THE POTENTIAL FOR TEFF AS AN ALTERNATIVE FORAGE CROP FOR IRRIGATED REGIONS

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ABSTRACT

Teff is a warm season, annual grass that originated in Ethiopia and was imported to the United States more than 25 years ago. It is not cold tolerant and must be planted after the last frost of the year. Teff hay is reported to be a highly palatable, nutritious forage and is especially popular with horse owners. Interest in growing teff as an alternative forage has increased dramatically as more hay producers are introduced to it in seed company brochures, Extension fact sheets, and popular agricultural publications. As demand for teff hay has increased, prices have grown accordingly. Teff has been formally evaluated by forage researchers in several Western states. The results of these experiments reveal that teff yields are highly variable and affected by irrigation levels, fertilizer applications and variety tested. However, most of the results indicate that teff grown under an adequate irrigation and fertility program can produce in excess of five tons per acre. Teff is currently grown on a commercial scale on limited acreage throughout the West. The experience of commercial growers correlates to that found by researchers with teff production levels of approximately five tons per acre when grown under adequate levels of irrigation, fertility and utilizing proper harvest management techniques. Yield and quality of teff are highest under multi-cut systems. Teff requires approximately 50 days between harvests and regrowth is severely reduced when teff is cut to a stubble height of less than three inches. Total nitrogen applications in excess of 100 pounds per acre seldom increase economical yields of teff hay. Fertilizer applied prior to and between harvests normally results in superior yields. A combination of research results and practical experience leads to the conclusion that teff is a viable alternative forage crop when produced under irrigated conditions in the warmer parts of the West.

Key Words: Teff hay, alternative forages, production practices

Introduction

Teff *Eragrostis tef* is a warm season, annual grass, originally imported from Ethiopia. It is an annual lovegrass species and other names for it include; tef, annual love grass, teff grass and summer annual grass. It is reported to be drought tolerant and grow on a wide variety of soils which is not surprising considering that there are nearly 4000 varieties identified worldwide. Teff is frost sensitive and will die if exposed to temperatures below 28° F. However, teff grows rapidly when days are hot and nights are warm.

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Teff produces nutritious, fine stemmed, palatable hay in a relatively short time period (40-60 days) during the summer months. It can be cut multiple times when the season is long enough and adequate water is available for regrowth. When managed properly, the nutrient content and digestibility can equal or exceed other cool season grass hays commonly used as grass

Teff hay is rapidly gaining favor with horse owners because of its high palatability and in part, due to its perceived low levels of nonstructural carbohydrates (NSC). The high level of interest and inquires has resulted in the establishment of several experiments throughout the western United States with the purpose of evaluating teff as a forage (Davison, 2006, 2009, Noreberg, et al. 2009). Numerous varieties of teff have been tested for yields, nutrient levels, response to, fertilizer, and irrigation levels and damage from herbicide applications (Davison, et al. 2010, Roseberg et al. 2006. In addition, agronomic information necessary for the successful production of teff has also been developed (Miller, 2010). All of this information is critical when a producer is trying to decide if teff hay is a viable choice for an alternative forage crop in the western United States.

Why Teff?

Although teff has been produced as hay commercially for over 20 years, interest in teff has grown dramatically during the past five. Teff hay production is now a regular feature story in the popular press and demand for teff hay continues to increase, especially among horse owners. A Google search for "teff hay for horses" indicates the level of interest in teff with pages of articles related to teff and even more questions being posed on chat rooms, blogs etc. In Nevada, the interest has resulted in an increasing demand and increasing prices since 2005 (Figure 1).

Numerous studies have evaluated teff hay yields in several states over a nearly 20 year period. (Table 1). In Nevada, a study comparing 15 different teff varieties not selected specifically for forage production found large differences in yields (Table 2) while work in Oregon found little difference between named forage varieties. This illustrates the importance of selecting varieties developed specifically for forage production. The results of experimental work and commercial production indicates that a reliable long term average production is somewhere between 5 and 6 tons/acre per season. Teff hay quality has also been evaluated by researchers and found to be comparable to cool season grass hay (Miller 2010, Staniar et al. 2010) (Table 3).

Alfalfa, *Medicago sativa,* is the dominant forage crop of the western United States. Fields producing alfalfa must be rotated periodically to other crops such as cool season annual grains which are harvested for hay. Historically the profit potential in small grain hay harvested as a rotation crop is small and many producers are searching for alternatives that can be produced using their normal haying equipment. In the right locations teff may fulfill this need as a higher value rotation crop to alfalfa. Teff has also been used as a double crop following winter annual cereal hay production. The winter annual grain is planted in September, harvested in early June followed by teff which is planted in mid to late June.

While teff is reported to be drought tolerant recent studies indicate that adequate irrigation is necessary for optimum production (Roseberg et al. 2006). The primary water savings possible with teff production is related to the relatively short growing season as compared to alfalfa and

fewer irrigations. A single cutting of teff is possible in as little as 40 days. Because it is a warm season, annual grass, teff is not planted until after the last frost and irrigation normally ceases well before the first frost. Research in Oregon indicates that irrigation requirements for teff range from 4-10" per cutting. Additional research results in Nevada and California recommend a minimum of 24" per season.

Is Teff Right For My Operation?

While teff can be an excellent alternative forage crop for many producers it must be planted where it can thrive. The primary consideration is climate. Teff is a warm season crop and will produce poorly when summer temperatures are too cool or where late frosts are common. In Nevada, teff grows very well in portions of the state that experience at least 3000 growing degree days (50°F base) per year and is marginal when the growing degree days drop below 2300 per year. Higher elevations that experience cool nights will also slow the growth of teff.

As stated previously, teff requires adequate irrigation and fertility for optimal production. Teff grows slowly for the first 2-3 weeks and recommended irrigations are light and frequent at this time. Once the roots are established teff is irrigated as any other grass crop. Teff nitrogen requirements are relatively small but applications up to approximately 120 pounds per acre per season of actual nitrogen are recommended.

Teff is harvested similarly to other grass hays and normal haying equipment is adequate to harvest teff. It can normally be cut two to three times per season depending on the length of the frost free period.

Because teff is still unknown to many consumers it often requires additional marketing efforts as compared to known forages. While palatability is high many horse owners report that their animals must "learn" to eat teff with acceptance very high after the horses become accustomed to eating it.

Recommended Teff Production Practices

If a producer decides to plant teff as an alternative forage source, several agronomic practices have proven beneficial across a wide spectrum of situations. As with any crop, success depends on matching the growth requirements of teff with the agronomic practices applied.

While teff will grow in many soil types including poor soils, it produces best in high quality soils that exhibit little problems such as high salts, or alkalinity. Teff seed is extremely small with approximately 1.25 million per pound. As such, it must be planted in a firm, fine, seed bed to avoid placing the seed too deep. Seed should not be placed deeper than ¼ of an inch and should be rolled after planting. A typical grain drill is inadequate for seeding teff properly. Brillion or air type seeders are preferred planters for teff. Rolling the field with a cultipacker has also been shown to be beneficial following the seeding operation. Raw seed should be planted at five to six pounds per acre. Coated seeds are normally planted at a rate double that of raw seed. Some producers report that coated seed is easier to plant due to the larger size and rates used. Currently

no herbicides are registered for use on teff. Therefore planting into a clean seedbed is strongly recommended. It is expected that two common broadleaved herbicides will be available for use in the near future.

Teff should not be planted until after the last frost date of the season. Soil temperatures of at least 60°F at seeding increase the germination and initial plant growth rates. Irrigation is normally required frequently following seeding and until the roots are established at two to three weeks. Once established, teff is typically irrigated in the same way as other grass crops.

Assuming that levels of other soil nutrients are not lacking, teff responds well to 50-60 pounds of actual nitrogen applied at seeding and after each cut. Nitrogen levels in excess of this amount have not proven to be economical and can cause lodging.

Teff is normally harvested when it is in the early boot stage. Cutting at this time has proven to balance nutrients and yields while avoiding excess lodging. Teff should be cut no shorter than three to four inches. Cutting teff plants shorter than three inches will reduce the rate of regrowth and may kill many of the teff plants. Practices that speeds drying after harvest are also beneficial as teff plants growing under the windrow are normally much slower to regrow than those growing in the open. A second cutting of teff can be expected approximately 50 days following the first. Total yields on two cuttings should be approximately five to six tons.

Conclusions

Teff forage production under irrigated conditions has been shown to be a feasible and often desirable alternative to conventional cool season grass and alfalfa hay production operations in the West. It is rapidly gaining acceptance as a premium feed source, especially for horse owners who desire low NSC forages for horses that are overweight or suffer from forage related metabolic disorders. This rising demand has resulted in higher prices for teff hay than other cool season crops typically rotated with alfalfa. Teff hay also fills a niche for producers needing a summer annual crop that can be produced in short water years and in a relatively short time frame. It can be produced using standard haying equipment and when proper agronomic practices are applied will produce yields equal to or greater than other cool season grass hays.

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Figure 1. Average Alfalfa and Teff Hay Prices in Fallon Nevada 2005-2011

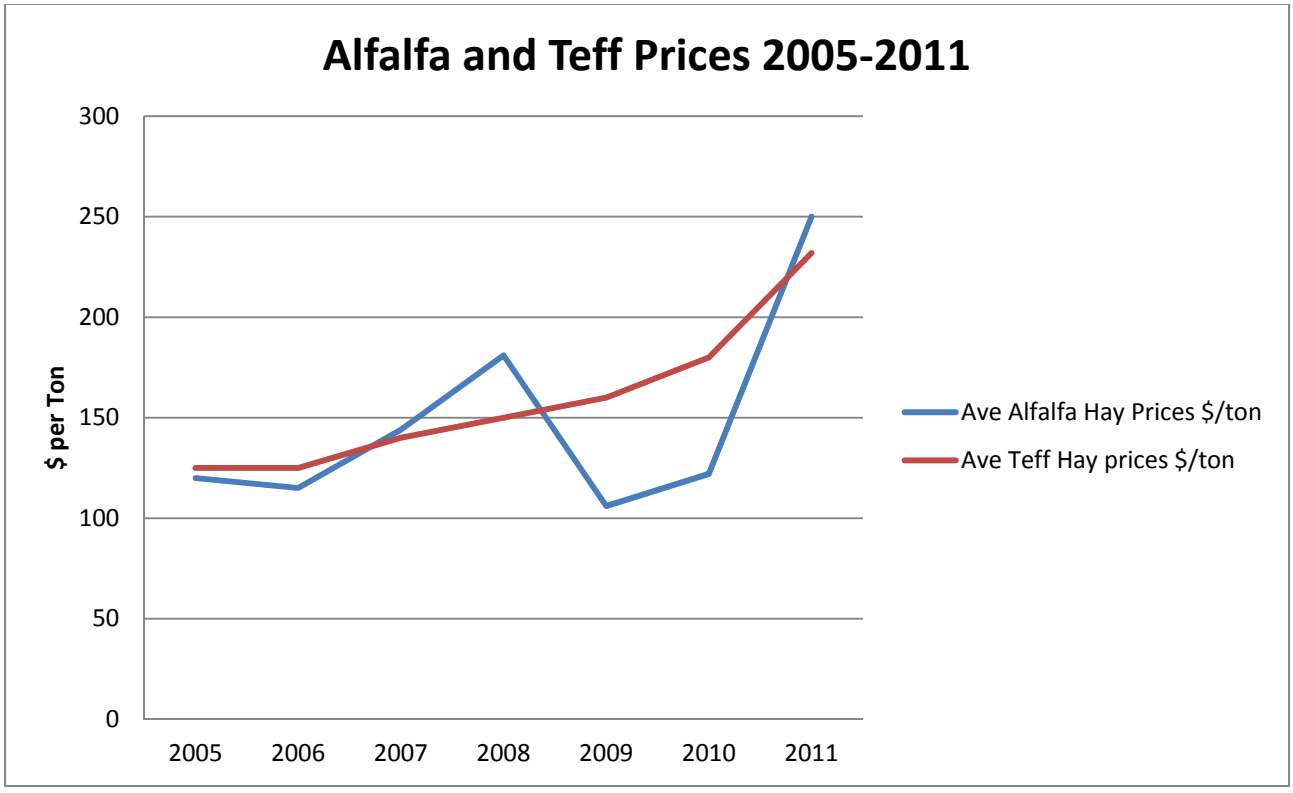

Table 1. Selected Average Irrigated Teff Forage Yields in the Western United States 1993-2010

Year	Location	Average Irrigated Yields (tons/acre)	Primary Author
1993	Montana	4.0-6.0	Eckhoff
2005	Oregon	3.3	Norberg & Roseberg
2006	Oregon	5.5	Norberg & Roseberg
2007	Oregon	5.0	Norberg & Roseberg
2003-2006	Nevada	1.6-5.0	Davison
2007-2009	California	5.3-8.9	Miller
2009	Nevada	4.5-9.4	Davison
2010	Nevada	2.6-5.4	Laca
2010	Utah	3.0-3.9	Laca

Table 2. Teff biomass yields Nevada 2009

Plant Accession Number/Name	Plant status (when harvested)	Ave. Biomass Production (tons/acre 100% dry matter)
193508	Lodged	9.4 a*
494465	Immature	8.3 ab
347632	Lodged	8.0 abc
494432	Lodged	7.8 abc
193514	Lodged	7.4 abcd
273889	Lodged	7.2 abcd
494479	Upright	7.0 abcd
Uk. Brown	Upright	6.6 cde
329680	Upright	6.5 cde
Dessie	Lodged	5.6 cdef
195932	Upright	5.5 cdef
494366	Upright	4.9 def
557457	Lodged	4.8 def
Uk. White	Upright	4.7 ef
494433	Immature	4.5 f

*Numbers followed by the same number are not significantly different from other varieties at the $P<0.05$ level

Table 3. Feed Quality for a Three Location Variety Trial (Ontario and Klamath Falls Oregon and Othello Washington

Harvest Number	Crude Protein	Acid Detergent Fiber	Neutral Detergent Fiber	Relative Feed Value	Relative Feed Quality
1st Cutting					
Minimum	11.0	36.2	58.0	82	89
Maximum	15.0	42.8	62.8	97	108
Average	**13.1**	**39.8**	**60.1**	**90**	**98**
2nd Cutting					
Minimum	8.1	37.0	58.5	80	78
Maximum	13.0	42.0	66.1	96	104
Average	**11.1**	**39.9**	**62.0**	**87**	**91**

Figure 2. Normal irrigation Schedules for Alfalfa and Teff in Western Nevada