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THE TOTAL NITROGEN, PHOSPHORUS AND CALCIUM CONTENT OF COMMON WEEDS AND NATIVE GRASSES IN OKLAHOMA*

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Information concerning the chemical composition of natural vegetation is very limited as compared with the total number of plants which have been studied, and the major portion of the investigations which have been conducted have been confined to weeds and grasses which grow in competition with cultivated crops.

Ince (5) determined the amount of nitrogen in thirteen common weeds which occurred in the cultivated fields of North Dakota and found that twenty-four out of the twenty-seven weeds which were analyzed contained larger amounts of nitrogen and phosphorus than wheat, oats, barley, and flax. The average nitrogen content of these weeds was 2.53 per cent and the phosphorus content was .29 per cent.

Snyder (11) analyzed fifteen different weeds for nitrogen and found that on the average they contained 3.01 per cent of this element. Portulaca cleraceae contained the largest amount of nitrogen, which was 4.40 per cent. Snyder suggests that weeds are not delicate feeders because of the large amount of mineral matter which they contain and when they are burned a heavy loss of nitrogen occurs.

Pickell (10) determined the protein content of nine Florida weeds and found that most of the plants were relatively low in nitrogen as compared

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with the results secured by the two previous investigators; although Portulaca cleraceae contained 4.05 per cent nitrogen, which is similar to the result secured by Snyder (11).

Campbell (2) studied the nitrogen content in the tops of eleven winter annuals which were secured in the fall and again in the spring. He found that the spring growth contained on the average 3.53 per cent nitrogen as compared with 2.63 per cent which occurred in the leaves and stems which grew in the fall. A comparison of the nitrogen content of nine annual plants at different stages of growth indicated that a rapid decrease in nitrogen content occurs between the blooming period and maturity. Just what effect the loss of leaves had on these results was not discussed. Six weeds growing in rye contained about the same amount of nitrogen as the rye plants when harvested at different periods during the growing season. The roots of certain weeds contained smaller amounts of nitrogen than the leaves, and the stems were usually higher in plant food than the roots.

Millspaugh (8) analyzed forty-nine different plants for total nitrogen, phosphorus, and potassium, and his results indicate that the composition of weeds and grass are very similar to that of cultivated crops although a marked variation occurs in certain species.

Cooper (3) found that the nitrogen, phosphorus, and calcium contents of Poa praetensis, Danthonia spicata, and Andropogon virginicus were all low when these plants were in full bloom. Cruickshank (4) and others have shown that the nitrogen and phosphorus content of grass decreases as the season advances and that young grass is high in nitrogen.

Stutzer and Seidler (12) analyzed seven important weeds for nitrogen, phosphorus, potassium, sodium, and calcium. These weeds contained larger amounts of plant food than ordinary field crops, and in some instances plants which contained large amounts of calcium were low in potassium.

Kling (6) has made a survey of the German literature on the chemical composition of weeds and reported the analyses of six common weeds, all of which were very high in plant food. The average nitrogen content was 3.64 per cent; phosphorus, .52 per cent; calcium, 2.35 per cent; and potassium, 6.20 per cent. These analyses were much higher than those secured by Stutzer and Seidler (12) on the same kind of plants.

Korsmo (7) published a table in his book on the food value contents of fifty-three different weeds. The average nitrogen content was 2.47 per cent; phosphorus, .33 per cent; potassium, 3.29 per cent; and calcium, 1.79 per cent. A greater variation occurred in the potassium content of the different plants than in case of calcium. These analyses point out very clearly that many weeds remove large amounts of plant food from the soil.

Nielson (9) and Brenchley (1) have classified a large number of weeds on the basis of their development on soils of varying degree of acidity and texture but did not study the effect of soil conditions on the composition of different plants.

White (13) studied the growth of Rumex acetosella on limed and unlimed soils and found that this plant responded to an application of limestone; however, the stimulating effect of lime on the growth of red clover resulted in the choking out of the red sorrel due to plant competition.

EXPERIMENTAL

Erosion of cultivated soils combined with a shallow zone of organic matter accumulation in the soil profile under virgin conditions has resulted in the production of large areas of marginal land in Oklahoma. The first type of vegetation which develops on abandoned areas are annual weeds and grasses typical of those plants which were most abundant in

the fields or along the borders or in fence rows while the land was in crops.

In many areas the change from the annual weed stage to the perennial weed stage and from the perennial weed stage to the mixed weeds and grass stage occurs very slowly. The fertility of the soil is one important factor which limits the rapid development of climax grasses in many areas and the absence of seed in the soil retards the appearance of those grasses where conditions are favorable for their development.

Due to differences in climatic and soil conditions, many weeds which appear in one part of Oklahoma are not abundant in other areas. Some species, however, are adapted to a wide range of conditions and may be found in both dry and moist climates. During the season of 1927 a few of the common weeds which appear on abandoned land, in waste places, and following the harvest of small grain were collected and analyzed. The results of these analyses are given in Table I.

In all cases the plants had reached the blooming stage and do not represent an immature condition. Many of the plants contained more than 2 per cent of nitrogen, which is similar to the amount of this particular element which occurs in cultivated legumes. The phosphorus content of these plants was exceptionally high on the average even in case of plants which were growing on relatively poor soil, such as Erigeron canadensis, which is a weed commonly found on sandy land. The calcium content of all the weeds was high as compared with the calcium content of native grasses.

Soil conditions and the ratio of stems to leaves in the different species of plants are important factors in affecting the nitrogen content of the plants. Coreopsis tinctoria has a small proportion of leaves as compared with the stems and is low in nitrogen. The effect of soil on the nitrogen content of weeds is shown in case of Ambrosia artemisiifolia (Sample No. 2, Table I) and Erigeron canadensis (Sample No. 14, Table I) which grew on a very poor sandy soil, and the plants were much lower in nitrogen than similar species grown on different soil.

In order to obtain further information on this particular subject, a large number of plants were collected in December, 1932. Most of the leaves had dropped before the plants were collected; consequently the analyses represent chiefly the plant food content of the stems. These analyses are given in Table II. In most cases the phosphorus content of the stems was very much lower than that which occurred in the first group of plants which were analyzed. Also there was a marked decrease in the nitrogen and calcium content which did not occur due to leaching or maturity but is due to the fact that the nitrogen and calcium content of the leaves is much higher than in the stems.

The lowest results occurred in case of Aristida oligantha, which is one of the first plants to appear on poor eroded land. This particular plant is exceedingly low in nitrogen, phosphorus, and calcium during all of its growth stages; however on good soil it will absorb considerably larger amounts of plant food than will be found in the plants produced under unfavorable conditions. This plant is easily carried by the wind and in the absence of competition from other plants it can secure a foothold in waste areas and survive under very unfavorable conditions.

Bermuda grass was much higher in nitrogen, phosphorus, and calcium during the different growth stages than most of the other grasses studied. This is an important factor in localities where a mineral deficiency in the forage may affect the growth of livestock.

In order to secure more complete information on the composition of the many different kinds of weeds which make up the major portion of the native vegetation in meadows, along roadsides and in cultivated fields

TABLE I.

The Nitrogen, Calcium, and Phosphorus Content of Mature Weeds and Grass Collected in Oklahoma in 1927.

No.	Scientific Name	Common Name	Location	PER CENT		
				Nitrogen	Phos.	Calcium
1	Acnida tamariscina	Water hemp	8 mi. E. of Enid	1.517	.426	1.754
2	Ambrosia artemisiifolia	Annual Ragweed	1½ mi. S. E. of Glencoe	.798	.144	1.519
3	Ambrosia artemisiifolia	Annual Ragweed	Exp. Sta. Farm, Stillwater	1.802	.298	2.360
4	Ambrosia psilostachya	Perennial ragweed	A. & M. Campus, Stillwater	2.222	.265	1.651
5	Ambrosia psilostachya	Perennial ragweed	11 mi. S. W. of Stillwater	1.739	.216	1.858
6	Applopappus ciliatus	Rosin weed	East of Buffalo	1.734	.160	1.751
7	Applopappus ciliatus	Rosin weed	1 mi. N. of Okeene	1.688	.262	2.381
8	Applopappus ciliatus	Rosin weed	1 mi. N. of Carrier	1.320	.150	1.680
9	Applopappus ciliatus	Rosin weed	5 mi. S. of Stillwater	1.765	.155	1.560
10	Buchloe dactyloides	Buffalo grass	A. & M. Campus, Stillwater	2.000	.130	.336
11	Coreopsis tinctoria	Wild Flax	1½ mi. N. E. of Carrier	0.913	.264	.801
12	Coreopsis tinctoria	Wild Flax	8 mi. E. of Enid.	1.071	.304	.597
13	Cynodon dactylon	Bermuda grass, (seed stage)	Exp. Sta. Farm, Stillwater	2.065	.391	3.022
14	Erigeron canadensis	Muletail	1½ mi. S. E. of Glencoe	1.188	.285	.775
15	Erigeron canadensis	Muletail	4 mi. W. of Quinlan	1.538	.228	1.107
16	Erigeron canadensis	Muletail	East of Buffalo	2.023	.258	.975
17	Erigeron canadensis	Muletail	S. E. of Chandler	1.393	.322	.965
18	Erigeron canadensis	Muletail	1 mi. N. of Carrier	1.882	.301	1.050
19	Erigeron canadensis	Muletail	5 mi. S. of Stillwater	2.225	.258	.945
20	Erigeron canadensis	Muletail	Exp. Sta. Farm, Stillwater	2.445	.279	1.060
21	Helianthus annuus	Wild sunflower	5 mi. S. E. of Stillwater	2.310	.190	1.700
22	Lactuca scariola	Wild lettuce	East of Buffalo	1.133	.307	1.150
23	Lactuca scariola	Wild lettuce	Near Goodwell	2.112	.346	2.861
24	Melilotus alba	Sweet clover	Exp. Sta. Farm, Stillwater	1.960	.144	.790
25	Rudbeckia hirta	Blackeyed Susan	S. E. of Chandler	.932	.300	2.260
26	Syntherisma sanguinalis	Crabgrass	501 Monroe St., Stillwater	1.676	.385	.355
27	Syntherisma sanguinalis	Crabgrass	Exp. Sta. Farm, Stillwater	2.189	.256	.423
28	Xanthium commune	Cocklebur	11 mi. S. W. of Stillwater	2.309	.211	2.120

TABLE II.

Nitrogen, Phosphorus, and Calcium Content of Stems of Mature Plants Collected in December 21, 1932. Nearly all of the Leaves Had Fallen.

No.	Scientific Name	Common Name	Location	PER CENT		
				Nitr'gn	Phos.	Calcium
1	Amaranthus graecizans	Tumble weed	1 mi. N. E. of Coyle	.700	.065	1.101
2	Amphiachyris dracunduloides	Broomweed	7 mi. W. of Yale (eroded land)	.669	.034	1.055
3	Amphiachyris dracunduloides	Broomweed	2 mi. S. of Stillwater	1.080	.085	.875
4	Andropogon sorghum	Sumac cane (old)	7½ mi. S. of Stillwater	.665	.084	.326
5	Andropogon sorghum	Sumac cane (new)	7½ mi. S. of Stillwater	.325	.066	.252
6	Applopappus ciliatus	Rosin weed	2 mi. S. of Stillwater	.630	.049	1.390
7	Argemone intermedia	Prickly poppy	1 mi. N. E. of Coyle	1.200	.075	1.540
8	Aristida oligantha	Triple awned grass	2 mi. S. of Stillwater	.378	.031	.150
9	Aristida oligantha	Triple awned grass	7 mi. W. of Yale (eroded land)	.294	.011	.192
10	Aristida oligantha	Triple awned grass	7 mi. W. of Yale (Virgin prairie pasture)	.206	.011	.211
11	Croton capitatus	Goat weed	7½ mi. S. of Stillwater	.468	.081	.990
12	Croton capitatus	Goat weed	3 mi. N. E. of Guthrie	1.090	.104	1.520
13	Cynodon dactylon	Bermuda grass	5 mi. N. W. of Perkins	1.200	.117	.405
14	Cynodon dactylon	Bermuda grass	2 mi. W. of Stillwater	1.120	.174	.318
15	Helianthus annuus	Wild sunflower	3 mi. N. E. of Guthrie	.398	.032	1.470
16	Helianthus annuus	Wild sunflower	4½ mi. S. of Stillwater	.370	.035	.960
17	Helianthus annuus	Wild sunflower	2 mi. S. of Stillwater	.391	.028	.825
18	Salsola kali	Russian thistle	1 mi. N. E. of Coyle	.750	.089	1.050
19	Spermacoce glabra	Rough button weed	4½ mi. S. of Stillwater	.465	.053	1.251
20	Syntherisma sanguinalis	Crab grass	7½ mi. S. of Stillwater	.570	.063	.294
21	Syntherisma sanguinalis	Crab grass	4 mi. N. W. of Perkins	.680	.078	.302
22	Xanthium commune	Cocklebur seed	3 mi. N. E. of Guthrie	1.580	.414	.465
23	Xanthium commune	Cocklebur stems	3 mi. N. E. of Guthrie	.495	.049	2.242
24	Xanthium commune	Cocklebur leaves	2 mi. E. of Glencoe	.980	.095	4.450
25	Xanthium commune	Cocklebur stems	4½ mi. S. of Stillwater	.296	.035	1.740
26	Xanthium commune	Cocklebur stems	1 mi. N. E. of Coyle	.329	.052	1.236

Table III.—Nitrogen, phosphorus, and calcium content of weeds and grass collected during June, 1933, near Stillwater, Oklahoma. In most cases the plants were blooming and represent a maximum growth stage.

No.	Scientific Name	Common Name	Location	PER CENT		
				Nitr'gn	Phos.	Calcium
1	Achillea millefolium	Common yarrow	8 mi. S. E. of Stillwater	2.285	.304	.940
2	Amaranthus hybridus	Pigweed	Exp. Sta. Farm, Stillwater	3.600	.341	2.910
3	Amaranthus retroflexus	Pigweed	Exp. Sta. Farm, Stillwater	2.300	.124	1.900
4	Amaranthus retroflexus	Pigweed	Exp. Sta. Farm, Stillwater	2.850	.075	1.870
5	Ambrosia artemisiifolia	Common ragweed	1½ mi. S. E. of Stillwater	2.340	.330	1.890
6	Ambrosia artemisiifolia	Common ragweed	Exp. Sta. Farm, Stillwater	2.261	.154	2.501
7	Ambrosia psilostachya	Perennial ragweed	Exp. Sta. Farm, Stillwater	2.060	.216	3.350
8	Ambrosia trifida	Horseweed	8½ mi. S. E. of Stillwater	1.804	.252	2.100
9	Andropogon sorghum	Johnson grass	Exp. Sta. Farm, Stillwater	.910	.127	.380
10	Apocynum hypericifolium	Dogbane	3 mi. S. E. of Stillwater	1.280	.105	.905
11	Applopappus ciliatus	Rosin weed	Exp. Sta. Farm, Stillwater	2.120	.159	1.820
12	Baptisia bracteata	False indigo	3 mi. S. E. of Stillwater	2.020	.069	1.250
13	Chenopodium album	Lamb's quarter	Exp. Sta. Farm, Stillwater	2.040	.149	1.115
14	Chenopodium leptophyllum	Pigweed	Exp. Sta. Farm, Stillwater	2.240	.093	1.138
15	Circium canascens	Silver thistle	Exp. Sta. Farm, Stillwater	2.825	.165	2.291
16	Convolvulus arvensis	Bindweed	Exp. Sta. Farm, Stillwater	1.804	.252	2.100
17	Desmodium sessilifolium	.....	3 mi. S. E. of Stillwater	1.400	.065	1.550
18	Desmonthus illinoense	.....	3 mi. S. E. of Stillwater	1.900	.101	1.610
19	Diodia teres	Button weed	Exp. Sta. Farm, Stillwater	2.590	.200	1.665
20	Diodia teres	Button weed	8½ mi. S. of Stillwater	1.950	.146	1.275
21	Erigeron canadensis	Muletail	Exp. Sta. Farm, Stillwater	2.165	.212	.925
22	Euphorbia Hexagona	Hexagonal spurge	8½ mi. S. of Stillwater	2.605	.212	1.090
23	Helianthus annuus	Wild sunflower	Exp. Sta. Farm, Stillwater	2.858	.274	2.370
24	Helianthus petiolaris	Wild sunflower	8½ mi. S. E. of Stillwater	1.800	.190	1.790
25	Ipomea pandurata	Wild potato vine	Exp. Sta. Farm, Stillwater	2.765	.180	1.285
26	Lactuca scariola	Wild lettuce	Exp. Sta. Farm, Stillwater	1.650	.190	1.450
27	Lespedeza virginica	.....	3 mi. S. E. of Stillwater	1.540	.098	.720
28	Oenothera laciniata	Evening primrose	Exp. Sta. Farm, Stillwater	1.150	.185	2.420
29	Petalostemum purpuereum	Prairie clover	3 mi. S. E. of Stillwater	1.280	.075	1.545
30	Plantago Purshii	Plantain	8½ mi. S. E. of Stillwater	1.045	.154	.970
31	Polygonum hydropiperoides	Smartweed	Exp. Sta. Farm, Stillwater	1.585	.091	.985
32	Polygonum pennsylvanicum	Smartweed	Exp. Sta. Farm, Stillwater	2.540	.147	1.550
33	Polygonum ramoeissimum	Knotweed	3 mi. S. E. of Stillwater	.890	.075	.370
34	Portulaca oleraceae	Purslane	Exp. Sta. Farm, Stillwater	3.795	.525	.840
35	Psoralea pedunculata	Wild alfalfa	2 mi. W. of Stillwater	2.300	.182	1.500
36	Psoralea pedunculata	Wild alfalfa	3 mi. S. of Claremore	2.010	.138	1.725
37	Psoralea pedunculata	Wild alfalfa	4 mi. S. E. of Stillwater	2.010	.126	1.400
38	Rumex crispus	Curled dock	Exp. Sta. Farm, Stillwater	1.740	.185	.878
39	Solanum carolinense	Horse nettle	Exp. Sta. Farm, Stillwater	3.280	.200	1.830
40	Solanum rostratum	Buffalo bur	Exp. Sta. Farm, Stillwater	3.410	.210	1.880
41	Vernonia	Iron weed	3 mi. S. E. of Stillwater	1.105	.085	1.260
42	Xanthium commune	Cockle bur	6 mi. S. E. of Stillwater	1.843	.280	2.440

another series of plants were collected in June, 1933. The results of these analyses are given in Table III.

Most of these plants contained more than 2 per cent of nitrogen. Those which contained more than 3 per cent of nitrogen were not as mature as the average plants which were collected. This includes Amaranthus, hyridus, Portulaca oleraceae, Solanum carolinense, and Solanum rostratum. Many of these plants studied commonly occur in areas of prairie and although they are objectionable from the standpoint of the quality of hay produced, it is very evident that some of these plants are higher in phosphorus and calcium content than the prairie grasses. The presence of these weeds in the hay would increase the total mineral content of the forage and under many conditions this effect would improve rather than injure its feeding value.

It has been suggested by certain investigators that livestock graze on those areas where the plants are high in ash. In some instances this is true; however, sheep which feed heavily on weeds will eat the common rag weed (Ambrosia artemisiifolia) and the perennial rag weed (Ambrosia psilostachya); however they do not eat common yarrow (Achillea millefolium). Consequently the presence of organic substances which affect the palatability of vegetation is undoubtedly an important factor from the standpoint of the commercial utilization of green plants for grazing purposes.

The effect of weeds and grasses on the conservation of plant foods in uncultivated fields and during periods when crops are not in an active growing condition is important under many conditions. Most weeds are high in nitrogen and decay more rapidly than residues from corn, kafir, and small grain. The effect of the concentration of large amounts of ash at the surface of the soil is an important factor in affecting nonsymbiotic fixation of nitrogen which is one of the important processes by which abandoned land becomes more productive after a few crops of weeds have been grown and the residues accumulate in the surface soil. Perennial rag weed, rosin weed, wild sunflower, muletail, and cocklebur are some of the more vigorous plants appearing on eroded land. All of these plants contain much larger amounts of calcium and phosphorus than the native grasses and the continued growth of these plants on abondoned land produces a marked influence on the availability of mineral matter in the soil. This condition also produces a stimulating effect on the development of grasses when they begin to appear.

In order to compare the composition of weeds with the composition of native grasses, the results of a large number of analyses which have been made by H. A. Daniel on plants collected over a period of years are given in Table IV.

Grasses are as a rule low in nitrogen, phosphorus, and calcium. However, Agrostis alba, Cynodon dactylon, Paspalum dialatatum, Buchloe dactyloides, and Syntherisma sanguinalis are all fairly high in phosphorus content as compared with the other grasses. The calcium content of grasses is low; although Bermuda grass is much higher than the average and Dallis grass is exceedingly low in this particular element.

SUMMARY

A study of the nitrogen, phosphorus, and calcium content of common weeds and native grasses growing in Oklahoma was made.

Two hundred and twenty-nine composite samples were collected and analyzed. This collection included fifty-nine different species of plants.

Weeds were higher in nitrogen, phosphorus, and calcium than grasses, and plants growing on good soil were higher in nitrogen than similar plants growing on poor soil,

TABLE IV.

The Average Composition of Common Oklahoma Grasses.

No.	Scientific Name	Common Name	Number of Samples Analyzed	Av. Comp. in Per Cent		
				Nitr'gn	Phos.	Calcium
1	Agrostis alba	Redtop	3	1.047	.203	.376
2	Aristida oligantha	Tripled awned grass	5	.605	.059	.189
3	Andropogon furcatus	Big blue stem	26	.515	.086	.276
4	Andropogon scoparius	Little blue stem	43	.614	.072	.269
5	Andropogon virginicus	Broom sedge	3	.610	.084	.240
6	Andropogon torreanus	Silver beard grass	2	.718	.100	.328
7	Buchloe dactyloides	Buffalo grass	14	.987	.126	.339
8	Boutebua gracilis	Grama grass	8	.933	.108	.314
9	Cynodon dactylon	Bermuda grass	14	1.294	.179	.659
10	Paspalum dilatatum	Dallis grass	4	1.109	.137	.186
11	Sorghastrum nutans	Indian grass	6	.827	.085	.291
12	Syntherisma sanguinalis	Crab grass	5	1.460	.190	.359
			AVERAGE	.893	.119	.319

Young plants are higher in mineral nutrients and nitrogen than older plants. The stems are lower in nitrogen, phosphorus, and calcium than the leaves.

Aristida oligantha, which is commonly found on very poor soil, contained very low amounts of mineral plant food. Diodia teres also grows on land which will not support many other kinds of native plants but was high in nitrogen, phosphorus, and calcium. The feeding power of the plant is the probable explanation of this difference.

The effect of weeds on the preservation of plant foods and the possible stimulation of nitrogen fixation has meen emphasized.

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