CHALLENGES AND BENEFITS OF INTERSEEDING LEGUMES INTO GRASS DOMINATED STANDS

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ABSTRACT

Interseeding legumes into grass-dominated stands can benefit pasture and hay producers by increasing the yield and quality of forage they produce and reducing their need for inputs of nitrogen fertilizer. The challenge is to get the legumes established given the competition from existing vegetation. This study confirmed that suppressing the grasses with glyphosate prior to seeding results in the most consistent legume establishment. Close mowing to simulate heavy grazing generally did not result in improved establishment. Of the 5 legumes evaluated, alfalfa established the best in the glyphosate treatment in Colorado, increasing yield by over a ton per acre. In Idaho, establishment was more variable with red clover establishing well regardless of suppression treatment. No legumes established at the Oregon site due to heavy rodent activity. This study highlighted the importance of suppressing the existing grasses and choosing a vigorous legume species for interseeding to reduce the risk of seeding failure.

Key Words: interseeding, sod-seeding, no-till seeding, alfalfa, birdsfoot trefoil, red clover, sainfoin, white clover

INTRODUCTION

Many producers that manage grass-dominated pastures and hayfields are seeking information on how to successfully interseed various types of legumes into their stands in an effort to improve both the quantity and quality of forage they produce. The main driving force behind their increased interest in interseeding has to do with the rising price of nitrogen fertilizers in recent years. Legumes are an attractive option to fertilizer due to their ability to fix atmospheric nitrogen through a symbiotic relationship with bacteria that infect the roots forming nodules. As the nodules slough off and decay over time, some of the nitrogen that has been fixed is released for uptake by the associated grasses. Just like adding nitrogen fertilizer, the added nitrogen from the decaying nodules can increase the yield and protein content of the grasses.

Interseeding legumes into grass stands can also significantly improve forage quality since legumes are typically higher in crude protein content and digestibility compared to grasses. In addition, total productivity often increases because the root systems of many legumes (e.g. taprooted species like alfalfa and red clover) occupy a different part of the soil profile, exploiting water and nutrients that would otherwise not be utilized by the grasses. The broad leaves of

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legumes also help to increase capture of incoming solar radiation, especially in a grazing situation where plants are kept much shorter compared to a grass hayfield that is only harvested 2 or 3 times per year.

So, if legumes are so great, why aren't more producers interseeding them into their grass pastures and hayfields? One of the big reasons is that the risk of failure is higher compared to complete renovation with conventional tillage and seedbed preparation. Grasses that are well-established compete very effectively for water, nutrients, light, and space. Competition from the grasses is compounded by the fact that many forage legumes have weak seedling vigor. Even when interseeded legumes do establish, it often takes 2 to 3 years before they reach full productivity due to competition from the grasses. Many producers just aren't willing to take the risk and/or don't have the patience to wait 3 years for the legumes to fully establish.

Interseeding of new species into existing stands is not a new practice. In its simplest form, seeds of a desired forage species were collected and hand broadcast across pastures or hayfields. Ranchers in the Gunnison Basin of Colorado tell of hanging burlap under their hay sleds during winter feeding to collect clover and grass seeds that fell through the slats of the sled. The seed was periodically collected and then hand broadcast across their hay meadows in the spring. Over time (i.e. years), they were able to successfully increase the amount of red and alsike clover in their meadows. The advent of today's broadcast spreaders has made it much easier to achieve more even distribution of seed. Even with these advances in seed distribution, the percent of plants that actually establish following this type of interseeding (also referred to as overseeding when the seed is broadcast) is very small. Numerous studies have been conducted comparing the establishment success of broadcasting versus drilling the seed and drilling is almost always superior to broadcasting. The problem with drilling is finding access to a drill that is heavy enough to penetrate the established sod without placing the seed too deep.

There are numerous types of drills available from various manufacturers that will effectively interseed into existing grass stands. For most producers, these drills are too expensive and not used often enough to warrant owning. The best option is to either lease a drill or hire someone that does commercial seeding. Even when using an appropriate drill, competition from the existing grasses is still an issue that often leads to poor establishment of the seeded species. To improve establishment success, the existing grasses need to be suppressed prior to drill seeding. Even though previous studies have shown the importance of suppressing the existing vegetation prior to seeding, most producers are reluctant to do so and opt for direct interseeding. They then dismiss interseeding as a viable method of improving their pastures and hayfields because of poor establishment of the seeded species.

In an effort to demonstrate interseeding methods to producers, small plot studies were initiated in Colorado, Idaho, and Oregon to evaluate the establishment success of various legume species, including alfalfa, birdsfoot trefoil, red clover, white clover, and sainfoin, interseeded into grass dominated pastures and hayfields, with and without suppression of the existing vegetation.

METHODS

This study was conducted in cooperation with 3 producers at sites located near Fort Collins, CO, Kimberly, ID, and Klamath Falls, OR. The Colorado site is flood irrigated from gated pipe and is dominated by orchardgrass, meadow brome, and smooth brome with minor amounts of tall fescue and perennial ryegrass. There were no existing legumes in the stand. The Idaho site is irrigated with a pivot sprinkler and is dominated by orchardgrass with minor amounts of smooth brome, perennial ryegrass, and Kentucky bluegrass. There were some existing white clover and alfalfa plants (<10%) in the stand. The Oregon site is characteristic of a mountain meadow dominated by meadow foxtail and Kentucky bluegrass. It is flood irrigated and there were no existing legumes present.

A randomized complete block design with 4 replications was utilized at each site. Five legume species were tested: 'Rugged' alfalfa @ 8 lbs PLS/ac, 'Norcen' birdsfoot trefoil @ 6 lbs PLS/ac, 'Shoshone' sainfoin @ 18 lbs PLS/ac, 'Starfire' red clover @ 5 lbs PLS/ac, and 'Kopu II' white clover @ 3 lbs PLS/ac. Each legume was interseeded into plots treated in the following manner: no suppression (seeded directly into the existing vegetation), mowed to a 2 inch stubble height just prior to seeding to simulate close spring grazing, and sprayed with glyphosate herbicide at 1 qt/ac 2 weeks prior to seeding when existing vegetation had 4 to 6 inches of new growth. To evaluate the effectiveness of interseeding the various legumes, two types of controls were included: no fertilizer/no seed and nitrogen fertilizer applied at 80 lbs N/ac in the spring and 40 lbs N/ac after the first harvest (if harvested twice). Plot size was 6 by 20 ft.

All legume seed was inoculated with the appropriate *Rhizobium* bacteria prior to planting to insure nodulation. At the Colorado and Oregon sites, planting was done with a 5.6 ft. wide no-till drill equipped with double-disk openers and leading coulters (Model 3P605NT, Great Plains Mfg., Inc., Salina, KS). For seeding small plots, the drill was fitted with a cone seeder attachment (Kincaid Equipment Mfg., Haven, KS). At the Idaho site, a modified John Deere Powr-till drill was used for seeding. It was modified by reducing the width from 8 to 5.3 ft. and adding a cone seeder attachment. Legumes were interseeded in late May or early June of 2010 at all 3 sites.

Plots were harvested either once or twice in 2010 based on the normal practice for each location. The legumes did not reach sufficient size in 2010 to contribute to yield or quality. In May of 2011, success of legume establishment was measured at each site using a frequency grid method (Vogel and Masters 2001). Presence or absence of the seeded legume was determined in 2, 25-grid frames per plot and the counts converted to percent frequency. In 2011, yields were taken once in Colorado (July 2) and twice in Idaho (July 7 and Oct. 4). Yields were not taken in Oregon due to poor legume establishment resulting from a major infestation of meadow voles. Forage quality will be determined using near infrared reflectance (NIR).

RESULTS AND DISCUSSION

One of the biggest challenges that must be overcome when interseeding legumes into established grass stands is competition from the existing vegetation. There are numerous methods that can be used to suppress the existing grasses. The method that has given the most consistent results is

spraying the grasses with a sublethal rate of glyphosate herbicide. Choosing the rate to use is always a tricky proposition. Too light and you don't get adequate suppression and too heavy results in many of the grasses being killed. Experience has shown that most of the common pasture and hay grasses such as orchardgrass, smooth brome, meadow brome, and tall fescue recover rather quickly following application of glyphosate at sublethal rates. Kentucky bluegrass is one grass that is easily killed with even light rates of glyphosate.

Timing of application of the glyphosate can also impact the results. Spring application and seeding are very common. The grasses tend to be more tolerant of glyphosate applied at this time of year because the plants are not storing carbohydrates. The glyphosate will burn the tops but will not be translocated into the root system killing the plants. Fall application of glyphosate at equivalent or lighter rates compared to the spring tends to have a more severe impact on the grasses because both carbohydrates and the herbicide get translocated into the root system. It is not uncommon for almost 100% of the grasses to be killed with a fall application of glyphosate.

Besides glyphosate, paraquat herbicide has been used to suppress existing grasses prior to interseeding. This herbicide is less effective because it only burns the tops of the grasses off for a short period of time. They tend to recover too quickly and compete with the emerging legume seedlings. Other methods that have been tried include close mowing just prior to seeding using a rotary or flail-type mower, shallow disking or rototilling, and heavy grazing up until the time of seedling emergence. Producers are reluctant to use the more aggressive suppression methods such as glyphosate because they must sacrifice some of their pasture or hay crop during the establishment year. They prefer to use heavy grazing because their livestock benefit from the forage, but just like the results from using paraquat, the grasses tend to recover too quickly.

In this study, we chose to look at glyphosate since it is generally the most successful suppression treatment, close mowing to simulate heavy grazing because producers are really interested in that approach, and direct interseeding. Based on frequency measurements taken in the spring of 2011, suppression of the existing grasses with glyphosate was the only treatment that allowed for establishment of all 5 legume species at the Colorado site (Table 1). Alfalfa was the most successful with a frequency of 73% in the glyphosate treatment. Birdsfoot trefoil, red clover, and sainfoin were intermediate with an average frequency of 33%. Even though white clover had the lowest frequency of occurrence, it will be able to spread over time due to its stoloniferous growth habit.

Unlike the Colorado site, results from Idaho were more variable (Table 1). Glyphosate did not stand out as the best suppression treatment. Averaged across legume species, frequency of occurrence was essentially the same between direct interseeding and suppression with glyphosate. Red clover and birdsfoot trefoil established well in the direct seeded plots with an average frequency of 33%. In the mowed plots, red and white clover established well. Alfalfa and red clover performed the best in the glyphosate treated plots. Red clover was definitely the most vigorous of the legumes seeded at the Idaho site, establishing well in all 3 suppression treatments with an overall average frequency of 39%.

A possible reason for the differential response among suppression treatments at Idaho compared to Colorado was that a different type of interseeding drill was used. Although the John Deere

Table 1. Frequency of occurrence (%) of 5 legume species following direct interseeding into grass-dominated stands (no suppression) or stands that had been suppressed with either glyphosate herbicide or close mowing. Suppression treatments and legume interseeding occurred in the spring of 2010 at sites near Fort Collins, Colorado and Kimberly, Idaho. Frequency measurements were taken at green-up in the spring of 2011.

Species	No Suppression	Mow	Glyphosate	Mean
		Colorado (%)		
Alfalfa	4.0	1.0	73.0	26.0
Birdsfoot Trefoil	0.0	0.0	29.0	9.7
Red Clover	0.5	0.0	37.0	12.5
Sainfoin	0.0	0.0	33.5	11.2
White Clover	0.0	0.0	15.0	5.0
Mean	0.9	0.2	37.5	
		Idaho (%)		
Alfalfa	6.5	3.0	27.0	12.2
Birdsfoot Trefoil	31.3	4.0	2.5	12.6
Red Clover	34.0	34.0	49.0	39.0
Sainfoin	9.0	4.5	19.5	11.0
White Clover	16.0	23.0	6.7	15.2
Mean	19.4	13.7	20.9	

Powr-till drill does not disturb a lot of the existing vegetation, it does remove some of the roots in a narrow band (~3/4 of an inch) that the seed is dropped into. A double-disk opener drill with leading coulters like the Great Plains only slice the sod which has little effect on suppressing the existing vegetation.

Although there were no legumes that survived at the Oregon site in the replicated small plot trial, there were some that did survive in an adjacent larger-scale demonstration area. In the glyphosate treated area, birdsfoot trefoil stood out as the best with a frequency of occurrence of 30%. Only minor amounts of alfalfa (2%) and white clover (3.5%) were present. Red clover was present but did not show up in any of the frames. In the mowed area, only minor amounts of white clover (2%) and birdsfoot trefoil (4%) were present. Unlike the small plot area, this area was exposed to grazing during the establishment year. Although grazing with its associated hoof action can lead to injury and death of seedlings, it also keeps the overstory shorter which reduces light competition. Legume seedlings become spindly and yellow if they are under light stress for too long. Seedlings in this condition are very tender and often die once the overstory is removed and they are exposed to harsher environmental conditions.

The main benefits of interseeding legumes into grass-dominated stands are increased forage yield and quality and a reduced need to apply nitrogen fertilizer. At the Colorado site, very few legumes established in the direct seeded or mowed treatments (Table 1) and this was reflected by no increase in yield (Table 2). Alfalfa established well in the glyphosate treatment and increased yield by over 2000 lbs/ac compared to the unfertilized control. The grass-alfalfa mix even out yielded the control fertilized with 80 lbs N/ac by over 700 lbs/ac. Red and white clover and birdsfoot trefoil that established in the glyphosate treated plots had an intermediate effect on yield falling between the unfertilized and fertilized controls. Even though sainfoin established

well in the glyphosate plots (Table 1), the plants were small, did not compete well with the grasses, and did not contribute to total yield.

As discussed earlier, establishment of the various legumes in relationship to the suppression treatments was quite variable at the Idaho site (Table 1). Red clover established well across all 3 suppression treatments and this was reflected by increased yield in those plots. In the glyphosate

Table 2. Total seasonal yield (lbs/ac) of 5 legume species following direct interseeding into grass-dominated stands (no suppression) or stands that had been suppressed with either glyphosate herbicide or close mowing. Suppression treatments and legume interseeding occurred in the spring of 2010 at sites near Fort Collins, Colorado and Kimberly, Idaho. Yield measurements were taken in 2011 for 1 harvest in Colorado and 2 harvests in Idaho. A control with no interseeding and no fertilization plus a nitrogen fertilized control were included for comparison.

Species	No Suppression	Mow	Glyphosate	Mean
	Colorado (lbs/ac)			
Control				1091
Fertilized				2527
Alfalfa	1391	1007	3243	1880
Birdsfoot Trefoil	1398	1394	1756	1516
Red Clover	1063	989	2204	1418
Sainfoin	891	744	1124	919
White Clover	1177	1075	1498	1250
Mean	1184	1042	1965	
	Idaho (lbs/ac)			
Control				4025
Fertilized				3438[a]
Alfalfa	3564	3558	4324	3815
Birdsfoot Trefoil	3786	4289	4097	4057
Red Clover	5073	4774	5666	5171
Sainfoin	3815	3276	4241	3778
White Clover	4247	3797	3702	3915
Mean	4097	3939	4406	

[a]Plot was not fertilized in 2011.

treatment, the grass-red clover mix yielded over 1600 lbs/ac more forage compared to the unfertilized control. Generally, the better a particular legume established, the greater the impact on total yield. Just like at the Colorado site, sainfoin did not perform well at the Idaho site.

At the time this paper was written, forage quality analyses had not been completed, but we anticipate a significant increase in quality in those treatments where the legumes established well. Brummer (1999) found that interseeded birdsfoot trefoil increased crude protein content of mountain meadow hay by 3 percentage points (from 7.5 to 10.5%) when it made up about 25% of the composition.

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