EFFECT OF SOIL TREATMENT ON FORAGE YIELDS AND VEGETATIONAL GROUND COVER

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Vegetational response to soil treatments can be measured by a number of different methods. Yield of dry matter is a conventional method usually employed; however, the yield from a given area does not provide a measure of the contribution of individual species to the total, nor does it indicate the percentages of weeds and other undesirable species present. Separation of species by manual methods is tedious and expensive. Because of this, much valuable data is lost, particularly as it relates to the effect of fertilizer materials on the occurrence of species in a turf.

Some two decades ago the point quadrat method was (1) introduced as a machine for measuring ground cover. Although it is not suited for use with tall vegetation, it does have a distinct place in making measurements on pastures and other types of turf. The point quadrat (Fig. 1) provides a rapid method of measuring the botanical composition of vegetation. It does not measure yields in terms of grams or pounds, although some recent work by Arny et al (2) using a series of factors did indicate that the point quadrat could be used to give both a measure of yield and botanical composition.

The data presented in this paper were obtained in 1940 and 1941 from a series of plots at the University of Illinois Soil Experiment Field located at Elizabethtown, Illinois, in Hardin County.

MATERIALS AND METHODS

Five plots approximately 1 x 9 rods in area were seeded on September 18, 1935. Fertilizer materials and limestone were applied, crossing the seeding mixture plots. Each seeding-mixture-soil-treatment plot was one rod square.

The fertilizer materials and limestone and the annual application per acre, excepting limestone which was applied in sufficient quantity to correct acidity, were as follows:

Plot 1= 250 pounds of rock phosphate
150 pounds of sodium nitrate
Plot 2= 200 pounds of superphosphate—20 percent
150 pounds of sodium nitrate
Plot 3= 250 pounds of rock phosphate
Plot 4= 200 pounds of superphosphate—20 percent
Plot 5= 75 pounds of 9-27-9 fertilizer
Plot 6= No treatment
Plot 7=4000 pounds of limestone
Plot 8= 250 pounds of 0-24-12 fertilizer
Plot 9=4000 pounds of manure

The seeding mixtures and the acre rates of application were:

Mixture No.1=	
Kentucky bluegrass	8 pounds
Redtop	5 pounds
White clover	3 pounds
Alsike clover	3 pounds
Mixture No. 2=	
Kentucky bluegrass	8 pounds
White clover	3 pounds
Bermuda grass	6 pounds
Korean lespedeza	5 pounds

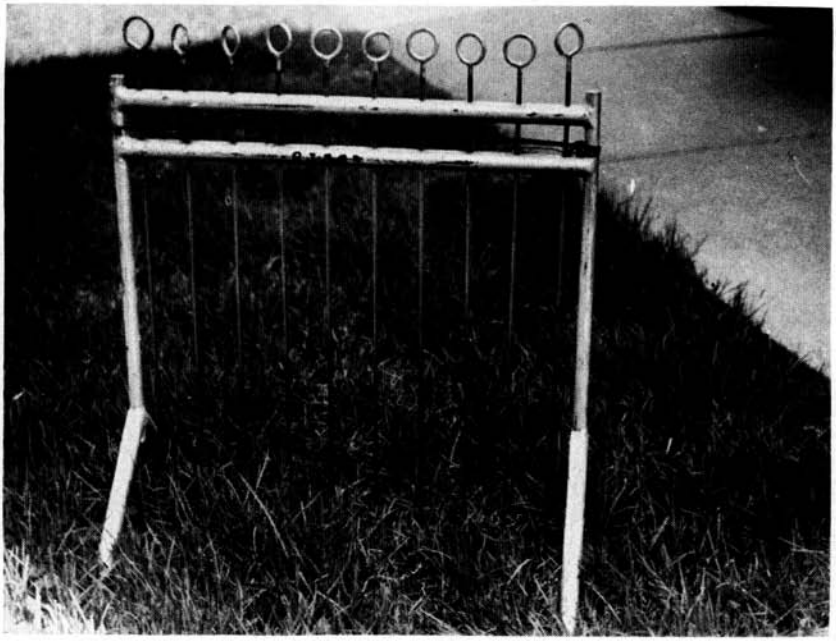

FIG. 1.—The point quadrat.

Mixture No. 3=	
Timothy	8 pounds
Redtop	4 pounds
Red clover	4 pounds
Korean lespedeza	4 pounds
Mixture No. 4.=	
Orchard grass	6 pounds
Kentucky bluegrass	3 pounds
Redtop	3 pounds
White clover	4 pounds
Korean lespedeza	4 pounds
Mixture No. 5=	
Kentucky bluegrass	8 pounds
White clover	3 pounds
Timothy	5 pounds
White sweet clover *(Melilotus alba)*	4 pounds

All fertilizers were applied beginning in 1931. The first seedings were made in 1931 and 1932. As indicated previously, new seedings were made in 1935. The data reported in this paper are for the years 1940 and 1941.

Hay yields were obtained by sampling each soil-treatment plot (with a small quadrat) twice during each season, usually early in June and again in August. Point quadrat readings were made before either the first cutting or followed the second cutting of hay or both.

RESULTS—YIELD DATA

Yields of air-dry hay for the seasons of 1940 and 1941 are given in Table 1. The relationship between seed mixtures and soil treatment is marked excepting seed mixture No. 1 which contained no lespedeza, timothy, or sweet clover. In 1940, a good season for tall growing grass species, large yields were obtained with few exceptions. In 1941, the yields were greatly reduced. This reduction was presumably caused by lack of moisture. When moisture is deficient, plants are unable to utilize fertilizer materials applied to the soil. Instead of stimulating growth these materials apparently have a drepressing effect. Where no soil treatment

TABLE 1.—HAY YIELDS FROM SOIL-TREATMENT—SEED MIXTURE PLOTS FOR YEARS OF 1940-1941

(Totals for Two Years)

Plot	Mixture No. 1 lbs./A	Mixture No. 2 lbs./A	Mixture No. 3 lbs./A	Mixture No. 4 lbs./A	Mixture No. 5 lbs./A
1	1940—1200 1941—1008	4684 974	7069 1133	6961 600	6746 773
	2208	5658	8202	7561	7519
2	1940—1400 1941—1008	2726 974	6422 1133	937 1200	7186 1030
	2408	3700	7555	2137	8216
3	1940—1754 1941— 336	703 650	636 1416	1190 600	7560 773
	2090	1353	2052	1790	8333
4	1940—1741 1941— 672	904 650	2752 850	1361 600	7274 1030
	2413	1554	3602	1961	8304
5	1940—2222 1941— 336	1194 650	2377 1133	2740 600	4768 1803
	2558	1844	3510	3340	6571
6	1940—1182 1941— 672	268 650	408 1133	302 1200	1624 1288
	1854	918	1541	1502	2912
7	1940—1195 1941— 672	326 650	1840 1416	6665 2100	2754 1288
	1867	976	3256	8765	4042
8	1940—1285 1941—1008	3344 974	4786 1416	3638 1200	5892 2061
	2293	4318	6202	4838	7953
9	1940—1416 1941— 672	504 1299	3742 1416	3052 1800	2318 2318
	2088	1803	5158	4852	4636

has been applied (Plot 6) the yield depressions did not take place.

POINT QUADRAT DETERMINATIONS

Although a number of point quadrat determinations were made, only two sets of data are included. These data are indicative of the vegetational cover. Tables 2 and 3 give quadrat data obtained in November 1940 and August 1941. One hundred point readings were made on each plot on each date.

Native grasses consisted of *Paspalum, Panicum,* and *Digitaria* sp. Some *Andropogon virginicus* (broomsedge) occurred on the lime and no treatment plots. Dominant weed species were *Plantago lanceolata, Rumex acetosella, Diodia teres, Taraxacum officinale,* and *Bursa pastoris.*

DISCUSSION OF RESULTS

Some changes in vegetational cover occurred during the two seasons, apparently a result of moisture differences. In general, a rather close relationship existed between the total contribution by species to percentage of ground cover in the two seasons (1940 and 1941). If the single species, Kentucky bluegrass (*Poa pratensis*) is taken as an example it will be noted that relative percentages showed an increase in 1941 over 1940, excepting with seed mixtures No. 2. The principal differences were in the percentages of space having no vegetation.

Another interesting difference occurred between the total percentages (all soil treatments) of ground cover contributions by the native grass species during the two seasons. Some people have expressed the opinion that the use of fertilizers is effective in eliminating native species through stimulating competition by seeded grasses. Although the differences are not large (with one exception), soil treatment apparently is not a large factor in its effect on the presence or absence of native species.

Kentucky bluegrass seed makes up part of seed mixtures 1, 2, 4 and 5: however, it appears in most of the soil-treatment — seed-mixture plots, including plots of mixture No. 3 where no bluegrass was seeded. The lowest percentages of bluegrass are found on the series of plots which did not receive fertilizer. No bluegrass was found on the untreated plot of mixture No. 3 in 1941. Where phosphorus was part of the fertilizer application treatment, Kentucky bluegrass provided the larger part of the ground cover.

Orchard grass (*Dactylis glomerata*) occurred in appreciable percentages where seeded. Some small percentages occurred on a few plots of seed mixture series No. 5. It was assumed that some seed was carried in from mixture No. 4 by wind.

Timothy (*Phleum pratense*) was seeded in mixtures No. 3 and No. 5. Only small percentages are found in seed mixture series No. 3 plots, with a trace in one plot of seed mixture series No. 2. After some six or seven years, competition and mowing seems to have limited timothy to a few surviving plants.

Redtop (*Agrostis alba*) was seeded in seed mixture series Nos. 1, 3 and 4. After a few years, redtop cannot compete successfully with Kentucky bluegrass, particularly where soil treatments favor the former. On seed mixture series No. 3 plots, where bluegrass was not a part of the original seeding, redtop is well established.

A number of other interesting relationships are apparent in Tables 1 and 2. From a practical point of view, and over a period of years, it would seem to be more economical to omit alsike clover (*Trifolium hybridum*), white clover (*Trifolium repens*), redtop and timothy and certain seeds from mixtures containing bluegrass because they do not seem to constitute a large part of the ultimate turf. However, these species fill a very definite place in seeding mixtures. Redtop, timothy, and orchard grass act as nurse crops for the more slowly germinating Kentucky bluegrass and as "filler" grasses until such a time as the more aggressive Kentucky bluegrass begins to spread.

TABLE 2.—GROUND COVER PERCENTAGES OBTAINED ON NOVEMBER 18-19, 1940

Species	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed mixture No. 1—consisting of Kentucky bluegrass, redtop, white clover and alsike clover									
Ky. bluegrass	80	49	49	55	48	36	39	54	52
Redtop	.....	.....	8	6	2	3	10	3	5
Orchard grass	.....	.....	....	....	.....	.....	....	1	....
Native grasses	.....	.....	....	....	4	8	3	2	....
White clover	.....	.....	....	1	.....	.....	....	.....	....
Alsike	.....	.....	....	1	.....	.....	....	.....	....
Lespedeza	.....	.....	2	3	4	11	5	1	....
Weeds	2	3	....	1	4	5	3	1	1
No vegetation	11	28	29	23	31	29	34	20	24
Dead vegetation	7	20	12	10	7	8	6	18	18
Seed mixture No. 2--Kentucky bluegrass, Bermuda grass, white clover, Korean lespedeza									
Ky. bluegrass	93	83	81	71	63	35	68	63	62
Timothy	.....	.....	....	....	.....	.....	2	.....	....
Native grasses	.....	.....	2	....	2	6	1	1	2
Lespedeza	.....	.....	....	2	2	10	2	2	5
Weeds	1	2	2	....	.....	6	1	10	5
No vegetation	1	3	7	15	20	36	18	13	22
Dead vegetation	5	12	6	12	13	7	8	11	4
Seed mixture No. 3—Timothy, redtop, red clover, Korean lespedeza									
Ky. bluegrass	5	16	7	12	30	.....	....	29	8
Redtop	23	43	34	27	19	25	37	10	28
Timothy	1	1	....	3	6	5	....	10	9
Orchard grass	7	.....	....	....	.....	.....	1	.....	....
Native grasses	.....	.....	....	2	.....	6	6	2	2
Lespedeza	.....	.....	6	7	4	12	9	2	7
White clover	.....	.....	....	1	.....	.....	....	.....	1
Weeds	19	.....	9	3	1	2	5	8	6
No vegetation	27	25	15	21	29	41	32	27	33
Dead vegetation	18	15	29	24	11	9	10	12	6
Seed mixture No. 4—Kentucky bluegrass, redtop, orchard grass, lespedeza, white clover									
Ky. bluegrass	23	32	42	31	28	1	1	28	4
Redtop	1	3	8	6	4	11	8	9	7
Orchard grass	45	32	13	19	21	14	24	22	11
Native grass	.....	.....	....	....	.....	.....	....	.....	1
Lespedeza	.....	.....	....	3	.....	18	23	.....	9
Weeds	5	.....	....	....	.....	6	2	1	13
No vegetation	18	29	29	35	34	31	40	33	47
Dead vegetation	8	4	8	6	12	19	2	7	8

TABLE 2—*Concluded*

Species	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed mixture No. 5—Kentucky bluegrass, timothy, sweet clover and white clover									
Ky. bluegrass	37	48	55	51	55	30	43	52	48
Redtop	.....	.....	....	....	.....	.....	2	.....	11
Orchard grass	10	14	4	....	.....	4	4	8	7
Native grasses	.....	.....	2	2	2	6	....	.....	....
Lespedeza	.....	.....	....	....	.....	2	9	.....	....
Sweet clover	.....	.....	....	....	.....	.....	1	.....	2
Weeds	20	6	12	4	3	16	6	.....	3
No vegetation	23	21	14	31	25	26	29	29	27
Dead vegetation	10	11	13	12	15	16	6	11	2

TABLE 3.—GROUND COVER PERCENTAGES ON AUGUST 14, 1941

Species	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed Mixture No. 1									....
Ky. bluegrass	74	65	45	38	43	31	51	57	55
Redtop	.....	.....	....	5	2	4	4	4	2
Native grasses	.....	.....	6	4	6	28	20	6	4
Lespedeza	.....	.....	13	14	6	13	....	.....	....
Weeds	3	2	....	....	8	5	1	6	4
No vegetation	13	18	23	27	29	19	21	22	28
Dead vegetation	10	15	13	12	6	.....	3	5	7
Seed Mixture No. 2									
Ky. bluegrass	56	57	48	53	54	37	46	48	49
Native grasses	1	.....	3	....	1	3	2	4	1
Lespedeza	.....	.....	....	4	1	7	7	1	....
Weeds	5	5	1	....	1	4	....	10	....
No vegetation	28	26	35	30	29	42	30	20	32
Dead vegetation	10	12	13	13	14	7	15	17	18

TABLE 3—*Concluded*

Species	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed Mixture No. 3									
Ky. bluegrass	29	40	9	32	2	.....	14	44	5
Redtop	15	17	40	27	15	39	55	11	29
Timothy	8	12	9	5	1	5	3	4	....
Native grasses	.....	.....	1	....	9	4	1	2	1
Lespedeza	.....	.....	....	4	56	19	2	.....	8
Weeds	16	.....	6	2	1	4	....	7	17
No vegetation	28	24	29	21	15	21	24	25	35
Dead vegetation	4	7	6	9	1	8	1	7	5
Seed Mixture No. 4									
Ky. bluegrass	23	32	30	21	27	1	5	27	10
Redtop	.....	1	2	5	4	2	....	5	1
Orchard grass	30	28	24	21	18	11	19	26	10
Native grasses	.....	.....	....	3	1	2	....	2	....
Lespedeza	.....	.....	....	8	7	60	53	3	24
Weeds	3	5	1	3	4	4	3	.....	10
No vegetation	36	26	33	28	23	16	15	25	40
Dead vegetation	8	8	10	11	11	4	5	12	5
Seed Mixture No. 5									
Ky. bluegrass	65	52	60	65	62	22	29	56	49
Redtop	.....	.....	....	....	.....	3	1	2	2
Timothy	.....	1	....	....	.....	.....	1	.....	....
Orchard grass	3	16	1	....	.....	9	3	3	2
Native grasses	.....	.....	5	6	4	33	25	1	4
Lespedeza	.....	.....	....	....	.....	2	12	.....	2
Weeds	6	11	3	3	5	6	4	1	3
No vegetation	22	13	23	20	18	22	22	29	31
Dead vegetation	4	7	8	6	11	3	3	8	7

The value of soil treatments can be assessed by comparing vegetational percentage totals and yields for the two seasons. These comparisons are shown in Tables 1 and 4.

No correlation between yields and percentages of ground cover is apparent. The relatively low yields of forage obtained from the "no treatment" plots trend toward correlation with the ground cover percentages as shown in Table 2. The high forage yields obtained from the nitrate-rock phosphate treatment are not reflected in the ground cover percentages. Weed species and orchard grass contributed materially to the forage yields on treatment plots 1, 5, 7, 8, and 9 of seed mixture No. 4.

Total yields of forage from all mixtures with the same treatment

TABLE 4.—VEGETATIONAL COVER PERCENTAGES AS AFFECTED BY SOIL TREATMENTS

Nov. 1940	Treatment plots								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
Seed Mixture									
No. 1	82	51	59	67	62	63	60	62	58
No. 2	94	83	85	73	66	57	74	76	74
No. 3	55	60	56	55	60	50	58	61	62
No. 4	74	67	63	59	54	50	58	60	45
No. 5	67	68	73	57	60	58	65	60	71
Totals	372	329	336	311	302	278	315	319	310
Average	74.4	64.8	67.2	62.2	60.4	55.6	63.0	63.8	62.0
August 1941									....
No. 1	77	67	64	61	65	[1]81	[1]76	73	65
No. 2	62	62	52	57	57	51	55	63	60
No. 3	[3]68	69	65	70	84	[2]71	[2]75	68	[3]60
No. 4	56	66	57	61	66	[2]80	[2]80	63	55
No. 5	74	[3]80	69	74	71	[1]75	[1]75	63	62
Totals	337	344	307	323	343	358	361	330	302
Average	67.4	68.8	61.4	64.6	68.6	71.6	72.2	66.0	60.4

(1) Includes large percentage of native grasses. (2) Includes large percentages of annual Korean lespedeza. (3) More than 10 per cent weed species.

are shown in Table 5. These data give conclusive evidence of the effect of these treatments on yields.

SUMMARY AND CONCLUSIONS

The effect of soil treatment on yields of air-dry hay indicate that nitrogen, phosphorus, potash and lime give large increases. Percentages of ground cover contributed by the various species are not related directly to yields when the point quadrat method is used. Some trends can be noted, but they are not consistent from year to year. Prevailing moisture conditions in a given season and the distribution of that moisture affect the percentage composition of the ground cover as well as the yields. Kentucky bluegrass (*Poa pratensis*) and orchard grass (*Dactylis glomerata*) and redtop (*Agrostis alba*) were most consistent in contributions to the percentage ground cover. The former species is aggressive and persistent on treated soils.

Some species, after a period of years, have been almost completely eliminated from the plots. Legumes, excepting Korean lespedeza (*Lespedeza stipulacea*) made up a very small part of the vegetation.

Botanical analyses using the point quadrat are valuable in measuring ground cover, but should not be re-

TABLE 5.—TOTAL YIELDS OF FORAGE FROM SOIL TREATMENT SERIES FOR 1940 AND 1941

Mixture	Soil Treatments								
	1 $NaNO_3$ rP	2 $NaNO_3$ sP	3 rP	4 sP	5 9-27-9	6 None	7 L	8 0-24-12	9 M
	Yields in Pounds Per Acre								
No. 1	2208	2408	2090	2413	2558	1854	1867	2293	2088
No. 2	5658	3700	1353	1554	1844	918	976	4318	1803
No. 3	8202	7555	2052	3502	3510	1541	3256	6202	5158
No. 4	7561	2137	1790	1961	3340	1502	8765	4838	4852
No. 5	7519	8216	8333	8254	6571	2912	4042	7953	4636
Total yields	31148	24016	15618	17684	17823	8727	18906	25604	18537
All mixtures with same treatment									

lied on as a measure of component weight contributions of the different species. Where a single specie is dominant or makes up a large percentage of the vegetation on a given plot the forage yield and point quadrat percentages are usually directly related. The inclusion of a single clump of vegetation such as orchard grass in a small yield sample can seriously disrupt this relationship, when the yield is calculated on an acre basis.

1. LEVY, B. E. AND MADDEN, E. A. The Point Quadrat Method of Pasture Analysis: New Zealand Jour. Agr., 46: 1933.

2. ARNY, A. C. AND SCHMID, A. R. A Study of the Inclined Point Quadrat Method of Botanical Analysis of Pasture Mixtures: Jour. Am. Soc. Agronomy, 34: 1942.