NATIVE FORB ESTABLISHMENT AND PERSISTENCE IN A GRASS-FORB SEEDING IN THE SOUTHERN PLAINS

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Abstract. Establishment of forbs in addition to grasses on marginal farmland in the Southern Plains can enhance wildlife habitat; improve forage quality; and, if legumes are used, fix nitrogen. This study explored establishment, herbage production, and persistence under grazing of five native forbs in northwestern Oklahoma. Purple prairie clover (*Dalea purpurea* Vent.), Illinois bundleflower (*Desmanthus illinoisensis* (Michx.) MacM.), scarlet pea (*Indigofera miniata* Ort.), partridge pea (*Cassia chamaecrista* L.), maximilian sunflower (*Helianthus maximilianii* Schrad.), and native grasses were drilled into a firm seedbed remaining after wheat (*Triticum aestivum* L.) was intensively grazed by cattle. Establishment of forbs and grasses was good, with an average of 1 plant established per 10 pure live seeds planted. The seeded forbs produced 33, 107, and 71 g m^{-2} representing 15, 29, and 36% of the herbage in the planting during the second, third, and fourth growing seasons, respectively. In June, grazing by steers was negligible on purple prairie clover and partridge pea, heavy on Illinois bundleflower, moderate on maximilian sunflower, and light to heavy on scarlet pea.

INTRODUCTION

Plowing of mixed- and shortgrass prairie in the Southern Plains began about 100 years ago. Extended drought, clean tillage practices, overgrazing, and high seasonal winds produced the great dust storms of the 1930s. The most severe wind erosion occurred in the Oklahoma panhandle and adjacent areas of adjoining states. Though not as spectacular, water erosion also was, and is, a major problem in the Southern Plains. Since the 1930s, establishment of grasses on eroded, marginal farmland has been a major part of conservation programs.

Establishment of forbs along with grasses would add diversity, thereby enhancing wildlife habitat (Schramm et al. 1987). Forbs could also improve forage quality and, if legumes were used, fix nitrogen in these plantings (Mauldin et al. 1988). However, forbs are not routinely seeded with native grass mixtures because 1) of added expense for forb seed, 2) seeding forbs precludes use of certain herbicides to control broadleaf weeds, and 3) information is sparse on establishment, benefits, and management of specific forb species.

Major contributors to knowledge on native forbs are the U.S. Department of Agriculture-Soil Conservation Service (SCS) Plant Materials Centers in Knox City, Texas; Manhattan, Kansas; and Los Lunas, New Mexico. These centers have screened many species and selections within species. Outstanding selections are released as named cultivars, and limited quantities of seed of promising, unreleased selections are made available to cooperators for field evaluation. Plant-available nitrogen is usually deficient in Southern Plains farmland as a result of 50 to 100 years of cropping and erosion. Thus, interest in native legumes has been long-standing (Kneebone 1959, Berg 1986, Maulden et al. 1988).

The objective of this paper is to document density, herbage production, and persistence under grazing of five forbs seeded in a mixture with six native grasses commonly planted on the Southern Plains. The forbs are selections that have generally proven outstanding in testing by SCS plant materials centers and others. This research is one segment of a regional study on land use effects upon runoff and associated soil and nutrient losses.

STUDY AREA AND METHODS

The study area is in northwestern Oklahoma on loamy upland soils (Woodward and Quinlan series; thermic Typic Ustochrepts). These soils, on 5 to 8% slopes, are typical of extensive areas of highly erodible soils on class IV land farmed to wheat (*Triticum aestivum* L.) in the Southern Plains. The soils are calcareous at or near the surface (pH near 8). They test low in nitrate nitrogen and adequate in plant-available P and K.

Long-term average annual precipitation on the area is 600 mm. Periodic, short-term drought is common, with wide yearly fluctuations in precipitation. About 70% of the precipitation is normally received during the frost-free period of mid-April to mid-October. The mean annual temperature is about 15 C with an expected yearly range of -18 to 40 C. Winds with gusts reaching 30 to 50 km/hr are common in the spring.

Under moderate grazing, native vegetation on loamy soils is usually dominated by a mixture of short, mid, and tall warm-season grasses. The grasses include blue grama (*Bouteloua gracilis* (H.B.K.)Lang. ex Griffiths), sideoats grama (*B. curtipendula* (Michx.) Torr.), little bluestem (*Andropogon scoparius* Michx.), sand bluestem (*Andropogon hallii* Hack.), switchgrass (*Panicum virgatum* L.), and Indian grass (*Sorghastrum nutans* (L.) Nash). Nomenclature follows Great Plains Flora Association (1986).

Local abundance of the warm-season forbs used in this study include purple prairie clover (*Dalea purpurea* Vent.), occasional on loamy upland sites; Illinois bundleflower *Desmanthus illinoensis* (Michx.) MacM.) and maximilian sunflower (*Helianthus maximilianii* Schrad.), occasional to common on moist sites protected from grazing; scarlet pea (*Indigofera miniata* Ort. var. *leptosepala* (Nutt.) B.L. Turner); and showy partridge pea (*Cassia chamaecrista* L.), occasional on upland sites and can be locally abundant on disturbed sites.

The area seeded to the native species mixture is a 3-ha gauged watershed previously farmed to wheat. The field was native range until plowed in 1979. A firm seedbed was developed by grazing wheat until mid-March 1987, allowing 10 days of wheat regrowth and then spraying with glyphosate.

In early April, a mixture of purple prairie clover *Kaneb*, Illinois bundleflower accession 421302, scarlet pea accession 477963, partridge pea *Comanche*, and maximilian sunflower *Prairie Gold* were drilled into the residue. Seeding was through the legume box of a Tye grassland drill equipped with double disc furrow openers and 1.5-cm depth bands. Spacing between rows was 25 cm. Each legume was inoculated with specific *Rhizobium* supplied by the Nitragin company. The legumes were not scarified. The following grasses were then drilled at a slight angle to the forb rows: blue grama *Hachita*, sideoats grama *El Reno*, little bluestem *Cimarron*, sand bluestem *Woodward*, switchgrass *Blackwell*, and Indian grass *Cheyenne*. Seeding rates (Table 1) suggested by SCS plant materials specialists were used for all species. Control of annual weeds was by flash grazing in early June and one mowing in late June.

Forb density was determined in July 1987 by identifying and counting each plant within 200 random placements of a 0.1 m^2 quadrat. Forb density was determined in June of 1988 and 1989 by 200 random placements of a 0.5 m^2 quadrat and in 1990 by 400 placements of a 0.5 m^2 quadrat. Grass species' density was determined each year using 100 placements of a 0.1 m^2 quadrat.

Herbage production at estimated peak standing crop (early July) was determined in 1988 by clipping forty 1/2 m^2 quadrats at ground

level, separating species, oven drying, and weighing. Because the planting was grazed in 1989 and 1990, ten 3 x 3 m exclosures were randomly placed in the field and relocated each year. A 2-m^2 quadrat was sampled within each exclosure in 1989. In 1990, a 4-m^2 quadrat was sampled for grasses and purple prairie clover, and 9-m^2 was sampled for the other forbs within each exclosure.

The planting was grazed with yearling steers (180-270 kg) in April 1988 (50 steer days/ha), 7 to 27 June 1989 (110 steer days/ha), and 13 June to 2 July 1990 (80 steer days/ha). Standing dead vegetation was grazed in January and February of 1989 and 1990 with a stocking of 250 steer days/ha each year.

Precipitation in 1987, the year of seedling establishment, was 743 mm; this is 143 mm greater than the long-term average. Precipitation in 1988, 1989, and 1990 was 584, 623, and 361 mm, respectively.

Table 1. Forb and grass seeding rate, percent establishment, and density.

Species	*Seeding rate*	*Established*	*Density*			
			1987	*1988*	*1989*	*1990*
	pls†/m^2	%	plants/m^2			
Purple prairie clover	10	8	0.8	1.3	1.6	1.5
Illinois bundleflower	2	15	0.3	0.14	0.11	0.09
Scarlet pea	4	25	1.0	1.1	0.9	0.7
Partridge pea	8	16	1.3	6.2	¥	¥
Maximilian sunflower	0.5	40	0.2	0.1	0.3	0.3
Blue grama	30	23	7	8	8	6
Sideoats grama	30	33	10	16	1.4	1.4
Little bluestem	30	10	3	4	4	4
Sand bluestem	12	§	§	1.3	1.5	1.3
Switchgrass	20	10	2	2.0	2.8	2.4
Indiangrass	20	§	§	0.8	1.1	1.5

† Pure live seed.

¥ Not counted, annual species, many seedlings found some very small.

§ Sand bluestem and Indian grass seedlings not differentiated.

RESULTS AND DISCUSSION

Establishment

By mid-May, following planting in early April 1987, grass seedlings were abundant, and scattered forbs were present. A two-week rainy period (20 cm pptn.) started May 19, followed by timely rains of 2 to 3 cm/week through mid-July. Percent establishment ([number of seedlings/m^2 July 1987 : number of pure live seeds/m^2 planted in April 1987] x 100) ranged from 8% for purple prairie clover to 40% for maximilian sunflower (Table 1). This is excellent establishment for this region and is apparently a reflection of timely rains and a firm seedbed.

Many of the seedlings were 10 to 20 cm tall by mid-July. A few blue grama and sideoats grama plants were producing seedheads, and a few purple prairie clover, Illinois bundleflower, and partridge pea were blooming. Nodules with pink to dark red interiors were found on five of five partridge pea, four of five scarlet pea, two of five bundleflower, and one of five purple prairie clover plants when dug on July 20. The soil was moist but not highly friable when plants were dug; so some nodules may have been pulled off and, thus, not observed.

Observations on Grazing

Grazing during the 1989 and 1990 growing seasons commenced when there was 20 to 30 cm of new growth on the tall grasses (early to mid-June). At that time, purple prairie clover, Illinois bundleflower, and maximilian sunflower were also about 30 cm tall, and prairie clover was starting to bloom.

Grazing by steers was managed so that about half the grass biomass was consumed. At this grazing intensity and season of use, purple prairie clover was not grazed. Illinois bundleflower was heavily grazed. Maximilian sunflower was not grazed initially, but flower buds were heavily grazed as they emerged above the rosette of basal leaves. Only a few tips of scarlet pea and partridge pea were grazed in 1989. However, scarlet pea was heavily grazed in 1990.

Heavy grazing on maximilian sunflower was observed in April 1988 when the planting was grazed to control scattered, volunteer yellow sweet clover (*Melilotus officinalis*(L.)Pall). At that time, sunflower leaves were 8 to 10 cm long, warm-season grass shoots were 1 to 3 cm long, and the other warm-season forbs had not started top growth.

Literature (Johnson and Nichols 1970, Wasser 1982, Great Plains Flora Association 1986) generally indicates that purple prairie clover, Illinois bundleflower, and maximilian sunflower will decrease under heavy grazing. The grazing experience on this planting suggests that this will occur under yearly early-season grazing (April and May in Oklahoma). Under management based on moderate grazing (graze about 1/2 of grass biomass) of warm-season grasses in June and early July, it appears that purple prairie clover will not be grazed, Illinois bundleflower will be heavily grazed, and maximilian sunflower (buds) moderately grazed.

Gain of steers grazing the planting in June 1989 was 1.1 $\pm$ 0.06 (std. error) kg/day/steer and 120 kg/ha. Gain over the period June 13-July 2, 1990, was 1.5 $\pm$ 0.1 kg/day/steer and 125 kg/ha. These gains are similar to or somewhat greater than gains expected on good condition native range in the area and probably are a reflection of the vigor of the young stand and the relatively high fertility of the field. Total herbage yield calculated from data in Table 1 ranged from 2000 to 3700 kg/ha/yr. These yields are within the range estimated for the SCS loamy prairie range site in western Oklahoma (Cole et al. 1966). The fertility of many old fields farmed 70 to 100 years is considerably lower than this field that was farmed for eight years before being seeded to the native mixture.

Forb Performance

Purple prairie clover.

Purple prairie clover, with a density of 1 to 2 plants/m^2, was the most abundant forb (Table 1) and contributed substantially to herbage production (Table 2). Density increased from the first to the second growing season, probably due to germination of initially dormant seed.

When blooming in June, this density of purple prairie clover is striking against a background dominated by warm-season grasses. One can speculate that the density in this study is adequate for small wildlife use; however, quantitative data are needed. The unpalatability to cattle later in the growing season may be an advantage or disadvantage. Field data are needed to quantify the N_2-fixing potential on N-deficient soils. If it is a good N_2 fixer, greater density may be desirable, and the limited palatability may be an advantage.

Illinois bundleflower.

Illinois bundleflower had good initial establishment, but density decreased over the four growing seasons (Table 1), probably in response to grazing and competition. From the grazing and wildlife (Schramm et al. 1987) aspects, bundleflower may be the most desirable forb planted in this study. However, it appears that excellent grazing management will be required to maintain this species in a mixed planting.

Table 2. Herbage production by species in July 1988, 1989, and 1990.

	Herbage harvested in July, g/m²		
Species	*1988*	*1989*	*1990*
Purple prairie clover	13	34	54
Illinois bundleflower	5	15	2
Scarlet pea	9	15	3
Partridge pea	T†	33	T
Maximilian sunflower	6	10	12
Blue grama	20	25	} 55
Sideoats grama	67	130	
Little bluestem	16	40	34
Sand bluestem and Indian grass	23	24	19
Switchgrass	23	26	18
Other species	33	17	3

†T=trace.

Scarlet pea.

Scarlet pea established well and persisted in this planting (Table 1). It was very lightly grazed in 1989 and heavily grazed in 1990. Grazing in 1990 may have been as an alternative to grazing drought-stressed grass. This species has shown the ability to spread on N-deficient soils (Berg 1986), making it a candidate for use on infertile eroded sites.

Showy partridge pea.

Showy partridge pea, an annual, established well and produced seed abundantly the year initially seeded. Its density and herbage production (Tables 1 and 2) in ensuing years was highly dependent upon rain received in June and July. The yellow flowers have high aesthetic appeal. Steers did not graze this species when other herbage was readily available. Many small nodules were found on partridge pea roots in this study.

Maximilian sunflower.

Maximilian sunflower established readily (Table 1) and produced flowers the first growing season. It persisted well despite being the first species in the mixture to wilt and have leaves dry up from drought. Thus, it may not persist on upland sites in this area under extended drought. Numerous maximilian sunflower seedlings emerged in the spring of 1990, the fourth growing season; these are not included in the density recorded in Table 1.

OUTLOOK

"You mean we're going to plant weeds with grass?" was a farmer's reaction to a slide presentation on this grass-forb planting. This skeptically phrased question indicates that benefits of including native forbs in seeding mixtures will have to be proved and demonstrated before being accepted by many farmers and ranchers.

Many questions need to be answered—including the following: Will cattle (sheep, goats, etc.) graze this forb? If so, when, and how much? What is the forage quality? What management is needed to maintain this forb in a grass-forb planting? What are the wildlife values? What density is optimum for quail (or other wildlife)? What management is needed to optimize domestic grazing and wildlife values? What techniques can be used to establish forbs in existing grass stands (Dovel et al. 1989)? What is the nitrogen-fixing potential of the legumes?

This study and plantings by conservation agencies illustrate that selected forbs can be established with grasses on marginal farmland in the Southern Plains. Quantifying benefits from forbs and the grazing management needed to maintain forbs now appears to be the next step.

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