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PRINCIPLES OF FORAGE LEGUME MANAGEMENT

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MANAGING LEGUME AND LEGUME-GRASS MIXTURES

Managing Pure Legume Stands

Forage legumes are planted in pure stands for seed production or to maximize legume forage production and N_2-fixation as a green manure or winter cover crop. A soil analysis should be done to determine what nutrients and how much are required and if lime is needed to raise the soil pH. Nitrogen fertilizer should never be applied to a pure legume stand since it will reduce N_2-fixation and increase weed competition.

The main management problem with a pure legume stand is usually weeds. Preplant herbicides cleared for clovers are Balan and Eptam which must be incorporated into the soil and therefore can only be used in prepared seedbed situations. Both are phytotoxic to annual grasses and cannot be used for clover-grass mixtures. The only postemergence herbicides cleared for use on forage legumes, other than alfalfa, are 2,4-DB and Kerb. Legumes should have 2 to 4 trifoliate leaves and broadleaf weeds must be less than 3 in. tall to use 2,4-DB. Even then, 2,4-DB may cause some temporary stunting of seedlings. Kerb contols some broadleaf weeds and some annual grasses including annual ryegrass and small grains. Therefore it should only be used on pure legume stands. All herbicides cleared for clovers can be used on alfalfa in addition to duiron, metribuzin, poast, pursuit, sinbar, trifluralin, and velpar. More herbicides are available for alfalfa because of the large alfalfa acreage and the regular use of herbicides to establish alfalfa. Grazing can also be used to keep weeds under control. Livestock will eat most weeds when they are young. Having good thick legume stands from planting the recommended seeding rate on a clean, firm seedbed will help reduce weed problems.

When a cool-season annual legume is over seeded on a warm-season perennial grass the growing seasons overlap during April and May. Any limiting plant nutrients except nitrogen should be applied about November 1 when daily low temperatures stop warm-season grass growth. Beginning in late March it is important to keep the legume grazed to a 3 to 5-in. height so sunlight can penetrate the plant canopy to stimulate growth of the warm-season grass. If the legume is not kept short in spring, early summer production of the perennial grass will be severely reduced. If soil moisture is low in late spring, grass recovery will be very slow. With crimson clover, some producers apply about 60 lb/acre of nitrogen fertilizer as the clover begins to flower to stimulate grass growth. A mixture of clover and grass is harvested for hay. No additional nitrogen is applied for a second hay cutting because nitrogen is available from the decaying legume roots and stubble.

Managing Legume-Grass Mixtures

Management of a legume-grass mixture requires an understanding of how legumes grow. The objective is to try to maintain an equal balance of legume and grass during the growing season. A general consensus is that a minimum of about 35% legume is necessary for the legume to make a significant contribution of forage and nitrogen.

A well nodulated legume can obtain nitrogen from the air or soil. Grass is completely dependent on the soil nitrogen. In a legume-grass mixture the legume will have the competitive edge as long as soil nitrogen is limited. Applying nitrogen fertilizer to a legume-grass mixture will stimulate growth of the grass. If sufficient nitrogen is applied, the grass will shade out the legume to the point where it will be substantially reduced or eliminated from the mixture.

Although legumes are planted in autumn, from 75 to 90% of the total forage production occurs in the spring. The challenge to the producer is to provide enough nitrogen for the grass to produce forage in the fall and winter while maintaining the legume stand for spring forage production. No nitrogen should be applied after March 1 since spring is the major legume-growing period. The producer has two management tools to control the percent legume in a mixture; rate and time of nitrogen fertilizer application and height of the pasture sward.

A study to demonstrate the influence of timing and number of nitrogen fertilizer applications to a crimson clover-annual ryegrass mixture was conducted for two growing seasons at the Texas A&M University Agricultural Research and Extension Center at Overton. Three rates of nitrogen were applied at planting or about four weeks later when the clover seedling had reached the first true leaf stage. Additional nitrogen was applied in January to most of the treatments. A pure stand of annual ryegrass with and without nitrogen fertilizer and a pure stand of crimson clover were also included. The studies were harvested in early March.

As expected, clover yields were low during the fall and winter with dry matter yields ranging from 286 to 582 lb/acre (Table 1). The lowest clover yields were in the pure clover stand and the mixture with no nitrogen and the highest clover yields were where nitrogen was applied only in January or at planting and in January. This implies that crimson clover did respond to nitrogen fertilizer, especially to that applied in January. The N_2-fixation process is sensitive to temperature and therefore probably reduced by the low winter temperatures. Ryegrass was more responsive to nitrogen. The importance of nitrogen for fall and winter grass production is demonstrated by yields of less than 100 lb/acre when no nitrogen was applied in a pure ryegrass stand or the mixture. The trend was for ryegrass production to increase as the total amount of nitrogen increased. Ryegrass yields were low in treatments that received no nitrogen in January.

The combined yield of clover and ryegrass by early March was lowest for the no nitrogen treatment that was similar to the pure clover stand (Table 1). But it was three to five times greater than ryegrass alone with no nitrogen. Applying nitrogen in January had the greatest impact on combined yields. Applying 60 lb nitrogen only in January produced yields equal to those where up to 150 lb of nitrogen was applied. Pounds of forage produced per pound of nitrogen fertilizer applied were calculated by subtracting the clover-ryegrass yield without nitrogen from the other treatments. The yield difference was divided by the pounds of nitrogen applied in each treatment. The greatest production per pound of nitrogen applied was when 60 lb nitrogen was applied in January.

Clover production during the spring was the greatest when planted in a pure stand or mixed with ryegrass without nitrogen fertilizer (Table 2). Spring clover yields tended to decrease as the amount of nitrogen fertilizer applied increased. Ryegrass yields were the greatest with a pure stand of ryegrass with 180 lb N/acre and the lowest where no nitrogen was applied in January. Comparing the total spring yields, the clover-ryegrass with no nitrogen produced as much forage as the pure stand of ryegrass with 180 lb of nitrogen.

Yields for the entire growing season are reported in Table 3. Other than the pure ryegrass stand with no nitrogen, clover-ryegrass with no nitrogen or only 60 lb nitrogen at the first true clover leaf stage were the least productive. The greatest clover-ryegrass yields occurred with 30 to 90 lb N at planting or first true clover leaf stage followed by 60 lb N in January and March. These treatments had higher yields than the pure ryegrass with 180 lb N. The most efficient use of nitrogen fertilizer was 7 lb forage was produced per lb nitrogen applied when clover-ryegrass was fertilized with 60 lb N in January and March with or without 30 lb N at planting. This was twice the response of applying N to a pure stand of ryegrass. The percent clover at the last harvest shows the decrease in clover as the amount of N applied increased.

Overseeded clover-ryegrass may not receive any N or up to two applications, depending on the amount of early forage production needed. Without N, sufficient forage for grazing is not available until February or early March, depending on location. Most efficient use of N fertilizer was with 60 lb N in January and March. Phosphorus and potassium should be applied at planting or shortly after planting. The most economical fertilization program is probably a single N application in December or January to enhance ryegrass production during the winter when there is very little clover growth. In this scenario, sufficient forage for grazing should be available in January or February.

Pasture height in late fall and winter should not exceed 5 to 6 in. to avoid shading of the legume. In northeast Texas, grass production is limited by low temperatures in January and

February. However, the tendency for producers is to accumulate 8 to 10 in. of growth before grazing to have sufficient forage during the winter. This would eliminate most legume plants from the mixture. If maximum forage production is the objective, an all grass pasture with high rates of nitrogen fertilizer would be the better option. The legume-grass mixture with limited nitrogen fertilizer will be less productive and have a lower carrying capacity but will have a lower cost per animal unit or pound of gain.

Summer Grass Recovery

Management practices such as a light disking and grazing or mowing the summer grass short enhances early forage production of overseeded winter forages. However, these same practices slow down the spring recovery of the warm-seasonal perennial grass. A three-year study at the TAMU Agricultural Research and Extension Center at Overton has shown that the autumn sod treatments hindered Coastal bermudagrass recovery even if not overseeded (Table 4). Disking reduced bermudagrass yields by an average of 600 to 700 lb/acre through mid to late June. Mowing the bermudagrass sod to a 1-in.vs 4-in. sod height reduced yields an average of 500 lb/acre when overseeded with clover, 250 lb/acre when overseeded with ryegrass or not overseeded. However, Coastal bermudagrass not overseeded was overgrown with winter weeds that hindered early bermudagrass growth.

Hay meadows that are managed for 3 to 6 cuttings a year should not be overseeded because of the reduction in early forage production that eliminates a May hay cutting. If only two hay cuttings are normally required there should be no major problems with overseeding. Another option is to use other pastures besides hay meadows for overseeded winter pasture.

Table 1. Influence of N rate and application time on fall and winter forage production of crimson clover-annual ryegrass mixture and pure ryegrass (2 yr. avg., Evers and Haby).

N application				Fall and winter yield			
Oct.	Nov.	Jan.	Total	Clover	Ryegrass	Total	lb forage per lb N
---lb/acre---							
Crimson clover-annual ryegrass							
0	0	0	0	318 cd†	91 g	408 de	--
0	0	60	60	582 a	425 ef	1007 ab	10.0
30	0	60	90	458 a-c	606 cd	1064 ab	7.3
60	0	60	120	492 ab	633 b-d	1126 ab	6.0
90	0	60	150	481 ab	782 ab	1263 a	5.7
0	30	60	90	438 a-d	543 de	981 b	6.4
0	60	60	120	383 b-d	595 c-d	978 b	4.8
0	90	60	150	374 b-d	718 bc	1092 ab	4.6
0	60	0	60	355 b-d	307 f	662 cd	4.3
0	60	60	120	357 b-d	753 a-c	1110 ab	5.9
Clover alone							
0	0	0	0	286 d	2 g	288 ef	
Annual ryegrass alone							
0	0	0	0	0 e	79 g	79 f	--
60	0	60	120	0 e	888 a	888 bc	4.0

†Yields within a column followed by the same letter are not significantly different at the 0.05 level, Fisher's protected LSD.

Table 2. Influence of nitrogen rate and application time on spring production of ryegrass-crimson clover mixtures, clover alone, and ryegrass alone (2 yr. avg., Evers and Haby).

N applied					Spring yield		
Oct.	Nov.	Jan.	Mar.	Total	Clover	Ryegrass	Total
lb/acre							
Ryegrass-Crimson Clover							
0	0	0	0	0	1994 a†	328 e	2322 de
0	0	60	60	120	1137 c	1425 c	2562 bc
30	0	60	60	150	1066 cd	1694 bc	2760 ab
60	0	60	60	180	854 de	1793 b	2647ab
90	0	60	60	210	881 de	1928 b	2810 a
0	30	60	60	150	818 e	1869 b	2687 ab
0	60	60	60	180	884 de	1864 b	2748 ab
0	90	60	60	210	740 e	1806 b	2546 b-d
0	60	0	0	60	1468 b	797 d	2266 e
0	60	60	0	120	928 c-e	1454 c	2381 c-e
Clover alone							
0	0	0	0	0	2183 a	8 f	2191 e
Ryegrass alone							
0	0	0	0	0	0 f	510 de	510 f
60	0	60	60	180	0 f	2373 a	2373 c-e

†Values within a column followed by the same letter are not significantly different at the 0.05 level, Fisher's protected LSD test.

Table 3. Forage produced per pound nitrogen applied by early March and for the total growing season (2 yr. avg., Evers and Haby).

N applied					Yield			lb forage	% clover last cut
Oct.	Nov.	Jan.	Mar.	Total	Clover	Ryegrass	Total	per lb N	
---lb/acre---									
					Crimson-Ryegrass				
0	0	0	0	0	2312 a†	418 f	2730 ef	--	86
0	0	60	60	120	1719 bc	1851 d	3569 bc	7.0	44
30	0	60	60	150	1524 cd	2300 c	3824 ab	7.3	48
60	0	60	60	180	1347 de	2426 bc	3773 ab	5.6	32
90	0	60	60	210	1362 de	2711 b	4073 a	6.4	31
0	30	60	60	150	1256 de	2412 bc	3668 b	6.3	63
0	60	60	60	180	1267 de	2459 bc	3726 ab	5.5	32
0	90	60	60	210	1115 e	2524 bc	3638 b	4.3	29
0	60	0	0	60	1823 b	1104 e	2928 de	3.3	65
0	60	60	0	120	1284 de	2207 cd	3491 bc	6.3	39
					Clover alone				
0	0	0	0	0	2469 a	10 g	2479 f	--	100
					Ryegrass alone				
0	0	0	0	0	0 f	589 f	589 g	--	0
60	0	60	60	180	0 f	3261 a	3261 cd	3.0	0

†Values in a column followed by the same letter are not significantly different at the 0.05 level, Fisher's protected LSD.

Table 4. Recovery of Coastal bermudagrass following fall sod treatments (1 vs. 4 in. tall sod, control vs. disking) and overseeding of arrowleaf clover, crimson clover, ryegrass, or not overseeding at Overton (3 year mean).

	Bermudagrass sod height when overseeded					
	1 in.	4 in.	Mean	1 in.	4 in.	Mean
	----------------Early summer Coastal bermudagrass production (lb/acre)----------					
	Arrowleaf overseeded			Crimson overseeded		
Control	1459	2069	1764†	870	2492	2181
Light disking	906	1263	1085	1466	1718	1592
Mean	1183	1666		1668	2105	
	Ryegrass overseeded			Not overseeded		
Control	1522	1778	1650	1989	2260	2125
Light disking	887	1142	1015	1407	1602	1505
Mean	1205	1460		1698	1931	

†All means between treatments significantly different at the 0.05 level, $P<0.001$.