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Drawdown of Soil Test Phosphorus and Potassium Levels by Alfalfa

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BACKGROUND

Alfalfa hay production removes large amounts of phosphorus (P) and potassium (K) from soils. Because of this, there is always interest in the reduction of soil test phosphorus (STP) and soil test potassium (STK) levels by high-yielding alfalfa. Regimented soil sampling for 2 years during an on-farm fertilizer study on a high yielding alfalfa field provided an insight into this.

METHODOLOGY

Soil samples (0-4 inch depth) were taken as part of a magnesium (Mg) and sulfur (S) study with alfalfa (var. Multistar) on the Eldon Calebs farm in Meade Co., KY, during the second and third year of productivity. Although mapped as a Crider soil, the soil characteristics more closely resemble Memphis soils. Since no P or K fertilizer was applied during the two years of this study, and since neither Mg nor S fertilization significantly increased hay yields, STP and STK levels were monitored to determine the effect of P and K removal by the two years of alfalfa hay production. Soil samples were analyzed by the University of Kentucky's Soil Testing Laboratory at Lexington, by use of Mehlich-3 extractant. Alfalfa hay yields were measured by weighing growth from a 11 ft length of an 8 ft 7 in wide mower swath through the center of each 25 ft x 25 ft plot. Grab samples were taken for use in determining moisture and nutrient content. Soil

samples from the 16 individual plots used for the study were initially taken following the first cutting of hay in May of 1998, when the Mg-S study began, and then again after the last harvest in October of 1998. They were sampled again on April 18, 1999 (before rapid growth began), October 23, 1999, and on February 23, 2000. Alfalfa hay yields of the fifth and sixth cutting in 1998 were reduced by drought. Despite drought stressed production, hay yield in 1998 was 5.6 T/A for the second through the sixth clippings (7.3 T/A, including the 1st clipping made by the producer prior to beginning the study). In 1999, only three cuttings were made (the last on July 23) because of severe drought. However, those 3 cuttings yielded 5.2 T/A.

RESULTS

Soil Test Phosphorus – Data from the 16 individual plots and the average of them are shown in Table 1. In 1998, removal of 36 lbs P/A (82 lbs P_2O_5) by alfalfa reduced the average STP from 70 lbs/A on 5-26-98 to 59 lbs/A at the end of the season on 11-05-98. Level of STP then dropped slightly during the overwinter period, to 54.5 lbs/A on 4-08-99. Following average removal of 29 lbs P/A (66 lbs P_2O_5) by alfalfa growth during 1999, average STP levels dropped further, to 43.8 lbs P/A on 10-25-99. During the overwinter period, they increased to 52 lbs P/A. A summary of P removal by alfalfa and drop in STP level from 5-26-98 to 2-23-2000 is shown in Table 2. The 2-year removal of 65.4 lbs P/A (150 lbs P_2O_5) resulted in a 18.7 lb P/A drop in STP. This 2-year change can be described as: with no P fertilization, each pound of P (2.29 lbs P_2O_5) removed by alfalfa dropped STP levels by 0.29 lbs P/A. Or, STP dropped by 1 lb P/A for each 3.4 lbs

P/A (8 lbs P_2O_5) removed. This rate of reduction in STP is very similar to the rate at which fertilizer P_2O_5 increased STP.

Soil Test Potassium – Individual plot data and averages are shown in Table 3. Average STK dropped from 487 lbs K/A on 5-26-88 to 336 on 11-05-98, following removal of 272 lbs K/A (326 lbs K_2O) by alfalfa. A further decrease in STK level occurred overwinter, down to 281 lbs K/A on 4-08-99. Alfalfa removed 192 lbs K/A (230 lbs K_2O) in the 3 hay clippings made during 1999. Despite this removal, STK levels had increased from 281 to 328 lbs K/A on 10-25-99. There was a slight drop in STK level overwinter, to 314 lbs/A on 2-23-2000. These data for the 2 year period 5-26-98 to 2-23-2000, are summarized in Table 4. Removal of 466 lbs K/A (559 lbs K_2O) during this period resulted in STK dropping by 173 lbs K/A. This 2-year change can be described as: with no K fertilization, each pound of K (1.2 lbs K_2O) removed by alfalfa, dropped STK by 0.37 lbs/A. Or, STK dropped by 1 lb/A for each 2.7 lbs K (3.24 lbs K_2O) removed. This rate of reduction in STK is very similar to the rate at which K_2O fertilizer increases STK.

SUMMARY

Decreases in STP and STK were less than the amounts of P and K removed by the crop, and indicate that after a build-up of soil test levels, it may take several years for crop removal to reduce them to original levels. The effect of P_2O_5 and K_2O removal by alfalfa hay production on reduction of STP and STK levels are similar to those found previously and confirm the use of currently used ratios of buildup/removal to predict

changes in soil test levels. Average removal per ton of alfalfa hay (12% moisture) for the 2 years was 6.1 lbs P (13.9 lbs P_2O_5) and 43.1 lbs K (51.8 lbs K_2O).

Table 3. Effect of K Removal by Alfalfa (Dry Matter Basis) on Change in Soil Test K

	1998			1999			2000
Plot	STK (lbs/A) 5-26-98[1/]	K-Removal[2/] lbs/A	STK (lbs/A) 11/05/98[3/]	STP (lbs/A) 04-08-99[4/]	K-Removal[5/] lbs/A	STK (lbs/A) 10-25-99	STK lbs/A 2-23-2000
1	417	234	302	222	160	181	231
2	339	203	240	205	219	249	242
3	495	269	335	279	187	280	387
4	445	274	404	281	224	256	371
5	475	253	278	227	142	225	279
6	395	230	263	229	149	257	282
7	547	298	381	328	178	304	362
8	633	294	442	340	232	381	341
9	643	262	286	280	163	452	285
10	467	300	317	284	178	264	303
11	459	251	289	235	204	448	295
12	497	290	416	282	194	347	369
13	514	281	404	329	215	621	356
14	503	304	325	330	203	299	298
15	498	316	410	349	265	331	317
16	464	287	279	295	204	346	309
AV	487	272	336	281	192	328	314

[1/] after 1st cutting
[2] total from cuttings 2-6 (K x 1.2 = K_2O)
[3/] after last cutting
[4/] before initial growth
[5/] total from cuttings 1-3 (K x 1.2 = K_2O)

No fertilizer K was applied during 1998 or 1999

Table 1. Effect of P Removal by Alfalfa (Dry Matter Basis) on Change in Soil Test P

	1998			1999			2000
Plot	STP (lbs/A) 5-26-98[1/]	P-Removal[2/] lbs/A	STP (lbs/A) 11/05/98[3/]	STP (lbs/A) 04-08-99[4/]	P-Removal[5/] lbs/A	STP (lbs/A) 10-25-99	STP lbs/A 2-23-2000
1	57	34	45	44	27	26	34
2	32	32	20	25	24	19	25
3	54	37	49	40	32	29	39
4	37	35	36	26	25	23	27
5	77	35	60	49	27	39	48
6	55	34	37	43	27	32	43
7	76	37	64	60	29	45	55
8	88	37	89	70	34	41	56
9	95	34	51	47	27	46	51
10	62	37	50	44	29	36	38
11	53	35	43	41	31	29	35
12	85	39	88	63	32	50	65
13	77	34	79	80	32	62	73
14	93	38	70	79	27	72	73
15	83	39	86	79	35	66	77
16	92	38	76	82	34	84	78
AV	70	36 (82 P_2O_5)	59	54.5	29 (66 P_2O_5)	43.8	52

[1/] after 1st cutting
[2] total from cuttings 2-6 (P x 2.29 = P_2O_5)
[3/] after last cutting
[4/] before initial growth
[5/] total from cuttings 1-3 (P x 2.29 = P_2O_5)

No fertilizer P was applied during 1998 or 1999

Table 2. Effect of P-Removal by Alfalfa (Dry Matter Basis) on Reduction of STP over a 2 Year Period

Plot		2-YR P-Removal. lbs/A	2-YR drop in STP (lbs/A)
1		61	23
2		56	7
3		69	15
4		60	10
5		62	29
6		61	12
7		66	21
8		71	32
9		61	44
10		66	24
11		66	28
12		71	20
13		66	4
14		65	20
15		74	6
16		72	14
	Av.	65.4 (150 P_2O_5)	18.7

Table 4. Effect of K-Removal by Alfalfa (Dry Matter Basis) on Drawdown of STK

Plot	2-YR K-Removal. lbs/A	2-YR drop in STK (lbs/A)
1	394	186
2	422	97
3	456	108
4	498	74
5	395	196
6	379	113
7	476	185
8	526	292
9	425	358
10	478	164
11	455	164
12	484	128
13	496	158
14	507	205
15	581	181
16	491	155
Av.	466	173