Production and Natural Regeneration of Annual Medics in West-Central Texas

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ABSTRACT

Several annual *Medicago* species have been found to be well adapted to the soils and climates of other areas of Texas, but their adaptation to west-central Texas has not been studied. We evaluated the establishment, yield, and natural reseeding potential of *Medicago truncatula, M. lupulina, M. polymorpha, M. minima, and M. orbicularis* on a Rioconcho clay loam/Spur clay loam soil complex near San Angelo, Texas during 1998 – 2004. All annual medics established following seeding in mid November 1998 although sub-freezing temperatures in December 1998 caused considerable seedling mortality. With one irrigation in November 1998 and above-normal winter and spring rainfall, all species produced a good seed crop in spring 1999. The medics did not establish in autumn 1999 because of dry conditions, but good establishment occurred in autumn 2000 following 8 in. of rainfall and a single irrigation in November 2000. Frequencies of seedlings ranged from 61% for 'Jemalong' barrel medic (*M. truncatula*) to 90% for 'Devine' little bur medic (*M. minima*) in late March 2001. Forage yields in early May 2001 did not differ significantly among the species, but ranged from 1250 (± 590) lb/acre for 'Jemalong' barrel medic to 2640 (± 610) lb/acre for 'Estes' button medic (*M. orbicularis*). Yield from a late-October 2000 planting of 'Devine' little bur medic in May 2001 was 3060 (± 620) lb/acre. 'Devine' little bur medic and 'Estes' button medic exhibited later maturation and tended to produce more forage than the other species. Frequencies of medic seedlings in the November 1998 plantings were low (≤ 25%) while frequency of 'Devine' little bur medic in the October 2000 planting was high (63%) during February 2004 following multiple tillage operations and planting of wheat in September 2003. Annual medics appear to have potential for improvement of rangelands and pastures in west-central Texas, but should be expected to produce significant forage amounts only in years with above-normal, cool-season rainfall or under irrigation.

KEYWORDS: forage, legumes, *Medicago lupulina, Medicago minima, Medicago orbicularis, Medicago polymorpha, Medicago truncatula*, pasture

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INTRODUCTION

Very few desirable forage legumes are present on rangelands in west-central Texas and few have been available for planting in mixtures with grasses on rangelands or improved pastures. Identification of productive, palatable legumes adapted to the soils and climate of west-central Texas would be very beneficial for livestock and wildlife production because of their capacity to fix atmospheric nitrogen and improve the quality of animal diets. Several annual species in the *Medicago* genus, commonly called annual medics, have been shown to be well adapted to the soils and climates of other areas of Texas. The genus *Medicago* contains the well-known perennial *M. sativa* and *M. falcata*, which are commonly known as alfalfa. The annual species are less well known in the USA, and are native to western Asia and the Mediterranean region, though many of the annual species have become naturalized over much of the world (Heyn 1963). A leaflet (L-306), authored by E. M. True, Extension Agronomist at Texas A&M, entitled "Burclover" listed four annual medics as having potential in Texas. This leaflet is not dated, but its contents suggest that it may have been written in about 1956. This leaflet suggests that there were five species of annual medics under evaluation or released for use in Texas at that time. In 1957, the Texas Research Foundation at Renner released a button medic (*M. obicularis*) (Davis et al. 1957). This release, "button clover", was not named, and the currently named cultivar 'Estes' is believed to be a rediscovery of the material originally released as button clover by the Texas Research Foundation. In 1998, 'Armadillo' bur medic (*M. polymorpha*) was released from the Texas A&M University Agricultural Research Station at Beeville (Ocumpaugh 1999). 'Armadillo' was derived from a collection from Pasture 18 at the Beeville Research Station.

Today, there is a renewed effort in Texas to evaluate introduced and naturalized annual medics which may be incorporated into grazinglands to improve the quality of forage and reduce the need for protein supplement and nitrogen fertilizer required to maintain acceptable levels of livestock and wildlife production (Ocumpaugh and Stichler 2000). The purpose of this experiment was to determine: 1) the adaptation of five annual medics to the soils and climate of west-central Texas; 2) their forage yield potential; and 3) the ability of these species to re-seed naturally.

METHODS AND MATERIALS

The experiment was established on a Rioconcho clay loam/Spur clay loam complex near Carlsbad, about 16 miles northwest of San Angelo, Texas. The site had been graded and borders were constructed to facilitate flood irrigation with treated sewage effluent. The experiment was arranged as a randomized complete block design with three replications of each of five annual medics (Table 1). These species were described by Ocumpaugh and Stichler (2000). The site was disked then the plots were seeded with a hand-held broadcast seeder on November 18-19, 1998. All seeds were inoculated with a *Rhizobium* inoculant for annual medic species immediately prior to planting. Plots varied from 19 to 24 ft in width and from 300 to 475 ft in length. The plots were cultipacked after seeding and flood irrigated within 1 week. Competition from tall weeds was suppressed by shredding to a 5-inch stubble height during early spring 1999. The plots were not cultivated after the initial seedbed preparation until late August 2003. All plots were flood-irrigated in mid November 2000 and again in late March 2001. Rainfall was recorded from a rain gauge located near the study site.

Table 1. *Medicago* species and planting rates utilized in an experiment near Carlsbad, Texas on November 18-19, 1998.

Common Name	Scientific Name	Seeding rate (lb bulk seed/acre)[2]
'Jemalong' barrel medic	*M. truncatula*	10.0
'BEBLK' black medic[1]	*M. lupulina*	6.0[3]
'Armadillo' bur medic	*M. polymorpha*	10.0
'Devine' little bur medic[1]	*M. minima*	6.2[3]
'Estes' button medic	*M. orbicularis*	10.0

[1]Indicates experimental material, seed not commercially available.

[2]Medicago and clover seeds are marketed and planted on a bulk seed basis. Over 90% of the seeds are normally germinable.

[3]Inadequate seed supply to plant at a seeding rate of 10.0 lb bulk seed/acre.

Frequency of occurrence of annual medic plants was estimated in each plot from 200 random placements of a 2-in.-diameter circular quadrat on March 21, 2001. Frequency sampling combines density and dispersion characteristics of plants (Hyder et al. 1963). Standing crop of annual medic forage was estimated by clipping to a 1-in. stubble height in five, 2.69-ft^2 quadrats in each plot on May 7-8, 2001. The samples were oven-dried, then weighed to the nearest 0.1 gm. Plot means of these data were subjected to analysis of variance and means were separated by $LSD_{0.05}$.

'Devine' little bur medic (*M. minima*) was planted in a 1.1-acre plot adjacent to the replicated experiment on October 31, 2000. The plot, which had grown wheat during the winter of 1998-99, was disked then 'Devine' seeds were hand-broadcast seeded at 9.1 lb bulk seed/acre. Seeds were inoculated with a *Rhizobium* for annual medic species immediately prior to planting. A spike-tooth harrow was pulled over the plot twice to cover the seeds. The plot was irrigated in early November 2000 and on March 28, 2001. Standing crop of Devine little bur medic was estimated on this plot by clipping to a 1-in. stubble height in eight 2.69-ft^2 quadrats on May 8, 2001, followed by oven-drying and then weighing the samples.

The annual medic plots were not tilled again until late summer 2003, when they were chiseled and disked to prepare a seedbed for planting wheat. Wheat was planted with a drill in early September 2003. The wheat was grazed by cattle during November 2003 and the plots were flood irrigated in early December 2003. Frequency of occurrence of annual medic plants was estimated in each plot in the replicated experiment from 200 random placements of a 2-in.-diameter circular quadrat on February 11, 2004. Frequency of Devine little bur medic in the 1.1-acre plot seeded October 31, 2000 was estimated from three samples of 200 random placements of 2-in.-diameter circular quadrats the same day.

RESULTS AND DISCUSSION

The soil was relatively moist at time of planting in November 1998 and 9.45 in. of rain were received during November 1998 through May 1999 (Table 2). Good stands of all five species emerged, but stands were substantially reduced by a brief period of sub-freezing temperatures in December 1998. Dense growth of annual, cool-season forbs occurred on the plots in spring 1999, but shredding at a 5-in. stubble height allowed the medics to produce a seed crop. The plots were not grazed by livestock, but deer had access to the plots. The plots were not irrigated during the autumn of 1999 and no seedlings emerged during the fall of 1999 or winter of 1999-2000 due to inadequate rainfall (Table 2). Good stands of annual medic seedlings emerged in all plots in

response to 8 in. of rainfall during September 25 through November 8, 2000 (Table 2) and a single irrigation in mid November 2000.

Table 2. Monthly rainfall (in.) at the annual medic site near Carlsbad, Texas during 1998 through 2003.

Month	Year					
	1998	1999	2000	2001	2002	2003
	inches					
January	0.40	1.25	0.20	1.45	0.65	0.15
February	0.60	0.00	0.10	1.00	1.70	1.80
March	3.10	2.50	0.80	1.50	1.30	1.70
April	0.00	1.50	0.10	0.65	0.35	0.00
May	3.10	2.85	0.35	1.50	0.20	1.40
June	1.00	5.40	6.55	0.95	2.20	5.75
July	0.00	3.25	0.00	0.45	5.70	1.00
August	2.65	0.45	0.00	2.15	1.20	2.00
September	0.00	0.10	0.75	2.85	2.40	5.45
October	2.70	0.55	5.10	0.65	5.30	3.15
November	0.50	0.00	2.15	3.15	0.80	0.55
December	0.85	0.35	0.60	0.20	1.70	0.00
Total	14.90	18.20	16.70	16.50	23.50	22.98

Frequencies of annual medics ranged from 61 to 90% in March 2001 (Table 3), indicating that the plant density was fairly high and that medic plants were fairly evenly distributed over the plots. 'Devine' little bur medic had the highest frequency (90%), although its frequency was not different from that of 'Estes' button medic (78%) or 'BEBLK' black medic (*M. lupulina)* (75%) ($P \leq 0.05$). The frequency of 'BEBLK' black medic (75%) was not significantly different from that of 'Armadillo' bur medic (69%) or that of 'Jemalong' barrel medic *(M. truncatula)* (61%) ($P \leq 0.05$) (Table 3).

Table 3. Mean frequency of occurrence of live plants of five annual medics on March 21, 2001 that had established during autumn 2000 from a seed crop produced in spring 1999 in an experimental planting near Carlsbad, Texas.

Annual medic	Frequency (%)
'Devine' little bur medic	90 a[1]
'Estes' button medic	78 ab
'BEBLK' black medic	75 abc
'Armadillo' bur medic	69 bc
'Jemalong' barrel medic	61 c

[1]Means followed by similar lower case letters are not significantly different at $P \leq 0.05$.

These data indicate that all species produced sufficient seeds during the spring of 1999 to produce fairly dense, uniform stands in the fall 2000/winter 2001, even though no seed crop was produced during the spring of 2000. It is interesting to note that 'Devine' little bur medic and 'BEBLK' black medic, which were seeded at 6.2 and 6.0 lb/acre, respectively, tended to have somewhat higher plant frequencies than 'Armadillo' bur medic and 'Jemalong' barrel medic, which were seeded at 10 lb/acre (Table 2). Deer grazing on the annual medics did not appear to be significant in the winter of 2000-2001, possibly because of an abundance of cool-season, annual vegetation on adjacent rangeland and wheat on adjacent cropland.

Yields in early May 2001 in the replicated experiment ranged from 1250 lb/acre for 'Jemalong' barrel medic to 2640 lb/acre for 'Estes' button medic (Table 4). Mean

yields were not significantly different (F = 1.9; P = 0.1871) among the annual medics due to plot-to-plot variation within the species. Although standing crops of associated cool-season annual grasses and forbs were not estimated, it was clear that their abundance and biomass were greater on plots with low yields of annual medics.

Table 4. Estimated yield of five annual medics on May 7-8, 2001 that had reseeded naturally without tillage following planting in November 1998 near Carlsbad, Texas.

Annual medic	Mean yield (lb/acre)[1]	Standard deviation
'Estes' button medic	2640	610
'Devine' little bur medic	2060	540
'BEBLK' black medic	1730	360
'Armadillo' bur medic	1700	980
'Jemalong' barrel medic	1250	590

[1]Means were not significantly different ($P \leq 0.05$).

Estimated yield of 'Devine' little bur medic in early May 2001 on the plot seeded October 31, 2000 was 3060 ± 620 (s.d.) lb/acre. Few cool-season, annual grasses or forbs were present on this plot. The higher herbage yield of 'Devine' on the plot seeded October 31, 2000 compared to the yield on the adjacent plots seeded to this species in November 1998 may have been due to a greater annual medic plant density, more recent soil disturbance, or to less competition from associated annual grasses and forbs.

Visual observations of the plots on May 17, 2001 revealed that 'Jemalong', 'BEBLK', and 'Armadillo' medics were rapidly drying, that 'Devine' was beginning to dry up, but that 'Estes' button medic continued to be green and succulent. This suggests that 'Devine' little bur and 'Estes' button medics may continue to grow and provide quality forage later into the spring in west-central Texas compared to 'Jemalong', 'BEBLK', and 'Armadillo'.

About 7.7 in. of rain fell on the study site during September through October 2003 (Table 2). The wheat planted on the plots in September 2003 grew well, but establishment of the annual medics from the seed crop produced in spring 2001 was much less than we had expected based on establishment in autumn of 2000. Mean frequencies of the annual medics on February 11, 2004 ranged from 1% for 'BEBLK' black medic to 25% for 'Devine' little bur medic (Table 5), but the means were not significantly different (P = 0.16). These low frequency values indicated that medic plant densities were much lower than had been observed in March 2001. We also noticed in February 2004 that the distribution of medic plants in all plots tended to be patchy, rather than uniform. These plots had to be disked twice to prepare the seedbed for planting wheat. This tillage may have covered the annual medic seeds too deeply for optimal emergence. However, the mean frequency of 'Devine' little bur medic on the plot seeded in October 2000 was 63% (± 1.6 s.d.), so excessive tillage may not totally explain the low establishment of annual medics in 2003 in the replicated experiment. We speculate that seed production in spring 2001 may have been greater on the 'Devine' plot seeded in October 2000 than on the plots of other medic species seeded in November 1998. Tillage only about 2 in. deep is recommended for maintaining good stands of reseeding annual medics (Darcy Turner, Turner Seed Co., Breckenridge, TX, personal communication). No-till or minimum-tillage methods should be considered when planting wheat over annual medics.

Table 5. Mean frequency (%) of live plants of five annual medics growing in a mixture with wheat on February 11, 2004.

Species	Frequency (%)[1]
'Jemelong' barrel medic	13
'BEBLK' black medic	1
'Armadillo' bur medic	16
'Devine' little bur medic	25
'Estes' button medic	14

[1]Means were not significantly different (P = 0.1587).

CONCLUSIONS

All five annual medics appeared adapted to the soils at the study site and to the climate of west-central Texas, although the winters during this study period were relatively mild. A brief period of sub-freezing temperatures in December 1998 killed a substantial percentage of the seedlings that had emerged following planting in mid-November 1998, and some seedling mortality was observed following sub-freezing temperatures in the winter of 2000-01. Seeding earlier in the fall might give annual medic seedlings sufficient time to harden and become more cold tolerant. Additional observations are needed to determine if these annual medics would survive a severe winter in west-central Texas. All five species produced acceptable stands in the fall of 2000 from seeds produced in the spring of 1999. Establishment of all annual medics in the replicated experiment was limited (≤ 25% frequency) in autumn 2003, whereas, that of 'Devine' little bur medic in an adjacent plot seeded October 31, 2000 was very good (63% frequency). We believe that excessive tillage may have limited emergence of the medics in 2003 by covering the seeds too deeply. Better establishment of 'Devine' little bur medic in 2003 on the plot seeded in October 2000 may have been realized because of greater seed production on this plot in spring 2001.

With supplemental water from irrigation and above-normal, cool-season rainfall, the five annual medics exhibited substantial to excellent potential to produce forage, with yields ranging from 1250 to 3060 lb/acre. Two species, 'Devine' little bur and 'Estes' button medic, retained green and succulent forage later into the spring than did 'Jemalong' barrel, 'BEBLK' black, and 'Armadillo' bur medics. 'Estes' button and 'Devine' little bur medics also tended to have the potential for greater forage yields. Without supplemental irrigation, these annual medics would likely produce significant amounts of forage and might only be present during years with above-normal, cool-season rainfall in the west-central Texas environment. Without irrigation, the earlier maturing material may prove to be more sustainable, as it may allow these to mature and set seed sufficiently early to avoid the more stressful late spring temperatures. Research from Argentina, suggests that *M. minima* is very tolerant to water stress (Fedorenko et al. 1995), and we have observed this to be true in other testing done with the 'Devine' material. Results from this experiment are very encouraging relative to identifying annual legumes for improving rangelands, tame pastures, and wildlife habitats in west-central Texas.

The experiences from other trials at several locations in Texas and Oklahoma suggest that 'Jemalong' barrel medic will be the least likely to withstand extreme cold temperatures. Testing as far north as central Oklahoma suggests that 'Devine' little bur, and 'BEBLK' black medic will have the greatest winter hardiness.

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