UTILIZATION OF TOPDRESSED SUPERPHOSPHATE BY PASTURE FORAGES IN SOUTHEASTERN VIRGINIA

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Research Report No. 10

Virginia Agricultural Experiment Station
Virginia Polytechnic Institute
Blacksburg, Virginia

July, 1957

UTILIZATION OF TOPDRESSED SUPERPHOSPHATE BY PASTURE FORAGES IN SOUTHEASTERN VIRGINIA[1/]

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With the increase of livestock farming in southeastern Virginia, greater emphasis ultimately must be placed on efficient pasture practices. Much of the pasture land in this section is only infrequently reseeded. Hence, for production of high quality forage, considerable quantities of available phosphorus are necessary and it is likely that phosphorus amendments should be applied on the pastures at various intervals, rather than in a single heavy application prior to their establishment.

Formerly, many investigators believed that because of its slow penetration into the soil all phosphate fertilizer should be mixed thoroughly with soil. However, considerable evidence (4,6,8,9,10,11) has been accumulated verifying the effectiveness of topdressed superphosphate on established pastures. Studies by Caldwell, et al. (1) and Lawton, et al. (5) indicated that as the rate of topdressed superphosphate increased, the percentage of plant phosphorus derived from the fertilizer also increased quite markedly. These investigators noted that in some cases as much as 50% of the total plant phosphorus was derived from the topdressed phosphate.

One objective of this study was to investigate, by use of superphosphate tagged with radioactive phosphorus (P32), the extent to which topdressed phosphate is utilized by established forages in southeastern Virginia. Also, the amount of phosphorus extracted from the soil by certain chemical tests is compared with that indicated to be readily available by the proportion of plant phosphorus derived from the topdressed superphosphate.

METHOD and MATERIALS

Ten plot sites in certain established pastures occurring on the Tidewater Research Station at Holland, Virginia were selected each

1/This study was supported in part by a grant from the American Bank and Trust Company, Suffolk, Virginia.

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year in 1953, 1954 and 1955. The herbage was clipped close to the ground and removed before broadcasting the tagged superphosphate at a rate of 50 pounds of P_2O_5 per acre. In each of the years, the fertilizer was topdressed on the meadows during the first week of April. The plots were 4 feet square and protection from grazing animals was provided by wire cages fastened to the ground.

Forage samples were obtained approximately 6 weeks following application of the fertilizer and separated into legume and grass constituents, predominantly ladino clover and orchard grass, respectively. The herbage was dried at 700° C and then ground in a Cristy mill. Samples of the ground material were ashed at 400° C and analyzed for total phosphorus content by use of ammonium vanadate. Radioactivity determinations were made by the solution counting technique. No information was recorded in regard to yields or the proportion of grasses and legumes in the samples.

Soil samples were obtained just prior to fertilization by sampling (10 or more borings per plot sample) the soil immediately surrounding each plot to a depth of 4 inches. The pH of the samples was determined, utilizing a 1 to 1 soil-water ratio, and the amounts of soil phosphorus extractable by $NaHCO_3$ (7), 0.002N H_2SO_4 (12), and cool 0.2N NaOH (3) were also determined. In the case of the 1954 and 1955 data, correlation coefficients were determined for the relationship of the 'A' values (2) to the amounts of soil phosphorus extracted by various reagents. Also, the amounts of soil phosphorus extracted by these reagents were correlated with each other.

The plots were located on imperfectly drained loam and fine sandy loam soils. The forage stands were good in all plots and potash levels were adequate.

RESULTS and DISCUSSION

Utilization of Topdressed Superphosphate

The pertinent data obtained from the soil and plant samples during 1953, 1954 and 1955 are given in table 1. In general, the phosphorus content of the grasses and legumes was similar, although that in the grasses tended to be slightly higher in 1954 and 1955. Also, the average percentage of plant phosphorus derived from the fertilizer by both grasses and legumes was similar. On some plots, as much as 40% of the phosphorus absorbed by the crops came from the fertilizer. In comparison with results elsewhere (1,5), utilization of topdressed superphosphate by established forages in this area was entirely satisfactory. Furthermore, in view of the rather low application of fertilizer (50 lbs./A. P_2O_5) and the high level of available

residual soil phosphorus in most of the plots (table 1), the results obtained demonstrate the effectiveness of topdressed superphosphate on established pastures in southeastern Virginia and justify recommendation of this procedure.

Correlation of 'A' Values with Certain Chemical Methods

The simple correlation coefficients determined for the relationships between the 'A' values and the amounts of soil phosphorus extracted by each of the three reagents and also between the amounts of soil phosphorus removed by each of the chemical extractants are presented in table 2. These correlation coefficients indicate strikingly closer relationships between 'A' values calculated from phosphorus utilization by grasses with that extracted by the chemical soil tests, than in the case of the legume-based 'A' values. Although the average percentage of plant phosphorus derived from the fertilizer was similar for any year as stated earlier, plot to plot differences were observed that probably caused the poor correlations found between 'A' values and chemical soil test results in the case of legumes. Two probable explanations of these findings are (1) the legumes may have obtained more phosphorus throughout a deeper zone than the grasses and therefore chemical extraction of samples of only the surface layer of soil would not be representative, and (2) the exposed stolons and the few remaining broad leaves of the legumes after removal of the herbage before fertilization may have absorbed enough P32 directly to account for the equivalent average uptake of fertilizer phosphorus by legumes as by grasses. Thus, the uptake of P32 by the legumes might not be closely related to the amount of available residual soil phosphorus in the sampled areas. Apparently, the more fibrous nature of the grass roots near the soil surface (top 3 to 4 inches) provided more representative absorption of soil and fertilizer phosphorus.

As shown in table 2, both the Truog (0.002N H_2SO_4) and the $NaHCO_3$ methods correlated equally well with the 'A' values calculated from P32 uptake by grasses. The 'A' values also correlated well with the cool 0.2N NaOH soluble forms of soil phosphorus in the case of the 0 to 2" layer sampled in 1955. However, this indicated that generally either the Truog or the $NaHCO_3$ method is preferable to 0.2N NaOH when checking pastures for content of readily available soil phosphorus.

The precipitation by weeks is given in table 3 for the spring periods of 1953, 1954, and 1955 when the tagged superphosphate was topdressed on the pasture plots and the forage grown. Note that some moisture was received each week during all of the growing periods considered. Adequate rainfall was obtained, for the most part, to support good forage growth and for sufficient penetration of the applied superphosphate. Therefore, availability of the fertilizer was probably not limited by weather conditions.

Summary

Radioactive materials were used to study the efficiency of topdressed superphosphate on established forages in southeastern Virginia. Also, 'A' values were compared with results of certain chemical tests for readily available soil phosphorus. In general, the results were as follows:

1. The average percentage of plant phosphorus derived from the fertilizer by both grasses and legumes was similar.

2. Utilization of topdressed superphosphate was sufficient to warrant recommendation of this method of application on established pastures in southeastern Virginia.

3. Correlation studies indicated strikingly closer relationships between 'A' values calculated from phosphorus utilization by grasses with that extracted by certain chemical soil tests, than in the case of the legume-based 'A' values.

4. Of the chemical soil tests studied, both the Truog (0.002N H_2SO_4) and the $NaHCO_3$ methods correlated equally well with the 'A' values and should provide reliable information regarding soil phosphorus availability to forages in southeastern Virginia.

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Table 1. Phosphorus uptake by established legumes and grasses, calculated 'A' values, and amounts of soil phosphorus extracted by various reagents, April-May period 1953-55, Holland, Va.

Plot Area	Plant Analyses: % Total P In Plants		Plant Analyses: % P Derived From P32		pH	Soil Analyses*: Pounds Available Soil P Per Acre				
						'A' Value		Truog Test	0.2 N NaOh	$NaHCO_3$ Test
	Grass	Legume	Grass	Legume		Grass	Legume		Inorg. Org.	
1953										
1	-	0.51	-	14.7	5.5	-	125	144	- -	-
2	-	0.46	-	11.5	5.5	-	168	154	- -	-
3	0.27	0.43	11.7	18.9	5.5	162	94	88	- -	-
4	0.32	0.46	13.4	10.9	5.3	140	175	96	- -	-
5	0.34	0.45	14.3	9.4	5.1	130	210	102	- -	-
6	0.38	0.48	14.1	19.1	5.4	133	92	68	- -	-
7	0.30	-	12.5	-	5.7	150	-	43	- -	-
8	-	0.46	-	19.9	5.3	-	86	84	- -	-
9	0.40	0.42	23.2	23.2	4.8	72	72	72	- -	-
10	0.48	0.39	15.9	16.5	5.5	115	111	69	- -	-
1954										
11	0.32	0.25	11.0	13.1	5.7	174	144	334	344	64 126
12	0.41	0.29	10.7	24.2	6.1	179	68	240	240	220 92
13	0.40	0.31	35.9	27.4	6.1	40	58	109	160	170 50
14	0.35	0.32	11.9	11.2	5.6	161	171	274	394	118 130
15	0.28	0.33	31.4	41.6	5.7	48	31	89	134	130 38
16	-	0.30	-	10.6	5.3	-	184	171	332	48 112
17	0.34	0.29	14.4	7.1	5.5	129	285	194	212	168 78
18	0.33	0.29	16.4	20.5	5.3	111	84	106	176	56 70
19	0.33	0.26	14.2	11.9	5.7	132	161	104	258	122 42
20	0.45	0.32	28.7	25.0	6.0	54	65	112	374	218 74
1955										
21	0.36	-	12.9	-	6.1	145	-	280	160	155 104
22	-	-	-	-	5.7	-	-	280	210	340 165
23	0.34	-	6.9	-	5.6	290	-	660	400	540 240
24	0.34	0.26	14.8	19.3	6.1	123	90	95	150	180 41
25	0.34	0.25	15.1	11.0	6.0	120	174	105	200	220 44
26	0.33	0.25	14.5	12.8	6.0	126	146	105	210	290 47
27	0.34	0.27	15.0	21.4	6.1	122	79	93	200	220 46
28	0.42	0.42	14.7	18.6	6.3	125	94	420	210	250 103
29	0.44	0.45	9.7	12.4	6.2	200	152	292	170	330 80
30	0.41	0.43	11.7	11.3	6.4	162	169	362	210	315 109

* Soils were sampled at 0-4" depth each year. The 1955 borings were divided in half and data shown represent 0-2" soil layer.

Table 2. Simple correlation coefficients for all combinations among the calculated 'A' values and the amounts of soil phosphorus extracted by the 0.002N H_2SO_4, cool 0.2N NaOH, and $NaHCO_3$ methods.

	Variables Correlated	Correlation Coefficients 1954 0-4"	1955 0-2"	1955 2-4"
1.	'A' values from legumes and 0.002N H_2SO_4 (Truog test) extractable soil P	0.36	0.13	0.14
2.	'A' values from legumes and 0.2N NaOH extractable inorganic soil P	0.31	0.26	0.01
3.	'A' values from legumes and 0.2N NaOH extractable organic soil P	-0.25	0.59	0.68[1]
4.	'A' value from legumes and $NaHCO_3$ extractable soil P	0.40[2] (0.81)	0.20	0.05
5.	'A' values from grasses and 0.002N H_2SO_4 extractable soil P	0.81**	0.82**	0.61[1]
6.	'A' values from grasses and 0.2N NaOh extractable inorganic soil P	0.44	0.81**	-0.17
7.	'A' values from grasses and 0.2N NaOH extractable organic soil P	-0.24	0.91**	0.56
8.	'A' values from grasses and $NaHCO_3$ extractable soil P	0.72*	0.89**	0.80**
9.	Soil P extracted by 0.002N H_2SO_4 and 0.2N NaOH, inorganic form	0.56	0.75*	0.29
10.	Soil P extracted by 0.002N H_2SO_4 and 0.2N NaOH, organic form	-0.15	0.76*	0.73*
11.	Soil P extracted by 0.002N H_2SO_4 and $NaHCO_3$	0.87**	0.90**	0.05
12.	Soil P extracted by 0.2N NaOH, inorganic form and organic form	-0.08	0.88**	0.36
13.	Soil P extracted by 0.2N NaOH, inorganic form and $NaHCO_3$	0.76*	0.79**	-0.10
14.	Soil P extracted by 0.2N NaOH, organic form and $NaHCO_3$	-0.32	0.81**	0.30

* Significant at 0.05 level.
** Significant at 0.01 level.
1 Nearly significant at 0.05 level.
2 Coefficient obtained by omission of one observation that appeared questionable.

Table 3. Precipitation by weeks for spring periods of 1953-55 when P32 superphosphate was topdressed on the pastures. (Holland, Va.)

Month	Week	Years 1953	1954	1955	Normal
March	1	1.31	1.22	2.06	
	2	0.57	1.42	0.21	
	3	0.35	0.32	1.21	
	4	0.29	0.84	0.08	
	Total	2.52	3.80	3.56	3.55
April	1	0.80	0.74	0.10	
	2	1.67	0.14	0.89	
	3	0.69	0.74	0.33	
	4	0.10	0.77	1.89	
	Total	3.26	2.39	3.21	3.56
May	1	2.08	0.23	0.08	
	2	0.18	2.90	0.44	
	3	2.31	2.39	0.09	
	4	0.07	0.41	1.62	
	Total	4.64	5.93	2.23	3.14