Pasture Recovery by Broadcast Seeding after Pugging Damage from Heifers

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Introduction

Many farmers in Ohio are utilizing grazing as a profitable and sustainable means of raising livestock. Having productive pastures is critical to a successful grazing operation. One limitation of grazing is that it must be managed according to the weather. Unlike confinement systems the climate is uncontrollable. Too much rain can cause pastures to become saturated and if cattle are in a wet area for an extended period of time they will cause severe pugging damage to the pasture. Pugging can be defined as the process of grazing animals penetrating the soil of a pasture with their hooves in wet conditions, causing direct damage to the plants as well as the soil structure (Nie *et al*. 2001). For a grazier, it is imperative that a pasture recover as quickly as possible after wet weather treading. Lost forage growth means lost production and lost profit. A 20-40% reduction in pasture utilization and 20-30% decline in pasture regrowth rate can be result of pugging damage (Horne 1987; Horne and Hooper 1990).

If a producer finds himself in a situation where he has a pugging damaged pasture, critical management decisions must be made. In making the decisions, the farmer must decide if the current forage species in the pasture are desirable or undesirable and also how soon the pasture will be needed again. If this pasture is composed of an undesirable species mix, this distressed condition could provide an opportunity to establish a new, more desirable species that would improve the pasture quality. However, if there is a high demand for the pasture to be back in the rotation soon, there is not time to kill the present forage and plant a new variety without severe loss of forage production.

Tall fescue (*Lolium arundinaceum*) is considered by many graziers to be an undesirable grass to graze. Presence of Endophyte, an intercellular fungus, in tall fescue as well as other palatability concerns have convinced many farmers to try to eliminate tall fescue from their pastures even though tall fescue is very hardy and productive in a variety of environments.

The objective of this study was to evaluate the feasibility of broadcast seeding new forage species into a predominantly tall fescue and white clover (*Trifolium repens*) pasture that had been recently damaged by pugging. Seven different forages were used and compared against a control. In addition, a cutting treatment was imposed on the pasture to compare the frequency of cutting on pasture quality. The pastures were evaluated for establishment of the new forages, speed of pasture recovery; pasture mass of the different forage varieties, and for nutritional composition.

Materials and Methods

The pasture on the Coe Farm (corner of Kenny and Ackerman) in Columbus, Ohio was used for this project. On May 1-2, 2004, 36 heifers were in a 0.5 ha paddock for 48 hours, the last 24 of which were under heavy rain. As a result the pasture suffered notable pugging damage.

A randomized complete block design with three replications was used to test the effects of seeding seven varieties of forages into the field five days later. The grid was laid out to have three rows of eight plots each (one for each treatment). The eight treatments were alfalfa (*Medicago sativa*), red clover (*Trifolium pratense*), birdsfoot trefoil (*Lotus corniculatus*), perennial ryegrass (*Lolium perenne*), chicory (*Cichorium intybus*), two varieties of orchardgrass (*Dactylis glomerata*), and a control. The control was treated the same as the other treatments except it had no seed broadcast into it. Each individual plot was 0.01 acres (11.2m x 3.7m). Within each of the three rows the treatments were randomly assigned to the eight cells in the row (**Diagram 1**). A typical field seeding rate was used for each forage (Ball, Hoveland, Lacefield 2004); this was converted to grams, and weighed out for broadcast seeding (**Table 1**). The seed was broadcast by hand into its assigned areas. Fertilizer was also applied according to soil tests obtained from the Animal Sciences 340: Management Intensive Grazing class. The fertilizer was 17-0-34 and was applied at a rate of 134 kg/ha. Each plot was then split in half and randomly assigned one of two cutting frequencies: tall or short (**Diagram 2**). The short treatment was cut twice as frequently as the tall half. A hand mower was used and the cutting height was approximately 3.5 inches.

Table 1. Seed species and seeding rates

Common Name	Scientific Name	Variety	Seeding Rate - lbs/ac (kg/ha)	Amount Used (g/0.01ac)
Alfalfa	*Medicago sativa*	Rugged	20 (22.44)	90.8
Birdsfoot Trefoil	*Lotus corniculatus*	Viking	6 (6.73)	27.24
Chicory	*Cichorium intybus*		8 (8.97)	36.32
Orchardgrass	*Dactylis glomerata*	Persist &	20 (22.44)	90.8
		Takena II	20 (22.44)	90.8
P. Ryegrass	*Lolium perenne*		25 (28.05)	113.5
Red Clover	*Trifolium pratense*	Starfire	12 (13.34)	54.48

A germination test was conducted to determine the viability of the seed being used (**Table 2**). Either a blotter or paper towel method was used accordingly. For each forage, two sets of 100 seeds were germinated for the assigned number of days and then all seeds that had begun to germinate were counted to determine a percentage from the 100 seeds.

Table 2. Germination Test		**Temperature**	**1st Check**	**2nd Check**
Forage/Variety	**Method**	**(Celcius)**	**(Days)**	**(Days)**
Alfalfa/Rugged	Blotter	20	4	7
Red Clover/Starfire	Blotter	20	4	7
Birdsfoot Trefoil/Viking	Blotter	20	5	12
Perennial Ryegrass	Paper Towel	15-25	5	14
Orchardgrass/Persist	Paper Towel	15-25	7	21
Orchardgrass/Takena II	Paper Towel	15-25	7	21
Chicory	Paper Towel	15-25	5	14

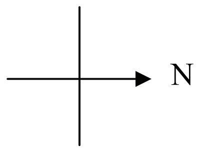
Once the seeded forages had time to fully emerge, establishment counts were taken to determine the number of plants/m^2. Plant populations were calculated by randomly tossing a 0.1 m^2 metal frame into each cell four times and counting the new forage plants within the frame each time. The twelve measurements (three replications with four measurements each) were averaged together to calculate the number of plants/m^2 for each forage treatment.

A nutritional analysis was performed on sample clipping taken in the fall. The 0.1 m^2 frame was used to randomly select four clipping from each cell. The three cells of each forage treatment were combined so that eight samples were submitted to the lab to be analyzed for nitrogen, macro minerals, ADF, and NDF.

Pasture mass was measured by using a rising plate meter. Differential mowing was performed from the spring of 2004 through the fall of 2004 with the last mowing coming in the middle of October when the entire pasture was mowed to the same level. The next spring the pasture was then left uncut until production measurements were taken on May 1, 2005 (one year to the day the heifers pugged the pasture). Measurements were taken with the rising plate meter to determine the height and density of the pasture. Seven random readings were taken in each half cell so that the cutting treatment as well as the forage treatment could be evaluated. In addition, a sample was cut and weighed to calibrate the rising plate meter so that the height (cm) could be converted into mass (kgDM/ha). Using the SAS System an analysis of variance was then performed on the data collected with the rising plate meter to determine the level of significance of the results.

Diagram 1

Pasture Renovation

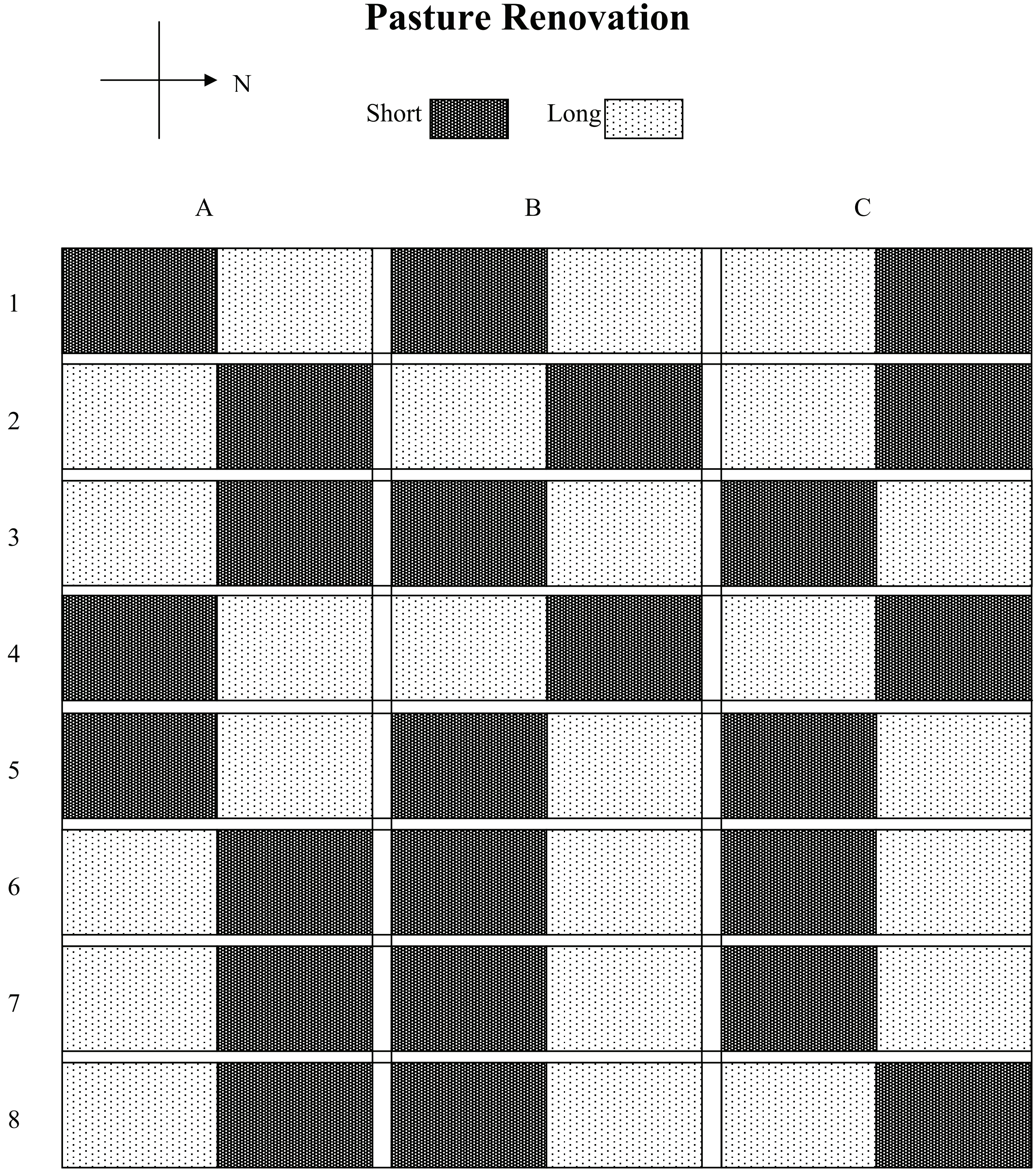


Each cell = 36.3 ft x 12 ft, thus = 0.01 ac

	A	B	C
1	Red Clover (Starfire)	Birdsfoot Trefoil (Viking)	Orchardgrass (Persist)
2	Chicory	Orchardgrass (Persist)	Control
3	Alfalfa (Rugged)	Control	Red Clover (Starfire)
4	Control	Alfalfa (Rugged)	Chicory
5	Perennial Ryegrass	Chicory	Birdsfoot Trefoil (Viking)
6	Birdsfoot Trefoil (Viking)	Red Clover (Starfire)	Orchardgrass (Takena II)
7	Orchardgrass (Takena II)	Perennial Ryegrass	Alfalfa (Rugged)
8	Orchardgrass (Persist)	Orchardgrass (Takena II)	Perennial Ryegrass

Diagram 2

Pasture Renovation



Results and Discussion

The results of the germination tests were mixed (**Table 3**). Some of the forage varieties did very well. Both the perennial ryegrass (95.5%) and alfalfa (94.5%) had near complete germination. Other forages that also did well were the orchardgrasses (Takena II – 76% and Persist – 70.5%) and the chicory (68.5%). The chicory had dramatically different results from the two tests. Finally, the red clover (31%) and birdsfoot trefoil both performed poorly. The seed used in this project was clearly ranging in germination performance which will directly affect the ability of the forage to establish itself in a competitive environment. The wide range in germination may be due to the seed's age. For example, red clover would be expected to germinate quickly and almost completely. However, the red clover seed that was used was taken from a lab where it may have been stored for an extended time period and had become less viable.

Table 3. Germination Emergence Counts

Results	Test	1st Check[1] (out of 100)	2nd Check[1] (out of 100)	Total (out of 100)	Average (%)
Alfalfa (Rugged)	1	90	4	94	94.5%
	2	92	3	95	
Red Clover (Starfire)	1	4	37	41	37.0%
	2	5	28	33	
Birdsfoot Trefoil (Viking)	1	24	8	32	31.0%
	2	26	4	30	
Perennial Ryegrass	1	81	13	94	95.5%
	2	90	7	97	
Orchardgrass (Persist)	1	72	0	72	70.5%
	2	69	0	69	
Orchardgrass (Takena II)	1	78	0	78	76.0%
	2	74	0	74	
Chicory	1	79	4	83	68.5%
	2	48	6	54	

[1] See Table 2 for number of days for 1st and 2nd check

Table 4. Establishment (plants/)

Forage	Mean (plants/m^2)
Alfalfa	115.42
Birdsfoot Trefoil	0.00
Chicory	50.00
Orchardgrass (Persist)	166.67
Orchardgrass (Takena II)	168.33
P. Ryegrass	214.17
Red Clover	16.25

Pasture recovery time was not affected by the broadcast seed. The control recovered just a fast as the other seven forage treatment methods, however new forage species were established using this method. The plant establishment counts were taken in early fall and represent the number of plants from each species that have established themselves in the competitive pasture environment (**Table 4**). The establishment rates were similar to the germination rates in that there was a wide range of results. The perennial ryegrass (214 plants/m^2), orchardgrasses (167 & 168 plants/m^2), and alfalfa (115 plants/m^2) were all found abundantly in the plots. The chicory (50 plants/m^2) was easy to spot. While it did not have as many plants present as the forages above, there also was not as many seeds sown because of its seeding rate (8.97 kg/ha) when compared to the grasses. Chicory is a bigger plant and needs more space so successful establishment of chicory would by nature have fewer plants per square meter when compared to grasses. Finally red clover (16 plants/m^2) was difficult to find and birdsfoot trefoil (0 plants/m^2) never was found.

The weight of each seed (seeds/lb) was obtained from the NRCS Plants Database website. This weight was used with the seeding rate to determine the number of seeds sown/m^2 in each forage treatment. The plants/m^2 was then divided by seeds/m^2 to obtain the percent of seeds that established themselves in the pasture environment (**Table 5**). The only change in rank from the establishment counts was alfalfa having a higher % seeds established than orchardgrasses, but the orchardgrasses had a greater number of plants/m^2 than alfalfa.

Table 5. Percent of Seeds Established

Forage	Mean (plants/m^2)	lb/ac	seeds/lb	seeds/m^2	% Seeds Established	% Germination
Alfalfa	115.42	20	226800	1121	10.30%	94.5%
B. Trefoil	0.00	6	369840	548	0.00%	31.0%
Chicory	50.00	8	426400	843	5.93%	68.5%
OG - Persist	166.67	20	427200	2111	7.89%	70.5%
OG - Takena II	168.33	20	427200	2111	7.97%	76.0%
P. Ryegrass	214.17	25	240400	1485	14.42%	95.5%
Red Clover	16.25	12	272160	807	2.01%	37.0%

The establishment counts were similar to the germination results in range and rank so a regression analysis was performed to determine the level of correlation between the two results. The analysis showed a medium-high level of correlation (r^2 = .6903) between the two measurements (**Graph 1**). We would expect better establishments from red clover and birdsfoot trefoil if a more viable seed was used.

Graph 1

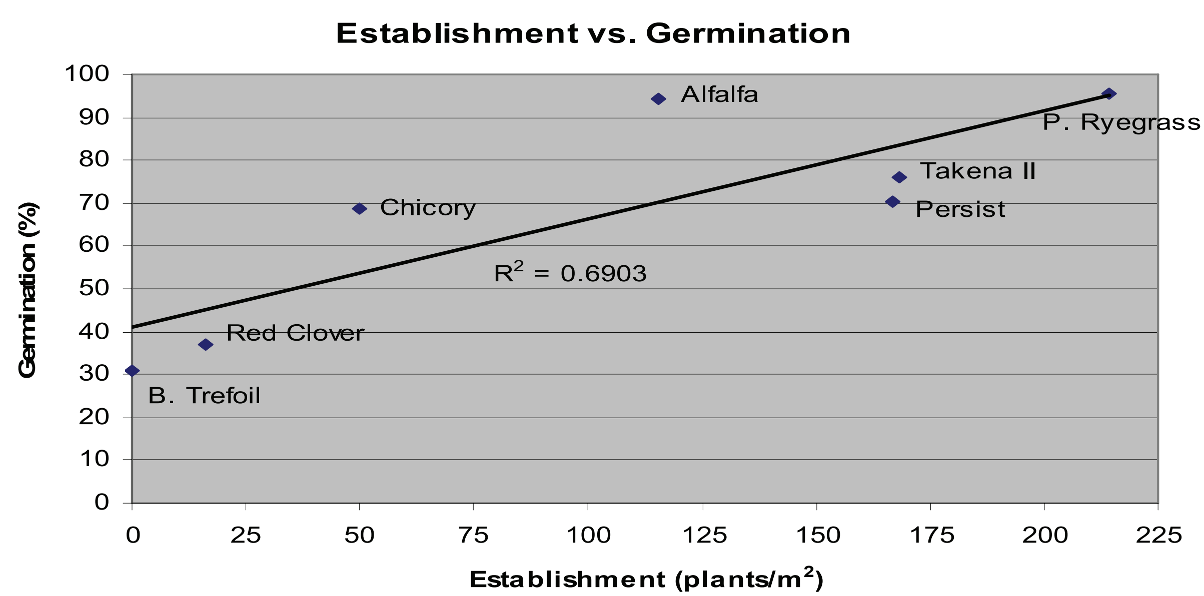


Table 6. Nutritional Analysis			
Forage	**% ADF**	**% NDF**	**%Crude Protein**
Control	25.38	48.50	19.253
Alfalfa	27.92	48.98	15.803
Red Clover	27.03	51.10	16.230
Birdsfoot Trefoil	26.74	54.70	16.979
Chicory	25.44	45.62	17.305
Perennial Ryegrass	23.06	46.28	18.301
Persist	27.20	50.58	16.946
Takena II	26.98	52.84	16.956

The results of the nutritional analysis were inconclusive (**Table 6**). There was a lack of consistency throughout the results. The control had the highest percent crude protein while the alfalfa had the lowest percent crude protein. Both of these where contradictory from what was expected. Likewise, the control (predominantly tall fescue) had the second lowest percent ADF and third lowest percent NDF. Furthermore, the birdsfoot trefoil treatment should have been very similar to the control since no trefoil was ever found in the experiment, but this was not reflected in the nutritional analysis. However, chicory was very low in percent NDF and relatively high in percent crude protein which is consistent with chicory's nutritional makeup. The results appear to show that the nutritional composition of the pasture was not altered. However, the results could also be an outcome of sampling time (samples were taken in late fall) or sampling error.

Table 7. Yield Results					
Treatment	**Cutting**	**Height (cm)**	**Difference**	**Mass (kg/ha)**	**Average**
Alfalfa	short long	38.3 36.6	1.7	7359 7026	7192
Birdsfoot Trefoil	short long	39.8 37.8	2.0	7640 7256	7448
Chicory	short long	38.5 37.3	1.3	7397 7154	7276
Control	short long	42.0 39.3	2.7	8063 7538	7800
Perennial Ryegrass	short long	43.4 37.3	6.1	8331 7154	7743
OG - (Persist)	short long	42.5 40.9	1.6	8165 7858	8012
Red Clover	short long	39.4 37.1	2.3	7564 7116	7340
OG - Takena II	short long	43.7 39.3	4.4	8395 7551	7973

The measurements taken with the rising plate meter the following spring had some significant results. **Table 7** shows the height in cm and corresponding mass in (kgDM/ha). The equation derived from the calibration test showed the conversion from height to mass to be: mass = 191.97(height). The difference in height between the short and tall cutting treatments (short cut twice as often as tall) showed that the short treatment had more height in each forage treatment. Also, the grasses had more production than did the legumes and forb. The two orchardgrasses had the top production (Persist - 8012 kgDM/ha and Takena II – 7973 kgDM/ha). This was followed by the control (7800 kgDM/ha) which is predominantly tall fescue. Also

Table 8. Cutting Treatment		
Cutting Frequency	**Height (cm)**	**Mass (kgDM/ha)**
Long	38.19	7332
Short	40.97	7864

showing high production was the perennial ryegrass with 7743 kgDM/ha. Interestingly, the birdsfoot trefoil treatment showed much lower production than the control (7448 kgDM/ha vs. 7800 kgDM/ha) even though no birdsfoot trefoil was ever found during the experiment making it essentially another control. Rounding out the bottom of the range was the red clover (7340 kgDM/ha), chicory (7276 kgDM/ha), and alfalfa (7192 kgDM/ha). Yet in each case, the short cutting treatment has a higher yield than the long cutting treatment. Therefore, the mean of all the short treatments is greater than the tall treatments (**Table 8**).

Table 9a. ANOVA - Dependent Variable: Mass					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	17	39011268.52	2294780.50	13.29	<.0001
Error	30	5179984.72	172666.16		
Corrected Total	47	44191253.24			

Table 9b.			
R-Square	**Coeff Var**	**Root MSE**	**Mass Mean**
0.882783	5.468946	415.5312	7598.013

Table 9c.					
Source	**DF**	**Type I SS**	**Mean Square**	**F Value**	**Pr > F**
Block	2	30143363.91	15071681.96	87.29	<.0001
Species	7	4386888.62	626698.37	3.63	0.0060
Cut	1	3405445.63	3405445.63	19.72	0.0001
Species*Cut	7	1075570.37	153652.91	0.89	0.5266

Table 9d. Means Separation Test					
Forage	**Mean (kgDM/ha)**	**Grouping[1]**			
Persist (Orchardgrass)	8011.5	A			
Takena II (Orchardgrass)	7973.2	A			
Control	7800.4	A	B		
Perennial Ryegrass	7742.8	A	B	C	
Birdsfoot Trefoil	7448.4		B	C	D
Red Clover	7339.7		B	C	D
Chicory	7275.7			C	D
Alfalfa	7192.5				D

[1] Means with the same letter are not significantly different

An analysis of variance was performed using with 0.05 as the level of significance to analyze the data from the rising plate meter (**Tables 9a-d**). There was a statistically significant difference in between the block, the forage treatment and the cutting treatment (**Table 9c**). **Table 9d** shows the forage treatment grouped by which treatments are significantly different from one another. With four different groups the treatments can be compared in several manners. Alfalfa had the lowest yield and this may be attributed to the fact that the frequent mowing did not allow enough time for the alfalfa to properly recover before being cut again. This is in contrast to the effect frequency of cutting had on the entire species mix. The cutting treatment, as stated above, shows that the difference between the short treatments yield over the long treatments is significant. Therefore pasture yield can be increased by frequent mowing. Finally, the significant difference between the blocks may be due to the slight slope on which the experimental block was laid out. The higher ground had a higher mass while the lower ground showed a lower mass.

Conclusion

The results of this study confirmed that broadcast seeding in a pugging damaged pasture is an effective way of establishing some new species mix into a predominantly tall fescue sward. Broadcast seeding is a simple and low cost method making it a quick and easy way for graziers to use. The success of this method was highly correlated with the seed's germination rate. Broadcast seeding did not improve pasture recovery time, but there were production differences between the forage treatments and the cutting treatments. The grasses out produced the legumes and forb. Maybe even more significant than that was the improved yield of the short cutting treatment over the long cutting treatment. It remains to be seen how much of this yield improvement was a result of the complete mowing of all plants versus the frequent cutting. This study showed no improvement in the nutritional composition of the pasture. Yet, while the nutritional composition of the pasture may not have changed, the overall species diversity certainly has improved. The new forages diluted the effect of the endophyte infected tall fescue. It remains to be seen what effect this method has on a pasture in the long-term. If the new species still persist after a couple years of grazing has yet to be measured. This method is not intended to completely eradicate the tall fescue from the pasture, but is a quick, inexpensive, and short-term solution to improve pasture quality through the establishment of desirable species within the existing species mix.

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