MEDICS AND CLOVERS FOR THE CROSS TIMBERS

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Summary and Application

The effect of harvest on forage yield, herbage quality, seed production and subsequent stand persistence in cool-season legumes in the Cross Timbers have not been determined. Sixteen *Medicago* spp. (medics) and *Trifolium* spp. (clovers) were seeded into plots at Stephenville and then subjected to season-long cutting heights of 2 in., 4 in. (when growth exceeded 4 and 6 in., respectively) and April-only harvest over two seasons. Several yielded over 2 tons dry forage acre^{-1} both years although two crimson clover (*T. incarnatum*) entries and common ball clover (*T. nigrescens*) had the most consistent yields into a third season when freeze damage affected most medics. Crude protein (CP) concentrations were high (over 13% for medics) even if harvest was delayed until April. Seed yields varied considerably (from 44 to 1574 lb acre^{-1} year^{-1}) but were not affected by harvest treatment and did not seem to have a direct influence on stand regeneration. Results indicate that some of these cool-season legumes may be useful for early season grazing in the Cross Timbers and will reseed themselves even if harvested.

Abbreviations: CP, crude protein

Introduction

Annual medics and clovers are naturalized throughout Texas (1), contributing crucial winter and spring forage or seed for game birds, white-tailed deer (2) and domesticated livestock. Although occasionally used in cultivated pasture or wildlife plots, these naturalized legumes are found on range and improved pasture where they have volunteered and spread naturally through heavy seed production. Seed production is therefore essential for stand persistence but can be detrimentally affected by harvest regime. Most cool-season annual legumes produce hard seed that resist germination, thereby building up soil seed reserves and guaranteeing long-term reseeding potential. Little is known, however, about species tolerance to harvest height, particularly as it affects subsequent seed production and stand regeneration in subsequent cool-seasons.

The objective of this study was to examine the effects of harvest height, starting early in the cool season, on seed production and stand persistence of 16 annual cool-season forage legumes. Only six of these are registered cultivars and one a commercial release 'Estes' while the remaining entries are referred to in this article by their location of collection within Texas (Table 1). Comparative forage yields as well as forage crude protein concentration were also studied.

Methods and Materials

The experiment was carried out at the Texas A&M University Agricultural Research and Extension Center at Stephenville during the cool growing seasons of 1999-2000 and 2000-2001 with a final harvest in April 2002. The soil was a Windthorst fine sandy loam (pH 6.0, 8 ppm P, 247 ppm K, 1751 ppm Ca, and 529 ppm Mg). The site was tilled in 1999 prior to seeding but was not tilled in 2000 or 2001 to allow volunteer reseeding. It was kept free of weeds both years with the November application of Select (clethodim) at 8 fl. oz $acre^{-1}$ and Pursuit (ammonium salt of imazethapyr) at 3 fl. oz $acre^{-1}$. In addition, carbaryl (1-naphthyl N-methylcarbamate) at 20.5 fl. oz active ingredient $acre^{-1}$ was applied to plots in Stephenville in March of both 2000 and 2001 to control herbivory by larval alfalfa weevil (*Hypera postica*) and twelve-spotted cucumber weevil (*Diabrotica unclecimpunctata howardi*).

Since rainfall from October 1999 to May 2000 was low (13 in.), irrigation was applied in months that had less than 50% the long-term average rainfall. As a result, rainfall and irrigation totals for the first season totaled 17.7 in. compared to a 16.6 in. long-term precipitation average for the same period. Rainfall the second season (2000-2001) was greater (27.4 in.) and well distributed so that no irrigation was applied. No irrigation was applied the third growing season (2001-2002) when rainfall was again above-average, totaling 22.3 in.

In October 1999, seeds of sixteen cool-season annual legumes (see Table 1) were scarified and inoculated with specific Rhizobia prior to broadcasting onto 20 by 6 ft. plots. Soil was compacted with a roller to provide good soil-seed contact. Plots were allowed to reseed themselves in the autumn of 2000 and 2001 and no additional seed was added those seasons. Although these entries have seedpods and seed heads that do not shatter and seed fell directly under plants, some seeds did move (by rain or wind) into adjacent plots and had to be removed by hand.

Plots were divided into subplots consisting of 6 ft. by 6 ft. areas clipped at 2 in. or 4 in. whenever growth exceeded 4 and 6 in., respectively. Plants in a third subplot were harvested in April only. In April, all three harvest treatments were sampled to a 2 in. height. Total annual production was determined by hand clipping the inner 3 ft. by 3 ft. of each subplot. Subplots were harvested only once (April) in 2002 as a one-time harvest to measure residual effect of harvest treatments from the previous years. Representative forage sub-samples were analyzed for CP concentrations.

Starting in April of 2000 and 2001, seeds were collected as they matured from an inner 1 ft. by 1 ft. outside the 3 by 3 ft. portion of each subplot harvested for April forage yield. This was done to avoid influencing seed number effects on subsequent season forage yields. Seed yields from April-only harvest subplots therefore represent the seed production potential of the entries where no forage is removed throughout the season. Sampled pods were then dried and the seeds removed to estimate seed yield. Seed was subsequently returned to the respective plots.

The plots were arranged in a randomized complete block design and clipping heights were super-imposed on these in a split-plot arrangement. Year, entry and clipping regime were used as independent variables in the model and analyzed for interactions. Year was included in the model despite the fact that plots were seeded the first year and self-reseeded the second year since seedling numbers were not considered to be limiting either year. Forage yields the third year were not compared to previous years since harvest treatments were not imposed during the final season. Results were submitted to an analysis of variance with Duncan's Multiple Range test ($P<0.05$) used to separate means in the case of significant effects.

Results and Discussion

Forage Yield

Peak forage distribution varied with legume species and origin. Ball and crimson clovers had earliest production (February) compared to rose clover (*T. hirtum*; March). Among the annual medics, Armadillo burr (*M. polymorpha*), Jemalong barrel (*M. truncatula*), Estes button (*M. orbicularis*) and the Beeville black (*M. lupulina*) all had measurable yields in February. The Beeville flecked, Stephenville spotted (*M. arabica*) and Ueckert burr medics had measurable production only in April. The more precocious entries would likely be better suited for early season grazing while those producing greater biomass in late spring may be better suited for hay production since animals cannot keep up with production. Producers may want to consider species blends to maximize season of production, although care should be taken to inoculate each species with its own Rhizobia strain.

There was an entry by year interaction (*P*=0.001) for total season forage yields (Table 2). Jemalong barrel (*M. truncatula*) and Devine little medic (*M. minima*) both produced over 5000 lbs forage acre^{-1} the first season, a contrast to less than 1200 lbs acre^{-1} produced by both the Stephenville spotted medic and the Beeville flecked burr medic during the same year. During the second year, Dixie crimson clover out-yielded all other entries (5400 lbs acre^{-1} year^{-1}) followed by Armadillo burr medic (4800 lbs acre^{-1} year^{-1}). These two entries, along with six others, increased production from the first to the second season likely as a result of earlier seedling establishment and improved soil moisture conditions due to rainfall patterns the second year. In contrast, barrel, little and black medics showed a decrease in productivity despite improved soil moisture, perhaps explained by inadequate seed production (see seed results below) or sub-optimal seedling numbers due to hard seed. There was also a harvest treatment by year interaction (*P*=0.01) with the lowest production measured in the 2 in. height during the establishment year (Table 2). During the second season, the April-only harvest resulted in 23% greater yields than the 4 in. harvests that, in turn, out-yielded the 2 in. harvests by nearly 8%. The lower harvest heights likely reduce leaf area that in turn negatively affected regrowth.

Third Season Residual Forage Yield

Prolonged low temperatures reaching down to 10^{o}F during a seven-day period in March 2002 severely damaged all medic seedlings late in season three. Among the medics, the two button entries were the most cold tolerant, out-yielding all other medics by nearly 1000 lbs acre^{-1} year^{-1}. The two crimson clovers and ball clover all still produced over 5000 lbs forage acre^{-1} year^{-1} despite the cooler temperatures. If seed from these clovers prove hard enough to resist germination during humid, wet summers (the summers were atypically dry during this study), stands may be able to persist over many years, making these clovers very attractive for the Cross Timbers.

April forage yield of the third year following a season without harvest treatments indicated no measurable (*P*>0.10) residual effects of different harvests during the previous two seasons. Greater number of seeds in yrs 1 and 2 did not necessarily translate into greater forage yield the third year. Crimson and ball clovers were the highest forage producers the third year (Fig. 1) following two years during which, except for Ball clover, they did not necessarily produce greater seed numbers than some of the medics (data not shown). This was a clipping study, however, and grazing animals will consume most of the seed of crimson and ball clovers unless grazing is deferred or stocking rate reduced during the seed maturation period. In contrast, most of the medics will produce seed even under fairly intensive grazing because of their low growth form.

Forage Crude Protein

There was an entry by harvest by year interaction (*P*=0.02) for forage CP concentrations (Table 3; only year 1 data shown). Crude protein concentrations tended to be highest in the 2 in. harvest and were particularly low in the April-only harvested forage of the crimson and rose clovers both years. These entries appeared to have more stem in harvested material since they have upright growth habits and this was compounded, in the case of crimson clover, by early maturation.

First season CP concentrations were very low for the rose clover (10.1-11.9%), a possible indication of poor nodule infection with the appropriate Rhizobium strain despite specific inoculation at seeding. Values increased considerably the second season with less chlorosis visible in the plots, a possible indication that the specific Rhizobia may have multiplied by the second season to infect more rose clover plants. Increased plant development as a result of improved growing conditions may have been a factor in increased CP concentrations the second season. This phenomenon was discernable for Beeville black medic, both button medics, and all burr medics. Armadillo burr medic, for example, jumped 50% from 16.2% year 1 to 24.6% CP year 2 in the 2 in. harvest.

Seed Yield

Beeville black medic had the greatest (*P*=0.001) seed yield, over 1518 lbs acre^{-1} year^{-1} when averaged over years and harvest regimes (Fig. 2). George black medic was the only entry among the less productive seed yielders whose forage yields the second year may have been negatively affected by low seed yields. Even this entry, however, produced the equivalent of over 4000 seed per yd^{2} (data not shown) that, once hard seed is begins to break down, should be enough to maintain a stand.

Conclusions

The clovers and button medics proved to be more cold tolerant during the trial, reflected in a greater potential for more consistent, long-term production at Stephenville. Season-long forage production of over 2.5 tons acre^{-1} by the crimson and ball clovers, regardless of harvest regime, indicates good production potential by these entries in the Cross Timbers of Texas and Oklahoma. Estes button medic and rose clover also had consistent production, regardless of soil moisture and temperatures, dipping down below 1.5 tons only in the third season.

Late spring development make black, flecked, spotted and little burr medics less useful for late winter or early spring grazing. In contrast, upright growth habit and early flowering of crimson clover and upright growth habit of rose clover may have contributed to lower quality, possibly countered if these are harvested early and repeatedly.

Forage CP concentrations were generally high (more so the second season), a desirable trait for both livestock and wildlife. Deferring harvest to April tended to decrease the nutritive value of the legumes because of maturity, so they should probably be grazed or harvested for hay before seed set.

More severe harvest (2 in. cutting height) did result in fewer seeds produced during the trial but this did not translate into fewer seedlings the subsequent season, further indicating that seed production should not be a limiting factor in stand regeneration of any of these annual legumes.

The range in forage production

precocity, growth habit, resistance to low temperatures, and palatability to insects observed within these sixteen cool season annual forage legumes indicates that there is probably a usable entry for just about any production system in the Cross Timbers. This would include forage growth patterns for early grazing or late season hay production, heavy seed producers for game birds, and substantial production of high quality forage for herbivores, both domesticated and wild. This information can also be used to develop multi-species blends to best suit the forage needs of producers in the region.

Acknowledgements

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Literature Cited

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Table 1. Common names or origin, scientific name, seeding rates, and first harvest month of annual cool season legumes harvested at 2 in. at Stephenville, TX.

Common name	Cultivar/ Origin (TX)	Latin binomial	Seeding rate lb acre^{-1}	First harvest month
Barrel medic	Jemalong	*Medicago truncatula* Gaertn.	10	February
Little burr medic	Devine	*M. minima* (L.) L.	10	March
BEBLK black medic	Beeville	*M. lupulina* L.	10	February
Crimson clover	Dixie	*Trifolium incarnatum* L.	22	February
Button medic	Estes	*M. orbicularis* (L.) Bartal.	10	February
Button medic	Stephenville	*M. orbicularis* L.	10	March
Black medic	George	*M. lupulina* L.	10	March
Rose clover	Overton R18	*T. hirtum* All.	22	March
Burr medic	Armadillo	*M. polymorpha* L.	10	February
Crimson clover	AU Sunrise	*T. incarnatum* L.	22	February
Ball clover	Common	*T. nigrescens* Viv.	4	February
Burr medic	Stephenville	*M. polymorpha* L.	10	March
BECOM burr medic	Beeville	*M. polymorpha*	10	March
Burr medic	Ueckert	*M. polymorpha*	10	April
Spotted burr medic	Stephenville	*M. arabica* (L.) Huds.	10	April
Flecked burr medic	Beeville	*M. polymorpha*	10	April

Table 2. Forage yield of sixteen cool-season annual legumes at Stephenville, TX reported as entry by year (entry X year interaction *P*=0.001; pooled over harvests) and harvest treatment by year (harvest X year *P*=0.01; pooled over entries).

	Year 1	Year 2
	----------lbs acre^{-1} yr^{-1}----------	
Entry		
Jemalong barrel medic	5206 a†	4010 fg
Devine little burr medic	5197 a	3600 h
BEBLK black medic, Beeville	5010 b	2893 j
Dixie crimson clover	4679 c	5394 a
Estes button medic	4465 d	4492 d
Button medic, Stephenville	3983 e	4679 c
George black medic	3661 f	982 l
Overton R18 rose clover	3554 f	4126 f
Armadillo burr medic	3054 g	4822 b
AU Sunrise crimson clover	2893 h	4027 fg
Ball clover	2875 h	4376 e
Burr medic, Stephenville	2456 i	3626 h
BECOM burr medic, Beeville	2259 j	4001 g
Ueckert burr medic	2054 k	2224 k
Spotted burr medic, Stephenville	1107 l	3188 i
Flecked burr medic, Beeville	839 m	3286 i
Harvest		
April-only	3367 a	4367 a
4 in. cutting height	3367 a	3545 b
2 in. cutting height	3268 b	3286 c

†Values within the same column and subheading followed by different letters differ (*P*<0.05) according to Duncan's multiple range test.

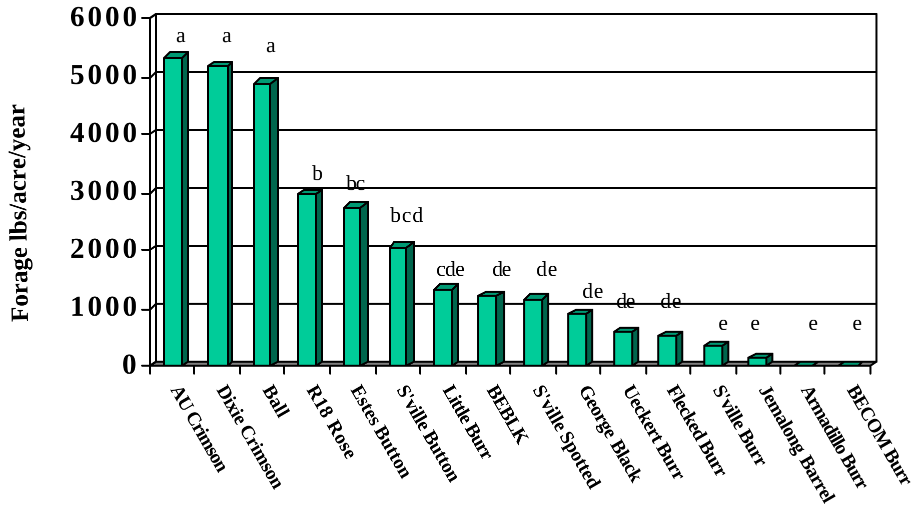

Fig. 1. April forage yield of sixteen self-reseeding cool season annual legumes at Stephenville, TX the third season after planting and pooled over three harvest regimes imposed the first two seasons (*P*=0.001; columns with similar letters do not differ according to Duncan's multiple range test at *P*=0.05).

Table 3. Crude protein (CP) concentration of sixteen cool-season annual legumes harvested from February through April at 2 or 4 in. cutting height or in April-only at Stephenville, TX during the 1999-2000 cool season (entry X harvest X year interaction *P*=0.02).

Entry	2 inches	4 inches	April-only
	---------------Forage % CP-----------------		
Jemalong barrel medic	24.1 a†	18.4 b	15.3 bcd
Devine little burr medic	17.4 cd	14.4 d	16.6 b
BEBLK black medic, Beeville	18.3 c	18.1 b	16.4 bc
Dixie crimson clover	16.3 def	16.2 c	12.1 hi
Estes button medic	24.6 a	22.3 a	15.1 cd
Button medic, Stephenville	22.4 b	21.0 a	20.6 a
George black medic	21.8 b	21.3 a	20.3 a
Overton R18 rose clover	11.9 j	10.2 f	10.1 j
Armadillo burr medic	16.2 def	13.2 de	14.6 def
AU Sunrise crimson clover	15.0 fgh	14.3 d	11.2 ij
Ball clover	16.6 de	13.6 de	13.6 efg
Burr medic, Stephenville	13.5 i	13.5 de	13.3 fgh
BECOM burr medic, Beeville	14.4 ghi	13.4 de	12.9 gh
Ueckert burr medic	15.8 efg	16.0 c	14.9 de
Spotted burr medic, Stephenville	14.6 ghi	12.5 e	14.3 defg
Flecked burr medic, Beeville	14.0 hi	4.6 d	13.3 fgh

†Values within the same column followed by different letters differ (*P*<0.05) according to Duncan's multiple range test.

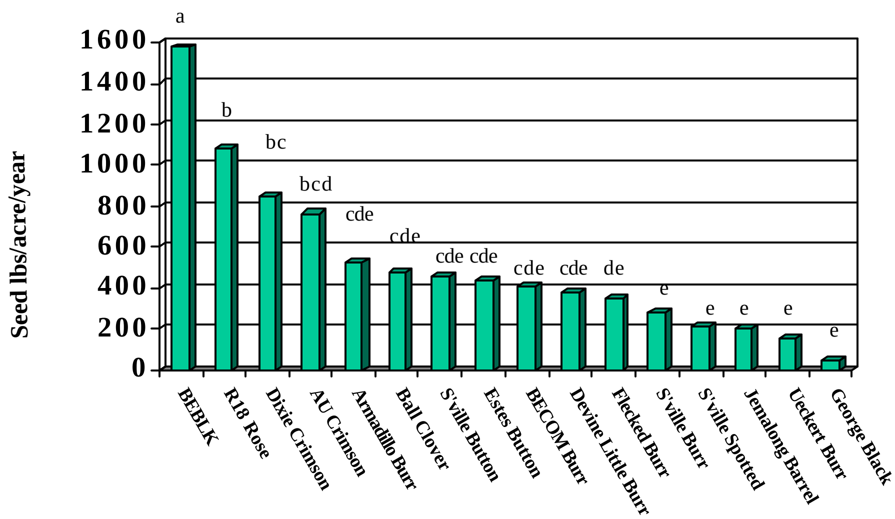

Fig. 2. April seed yield of sixteen self-reseeding cool season annual legumes at Stephenville, TX pooled over two seasons and three harvest regimes (*P*=0.001; columns with similar letters do not differ according to Duncan's multiple range test at *P*=0.05).