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Agronomic Characteristics of Native and Naturalized Cool Season Legumes Collected in Texas

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Summary

Seeds of six naturalized cool season legumes collected in Erath County and other parts of Texas were compared to six commercially available cool season legumes at Stephenville. Forage was either harvested in April and June or June-only while seeds were collected from both April-harvested and June-only harvested sub-plots. Local button medic and narrow leaf vetch produced nearly 1.5 tons DM (dry matter)/acre when harvested in April. However, only Overton R18 rose clover, Stephenville burr medic and Stephenville button medic produced any significant seeds when forage was harvested in April. The legumes produced over four times as much seed when they were harvested only in June but forage yields were cut in half. This indicates that there must be a trade-off in harvest management and stand persistence of these self-reseeding annuals. Variable fiber, lignin, crude protein (CP) and phosphorus (P) concentrations of forage harvested in April indicate that these quality indicators should be considered when selecting legumes for cattle, sheep, goat or wildlife pastures.

Introduction

Legumes are generally high in crude protein and digestibility, making them an asset to any pasture or range system. If a portion of the forage available to ruminants consists of legumes, this provides the CP required by the rumen microbes and enhances the digestibility of frost-killed summer grasses in a winter pasture. Browsers such as deer or goats depend even more heavily on winter forbs from which they select a much higher quality diet than grazers.

Native or naturalized forages usually have some advantages when compared to introduced species or cultivars. Adaptation to climatic extremes, soil moisture, soil pH, soil mineral status, insect predation and local pathogens are some of these advantages. Agronomic characteristics, however, are not always the best. Natural selection may not have favored yield, forage quality, timely production peaks, seed production or grazing tolerance.

In the spring of 1998, seed of several naturalized, volunteer cool season legumes were collected in Erath County. The objective of this trial was to run plot studies with these and compare their agronomic characteristics to self-reseeding, cool season legumes collected elsewhere in Texas or commercially available.

Table 1. Climatic data at Stephenville during the months of the experiment.

Month	Precipitation (inches)		---------------------Temperature (^{o}F)--------------------------				
	1998-9	30 yr Ave	High	Mean high	Low	Mean low	Mean
December	2.8	1.9	77	56	14	33	44
January	1.2	1.3	83	62	13	32	47
February	0.0	2.0	82	68	24	39	54
March	1.5	2.1	79	65	23	42	53
April	2.0	3.1	91	78	30	51	65
May	3.0	4.5	93	83	38	59	71
Total	10.5	14.9					

Procedure

Medicago ploymorpha (Stephenville burr medic), *M. turbinata* (spineless or Stephenville cogwheel burr medic), *M. lupulina* (Stephenville black medic), *M. orbicularis* (Stephenville button medic), *M. minima* (Stephenville little burr medic) and *Vicia sativa* subsp. *nigra* (Stephenville narrow leaf vetch) seed were collected in Erath County in the spring of 1998. *Vicia ludoviciana* (black-seeded PAST3, green-seeded PAST3 and Hoverson deer pea vetch) was collected by William Ocumpaugh and Richard Hoverson in the Rio Grande Valley and is the only true native in this study. Commercially available *V. villosa* (hairy vetch), *V. dasycarpa* cv. Lanna (lanna vetch), *Trifolium hirtum* cv. Overton R18 (a rose clover developed in northeast Texas by Ray Smith), *T. pratense* cv. Dixie (crimson clover) and *M. polymorpha* cv. Armadillo (a burr medic developed in south Texas by Bill Ocumpaugh) were included in the trial for comparison. The entries were seeded October 15, 1998 in Jiffy Pot peat cups after inoculation with specific *Rhizobia*. These were then transplanted December 1 to 6.56' X 3.94' plots at 0.98' intra-row and 1.31' inter-row spacings in 3 replications (60 individual plants) in cultivated Windthorst sandy loam (pH 6.6, P 11 ppm and K 110 ppm). Plots were hand weeded and received only natural precipitation (see Table 1 for rainfall and temperature during the experiment).

In mid-January and mid-April, plots were evaluated for frost/insect damage (0=none; 3=severe), survival percentage, spread/height, vigor (0=dead; 3=high vigor) and flowering/seed set. The plots were split so that one half (3.94" X 3.28") were harvested on April 30 for yield and all subplots were harvested June 8 for yield and seed production. Yield measurements consisted of harvesting 9 plants at a 1.5 inch stubble height (or length from crown) while seed production consisted of collecting all seeds of the inner 2 plants and deriving seed number estimates from a

50 pod sub-sample. Acid detergent fiber (ADF), lignin, nitrogen and phosphorus were run on April 30 harvest samples.

Results

Prolonged freezing weather in December and January caused severe frost damage and plant loss in the Armadillo burr medic (Table 2). Despite moderate frost damage in the Stephenville narrow leaf vetch, Stephenville burr medic, Stephenville cogwheel medic and lanna vetch, this did not result in severe plant loss to these entries. Hairy vetch was the most vigorous legume in January while the Armadillo burr medic and the black-seeded deer pea vetch were the least vigorous.

All entries flowered and began setting seed by April. Individual plant survival was below 50% for both Armadillo burr medic and the black-seeded deer pea vetch but was over 80% for all other entries (Table 2). Insect damage by alfalfa weevil, 12 spotted cucumber weevil, leaf hoppers and aphids was visible in April on the Armadillo burr medic, Stephenville burr medic and Stephenville cogwheel medic. A single application of Seven XLR Plus (Carbaryl at 1 quart/acre) in mid-March allowed for some recovery by April. Hairy, Stephenville narrow leaf and lanna vetches were all very vigorous in April while Armadillo burr medic and the three deer pea vetches were again the least vigorous. In the case of Armadillo, insect pressure was the primary contributor to low plant vigor while the deer pea vetches did not develop. Plant spread or height was over 17 cm for all entries and over 40 cm for hairy and lanna vetch in April.

Table 2. Survival, frost damage (0-3; 0=no damage), insect damage (0-3; 0=no damage), plant vigor (0-3; 0=dead) and spread/height of 14 cool season legumes.

Legume	*Survival (%)*		*Damage (0-3)*		*Plant vigor (0-3)*		*Spread*
	January	*April*	*January Frost*	*April Insect*	*January*	*April*	*April (inches)*
Lanna vetch	100.0	100.0	1.7	0.0	2.3	3.0	21
Stephenville button medic	100.0	100.0	0.7	0.0	2.7	2.3	10
Stephenville black medic	100.0	98.3	1.0	0.0	2.7	1.8	11
Stephenville narrow leaf vetch	100.0	98.3	2.3	0.0	1.7	2.8	12
Hairy vetch	100.0	96.7	0.0	0.0	3.0	3.0	17
Dixie crimson clover	98.3	96.7	1.0	0.0	2.3	2.0	11
R18 Overton rose clover	98.3	95.0	0.0	0.0	2.3	2.2	10
Stephenville burr medic	98.3	82.3	1.7	1.0	1.7	2.0	13
Green-seeded deer pea vetch	96.7	87.0	0.3	0.0	2.0	2.0	14
Stephenville cogwheel medic	93.7	89.0	2.0	1.0	1.7	1.8	11
Stephenville little burr medic	93.3	90.3	0.3	0.0	1.7	2.0	7
Black-seeded deer pea vetch	92.0	44.3	0.7	0.0	1.0	1.0	9
Hoverson deer pea vetch	91.7	84.0	0.3	0.0	2.0	1.7	14
Armadillo burr medic	54.0	39.7	3.0	1.3	1.0	1.7	7
P value	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LSD (0.05)	8.0	23.9	0.8	0.8	0.8	0.6	6.6

The lower the ADF concentrations in plants, the more easily the plants are digested. Acid detergent fiber was exceptionally low in forage samples of the Stephenville black medic, Stephenville little burr medic and the Stephenville burr medic (Table 3). The first two of these were still producing fresh green growth at the time of harvest while the third, the local burr medic, was producing green regrowth after earlier insect damage. Legumes with ADF concentration over 35% included Overton R18 rose clover, hairy vetch, crimson clover and lanna vetch. The high ADF values of Armadillo burr medic were likely a result of continued insect predation that left little more than stems on most plants. The various legumes in this trial matured, flowered and set seed at different times.


Common vetch

In general, lignin is indigestible and often binds with CP to make that unavailable to animals. The rose clover and Stephenville black medic both had lignin concentrations under 5% (Table 3); Armadillo burr medic, hairy vetch and lanna vetch all had lignin concentrations over 8%. In the case of the Armadillo, insect leaf predation left mainly stems which are normally higher in lignin concentration while the two vetches were very leafy at the time of harvest.

Crude protein concentration was particularly high in the Stephenville button medic (19.5%) and the hairy vetch (Table 3); it was particularly low in the rose clover (10.0%) and the Stephenville little burr medic (11.1%), indicating possible problems with *Rhizobium* inoculation. It is important that legumes have these bacteria in contact with their roots in order to form the nodules that will fix atmospheric N for the plant. The only naturalized legume that came close to the 0.46% P of crimson clover was the Stephenville cogwheel medic (0.35% P).

Table 3. Acid detergent fiber (ADF %), lignin (%), nitrogen (N %) and phosphorus (P %) concentrations in the forage dry matter harvested from 14 cool season legumes in April at Stephenville.

Legume	*ADF %*	*Lignin %*	*CP %*	*P %*
Stephenville black medic	20.8	4.45	17.8	0.23
Stephenville little burr medic	22.0	5.83	11.1	0.18
Stephenville burr medic	26.8	6.21	16.9	0.26
Stephenville button medic	30.0	6.02	19.5	0.29
Stephenville cogwheel medic	30.7	6.24	14.0	0.35
Narrowleaf vetch	31.5	7.65	17.8	0.24
Green-seeded deer pea vetch	32.6	7.88	18.4	0.27
Hoverson deer pea vetch	32.8	7.73	14.1	0.20
Black-seeded deer pea vetch	33.0	7.70	12.1	0.22
Armadillo burr medic	35.1	9.40	15.0	0.20
Dixie crimson clover	36.5	7.42	13.6	0.46
Lanna vetch	36.8	8.64	17.4	0.25
R18 Overton rose clover	37.9	4.86	10.0	0.27
Hairy vetch	38.3	8.34	22.1	0.28
P value	0.01	0.01	0.01	0.01
LSD (0.05)	4.9	1.05	0.67	0.11

Stephenville narrow leaf vetch, lanna vetch and Stephenville button medic produced close to 1.5 tons/acre DM in April despite receiving only 1.5” rainfall in February and March (Table 4). Although this is not a large quantity of forage, it could be a very significant contribution to a pasture or range mix. All other legumes produced less than 1 ton of DM while Armadillo burr medic and black-seeded deer pea vetch had insignificant production, Armadillo due to severe freeze and insect damage (especially the alfalfa weevil) and the vetch due to weak development. Forage availability declined an average 51% from April 30 to June 9th (Table 4) as all the legumes produced a seed crop. The June material was mostly stems and pods in most entries. The green-seeded and Hoverson deer pea vetches out-produced the black-seeded deer pea vetch by a factor of nearly 10, indicating a similarity in adaptation of the first two relative to the black-seeded vetch.

Table 4. Forage dry matter yield of 14 cool season legumes harvested in April and June or only in June (entry X harvest *P*=0.06; $lsd_{0.05}$=839).

Legume	*April & June*	*June only*
	-------------lbs	Acre^2----------
Stephenville button medic	3,440	1,083
Lanna vetch	3,019	1,199
Stephenville narrowleaf vetch	2,928	1,414
R18 Overton rose clover	2,159	910
Hairy vetch	1,977	686
Green-seeded deer pea vetch	1,687	637
Hoverson deer pea vetch	1,489	1,207
Stephenville little burr medic	1,348	521
Stephenville burr medic	1,207	1,249
Stephenville black medic	1,191	926
Dixie crimson clover	1,042	819
Stephenville cogwheel medic	868	149
Armadillo burr medic	174	248
Black-seeded deer pea vetch	174	41
Average	1,620	794

Seed production estimates were tenuous in the narrow leaf and deer pea vetches since these dehisced readily once ripened. An estimate was made based on shattered pods and pods collected before shattering occurred. The burrs of all the medics (except black medic, which did not drop seeds) were collected both on the plant and on the ground.

Harvesting forage on April 30 decreased all seed production to 22% that produced if plants went unharvested until June 8 (Table 5). Early forage harvest reduced seed set the least in rose clover, which produced 60% and little burr medic, which produced 35% that of plants harvested only in June. Button medic, at 133 seeds/ft^2 when harvested in June, also produced sufficient seed to likely maintain a stand. Preliminary observations the following November indicated that all June-clipped subplots had good volunteer seedling recruitment.

Table 5. Seed produced per ft^2 by 14 cool season legumes in June when forage was either previously harvested in April or never harvested (entry X harvest P=0.01; $lsd_{0.05}$=450).

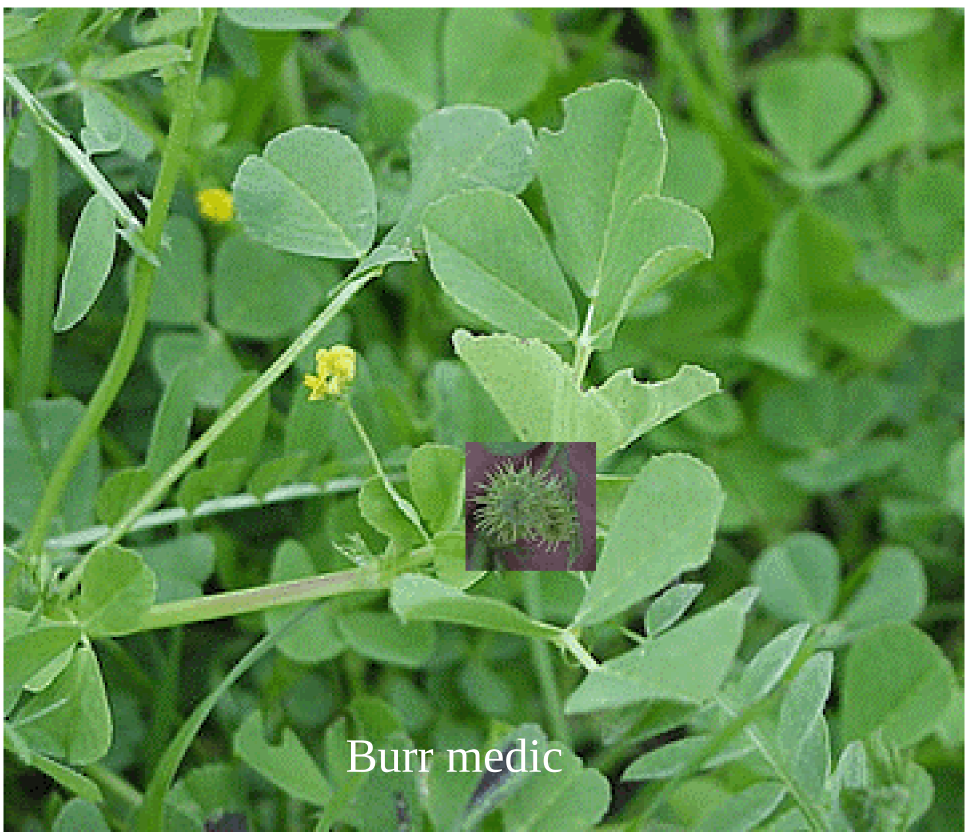
Legume	*April harvest*	*No harvest*
	----------seeds	$Foot^2$----------
R18 Overton rose clover	1,249	2,085
Dixie crimson clover	13	1,884
Stephenville little burr medic	405	1,155
Green-seeded deer pea vetch	2	865
Stephenville button medic	133	630
Armadillo burr medic	0	451
Stephenville burr medic	11	363
Lanna vetch	0	285
Hoverson deer pea vetch	19	267
Stephenville black medic	61	195
Hairy vetch	12	119
Stephenville narrow leaf vetch	3	99
Stephenville cogwheel medic	1	74
Black-seeded deer pea vetch	0	66
Average	136	610

Conclusions

Freeze damage in January was a strong factor in stunting Armadillo burr medic growth but had only a slight effect on other medics. Armadillo was selected from naturalized medic pastures in Bee County and may not be as well adapted to northern counties as naturalized medic populations. Direct seeding may improve freeze tolerance through more gradual adaptation. The pH of the soils in this study was also lower than those normally found in Bee County. The prolonged (continuous for three days in December) freezing temperatures experienced during this trial may be unusual for the area, however, since even locally collected naturalized vetches and medics also showed some freeze damage.

Low rainfall was an important factor during this trial. There was very little precipitation for a 60 day period during January through March; total rainfall during the experiment was only 70% of the long-term average. Armadillo burr medic, for example, produced 1,400 lbs/acre in a March, 1998 harvest the previous season at Stephenville when rainfall was 25% higher and insect damage was considerably lower.

Insect predation, was especially heavy in late spring and may be an important factor in winter annual legume population survival since seed production may be affected. Both the *M. polymorpha* and the *M. turbinata* in this trial were moderately affected by insect damage. Insect damage, which removes higher quality leaves, likely decreased quality parameters for those entries which were predated more heavily. Large-scale pastures may not be as prone to intense attack, however, as insect spread and control by beneficials may be subject to different dynamics. In addition, when rainfall is higher, plant biomass is likewise higher, allowing pasture plants to more easily tolerate insect predation.

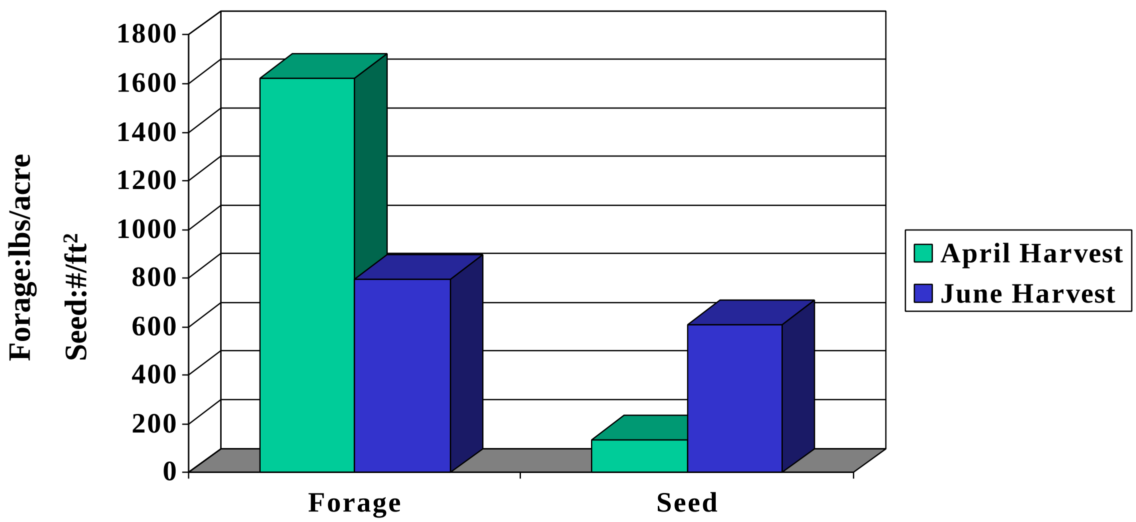


Quality factors varied considerably among the legumes studied. If the individual species had been harvested at the same maturity (rather than the same date), quality differences, as indicated by laboratory analysis, might not have been so disparate. These results can only be used to compare the legume quality in late April. At this date, naturalized little burr and black medic collected near Stephenville were exceptionally low in ADF concentration. Different growth patterns, especially onset of seed production, may have contributed to these differences within species and ecotypes. If harvests took place in March, for example, or whenever plants started flowering, quality parameters for all entries would likely be higher. Lignin concentration was exceptionally high in the Armadillo medic due to leaf loss; it was also high in all the vetches. The vetches and the naturalized medics (with the exception of the little burr) all had high CP concentrations, making them a potential asset in ruminant diets. The naturalized cogwheel medic and the commercial crimson clover were higher in P concentration than any of the other entries. Low concentrations of available soil P in the Cross Timbers area make this higher concentration in the plants particularly important to wildlife that does not generally have access to mineral blocks.

Forage yields were low on average for all entries. Button medic and narrow leaf vetch were the only naturalized legumes to get close to 3,000 lbs acre^2 while the lanna vetch was the only commercial entry to get close to that mark. Years with better moisture in February and March may result in better overall yields. Armadillo and the black-seeded deer pea vetch, both originating from warmer latitudes, had negligible yields. Higher plant concentrations would likely increase forage production for these smaller legumes as well. The Armadillo, despite insecticide application, was heavily affected by insect damage in the March. Forage harvest any earlier than April, for example, would have resulted in no yield. The material harvested in April was regrowth following application of insecticide in mid-March.

However, even the better yielding entries would be commercially viable for animal production systems only where they could reseed themselves annually. Heavy seed production is important for stand persistence of these annual plants. Even though seeds are often able to survive multiple years due to hard seed coatings, occasional heavy seed set is extremely important for local legume populations. Under heavy, late spring harvest, the Overton R18 rose clover was the only heavy seed producer. The locally collected little burr and button medics might be able to sustain soil seed banks as well, but seed predation by insects, rodents and birds might eventually deplete these. Most entries were able to produce 200 or more seed foot^2 when rested through late spring, but such management may not be viable under commercial production. Legumes with more prostrate growth habits, such as the little burr or black medics, may be better adapted to seed production under continuous grazing.

Although results might be different with higher plant densities and wetter springs, data from this year would indicate that forage production and reseeding ability of both introduced and naturalized/native annual winter legumes may not always be sufficiently strong to give a good return for cattle and sheep producers accustomed to low-key pasture management. Continuous heavy grazing will likely preclude stand establishment and persistence. Figure 1 illustrates this trade-off of forage yield harvested early for seed production later in the season. However, less intensive systems such as wildlife management, range reseeding for rotational grazing/browsing or fallow land might benefit from the introduction of these native/naturalized legumes. Observations in the Cross Timbers bear this out—naturalized winter annual legumes persist only



where winter overgrazing by livestock does not take place.

Figure 1. Forage yield and seed production of 14 cool-season annual legumes harvested in April and June or in June-only at Stephenville.

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