Fertilizer Experiments with Tall Fescue and White Clover in Alabama



BULLETIN 559 JUNE 1984

ALABAMA AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY
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FIRST PRINTING 3M, JUNE 1984

FERTILIZER EXPERIMENTS WITH TALL FESCUE AND WHITE CLOVER IN ALABAMA

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INTRODUCTION

TALL FESCUE is grown on more than 800,000 acres in Alabama and is the dominant pasture grass in the northern one-fourth of the State. It is easily managed and persists well on the wide range of soils that occur in northern Alabama. The variety that is grown on almost all of these acres is Kentucky 31.

White clover is often interplanted with tall fescue. Clover improves the quality of the forage and serves as a substitute for nitrogen fertilizer for the grass. The fertilizer needs of tall fescue and white clover for high forage production are usually different.

Producing high yields of a good-quality forage from tall fescue requires the timely application of optimum rates of nitrogen, phosphorus, and potassium fertilizers. Proper fertilization practices are critical for maintaining adequate clover in a fescue pasture. Too much nitrogen will encourage take-over by the grass; too little phosphorus or potassium will encourage encroachment and take-over by fescue and weeds.

There have been a few nitrogen rate experiments with fescue and fescue-clover mixtures in the Southeast, but none in Alabama. Even fewer experiments have included phosphorus and potassium rates. To obtain fertilizer-response data under Alabama conditions, field experiments were established at

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three different sites. One experiment was located on the Plant Breeding Unit of the Alabama Agricultural Experiment Station near Tallassee, Alabama. In this test, rates of nitrogen (N) were compared on two tall fescue varieties, Kentucky 31 and AU Triumph. Two other experiments were established in farmers' pastures in northern Alabama (Madison and Morgan counties). These compared rates of N, rates of phosphorus (P_2O_5), and rates of potassium (K_2O) fertilizers on Kentucky 31 tall fescue, alone and in combination with Regal white clover. Results of these three experiments are presented in this report.

N RATES FOR KENTUCKY 31 AND AU TRIUMPH TALL FESCUE

This experiment with tall fescue was conducted at the Plant Breeding Unit on a Cahaba fine sandy loam with a pH of 6.2 which tested High in phosphorus (P) and High in potassium (K). Auburn's Soil Testing Laboratory recommended no lime and no P_2O_5 or K_2O fertilizer. The experiment was conducted for 2 years, 1978-79.

PROCEDURES

Before establishing the experiment, the entire test area was rotary tilled. Plots measuring 4 × 20 feet were arranged in a completely randomized block with four replications. Each plot was planted to eight rows, 6 inches apart, with Planet Jr. seeders at a seeding rate of 10 pounds per acre. Annual N rates from ammonium nitrate were 75, 150, 250, and 350 pounds per acre. To promote initial establishment of tall fescue, all plots received 75 pounds per acre of N in the fall at planting; the remaining N was applied in three equal applications, one after each harvest. During the second year, one-fourth of the N fertilizer was added in the fall, and the remainder was added in equal amounts after each of the first three harvests. A total of four harvests was made each year.

Forage samples for laboratory analysis were taken just prior to each harvest and dried at 158°F. These samples were analyzed for total N and for "in vitro" digestibility. Harvesting of plots was done when plants were about 10 inches tall with a flail-type mower taking a 32-inch swath through the middle of each plot, leaving a stubble height of 3 to 4 inches. The harvested green forage was weighed, and a sample was taken for dry matter determination.

Results and Discussion

The lowest N rate (75 pounds per acre) produced an average forage yield of 2,650 pounds per acre of Kentucky 31 and 3,250 pounds per acre of AU Triumph, table 1. The second increment of N (150 pounds per acre) produced an additional 1,550 pounds of Kentucky 31 and 1,750 pounds of AU Triumph. The next 100 pounds of N produced 800 pounds of Kentucky 31 and 1,150 pounds of AU Triumph. Maximum forage yields were produced with 250 pounds per acre of N on both varieties, with AU Triumph being the highest yielder at all N rates. However, the amount of forage produced by each pound of N was sharply lower above 150 pounds per acre of N, table 1. Thus, the most economical response was produced by 150 pounds per acre of N.

TABLE 1. FORAGE YIELD OF KENTUCKY 31 AND AU TRIUMPH TALL FESCUE AS AFFECTED BY NITROGEN RATES AT THE PLANT BREEDING UNIT, TALLASSEE

N rate, lb./acre	Per acre yield of dry forage[1]						Forage increase per lb. of additional N	
	Kentucky 31			AU Triumph				
	1978	1979	Av.	1978	1979	Av.	KY 31	Triumph
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
75	2,400	2,900	2,650c	3,100	3,400	3,250c	—	—
150	4,400	4,000	4,200b	5,400	4,600	5,000b	20.7	23.3
250	5,500	4,500	5,000a	7,000	5,300	6,150a	8.0	11.5
350	6,200	4,600	5,400a	7,000	5,200	6,100a	4.0	−0.5

[1]Within a variety, yields followed by the same letter are not different at the 5 percent probability level.

The N content of each grass (a measure of crude protein) increased with each increase in fertilizer N rate, table 2. The lowest N rate (75 pounds per acre) produced forage containing about 2.5 percent N (equivalent to 15.6 percent protein). The optimum N rate (150 pounds per acre) produced forage containing about 3 percent N (equivalent to 18.7 percent protein). The highest N rate (350 pounds per acre) produced forage containing almost 25 percent protein (4 percent N).

Although the protein content was greatly affected by N rates, the digestibility of the forage was not. The forage produced at the lowest N rate (75 pounds per acre) had slightly lower digestibility than higher N rates, but digestibility did not differ among the higher rates.

TABLE 2. NITROGEN CONTENT AND IN VITRO DRY MATTER DIGESTIBILITY OF KENTUCKY 31 AND AU TRIUMPH TALL FESCUE AS AFFECTED BY NITROGEN RATES AT THE PLANT BREEDING UNIT, TALLASSEE

N rate, lb./acre	N content of dry forage				Digestibility of forage			
	Kentucky 31		AU Triumph		Kentucky 31		AU Triumph	
	April 7	May 16	April 7	May 16	April 7	May 16	April 7	May 16
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
75	2.82	2.51	2.53	2.39	68.8	62.0	69.9	60.7
150	3.37	2.86	2.97	2.90	74.6	65.9	72.8	64.8
250	3.89	3.19	3.26	3.58	77.2	71.6	70.0	66.1
350	3.96	4.02	3.57	3.95	75.6	67.2	75.2	65.7

The AU Triumph variety made more winter growth than Kentucky 31. This characteristic was demonstrated by the higher yield in March of AU Triumph relative to Kentucky 31 (1,300 versus 400 pounds per acre), figure 1. Yields of the two varieties were about the same during the rest of the year.

N-P-K RATES FOR TALL FESCUE

Two sites, which are representative of much of the pastureland in northern Alabama, were selected as suitable for fertilizer experiments because of their low fertility status. Both were in farmers' pastures and both were on soils with underlying fragipans that are generally impervious to water movement and root growth.

One experiment was located on the Sheriff's Boys' Ranch in Morgan County. The soil is classified as Wynnville fine sandy loam with a nearly level topography and poor surface drainage. It has a strongly developed fragipan at about 20 inches below the surface. This tended to keep the soil too wet during late winter and early spring and too dry during summer and fall. Yield potential on this site is not high because of poor moisture regimes.

A second experiment was located on the farm of B. H. Reeves in Madison County. The soil is classified as a Dickson silt loam with a 2 percent slope and good surface drainage. It has a fragipan at about 30 inches below the surface. This soil was reasonably well drained during wet winter months and was reasonably tolerant of droughts during summer and fall.

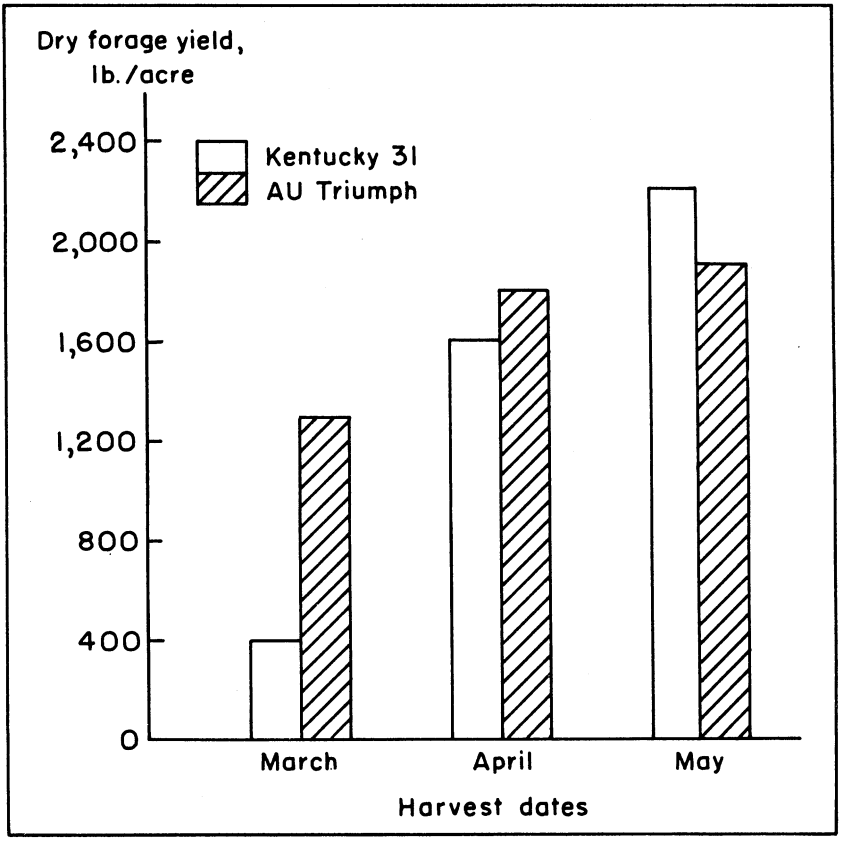

FIG. 1. Average seasonal distribution of Kentucky 31 and AU Triumph tall fescue forage at the Plant Breeding Unit, Tallassee, (N rate = 150 pounds per acre).

PROCEDURES

The soil from each site was sampled prior to establishing the experiments and analyzed by Auburn's Soil Testing Laboratory. The Wynnville soil had a pH of 6.2, available P of 4 pounds per acre (fertility index = 20 Very Low), and available K of 50 pounds per acre (fertility index = 60 Low). The Dickson soil had a pH of 5.5, available P of 4 pounds per acre (20 Very Low), and available K of 84 pounds per acre (70 Medium).

Wynnville fine sandy loam (Boys' Ranch)

An area within the pasture was fenced and completely renovated in September 1976. The soil was turned about 8

inches deep, disked, limed with 1 ton per acre of dolomitic limestone, and disked again. The area was divided into plots measuring 5 × 20 feet, and fertilizer treatments were arranged in a completely randomized block with four replications. Fertilizer rates were as follows: N at 0, 60, 120, and 180 pounds per acre as ammonium nitrate; P_2O_5 at 0, 30, 60, and 120 pounds per acre as concentrated superphosphate; and K_2O at 0, 30, 60, and 120 pounds per acre as muriate of potash (potassium chloride). One-half the N and all P and K were applied in September; the remainder of N was applied in March. Gypsum was applied uniformly to the entire area at a rate that provided 20 pounds per acre of sulfur. After fertilizer and gypsum were broadcast, a seedbed was prepared and 10 pounds per acre of Kentucky 31 seed were broadcast on the area. Seeding was followed by a light disking and harrowing to cover the seed. An excellent stand was obtained by October 1.

Dickson silt loam (B. H. Reeves)

Renovation of an area within the pasture was begun in August 1977. It was sprayed twice with a 1-pound-per-acre rate of a 3:1 mixture of 2,4-D and Dicamba for weed control. After the weeds had died, the area was mowed, chisel-plowed several times to a depth of about 6 inches, and then disked. Final seedbed preparations were made in mid-October after several rains. Fertilizers and lime (1 ton per acre) were applied, as described above for the Boys' Ranch, followed by disking. Kentucky 31 was seeded broadcast at 10 pounds per acre and disked in lightly.

Management Problems

Each experimental site had special problems, particularly with weeds, that affected yields and survival of new stands of tall fescue. Some management problems that may have influenced yields are noted for each site.

Wynnville fine sandy loam (Boys' Ranch)

Harvests of forage were made in April and May 1977, after which an excessive, but almost even, stand of weeds emerged throughout the plot area. Weeds in the grass plots were sprayed with 2,4-D in August 1977 and again with 2,4-D and Dicamba

in October 1977. Afterwards, the plots were mowed and harvested material was removed from plots and discarded.

Harvests for records in 1978 were made in April and May. Common lespedeza began to grow vigorously in some plots in June, particularly those with lower N rates. Consequently, plots were clipped in late June, then sprayed with a 3:1 mixture of 2,4-D and Dicamba in early July at a rate of 1 pound per acre. The June harvest was discarded because of contamination by lespedeza and other weeds.

Three harvests were made in 1979, the last being June 4. Broomsedge and summer cedar (dogfennel) persisted at all fertility levels, but were particularly a problem in low-fertility plots.

Dickson silt loam (B. H. Reeves)

After the experiment was established in October 1977, a freeze in January 1978 caused considerable soil heaving, destroying many grass seedlings in the process. There was not enough fescue to harvest during the following spring. By mid-May, the plots had been taken over by bitterweed, horsenettle, and other broadleaf weeds. At that time, the entire area was sprayed with a 3:1 mixture of 2,4-D and Dicamba. This spray was repeated July 5 because of surviving horsenettle. The area was again sprayed August 16 with glyphosate at 2 pounds per acre to control dallisgrass. The test site was disk plowed twice in late August, then disked, fertilized, and replanted September 27, 1978. An excellent stand of grass was achieved by early November. No further management problems were encountered during 1979 and 1980, and yields on high-fertility plots were quite satisfactory.

Results and Discussion

Forage Yield

Forage yields were much higher on the Dickson soil than on the Wynnville soil. This was probably because the Wynnville soil had poorer surface drainage and an impervious fragipan closer to the soil surface. These properties tend to cause high water tables during wet periods (e.g., late winter) and increased drought stress during dry periods (e.g., early fall). Growth started later in the spring on the Wynnville soil, and all treatments failed to produce enough forage on this soil to harvest in the fall. In contrast, a fall harvest was made on the Dickson soil each year.

Nitrogen (N) Rates

Forage yield of tall fescue was increased markedly by N fertilizer, table 3. Each increment of N increased forage production at each test site, with the highest yields being produced by the highest N rate (180 pounds per acre). Even without N fertilizer, yields were good on the Dickson soil. For example, yields without N fertilizer were 56 percent of maximum on the Dickson soil but only 12 percent of maximum on the Wynnville soil. Each pound of N produced about 23 pounds of dry forage, up to and including 180 pounds per acre of N, on the Wynnville soil. The first 120 pounds of N on the Dickson soil also produced about 23 pounds of dry forage for each pound of fertilizer N. The last 60-pound increase (120 versus 180 pounds per acre), however, produced just over 7 pounds of forage per pound of N. Consequently, the optimum N rate for tall fescue was about 180 pounds per acre on the Wynnville soil and about 120 pounds per acre on the Dickson soil. The current recommendation by Auburn's Soil Testing Laboratory is 60 pounds per acre of N in the fall and another 60 pounds in early spring.

TABLE 3. FORAGE YIELD OF KENTUCKY 31 TALL FESCUE AS AFFECTED BY N FERTILIZER RATES ON TWO SOILS IN NORTHERN ALABAMA

N rate, lb./acre[2]	Dry forage yield per acre[1]						
	Wynnville fine sandy loam				Dickson silt loam		
	1977	1978	1979	Av.	1979	1980	Av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	380	510	600	500d	5,150	3,200	4,180c
60	2,530	2,000	1,660	2,060c	6,180	5,770	5,980b
120	3,740	3,160	2,500	3,130b	6,580	7,500	7,040a
180	5,250	3,300	3,630	4,060a	6,590	8,370	7,480a

[1]Within a soil series, yields followed by the same letter are not different at the 5 percent probability level.

[2]P_2O_5 and K_2O were each applied to all N plots at a rate of 120 pounds per acre.

Phosphorus (P_2O_5) Rates

Both soils tested Very Low (20 VL) in available P, but there was a big difference in yields between the two locations, table 4. Forage produced on the "no P" plots averaged 640 pounds per acre on the Wynnville soil but 5,370 pounds per acre on the Dickson soil. Optimum P_2O_5 rates were about 60 pounds per acre on Wynnville soil and about 30 pounds per acre on Dickson soil. The current recommendation for a Very Low P soil is 100 pounds per acre of P_2O_5.

TABLE 4. EFFECT OF PHOSPHORUS FERTILIZER RATE ON FORAGE YIELD OF KENTUCKY 31 TALL FESCUE ON TWO SOILS IN NORTHERN ALABAMA

P_2O_5 rate, lb./acre[2]	Per acre yield of dry forage						
	Wynnville fine sandy loam				Dickson silt loam		
	1977	1978	1979	Av.	1979	1980	Av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	430	660	840	640c	4,540	6,210	5,370b
30	2,180	2,730	2,760	2,560b	5,990	7,100	6,540a
60	3,590	3,160	3,230	3,330a	6,350	7,700	7,020a
120	3,740	(lost)	2,890	3,310a	6,580	7,970	7,270a

[1]Within a soil series, yields followed by the same letter are not different at the 5 percent probability level.
[2]Nitrogen and K_20 were each applied at a rate of 120 pounds per acre to all P rates.

Potassium (K_2O) Rates

The Wynnville soil tested Low (60 L) in K, and the Dickson soil tested Medium (70 M). Forage yield on the "no K" plots was 56 percent of that produced at the highest K_2O rate on the Wynnville soil, table 5. The "no K" plots on the Dickson soil produced 88 percent as much forage as the highest K_2O rate. Optimum K_2O fertilizer rates were about 30 pounds per acre on each soil. The current recommendation is 80 pounds per acre of K_2O on a Low K soil and 50 pounds per acre on a Medium K soil.

TABLE 5. EFFECT OF POTASSIUM FERTILIZER RATE ON FORAGE YIELD OF KENTUCKY 31 TALL FESCUE ON TWO SOILS IN NORTHERN ALABAMA

K_20 rate, lb./acre[2]	Per acre yield of dry forage						
	Wynnville fine sandy loam				Dickson silt loam		
	1977	1978	1979	Av.	1979	1980	Av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	2,500	lost	1,380	1,960b	6,190	6,610	6,400b
30	3,180	lost	2,660	2,920a	6,720	7,320	7,020a
60	3,800	lost	2,670	3,230a	6,720	7,470	7,090a
120	3,730	lost	3,260	3,490a	6,580	7,970	7,270a

[1]Within a soil series, yields followed by the same letter are not different at the 5 percent probability level.
[2]N and P_2O_5 were each applied to all K plots at a rate of 120 pounds per acre.

Forage Composition

Samples of dry forage were taken from each treatment after each harvest in 1979 and analyzed for N (protein), P, K, calcium (Ca), magnesium (Mg), and sulfur (S).

Nitrogen Rates

The rate of N fertilizer affected the level of protein N in the forage but not the level of any of the other major nutrients,

TABLE 6. EFFECT OF N FERTILIZER RATE ON ORGANIC-N CONTENT (PROTEIN) OF KENTUCKY 31 TALL FESCUE FORAGE ON TWO SOILS IN NORTHERN ALABAMA

N rate, lb./acre	Percent organic N of dry forage by harvest date						
	Wynnville fine sandy loam			Dickson silt loam			
	Apr. 5	May 1	June 4	Apr. 10	May 2	May 25	Sept. 12
0	2.1	2.2	1.6	2.4	1.9	2.1	2.3
60	2.9	2.2	1.8	3.1	1.9	2.3	1.9
120	3.4	2.3	1.7	3.0	2.5	2.2	1.9
180	3.9	2.6	1.8	2.8	2.7	2.1	1.9

table 6. However, the N rate affected protein content only in early spring harvests. On the Wynnville soil, the first harvest (April 5) showed a marked increase in forage N with increasing N rate, but the other two harvests did not. On the Dickson soil, the greatest increase in forage N was in the second harvest (May 2).

Average forage contents of the other major nutrients on the Wynnville site were 0.36 percent P, 0.15 percent S, 0.58 percent Ca, 0.22 percent Mg, and 2.3 percent K. Average forage contents of these nutrients on the Dickson site were 0.30 percent P, 0.22 percent S, 0.76 percent Ca, 0.32 percent Mg, and 2.6 percent K. Harvest dates had no noticeable effect on these contents.

Phosphorus Rates

The rate of P fertilizer greatly affected the P content of forage, but not the content of any of the other major nutrients, table 7. The P content of forage did not change significantly from one harvest to the next, as the N content did. Phosphorus-deficient forage contained less than about 0.25 percent P.

Average forage contents of the other major nutrients on the Wynnville site were 2.5 percent N, 0.15 percent S, 0.54 percent Ca, 0.21 percent Mg, and 2.4 percent K. These

TABLE 7. EFFECT OF P FERTILIZER RATE ON P CONTENT OF KENTUCKY 31 TALL FESCUE FORAGE ON TWO SOILS IN NORTHERN ALABAMA

P_2O_5 rate, lb./acre	Percent P of forage by harvest date						
	Wynnville fine sandy loam			Dickson silt loam			
	Apr. 5	May 1	June 4	Apr. 10	May 2	May 25	Sept. 12
0	0.18	0.15	0.11	0.14	0.17	0.14	0.16
30	.28	.19	.12	.28	.20	.19	.12
60	.28	.29	.23	.21	.20	.28	.24
120	.48	.36	.36	.26	.25	.30	.26

nutrient contents were not significantly affected by harvest dates.

Potassium Rates

Increasing rates of K fertilizer greatly increased the K content of harvested forage on the Wynnville soil and to a lesser extent on the Dickson soil, table 8. The highest K contents occurred in the first harvest (April 5) on the Wynnville soil, but there was no difference in K contents of the first three harvests (April 10-May 25) on the Dickson soil. Potassium-deficient forage contained less than 1.5-2.0 percent K on the Wynnville soil and less than about 2.4 percent K on the Dickson soil. Differences in weed infestations could have caused this difference. The sward on the Dickson soil was nearly weed free, whereas weeds were a problem on the low-fertility plots of the Wynnville soil.

Rates of K had only slight effects on forage content of the other major nutrients. There were slight decreases in N and Mg contents with increasing K rates, but other nutrients were unaffected. Average forage contents on the Wynnville soil were 2.6 percent N, 0.35 percent P, 0.15 percent S, 0.66 percent Ca, and 0.26 percent Mg. On the Dickson soil, they were 2.6 percent N, 0.29 percent P, 0.21 percent S, 0.78 percent Ca, and 0.34 percent Mg.

TABLE 8. EFFECT OF K FERTILIZER RATE ON K CONTENT OF KENTUCKY 31 TALL FESCUE FORAGE ON TWO SOILS IN NORTHERN ALABAMA

K_2O rate, lb./acre	Percent K of forage by harvest date						
	Wynnville fine sandy loam			Dickson silt loam			
	Apr. 5	May 1	June 4	Apr. 10	May 2	May 25	Sept. 12
0	1.0	0.7	0.6	2.3	2.0	2.1	1.8
30	1.6	1.2	1.2	2.4	2.3	2.4	2.3
60	2.0	1.5	1.5	2.4	2.7	2.4	2.0
120	2.6	2.8	2.1	2.7	2.6	2.6	2.1

Weed Infestation

Weeds seriously encroached on the stand of tall fescue on low-fertility plots on the Wynnville soil, table 9. The dominant invading weeds were broomsedge, crabgrass, and common lespedeza. There was a significant encroachment of weeds even on some of the more fertile plots.

There were practically no weeds in the tall fescue sward on the Dickson soil.

TABLE 9. EFFECT OF N-P-K RATES ON PERCENT OF WEEDS IN THE TALL FESCUE SWARD AT THE CONCLUSION OF THE EXPERIMENT, 1979, ON WYNNVILLE SOIL

Nitrogen			Phosphorus			Potassium		
N rate, lb./acre	Percent weeds		P_2O_5 rate, lb./acre	Percent weeds		K_2O rate, lb./acre	Percent weeds	
	May 1	May 23		May 1	May 23		May 1	May 23
0	6	34	0	20	31	0	5	16
60	2	16	30	5	9	30	5	9
120	5	16	60	5	7	60	5	9
180	2	9	120	5	16	120	5	16

Soil-Test P and K

After the last harvest was made at each site, soil from each plot was sampled to a depth of 2 inches and analyzed by Auburn's Soil Testing Laboratory, table 10. Soil-test P was progressively increased by each increment of P fertilizer, and the highest rate (120 pounds per acre of P_2O_5) was required to raise the available P level above the Low rating. Soil-test K was also increased at the 60 and 120 pounds per acre rate of K_2O, but not at the 30-pound rate. Fertilizer was applied 3 years on the Wynnville soil and 2 years on the Dickson soil.

TABLE 10. SOIL-TEST LEVELS AT CONCLUSION OF EXPERIMENT WITH TALL FESCUE

Phosphorus[1]				Potassium[1]			
P_2O_5 rate, lb./acre	Soil pH	Available P		K_2O rate, lb./acre	Soil pH	Available K	
		Lb./acre	Rating			Lb./acre	Rating
Wynnville fsl							
0	6.1	3	20 V Low	0	6.2	47	60 Low
30	6.3	6	30 V Low	30	6.3	43	50 Low
60	6.4	9	40 V Low	60	6.2	54	70 Med
120	6.2	45	100 Med	120	6.2	68	70 Med
Dickson sil							
0	6.1	4	20 V Low	0	6.1	79	70 Med
30	6.1	12	50 V Low	30	6.0	84	70 Med
60	6.1	15	60 Low	60	6.1	107	80 Med
120	6.2	39	90 Med	120	6.2	148	90 High

[1]P and K applied for 3 years on the Wynnville soil and for 2 years on the Dickson soil.

N-P-K RATES FOR MIXTURE OF TALL FESCUE AND WHITE CLOVER

An area adjoining each of the N-P-K experiments with tall fescue in Madison and Morgan counties was used to conduct N-P-K rate experiments with a mixture of Kentucky 31 tall fescue and Regal white clover. The experimental sites and soil characteristics were described earlier.

PROCEDURES

Soil sampling and site preparation were described previously under the heading "N-P-K Rates for Tall Fescue." Fertilizer rates for fescue-clover mixture were the same as those for tall fescue except that the 180 pounds per acre rate of N was omitted. After the tall fescue had been seeded (as previously described), innoculated Regal white clover was seeded at the rate of 3 pounds per acre, and the soil was cultipacked for seed coverage.

MANAGEMENT PROBLEMS

The fescue-clover plots suffered the same problems outlined under "N-P-K Rates for Tall Fescue." Clover was replanted on the Wynnville soil in 1977 because of armyworm damage.

RESULTS AND DISCUSSIONS

Forage Yield

Forage yields on the Dickson soil were two- to three-fold higher than those on the Wynnville soil. The poor surface drainage of the Wynnville soil and its impervious fragipan within 20 inches of the surface are believed responsible for this. Clover and fescue growth got started later in the spring, and forage production was nonexistent in the fall on this soil.

Nitrogen (N) Rates

Forage yield of fescue-clover was increased by each higher rate of N fertilizer, table 11. Each pound of fertilizer N produced 9-15 pounds of additional forage. However, the increased yield was at the expense of the clover stand, which was progressively replaced by weeds or tall fescue at higher

TABLE 11. FORAGE YIELD OF A MIXTURE OF KENTUCKY 31 TALL FESCUE AND REGAL WHITE CLOVER AS AFFECTED BY N FERTILIZER RATES ON TWO SOILS IN NORTHERN ALABAMA

N rate, lb./acre[2]	Dry forage yield per acre[1]						
	Wynnville fine sandy loam				Dickson silt loam		
	1977	1978	1979	Av.	1979	1980	Av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	2,920	1,850	2,490	2,420b	8,320	4,920	6,620a
60	3,470	3,040	2,390	2,970ab	7,880	6,640	7,260a
120	4,310	4,260	2,970	3,850a	7,810	8,520	8,170a

[1]Within a soil series, yields followed by the same letter are not different at the 5 percent probability level.

[2]P_2O_5 and K_2O were each applied to all N rates at rate of 120 pounds per acre.

N rates. Thus, the quality of forage, as measured by the amount of clover in the sward, was sacrificed for higher yields with increasing N rates. The optimum N rate for maintaining maximum forage quality and a satisfactory yield level at the same time was zero.

Phosphorus (P_2O_5) Rates

Both soils were Very Low in available P, and forage yields were greatly increased by P fertilizer on both soils, table 12. There was little yield on the "no P" plots and hardly any clover survived on them. The optimum annual rate of P_2O_5 was about 60 pounds per acre on both soils. However, the optimum rate was 120 pounds per acre for the first year after planting. The current recommendation for a Very Low P soil is 160 to 180 pounds per acre of P_2O_5.

TABLE 12. EFFECT OF P FERTILIZER RATE ON FORAGE YIELD OF MIXTURE OF KENTUCKY 31 TALL FESCUE AND REGAL WHITE CLOVER ON TWO SOILS IN NORTHERN ALABAMA

P_2O_5 rate, lb./acre[2]	Per acre yield of dry forage						
	Wynnville fine sandy loam				Dickson silt loam		
	1977	1978	1979	Av.	1979	1980	Av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	190	940	420	520c	3,930	3,500	3,710c
30	1,180	1,650	1,330	1,390b	5,900	4,140	5,020b
60	1,570	1,800	2,040	1,800ab	7,490	4,980	6,230a
120	2,920	1,850	2,490	2,420a	8,320	4,920	6,620a

[1]Within a soil series, yields followed by the same letter are not different at the 5 percent probability level.

[2]N rate was zero and K_20 rate was 120 pounds per acre for all P plots.

Potassium (K_2O) Rates

The Wynnville soil was Low in available K, and yielded little forage on the unfertilized plots, table 13. The optimum K_2O rate for the first year was about 120 pounds per acre, but about 60 pounds per acre in subsequent years.

The Dickson soil was Medium in available K, and the optimum K_2O rate was about 30 pounds per acre. Even the "no K" plots produced relatively good yields on this soil. Current recommendations are 120 pounds per acre of K_2O for a Low K soil and 80 pounds per acre for a Medium K soil.

TABLE 13. EFFECT OF K FERTILIZER RATE ON FORAGE YIELD OF MIXTURE OF KENTUCKY 31 TALL FESCUE AND REGAL WHITE CLOVER ON TWO SOILS IN NORTHERN ALABAMA

K_2O rate, lb./acre[2]	Per acre yield of dry forage[1]						
	Wynnville fine sandy loam				Dickson silt loam		
	1977	1978	1979	Av.	1979	1980	Av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	610	1,260	880	920c	7,040	4,370	5,700b
30	1,690	1,850	1,390	1,640b	7,660	5,400	6,530a
60	2,140	1,950	2,320	2,140a	7,800	4,870	6,330a
120	2,920	1,850	2,490	2,420a	8,320	4,690	6,500a

[1]Within a soil series, yields followed by the same letter are not different at the 5 percent probability level.

[2]N rate was zero and P_2O_5 was 120 pounds per acre for all K plots.

Forage Composition

Forage samples were taken from each treatment after each harvest in 1979 and analyzed for N (protein), P, K, Ca, Mg, and S.

Nitrogen Rates

Increasing N rates on the Wynnville soil had no effect on the N content of forage at the first (April 5) and third harvests (June 4), but they decreased forage N at the second harvest, table 14. On the Dickson soil, increasing N rates increased forage N at the first harvest (April 10), decreased forage N at the second (May 2) and third harvests (May 25), and had no effect on the June 22 and September 12 harvests. These effects were probably the result of the ratio of fescue to clover in the sward, which was affected by N rate.

Average forage contents of other major nutrients on the Wynnville soil were 0.39 percent P, 0.14 percent S, 0.90 percent Ca, 0.24 percent Mg, and 2.4 percent K. Increasing N rates decreased Ca content of forage but had no effect on forage content of other macronutrients.

TABLE 14. EFFECT OF N FERTILIZER RATE ON ORGANIC N (PROTEIN) CONTENT OF DRY FORAGE FROM SWARDS CONTAINING A MIXTURE OF KENTUCKY 31 TALL FESCUE AND REGAL WHITE CLOVER

N rate, lb./acre	Percent organic N of dry forage by harvest date							
	Wynnville fine sandy loam			Dickson silt loam				
	Apr. 5	May 1	June 4	Apr. 10	May 2	May 25	June 22	Sept. 12
0	3.5	2.6	2.7	2.6	3.1	3.3	3.6	2.7
60	3.3	1.7	2.3	3.2	2.8	2.7	3.3	2.7
120	3.6	1.8	2.8	3.4	2.6	2.6	3.1	2.5

Phosphorus Rates

The P content of forage was greatly increased by increasing rates of P fertilizer, table 15. Early spring harvests tended to produce forage with higher P contents than later harvests. The data suggest that an adequate P level in the forage is about 0.20 to 0.25 percent P.

Increasing P rates on the Wynnville soil also increased forage content of N (1.8 to 2.9 percent) and Ca (0.58 to 1.09 percent), probably because of increased clover in the sward. On the Dickson soil, increasing fertilizer P increased forage content of Ca (0.9 to 1.3 percent) and of Mg (0.29 to 0.37 percent). Other average contents on Wynnville soil were 0.14 percent S, 0.23 percent Mg, and 2.4 percent K; on Dickson soil, they were 3.0 percent N, 0.18 percent S, and 2.5 percent K.

TABLE 15. EFFECT OF P FERTILIZER RATE ON P CONTENT OF DRY FORAGE FROM SWARDS CONTAINING A MIXTURE OF KENTUCKY 31 TALL FESCUE AND REGAL WHITE CLOVER

P_2O_5 rate, lb./acre	Percent P of dry forage by harvest date							
	Wynnville fine sandy loam			Dickson silt loam				
	Apr. 5	May 1	June 4	Apr. 10	May 2	May 25	June 22	Sept. 12
0	n.d.[1]	0.20	0.13	0.26	0.15	0.22	0.09	0.17
30	n.d.[1]	.29	.23	.35	.23	.24	.12	.12
60	n.d.[1]	.34	.24	.30	.22	.24	.21	.15
120	0.44	.52	.22	.30	.36	.34	.19	.28

[1]Too little forage to harvest.

Potassium Rates

Increasing fertilizer K rates generally increased forage content of K, table 16. Harvests earlier in the year tended to be higher in forage K than later harvests. The data suggest that an adequate K level in the forage is in the range of 2.0 to 2.5 percent K.

Increasing K rates increased forage N content (2.3 to 2.9 percent) on the Wynnville soil but not on the Dickson soil (3.1 percent N). Increasing fertilizer K decreased forage Ca (1.6 to 1.3 percent) and Mg (0.42 to 0.37 percent) on the Dickson soil but not on the Wynnville soil (1.0 percent Ca and 0.30 percent Mg). Forage S content was 0.15 percent on the Wynnville soil and 0.19 percent on the Dickson soil.

TABLE 16. EFFECT OF K FERTILIZER RATE ON K CONTENT OF DRY FORAGE FROM A SWARD CONTAINING A MIXTURE OF KENTUCKY 31 TALL FESCUE AND REGAL WHITE CLOVER

K_2O rate, lb./acre	Percent K of forage by harvest date							
	Wynnville fine sandy loam			Dickson silt loam				
	Apr. 5	May 1	June 4	Apr. 10	May 2	May 25	June 22	Sept. 12
0	n.d.[1]	2.2	1.3	2.4	2.3	1.8	1.7	1.1
30	n.d.[1]	1.8	2.0	2.4	2.4	2.0	1.7	1.3
60	n.d.[1]	2.1	1.7	2.7	2.5	2.4	2.3	1.5
120	2.7	2.2	2.5	2.8	2.7	2.3	2.0	1.5

[1]Too little forage to harvest.

Clover in Sward

Fertilizer rates had a decided effect on the amount of white clover remaining in the sward at the conclusion of each experiment, tables 17 and 18. The effects of increasing N rates was to sharply reduce the amount of surviving clover at both sites. The highest N rate (120 pounds per acre) was particularly detrimental, resulting in a sward containing less than 10 percent clover. The clover was replaced largely by broomsedge and dogfennel on the Wynnville soil and by tall fescue on the Dickson soil, which had no weed problem.

White clover barely survived in plots not receiving P fertilizer. Clover was replaced by broomsedge, dogfennel, and tall fescue on the Wynnville soil and by tall fescue on the Dickson soil. Clover also suffered stand losses in plots not receiving K fertilizer, but losses were less severe than in "no P" plots.

Not only were P and K fertilizers needed for optimum forage yields on both soils, they were also needed to maintain the high forage quality that is characteristic of white clover.

TABLE 17. EFFECT OF N-P-K RATES ON PERCENT OF CLOVER AND WEEDS IN THE FESCUE-CLOVER SWARD AT THE CONCLUSION OF THE EXPERIMENT ON THE WYNNVILLE SOIL

Nitrogen					Phosphorus					Potassium				
N rate, lb./acre	Percent weeds		Percent clover		P_2O_5 rate, lb./acre	Percent weeds		Percent clover		K_2O rate, lb./acre	Percent weeds		Percent clover	
	May 1	May 23	May 1	May 23		May 1	May 23	May 1	May 23		May 1	May 23	May 1	May 23
0	4	9	24	54	0	2	52	8	2	0	10	36	7	28
60	2	16	30	30	30	3	20	12	36	30	7	20	39	27
120	4	21	40	9	60	4	8	36	58	60	3	8	41	54
—	—	—	—	—	120	4	9	24	54	120	4	9	24	54

TABLE 18. EFFECT OF N-P-K RATES ON PERCENT CLOVER IN THE FESCUE-CLOVER SWARD AT THE CONCLUSION OF THE EXPERIMENT ON THE DICKSON SOIL

Nitrogen			Phosphorus			Potassium		
N rate, lb./acre	Percent clover		P_2O_5 rate, lb./acre	Percent clover		K_2O rate, lb./acre	Percent clover	
	Apr. 29	May 29		Apr. 29	May 29		Apr. 29	May 29
0	30	29	0	3	3	0	23	14
60	17	10	30	30	24	30	33	33
120	1	6	60	34	25	60	39	23
—	—	—	120	30	29	120	30	29

Soil-Test P and K

At the conclusion of each experiment, soil from each plot was sampled to a depth of 2 inches and analyzed by Auburn's Soil Testing Laboratory, table 19. Soil-test P was increased by each increment of P fertilizer (3 years on the Wynnville soil and 2 years on the Dickson soil). The highest P_2O_5 rate (120 pounds per acre) was required to raise available P above a Low rating at both sites. Soil-test K was increased slightly by the 60 pound-per-acre rate and was about doubled by 120 pounds.

TABLE 19. SOIL-TEST LEVELS AT CONCLUSION OF EXPERIMENT WITH TALL FESCUE-WHITE CLOVER MIXTURE

Phosphorus[1]				Potassium[1]			
P_2O_5 rate, lb./acre	Soil pH	Avail. P.		K_2O rate, lb./acre	Soil pH	Avail. K	
		Lb./acre	Rating			Lb./acre	Rating
			Wynnville				
0	6.4	2	10 V Low	0	6.6	50	60 Low
30	6.4	11	50 V Low	30	6.4	56	60 Low
60	6.4	22	70 Low	60	6.3	69	70 Med
120	6.2	33	80 Med	120	6.2	100	80 Med
			Dickson silt loam				
0	6.1	4	20 V Low	0	6.1	84	70 Med
30	5.9	10	40 V Low	30	6.1	83	70 Med
60	6.1	21	70 Low	60	6.0	96	80 Med
120	5.9	46	100 Med	120	5.9	166	100 High

[1]P and K fertilizers applied for 3 years on the Wynnville soil and for 2 years on the Dickson soil.

Seasonal Distribution of Yield

Tall fescue fertilized with adequate N produced much more early spring forage than fescue-clover when no N fertilizer was added, figure 2. The first forage harvest of the year (early

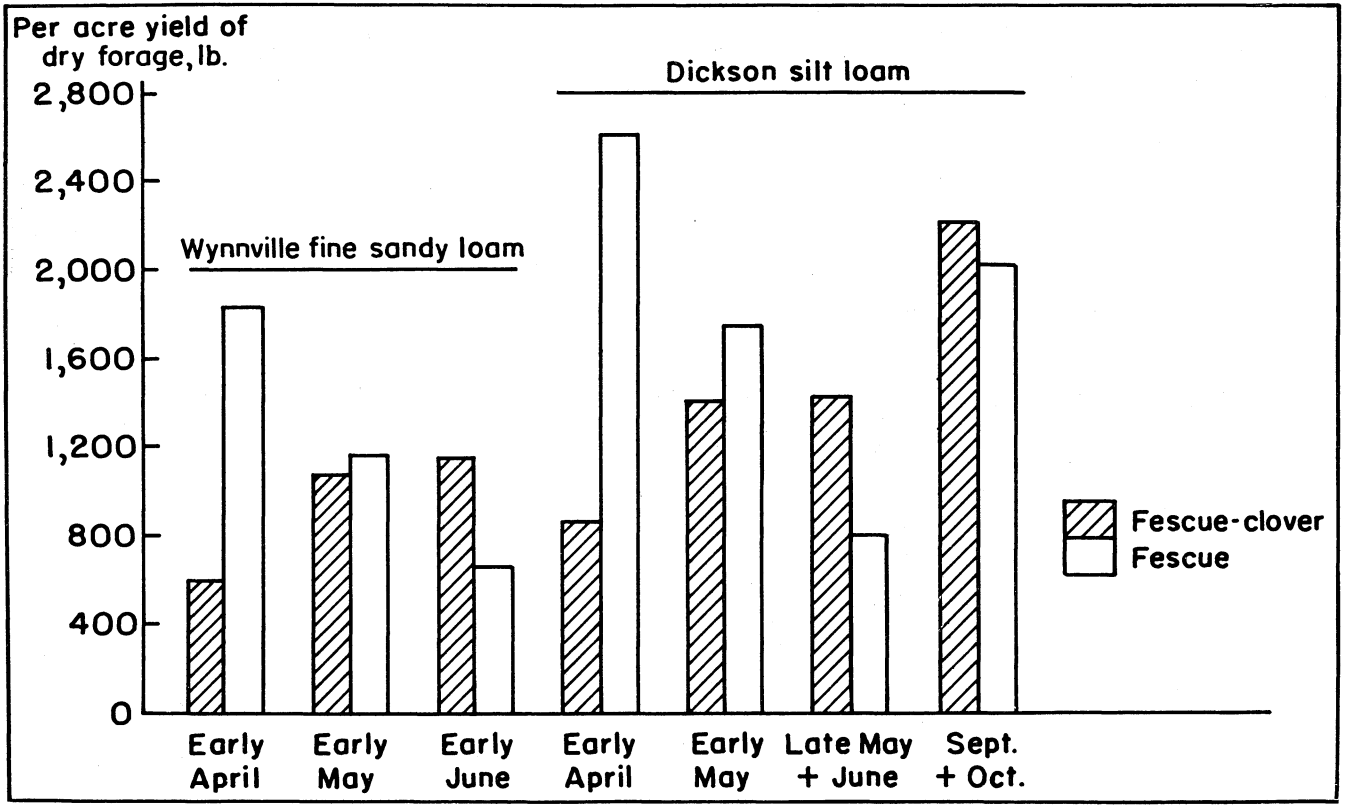

FIG. 2. Seasonal distribution of forage at recommended N fertilizer rates for tall fescue (120 pounds per acre) and for fescue-clover (none) on two experiments in northern Alabama.

April) from fescue was about three-fold of that from fescue-clover. The low temperatures of February and March are neither conducive to rapid white clover growth nor, apparently, to the rapid fixation of atmospheric N by clover rhizobia. Subsequent harvests of fescue-clover equaled or exceeded those of fertilized fescue in forage production.

From the standpoint of managing fescue-clover pastures for grazing animals, these data suggest that early spring forage production could be enhanced by a small application of N fertilizer in late winter (January or February). A N rate of 30 pounds per acre should be enough to boost early fescue growth, which should then be grazed, without stimulating fescue growth to the point it would become too competitive with the white clover.

SUMMARY

In a N rate experiment near Tallassee, Alabama, on a Cahaba fine sandy loam, the optimum N rate for tall fescue forage production was 120 pounds per acre. This matches the current recommendations of 60 pounds per acre of N in the fall and again in early spring.

AU Triumph produced more forage than Kentucky 31 tall fescue at all N rates in the Tallassee experiment.

In experiments in Madison and Morgan counties, the optimum N for Kentucky 31 tall fescue was 120 pounds per acre on a Dickson silt loam in Madison County and 180 pounds per acre on a Wynnville fine sandy loam in Morgan County.

The optimum N rate for a sward mixture of tall fescue and white clover was zero because of the loss of clover from the sward where N was applied (lowest N rate was 60 pounds per acre). However, a 30-pound-per-acre rate of N applied in late winter should provide additional early grazing without serious damage to the clover stand.

On soils testing 20 Very Low in available P, annual application of 30 to 60 pounds per acre of P_2O_5 was needed for maximum forage production by tall fescue. With white clover in the sward, 120 pounds per acre of P_2O_5 were needed the first year and 60 pounds per acre in subsequent years. These rates are somewhat lower than currently recommended rates.

On soils testing 60 Low and 70 Medium in available K, annual applications of 30 pounds per acre of K_2O were adequate for maximum yield of tall fescue forage. With white

clover in the sward, the soil testing 60 Low needed 120 pounds per acre of K_2O the first year and 60 pounds per acre in succeeding years; the soil testing 70 Medium needed only 30 pounds per acre annually.

White clover was unable to persist in the Low P soils. Weeds and tall fescue replaced clover in the sward where P fertilizer was not added.

White clover stand was diminished considerably where K fertilizer was not added. It was replaced by weeds and tall fescue.

ACKNOWLEDGMENT

The experiments in Madison and Morgan counties were made possible by the technical assistance of the county agents and J. G. Link, Agronomist, Alabama Cooperative Extension Service, and by the financial support of the Division of Agricultural Development, Tennessee Valley Authority.