Incorporating Legume Species into Teff as an Emergency Source of Forage

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ABSTRACT

Teff [*Eragrostis tef* (Zucc.) Trotter] is an annual warm-season grass that is known for its vigorous seedling growth and drought tolerance. Because of its annual growth habit and high yield potential during the summer months, this grass is becoming increasingly popular as an emergency source of forage that is used to supplement livestock when other forage sources are limited. Little is known about the compatibility of legumes and teff, or, the use of legumes in emergency sources of summer forage, in general. The objective of this study is to evaluate the yield and forage nutritive value of teff interseeded with various species of annual and short-lived perennial forage legumes. Teff was broadcast into a prepared seedbed at the University of Kentucky Spindletop Research farm on May 30. Nine species of legumes were drilled into plots approximately two weeks later when teff coleoptiles were beginning to emerge. Teff seedlings developed quickly following the seeding of the legumes due to abundant precipitation, and likely prevented establishment of many of the legumes species. Interseeding legumes did not increase ($P > 0.20$) forage yields compared to teff receiving 80 kg N ha^{-1}. Incorporating medium red clover [*Trifolium pratense* L.] into teff lowered forage yields ($P < 0.10$), and is likely due to the increased competitiveness of the legume. Medium red clover also increased ($P < 0.01$) the CP concentrations of the available forage. Sunn hemp [*Crotalaria juncea* L.]-teff mixtures had higher the CP ($P < 0.01$) and RFV ($P < 0.05$) and lower ADF) concentrations ($P < 0.01$) than the fertilized controls. Additional research is planned to evaluate the trends of this study under additional environmental conditions and to assess the suitability of sunn hemp as an emergency source of forage.

INTRODUCTION

- Teff [*Eragrostis tef* (Zucc.) Trotter] is an annual warm-season grass that is known for its rapid seedling and tolerance to dry conditions
- The grass's ability to produce high forage yields over a short period during the summer months has led to it being used to meet livestock nutrient requirements when the growth of a producer's primary sources of forage may unexpectedly become limiting (i.e. an emergency crop)
- Interseeding legume species into grasses is widely known to increase forage yields and improve forage quality
- Although high in quality for a warm-season grass, teff will likely benefit from the addition of legumes
  - There is limited knowledge of utilizing forage legume species during these occasional emergency situations when supplementing livestock is required, especially when included into mixtures with teff
- The objective of this study was to compare the forage production and nutritive values of teff interseeded with various annual and short-lived perennial species of forage legumes

MATERIALS AND METHODS

- The experiment was conducted at the University of Kentucky (UK) Spindletop research farm on a Bluegrass-Maury silt loam complex (Fine, mixed, active, mesic typic paleudalf)
- *'Tiffany'* teff (11 kg PLS ha^{-1}) was planted into a prepared seedbed (May 30) using a Brillion seeder
- Legumes (Table 1) were interseeded approximately two weeks later after the coleoptiles of the teff seedlings began to emerge to ensure the teff seed was not buried by the additional soil disturbance of the drill
  - A control plot not interseeded with legumes received 80 kg N ha^{-1}
- The emergence of each legume species was estimated using a visual rating system at one week after seeding
  - **Rating System**: **1** = < 20% of seeded row visible; **5** = > 80% of seeded row visible
- Yields were determined using a forage harvester when teff had reached the late boot stage of growth (July 17)
  - Little regrowth prevented any additional harvest of the plots
- A subsample of the harvested was removed to determine crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) using a micro-Kjeldahl and ANKOM fiber bag method respectively
  - NDF and ADF estimates were used to determine the relative feed value (RFV) of the forage
- Data analyzed as a RCBD with four replications in SAS with Least Significant Different (LSD) used to compare treatment means

Table 1. Species, varieties, and rates of legumes interseeded into teff on June 16, 2013.

Species	Variety	Seeding Rate *(kg PLS acre^{-1})*
Arrowleaf Clover [*Trifolium vesiculosum* Savi]	'Apache'	11
Ball Clover [*Trifolium nigrescens* Viv.]	'AU Don'	3.5
Cow Pea [*Vigna unguiculata* (L.) Walp.]	'Iron Clay'	34
Crimson Clover [*Trifolium incarnatum* L.]	'Dixie	28
Korean Lespedeza [*Kummerowia stipulacea* (Maxim.) Makina]	---	34
Mammoth (Single-cut) Red Clover [*Trifolium pratense* L.]	---	11
Medium (Double-cut) Red Clover [*Trifolium pratense* L.]	'Kenland'	11
Striate Lespedeza [*Kummerowia striata* (Thunb.) Schindl.]	'Kobe'	34
Sunn Hemp [*Crotalaria juncea* L.]	---	11

RESULTS AND DISCUSSION

Teff and Legume Establishment:

- In June and July of 2013, Lexington, KY received higher than normal amounts of precipitation (57.7 and 86.1% higher than the 30 year average for the site) and contributed to the rapid development of teff seedlings
- Teff accounted for 83% of the ground cover when estimated 10 days after seeding of the legumes and did not differ ($P > 0.10$) between treatments
  - The percent of ground cover of the legume species (1.95%) and bare soil (15.1%) were consistent ($P > 0.10$) between treatments
- The visual estimates of legume emergence also confirm that the development of each of the legume species was slower than teff, but there were differences among species ($P < 0.01$)
  - Approximately 40% of cow pea, Korean lespedeza, and mammoth red clover seedlings were emerged one week after seeding
  - Less than 20% of crimson clover seedlings had emerged at this, while teff had progressed to having 3-4 leaves fully emerged
- Although this appears to indicate that the presence of legumes was low, there is evidence the growth of a few of these species increased during the season and remained competitive with teff

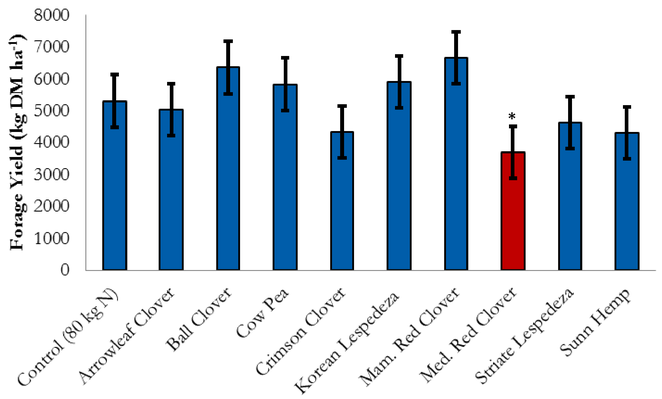

Figure 1. Forage yields (kg DM ha^{-1}) for teff interseeded with various species of legumes. Error bars refer to ± SED. Differences in bar color indicate treatment is significantly different (* = $P < 0.10$ & ** = $P < 0.05$) than the control (i.e. red = lower; green = greater).

Forage Yields

- Interseeding legumes did not increase ($P > 0.20$) forage production relative to the controls for most of the species (Fig. 1)
  - Most likely due to the competitiveness of teff limiting the growth of the legumes
- Medium red clover lowered ($P < 0.10$) forage yields (3,694 kg ha^{-1}) compared to teff fertilized with 80 kg N ha^{-1} (5,309 kg ha^{-1}; Fig. 1)
- The immediate cause for this reduction is not known, but may have be due to the competitiveness of the legume:
  - Red clover is known for its ability to establish quickly and may have overcome the initial delay in emergence
  - The clover seedlings may have increased the competition and slowed growth of the teff and/or prevented the emergence of grass seedlings later in the season

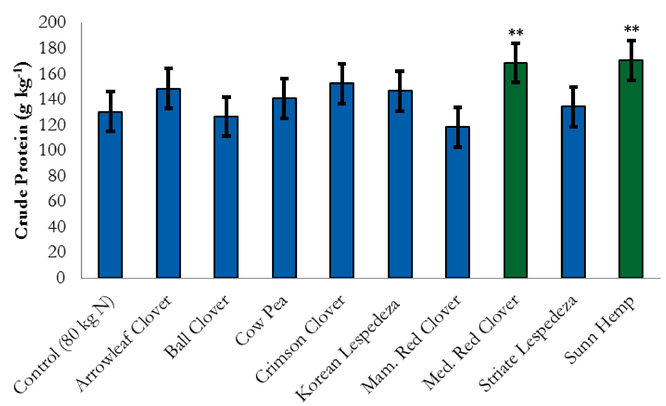

Figure 2. Crude protein (g kg^{-1}) of teff interseeded with various species of legumes. Error bars refer to ± SED. Differences in bar color indicate treatment is significantly different (* = $P < 0.10$ & ** = $P < 0.05$) than the control (i.e. red = lower; green = greater).

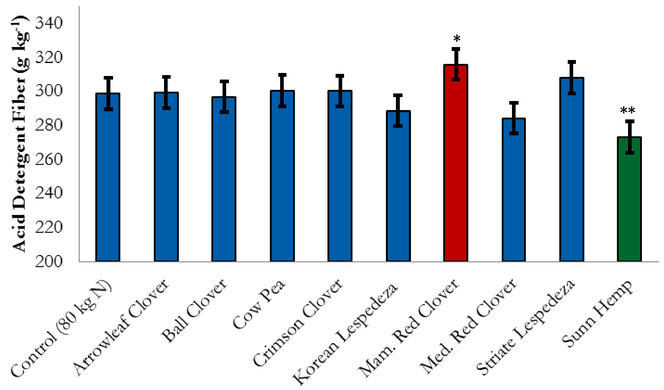

Figure 3. Acid detergent fiber (g kg^{-1}) of teff interseeded with various species of legumes. Error bars refer to ± SED. Differences in bar color indicate treatment is significantly different (* = $P < 0.10$ & ** = $P < 0.05$) than the control (i.e. red = greater; green = lower).

Forage Nutritive Value

- In contrast with yield, the interseeding of legumes had more of an impact on the nutritive value of the available forage
- Medium red clover (169 g kg^{-1}) and sunn hemp (171 g kg^{-1}) increased ($P < 0.01$) forage CP concentrations compared to the controls (130 g kg^{-1}; Fig. 2)
  - This provides some evidence that there was appreciable amounts of red clover in this treatment that may have suppressed growth of teff (Fig. 1)
- Forage NDF concentrations were similar ($P > 0.20$) between treatments (584 g kg^{-1})
- Interseeding sunn hemp decreased ($P < 0.01$) forage ADF concentrations (273 g kg^{-1}) compared to the control (299 g kg^{-1}), while ADF concentrations of the available forage increased ($P = 0.06$) for mammoth red clover treatments(316 g kg^{-1}; Fig. 3)
  - The later maturity and limited regrowth of this type of red clover may have lowered the amount of vegetative red clover shoots present within these stands, with the larger proportion of reproductive shoots increasing the ADF concentrations
- Sunn hemp also increased ($P < 0.05$) the relative feed value of the forage (112) compared to monocultures of teff (104; Fig. 4)

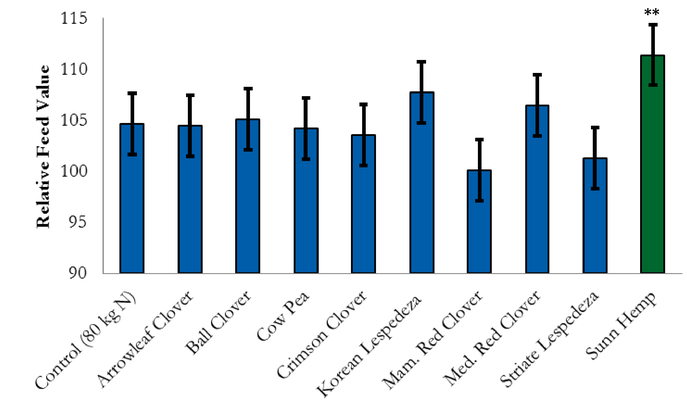

Figure 4. Relative feed value for teff interseeded with various species of legumes. Error bars refer to ± SED. Differences in bar color indicate treatment is significantly different (* = $P < 0.10$ & ** = $P < 0.05$) than the control (i.e. red = lower; green = greater).

SUMMARY

- Teff's aggressive nature and rapid seedling development made it incompatible with most of the interseeded legumes species
  - The high amount of precipitation received during the summer of 2013 contributed to the competitiveness of teff, and current trends will be evaluated under additional growing seasons
  - Medium red clover and sunn hemp did show some promise for being incorporated with teff as an emergency source of forage:
- Medium red clover increased the forage crude protein (CP) concentrations when interseeded with teff, but also reduced forage yields
- Although it did not increase forage yields, the addition of sunn hemp consistently improved all estimated parameter of forage nutritive value (i.e. CP, ADF, and relative feed value (RFV), with exception of neutral detergent fiber (NDF)
  - Sunn hemp is currently used primarily as a summer crop, but additional research may be needed to further evaluate its value as a forage, especially when used as an emergency crop