Protein, P, and K Composition of Coastal Bermudagrass and Crimson Clover

WILLIAM E. ADAMS, MATTHIAS STELLY, R. A. McCREERY, H. D. MORRIS AND CHARLES B. ELKINS, JR.[1]

Soil Scientist, Southern Piedmont Conservation Research Center, USDA-ARS-SWCRD, Watkinsville, Georgia; Professor, Assistant Professor, and Professor of Agronomy, University of Georgia, College Station, Athens; and Soil Scientist, Southern Piedmont Conservation Research Center, USDA-ARS-SWCRD, Watkinsville, Georgia.

Highlight

Increasing levels of N, P and K fertilization increased total nutrient uptake and the percentage of protein, P and K, in the Coastal bermudagrass forage. P and K content of associated crimson clover increased with increasing rates of application of each nutrient. Percent recovery of N and P in the forage declined with increasing rates of fertilization of each nutrient, but percent K recovery increased with increasing K rates. N-K balance was important in maintaining an optimum K level in the forage and reducing K-deficiency symptoms. Tame pastures supplement forest range and reduce the overall cost below that of tame pastures above.

[1]*Dr. Stelly is now Executive Secretary, American Society of Agronomy, Madison, Wisconsin; Mr. Elkins is presently Soil Scientist, USDA, ARS, Louisiana State University, Baton Rouge.*

Correspondence should be addressed to: William E. Adams, Research Soil Scientist, USDA-ARS-SWC, P. O. Box 555, Watkinsville, Georgia 30677.

Coastal bermudagrass *(Cynodon dactylon* (L.) Pers.) was released as a variety 22 years ago and is grown on more than 6,000,000 acres in the United States (Johnson et al., 1964). The present acreage is small compared with the potentially adapted areas in this and other countries (Burton, 1965) .Forage production of Coastal grown on various soils and under a wide variety of fertilizer levels has been reported (Fisher and Caldwell, 1959; Prine and Burton, 1956).

The influence of K on the incidence of leafspot on Coastal bermudagrass has been reported by Evans et al., 1964. Pretty (1964) has shown the importance of K in animal nutrition and Teel (1964) has studied the role of K in converting N to true protein.

The purpose of this investigation was to determine the effect of different levels of fertilization on: (1) the protein, P and K contents of Coastal bermudagrass, (2) the P and K contents of crimson clover *(Trifolium incarnatum)* grown in association with the grass, and (3) total uptake and percent recovery of N, P and K. The forage yields have been reported in a previous paper (Adams and Stelly, 1962).

Procedure

This investigation was conducted during 1955-1957 on Cecil sandy loam soil. Cecil soil comprises more than half of the total upland soils of the Piedmont Province which extends from Maryland into Alabama. These soils are representative of the red-yellow Podzolic Great Soil Group and are derived from red to brown weathered granite and/or gneiss. Texture ranges from sandy loam to loam. The clay fraction of Cecil profiles contains more than 40% of koalinite, 10 to 40% vermiculite and less than 10% gibbsite. The cation exchange capacity is approximately 4.8 me/100 g, with a pH range from 5.2 to 5.7 (0-6") and a bulk density range from 1.43 to 1.22 g/cm^3 (0-6"). Percent moisture by volume is approximately 19.61 and 7.28 for the 1/3 bar and 15 bars, respectively.

The fertility requirements of Coastal bermudagrass grown with crimson clover were studied in a factorial experiment. The fertilizer treatments, replicated three times in a randomized block, were: 0, 100, 200 and 400 lb/acre N; 0, 22, 43 and 87 lb/acre P, (0, 50, 100 and 200 P_2O_5); and 0, 41, 83 and 165 lb/acre K (0, 50, 100 and 200 K_2O). The P and K were applied one-half in the fall at clover seeding and one-half in the spring after clover harvest. The N was applied 37.5% after clover harvest, 37.5% after the first grass harvest and 25% after the second harvest.

The plots were 8 by 20 ft in size and the harvested area was 34 inches by 18 ft. The entire harvested sample was oven dried and ground for chemical determinations.

Nitrogen was determined by the Kjeldahl method (A.O.A.C., 1945) and converted to protein by multiplying by the factor 6.25. Phosphorus

and potassium were determined from plant samples ashed with perichloric, nitric and sulfuric acids. Phosphorus was determined colorimetrically by the molybdenum blue method with stannous chloride as the reducing agent. Potassium was determined by flame photometry according to the method of Wehunt et al. (1957).

All data were analyzed statistically. Duncan's Multiple Range Test was used to test for significant differences among treatment means (Duncan, 1951).

Results and Discussion

Coastal bermudagrass composition — Protein, P and K. — Nitrogen was the only nutrient applied that affected the protein content of the Coastal bermudagrass forage (Table 1). The protein content increased markedly from 9.44% at the O-N level to 16.37% at the 400-N level. The differences between all N levels were significant at the 1% level of probability.

Phosphorus fertilization significantly increased the P content of the Coastal bermudagrass forage (Table 1). The P content of the forage ranged from 0.17% at the 400-0-41 (N-P-K) level to 0.25% at the 400-87-0 level. The P level in this forage appears to be adequate for most livestock needs (Morrison, 1936).

The K content of the forage increased significantly with each increment of applied K and ranged from 0.74% at the 400-22-0 level to 1.84% at the 400-22-165 level (Table 1). At the three lower levels of K application, the K content of the forage decreased with increasing N levels. At the 165-lb level of K application, the K content of the forage increased with increasing N levels. The 200- and 400-N levels, the percentage K in the forage more than doubled as the K application was increased from 0 to 165 lb/acre.

Apparently, Coastal bermudagrass requires a high potassium content in the forage for optimum growth. Pronounced potassium deficiency symptoms—chlorotic leaves with dead edges—were observed on treatments receiving high N and low K applications, although forage samples from these treatments contained about 1% potassium.

P and K Content of Clover Forage.—The percent P in the crimson clover forage increased significantly with each increment of P applied to the Coastal bermudagrass (Table 2). The range was from 0.20% P at the 100-0-83 level of fertilization to 0.41% at the 0-87-0 level. The P content of the clover decreased slightly with increasing rates of both N and K.

The percent K in the clover forage ranged from 0.98 at the 0-K level to 3.00 at the 165-K level. There was a small, but

Table 1. Protein, phosphorus and potassium content of Coastal bermudagrass grown with Crimson clover at four levels each of nitrogen, phosphorus and potassium. 3-year average, 1955-1957.

N	P	Average Protein % at K Levels (Lb/A.)					Average P % at K Levels (Lb/A.)					Average K % at K Levels (Lb/A.)				
lb/A.	lb/A.	0	41	83	165	Avg.	0	41	83	165	Avg.	0	41	83	165	Avg.
0	0	9.87	9.75	9.81	9.44	9.71a	.20	.20	.18	.20	.20a	1.15	1.42	1.47	1.54	1.40a
	22	9.69	9.87	9.56	9.69	9.70a	.22	.22	.22	.21	.22b	1.16	1.35	1.56	1.62	1.42a
	43	9.56	9.81	9.37	9.75	9.62a	.23	.23	.24	.22	.23c	1.20	1.33	1.44	1.61	1.40a
	87	9.62	9.62	9.87	9.75	9.71a	.24	.25	.23	.23	.24d	1.23	1.49	1.54	1.59	1.46a
	Avg.	9.68a*	9.67a	9.65a	9.66a		.22a	.22a	.22a	.22a		1.19a*	1.40b	1.50bc	1.59c	
100	0	11.10	10.62	10.94	10.81	10.87a	.18	.19	.17	.17	.18a	1.00	1.28	1.57	1.61	1.37a
	22	11.00	10.81	10.75	10.44	10.75a	.22	.21	.20	.20	.21b	0.86	1.23	1.46	1.74	1.32a
	43	10.87	10.56	10.62	10.62	10.67a	.23	.22	.21	.22	.22c	0.93	1.24	1.49	1.71	1.34a
	87	10.56	10.81	10.94	10.56	10.72a	.23	.24	.23	.23	.23c	0.84	1.30	1.47	1.74	1.34a
	Avg.	10.88a	10.70a	10.81a	10.61a		.21a	.21a	.20b	.21a		0.91a	1.26b	1.50c	1.70d	
200	0	13.19	12.56	12.31	12.25	12.58a	.18	.17	.17	.17	.17a	0.88	1.16	1.55	1.80	1.35a
	22	13.37	12.31	12.44	12.31	12.61a	.22	.21	.21	.21	.21b	0.81	1.15	1.30	1.73	1.25a
	43	13.62	12.69	12.25	12.31	12.72a	.23	.23	.21	.21	.22c	0.86	1.20	1.33	1.84	1.31a
	87	13.06	12.37	12.12	12.12	12.42a	.23	.24	.23	.23	.23d	0.74	1.17	1.36	1.71	1.25a
	Avg.	13.31a	12.48a	12.28a	12.25a		.22a	.21a	.20b	.20b		0o82a	1.17b	1.39c	1.77d	
400	0	15.50	15.06	14.87	14.75	15.04a	.19	.17	.17	.18	.18a	0.87	1.14	1.53	1.90	1.36a
	22	15.81	15.56	15.12	15.31	14.45b	.23	.22	.20	.22	.22b	0.74	1.12	1.34	1.84	1.26a
	43	16.37	15.69	15.87	13.31	15.31c	.23	.23	.22	.22	.23c	0.84	1.06	1.78	1.80	1.25a
	87	15.56	15.31	15.37	15.44	15.42b	.25	.24	.24	.24	.24d	0.83	1.08	1.31	1.75	1.24a
	Avg.	15.81a	15.40b	15.31b	14.70c		.23a	.21b	.21b	.21b		0.82a	1.10b	1.37c	1.82d	

*Means in each group of four followed by the same letter are not significantly different at the 5 percent level of probability.

significant, reduction in the K content of the clover with increasing rates of both N and P. The K content of the clover generally declined at a constant K level with increasing N levels. This reduction reflected the increased uptake of K by the Coastal bermudagrass forage with increasing rates of N fertilization.

The percent K in the crimson clover forage declined at all fertilizer levels from 1955 to 1956 except where N was limiting all high K levels. At the 200- and 400-N levels, the decline in the percent K in the clover was as much as 25% from 1955 to 1956.

Nutrient Uptake and Recovery by Coastal bermudagrass and Crimson clover.—When the supply of other nutrients was adequate, Coastal bermudagrass made efficient recovery of applied N (Table 3). The efficiency of N recovery in the forage decreased as the N fertilization rate increased. Up to the 200-N level, Coastal bermudagrass recovered 86% of the applied N. Even at the 400-N level, 68% of the applied N was recovered in the Coastal forage during the year applied.

The excellent recovery of N by Coastal bermudagrass on Piedmont soils is similar to that reported on Coastal Plain soils (Burton et al., 1962) and indicates that this grass is efficient in N recovery under widely varying conditions.

The recovery of P in the

Table 2. Phosphorus and potassium content of Crimson clover grown on Coastal bermudagrass at four levels each of nitrogen, phosphorus and potassium. 3-year average, 1955-1957.

N Levels	P Levels	Avg. Phosphorus % at K Levels, lb/A.					Avg. Potassium % at K Levels, lb/A.				
lb/A.	lb/A.	0	41	83	165	Avg.	0	41	83	165	Avg.
0	0	.25	.22	.24	.24	.29a	1.31	1.93	2.48	3.00	2.18a
	22	.33	.30	.32	.33	.32b	1.31	1.69	2.45	3.00	2.11ab
	43	.38	.38	.39	.37	.38c	1.20	1.59	2.31	2.72	1.96 bc
	87	.41	.41	.39	.40	.40d	1.34	1.73	2.05	2.60	1.93 c
	Avg.	.34a*	.33b	.34a	.39c		1.29a*	1.74b	2.32c	2.83d	
100	0	.23	.22	.20	.22	.22a	1.11	1.73	2.36	2.79	2.00a
	22	.36	.31	.31	.28	.32b	1.11	1.51	2.00	2.82	2.00 b
	43	.38	.37	.36	.37	.37c	1.11	1.47	2.01	2.58	1.79 c
	87	.38	.41	.39	.38	.39d	1.22	1.44	1.90	2.58	1.79 c
	Avg.	.34a	.33b	.32c	.31c		1.14a	1.54b	2.07c	2.69d	
200	0	.27	.22	.22	.22	.23a	1.13	1.40	2.02	2.66	1.80a
	22	.36	.33	.29	.32	.33b	1.02	1.40	1.81	1.73	1.49 b
	43	.36	.35	.31	.32	.34c	.98	1.29	1.64	2.31	1.56 b
	87	.41	.39	.40	.39	40d	1.54	1.49	1.76	2.37	1.79a
	Avg.	.35a	.32b	.31c	.31c		1.17a	1.40b	1.81c	2.27d	
400	0	.29	.24	.26	.23	.26a	1.26	1.58	1.83	2.39	1.77a
	22	.30	.28	.32	.30	.30b	1.13	1.27	1.20	2.20	1.58 b
	43	.36	.37	.34	.34	.36c	1.18	1.31	1.61	2.17	1.57 b
	87	.39	.39	.37	.38	.38d	1.21	1.19	1.67	2.20	1.57 b
	Avg.	.33a	.32b	.33a	.31c		1.20a	1.34b	1.70c	2.24d	

*Means in each group of four followed by the same letter are not significantly different at the 5 percent level of probability.

Table 3. Nitrogen, phosphorus and potassium uptake and percent recovery by Coastal bermudagrass and crimson clover—1955-1957.

Nitrogen*			Phosphorus**					Potassium***				
Rate N	Uptake[1] N	Recovery	Rate P	Uptake, P Grass	Uptake, P Clover	Uptake, P Total	Recovery	Rate K	Uptake, K Grass	Uptake, K Clover	Uptake, K Total	Recovery
lb/A.	lb/A.	%	lb/A.	lb/A.	lb/A.	lb/A.	%	lb/A.	lb/A.	lb/A.	lb/A.	%
0	77.5		0	20.6	6.3	26.9		0	95.1	5.5	100.6	
100	163.9	86	22	27.2	9.7	36.9	45	41	135.2	14.7	149.9	120
200	248.7	86	43	29.8	10.7	40.5	32	83	184.2	24.9	209.1	131
400	348.1	68	87	34.5	15.0	49.5	26	165	259.5	61.4	320.9	133

*At 87-165 (P-K) **At 400-165 (N-K) ***At 400-87 (N-P)

[1]Clover not included.

Coastal and clover forage was considerably lower than the recovery of N (Table 3). The recovery of P at the 22, 43 and 87 lb/acre P levels was 45, 32 and 26%, respectively.

Coastal bermudagrass recovered the applied K more efficiently than any other nutrient (Table 3). The K absorbed from the soil by the Coastal and clover exceeded that applied at every level of K application. Even where 165/acre K were applied annually, at the 400-N level the K removal (grass and clover) was almost double that applied. The depletion of soil K at high forage production is in contrast to the accumulation of soil K at low N levels. The removal of K in the harvested forage at the lower N levels was not sufficient to seriously deplete the soil K.

The P and K uptake by crimson clover (Table 3) primarily reflects the influence of N, P and K levels on clover production. Both P and K uptake closely followed clover production when varying levels of each were applied. The P uptake by crimson clover was reduced by increasing nitrogen levels applied to the bermudagrass. This reduction in total P uptake was primarily due to a reduction in the yield of crimson clover. The P uptake by the clover increased with increasing levels of applied P (Table 3); P uptake at the 400-87-165 level was more than double that at the 400-0-165 level.

Increasing levels of N similarly affected K uptake by the crimson clover. The K uptake was reduced from 76.5 lb/acre at the 0-87-165 level to 61.4 lb. at the 400-87-165 level. Increasing levels of K increased K uptake by the clover and resulted in an elevenfold increase in K uptake from the 400-87-0 level to the 400-87-165 level (Table 3). This increase in K uptake was due primarily to the increased growth of the clover.

Supplementing Native Ranges. —Practically all southern ranges are seasonal and a combination of range and tame pasture must usually be worked out to achieve a practical year-round livestock operation. Improved pastures supplement forest range by providing: (1) hay in the spring and early summer for winter feeding, (2) fire-break strips through the forest and (3) furnish forage for livestock when they should be off the range. However, when native range is available to carry animals at least a part of the year, the overall cost of operation is generally reduced below that when cattle are carried on tame pastures throughout the year (Halls et al., 1964; Williams et al., 1955).

Summary

Increasing levels of N, P or K increased the percentage of protein, P or K, respectively, in the Coastal bermudagrass forage; also increased the total nutrient uptake of all three nutrients by Coastal bermudagrass. At the 400-N level of fertilization the P content of Coastal bermudagrass forage increased from 0.19% with no P fertilization to 0.25% when 87 lb. of P were applied. At the 400-N level the K content of Coastal forage increased from 0.83 to 1.15% as K fertilization was increased from 0 to 165 lb/acre. In general, much more P was applied than was recovered in the forage. High N fertilization resulted in the removal of almost two times as much K as was applied.

The P and K content of crimson clover increased with increasing rates of application of each nutrient at all N levels.

The percent recovery of N and P in forage declined with increasing rates of fertilization of each nutrient, whereas percent K recovery increased as K fertilization increased.

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