

Establishing Legumes in a Tall Fescue Sward

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Abstract

Tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort.] is a common grass species in the eastern half of the USA, but legumes grown with it could provide benefits. Obstacles to legume establishment in fescue pastures include disease, insect damage, and grass competition. Experiments were performed in 2010 and 2011 at Site 1 to test the efficacy of insect control, disease control, and two methods of grass suppression on seedling establishment of three legumes. The highest seedling density of red clover (*Trifolium pretense* L.) was obtained with glyphosate treatment regardless of pest control and for clipping without pest control. No overall or consistent benefit was found for white clover (*Trifolium pretense* L.) or trefoil (*Lotus corniculatus* L.) from seed and foliar insecticides or fungicides, or for grass suppression by either clipping or glyphosate application. Experiments were performed in 2012 and 2013 at Site 2 to test the efficacy of grass suppression by grazing cattle or by clethodim application. Seedling density of red clover was not significantly improved by either treatment, but the density of birdsfoot trefoil was increased by clethodim, and the density of white clover was increased in 2013 by both methods of grass suppression. Overall, red clover was least sensitive to grass competition. Birdsfoot trefoil was better served by the immediate effect of chemical suppression, whereas white clover benefitted most from the lengthier grass suppression provided by grazing.

Keywords

Red Clover, White (Ladino) Clover, Birdsfoot Trefoil, Herbicide, Grazing

1. Introduction

Pastures composed of legumes and grasses benefit from nitrogen (N) transfer from legumes to grasses. Legumes such as alfalfa (*Medicago sativa* L.) and soybean [*Glycine max* (L.) Merr.] can provide an annual average of 152 kg and 84 kg N ha⁻¹, respectively, via symbiotic N fixation [1]. Pasture legumes can fix 80 to 110 kg·ha⁻¹·yr⁻¹ of

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symbiotic N for companion grasses [2] [3]. Legumes grown with grasses also provide a more uniform seasonal distribution of forage than pure cool-season grass pastures because legumes such as alfalfa are less likely to go dormant during mid-summer [4].

Tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort.] is one of the most common grass species in the humid transition zone between the temperate North and mild South in the eastern half of the USA [5]. It was also one of the most dominant species in complex mixtures with other grasses and legumes at the end of a grazing study in Pennsylvania [6]. Maintaining adequate legumes in tall fescue was related to improved animal performance and farm profitability [7]. Ladino clover (*Trifolium repens* L.) interseeded into endophyte-infected tall fescue was more profitable than N-fertilized tall fescue alone [8]. In a plot study in southeastern Kansas with multiple legumes, returns from birdsfoot trefoil (*Lotus corniculatus* L.) were greater than those from alfalfa as well as from red and white clovers [9].

Legume species have differed in their effects on animal performance in fescue pasture. Allen *et al.* [10] reported that body weight gains of calves grazing stockpiled pastures of alfalfa-tall fescue were greater than those grazing red clover-tall fescue or N-fertilized tall fescue. Ladino clover in endophyte-infected tall fescue also resulted in better average animal gains than red clover or Korean lespedeza [11].

Despite the benefits known to occur from interseeding legumes into tall fescue, procedures have not been developed to the point that managers can incorporate legumes into pastures with any degree of confidence [2]. Approaches to improving legume establishment in tall fescue are numerous and include no-till drilling of legumes into tall fescue pasture [11]; controlling grass competition with herbicides [12], mowing, or grazing [13]; limiting N fertilization [14]; and planting pastures with different row orientations [15]. Although considerable research has been conducted on legume establishment, little progress has been made to address many of the problems, such as disease, insect damage, heat and/or water stress, and poor seedling vigor [2]. The experiments in this study were undertaken to identify and manage the most limiting factors in the complex interactions among diseases, insects, interplant competition, and the environment.

2. Materials and Methods

2.1. Experiment 1: Pest Control and Grass Suppression

Legume species were interseeded separately into endophyte-infected tall fescue at the Mound Valley Unit of the Kansas State University Southeast Agricultural Research Center (37°11.5'N, 95°27.4'W). The plot area had been seeded to tall fescue >2 years prior to the test, and had been hayed without benefit of fertilization. The soil was a Parsons silt loam (fine, mixed thermic Mollic Albaqualf) with a pH of 6.3, 7 mg·kg⁻¹ of available P (Mehlich 3), and 128 mg·kg⁻¹ of exchangeable K in the upper 15 cm, to which was added 25 kg/ha of P and 28 kg/ha of K. Spring temperature and precipitation data for the location in 2010 and 2011 are listed in **Table 1**.

Species were planted with a no-till plot seeder (6 rows with 25-cm spacings, at ~5 mm depth) in 6-m strips, 12 m long in four replications, within a randomized strip split-plot design. Seeding dates for the experiment were April 20, 2010, and April 18, 2011, in adjacent areas. Seeding rates of the species and cultivars provided approximately 250,000 seeds·ha⁻¹ and are listed in **Table 2**.

The seeded strips of legumes were randomly split into three 2-m subplots, each with six 25-cm rows, to determine the effects of pesticide protection on establishment. Grass suppression treatments (**Table 3**) were applied in 4-m strips randomly across each replication perpendicular to pesticide treatments, providing individual subplots of 1.5 by 4 m.

Legume seedling counts were taken randomly within a rectangle 33 cm long across the two center rows. In 2010, the rectangle was tossed about midway through the plot length; in 2011, two rectangles were counted at about one-third and two-third of the plot length, respectively. Legume seedling counts were made on June 17, 2010, and June 1, 2011, corresponding to 58 and 50 days after planting (DAP), respectively.

Data were analyzed using PROC MIXED in SAS [16], with replication considered random and all other factors fixed. Fisher's protected LSD was used for multiple comparisons ($\alpha = 0.05$).

2.2. Experiment 2: Grass Suppression by Grazing vs. Chemicals

The same three legume species (**Table 2**) were mixed and interseeded as previously described into endophyte-

Table 1. Monthly 30-year temperature and precipitation averages and departures from average for each location-year.

Item	Month	Mound valley			Parsons		
		30-year Average	Departure from average		30-year Average	Departure from average	
			2010	2011		2012	2013
Temperature, °C							
	March	7.7	-0.4	0.6	7.8	6.1	-4.4
	April	13.1	2.3	0.7	13.2	2.7	-3.9
	May	18.6	-0.4	-1.2	18.5	2.7	-1.7
	June	23.5	2.0	2.7	23.4	1.0	0.6
Precipitation, mm							
	March	88.1	-17.0	85.1	81.0	77.2	-51.3
	April	109.7	-70.6	19.1	111.3	122.4	-19.8
	May	167.6	-25.7	-45.2	150.6	-24.6	-4.1
	June	151.9	7.1	-107.7	140.5	-92.5	-77.7

Table 2. Legumes and rates (pure, live seed) interseeded into endophyte-infected tall fescue in 2010 and 2011, Mound Valley Unit, Southeast Agricultural Research Center.

Legume	Species	Cultivar	Seeding rate
			kg·ha ⁻¹
Red clover	<i>Trifolium pratense</i>	Cinnamon plus	16.8
Birdsfoot trefoil	<i>Lotus corniculatus</i>	Norcen	9.0
White (ladino) clover	<i>Trifolium repens</i>	Pinnacle	4.5

Table 3. Pesticide protection and fescue suppression treatments to enhance legume establishment in endophyte-infected tall fescue in 2010 and 2011, Mound Valley Unit, Southeast Agricultural Research Center.

Treatment	Material	Application	
		Date	Rate
			kg·ha ⁻¹
Pesticide	<i>Fungicide</i>		
	Mefenoxam-fludioxonil	Seed treatment	
	Pyraclostrobin foliar spray	May 21, 2010; May 24, 2011	0.16
	<i>Insecticide</i>		
Fescue suppression	Thiamethoxam	Seed treatment	
	Chlorpyrifos foliar spray	May 21, 2010; May 24, 2011	0.84
	Glyphosate	April 8, 2010; April 11, 2011	0.16
	Clipping	April 9, 29 and May 24, 2010; April 11 and May 17, 2011	---

infected tall fescue that had been managed as pasture, including fertilization, for >5 years at the Parsons Unit of the Southeast Agricultural Research Center (37°21.6'N, 95°17.3'W) on Parsons silt loam. Spring temperature and precipitation data for the location in 2012 and 2013 are listed in [Table 1](#). Plots (9.1 by 3.7 m) were seeded as previously described, in separate experiments on February 27, 2012, and March 15, 2013, with the cultivars and the rates listed ([Table 2](#)).

Suppression treatments were 1) grazing in lieu of clipping, 2) chemical suppression, and 3) an untreated check,

randomized in four blocks. Heifers (>225 kg) of primarily Angus breeding were excluded from treatments 2 and 3 with electric fence. Grazed plots were stocked intensively in 2012 from April 12 through May 16. In 2013, plots were grazed from April 22 through May 6 and again from May 17 through 28. Chemical suppression was provided with 0.14 kg/ha of clethodim on March 30 in 2012 and on April 19 in 2013.

In 2012, legume seedling counts were made on June 6, or 100 DAP, and in 2013, counts were taken on June 21, or 98 DAP. Legume seedling counts were taken randomly within a rectangle 76 cm long across the two center rows about midway through the plot length.

3. Results and Discussion

3.1. Experiment 1: Pest Control and Grass Suppression

Early spring moisture at Mound Valley in 2010 was lower than in 2011 and lower than the long-term average (Table 1). However, legume seedling density did not differ at ≥ 50 DAP between years, and no interaction between year and any treatment factor was detected, so two-year averages are shown. Legume species differed in seedling density, with red clover density greater ($P < 0.05$) than that of white clover and alfalfa (data not shown). The relative ability of red clover to establish was typical of most experiments (e.g., Guretzky *et al.* [14]) owing to the larger seed size of the short-term perennial.

There was a significant ($P < 0.01$) interaction among the three treatments, so means within legume, pest protection, and fescue suppression treatments are shown in Table 4. Red clover seedling density was initially higher than that of the other legumes (data not shown), but by 50 DAP, seedling density of some red clover treatments was no greater than that of a corresponding treatment of birdsfoot trefoil, and even of white clover when both were untreated.

Red clover seedling density was increased by protection with insecticide only when fescue was not suppressed. Grass suppression by glyphosate increased red clover density except where insecticide was used, and suppression by clipping increased density only when no pest protection was provided. The lack of treatment additivity could indicate some interaction between the legume and effects of the pesticide(s). Seedling density of birdsfoot trefoil and white clover seemed unaffected by pest protection or tall fescue suppression. In contrast, Cuomo *et al.* [12] found that suppression by glyphosate of cool-season grasses enabled much greater success in obtaining legume stands that included alfalfa, birdsfoot trefoil, red clover, and kura clover (*Trifolium ambiguum* M. Bieb.). Seguin *et al.* [13] also found that sod suppression by glyphosate or physical methods contributed to higher red, and particularly white, clover densities. The limited responses to suppression in this experiment may

Table 4. Two-year average seedling density of three legumes interseeded into tall fescue as affected by pest protection and fescue suppression.

Legume	Pest protection	Fescue suppression		
		None	Clip	Glyphosate
Seedlings m ⁻²				
Red clover	None	114	250	182
	Fungicide	163	160	226
	Insecticide	190	192	198
White clover	None	124	97	114
	Fungicide	114	89	104
	Insecticide	81	104	113
Birdsfoot trefoil	None	152	137	113
	Fungicide	120	172	118
	Insecticide	136	170	155

LSD_{0.05} = 58

relate to the lack of sufficient N to invigorate tall fescue growth [14]. An overall reduction in grass competitiveness was necessary at one site for physical grass suppression methods to equal chemical suppression [13]; thus, a recommendation for legume establishment without chemicals might be to reduce or eliminate N fertility or otherwise diminish the grass' energy reserves in the period prior to interseeding.

3.2. Grass Suppression by Grazing vs. Chemicals

The mean responses for legume seedling density to suppression treatments in 2012 and 2013 are shown by species, because legume \times treatment interactions were often significant (Table 5). Year \times treatment interactions were not significant ($P > 0.05$) for red clover or for birdsfoot trefoil. Red clover seedling densities were not significantly affected by treatment, whereas for birdsfoot trefoil, chemical suppression significantly increased seedling density compared with no treatment (the check) and grazing (Table 5).

White clover seedling density exhibited a year \times treatment interaction (Table 6). This occurred because the few seedlings found in 2012 resulted in no significant treatment difference, but the higher seedling density in 2013 resulted in significant differences. The two-year average seedling density in Table 5 with grass suppression appeared significantly better than the check. Seedling densities for the treatments by year (Table 6) indicate no difference because of largely unsuccessful establishment in 2012. In 2013, however, densities from chemical and grazed treatments were similar, but both were significantly ($P > 0.05$) greater than the check.

Seedling densities of red clover and birdsfoot trefoil were also much higher at ~ 100 DAP in 2013 than in 2012 (data not shown). Poor legume establishment in 2012 may have been related to the warmer, drier conditions in May and early June compared with those in 2013 and the long-term average (Table 1), emphasizing the role of environmental conditions at critical seedling stages.

4. Conclusions

The ability of red clover to establish stands with some grass competition, and with a less favorable environment compared with slower-establishing legumes, was demonstrated in these experiments, although the number of seedlings that survived in 2012 was less than 20% of those in 2013. A trend for lower establishment with grazing than chemical suppression could have resulted from treading or grazing damage [13]. This result suggests

Table 5. Average seedling density of three legumes from seedings in 2012 and 2013 as affected by tall fescue suppression by grazing or chemical treatments.

Suppression method	Red clover	White clover	Birdsfoot trefoil
	Seedlings m ⁻²		
No suppression	116	17	22
Grazed	87	46	30
Chemical	144	40	53
LSD _{0.05}	NS	23 ¹	18

¹Treatment \times year interaction significant ($P < 0.05$).

Table 6. White clover seedling density in tall fescue from seedings in 2012 and 2013 as affected by tall fescue suppression by grazing and herbicide treatments.

Suppression	Year	
Treatment	2012	2013
	Seedlings m ⁻²	
None	0	34
Grazed	1	93
Chemical	1	77
LSD _{0.05}	NS	28

that perhaps grazing should be terminated earlier for red clover than for the other species.

Birdsfoot trefoil establishment benefited more from the immediate, temporary effect of chemical treatment than from the more prolonged effects of grazing. This observation is consistent with observations that the species is most sensitive to grass competition at early seedling stages. The fact that white clover establishment was enabled at least as much by grazing as by chemical treatment may indicate that it benefited from the lengthier period of grass suppression provided by grazing and/or was less subject to grazing or treading damage than the other species.

When comparing species, establishment success should be interpreted differently for different species. Populations that could result in productive stands for grazing vary according to species' growth habits. For example, red clover, a biennial with an upright, bunch-type growth habit, may require a higher population to be acceptable than white clover, a perennial that can vegetatively propagate itself by stolons.

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