield and quality. Treatments consisted of single, at-plant applications of 30, 60, and 90 lb N/ac, as well as a split application of 30 lb N/ac at-plant and after each cutting. There was no total seasonal yield improvement with the split 30 lb N/ac treatment over the single, at-plant 60 or 90 lb N/ac in the 3-cut system. However, the single 30 lb N at plant was limiting on late-season cuts and resulted in lower total yields for the season. Teff yield and quality were optimized with nitrogen applications of 30 lb N/ac for each cutting. However, if crude protein content is a minimal concern, producers may be able to save fertilizer application costs by only applying 90 lbs N/ac at plant. The results indicate a N-use efficiency of 25-30 lbs of N needed to produce 1 ton of dry teff forage. Similar N-use efficiency was observed at the Los Lunas station in a corresponding study and in subsequent years under commercial production.

As mentioned previously, teff fits well into alfalfa rotations and can be an excellent hay crop to put in between alfalfa stands during the 1 or more years necessary to reduce allelopathic effects. If following alfalfa, enough residual nitrogen may remain in the soil to meet the relatively low nitrogen requirements of teff, even for multiple cuts in a season. This is especially true if the last topgrowth of the alfalfa was incorporated into the soil and not harvested for hay.

MISCELLANEOUS MANAGEMENT ISSUES

Weed Control

Weeds, particularly grass weeds, can be a major problem in teff production. Some broadleaf weeds can be difficult to control if not controlled early. Pigweed species are especially problematic in parts of the Southwest and are probably the number one broadleaf weed concern for teff in the region. Very few herbicides are labeled for use in teff and timing is critical for effective control. Only 2,4-D and Dicamba products (or combination) are labeled. No herbicides are labeled for grass control in teff, so it is important to know the weed history of the field prior to planting. Fields with persistent grassy weed problems (e.g., sandburs, foxtails) should be avoided when considering teff. Fortunately, in alfalfa rotations, many of the grassy weeds have been managed with the competitiveness of the alfalfa along with grass herbicides so that the seed bank has been reduced. These fields make for excellent conditions to insert teff into the rotation prior to going back into alfalfa.

Teff simply does not compete well with weeds. Some recommendations state that it is better to wait to plant until soil temperatures warm enough that teff growth is rapid and the seedling plants can be more competitive against germinating weeds. Research at Los Lunas, NM indicates that

an earlier planting may be more advantageous and that while teff growth is slow, small plants are able to get ahead of most summer weeds and weed competition is less severe. Later planting can put the germinating teff into the middle of the weed germination window, and reduced stands can ensue. This can be especially problematic in areas where multiple flushes of weeds occur throughout the growing season and if herbicide applications are delayed due to rain later in the spring or other unforeseen factors. A late freeze is one obvious drawback to earlier planting and can potentially kill a newly seeded field of teff. A longer interval until the first harvest also may occur in some cases with an earlier planting.

Nitrates

While teff has ‘no known toxicity issues’, it has long been suspected that it, like many grasses, may accumulate nitrates (NO₃) if conditions are conducive to do so. High nitrogen fertility and reduced plant growth due to drought or other stresses are perfect conditions for NO₃ accumulation. Teff samples taken in Oklahoma in summer 2015 indicate that teff can, in fact, concentrate high levels of nitrate. Laboratory analysis indicated that teff from one drought-stressed field contained as much as 13,750 ppm of nitrate and 22% crude protein. Four other fields sampled had over 4,000 ppm NO₃, two of which were over 5,000 ppm, the level considered ‘potentially toxic’ by most standards. Because nitrates persist in the hay, it is necessary to test hay prior to feeding. As we continue to learn more about teff with increased experience, nutritive value and toxicity testing will continue to play a major role in how we manage and utilize teff forages.

CONCLUSIONS

Although teff is not without its challenges, it has a fit and can perform well in certain situations. It can fit into short-water situations or when large amounts of forage are needed to be produced in a short amount of time with minimal inputs. In general, teff performs similarly in New Mexico as it does in other parts of the West; however, with high temperatures and prevailing irrigation limitations, yields tend to be more modest (3-4 tons/ac) than those reported for cooler regions (over 5-6 tons/ac). Higher yields may be obtained in the more southerly reaches of the Southwest with longer growing seasons and more cuttings and if irrigation is not limiting. Also, we found that non-fiber carbohydrates tend to be higher than values reported elsewhere. Evidence now exists that shows teff will accumulate toxic levels of nitrate under droughty conditions in the region. Weed control early is critical to good stand establishment and yield of quality hay. Earlier planting in the Southwest may allow for improved teff competition prior to the primary weed germination window but late frosts are a concern with this method. Nutritive value can be quite variable depending on cut and management; however, overall teff quality can be excellent and certainly comparable to or better than some cool-season grass hays such as tall fescue, which is common in New Mexico. In times of large supplies and low hay prices, having a high-demand alternative grass hay such as teff available for horse owners could improve marketability and profits for producers willing to try something different or diversify their operations.

REFERENCES

- Creech, E. M. Laca, J. Barnhill, and S. Olsen. 2012. Teff Hay Production Guidelines for Utah. Utah Coop. Ext. Serv. Pub. AG/Forages/2012-01pr. October 2012.
- Davison, J., M. Laca, and E. Creech. 2011. The potential for teff as an alternative forage crop for irrigated regions. *In: Proceedings, 2011 Western Alfalfa & Forage Symposium, Las Vegas, NV, 11-13 December, 2011.*
- Lauriault, L.M., D.M. VanLeeuwen, and J.L. Turner. 2013. Irrigation and nitrogen treatments slightly affected teff yield and quality in the Southwestern USA. Online. Forage and Grazinglands doi:10.1094/FG-2013-0326-01-RS.
- Miller, D. 2011. Teff Grass: Crop overview and forage production guide, 3rd Ed. CalWest Seeds.
- Miller, D. 2008. Teff as an alternative summer forage. *In: Proceedings, 2008 California Alfalfa & Forage Symposium and Western Seed Conference, San Diego, CA, 2-4 December, 2008.*
- Norberg, S., R. Roseberg, B. Charlton, and C. Shock. 2008. Teff: A New Warm-season Annual Grass for Oregon. Oregon State Ext. Serv. Pub. EM8970. October 2008.
- Pearson, C.H., and J. Brummer. 2008. Evaluation of teff as an alternative forage crop for western Colorado 2008. Colorado State Univ. Agric. Exp. Stn. Tech. Rep. TR09-12.
- Staniar, W.B., J.R. Bussard, N.M. Repard, M.H. Hall, and A.O. Burk. 2010. Voluntary intake and digestibility of teff hay fed to horses. *J. Anim. Sci.* 88:3296-3303.
- Undersander, D., J.E. Moore, and N. Schneider. 2010. Relative forage quality. Univ. of Wisconsin Ext. Pub. Focus on Forage. Vol. 12, No. 6.