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NITROGEN AND OTHER COMPOUNDS IN RAIN AND SNOW

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The importance of regularly analyzing the rain and snow for nitrogen and other compounds is widely recognized, both for its agricultural and hygienic significance. Messrs. F. T. Shutt and R. L. Dorrance of Ottawa, Canada, carried on a systematic investigation of the rain and snow through a period of ten years, 1908 to 1917, the results of which study have added much to our knowledge of the importance of the nitrogen compounds as an agricultural factor.

Our purpose has been to determine the amounts of the different nitrogen compounds, the chlorine, sulphates, and phosphates in the rain-water and snow of this locality — a continuation of the work which has been carried on here for a number of years, the results of which have appeared in the *Chemical News* from year to year.

The work was carried out in the Cornell College Laboratory under ordinary laboratory conditions. It covers a period of eight and one-half months, October 1, 1918, to June 15, 1919. The samples were collected in granite pans on an open spot near the center of the town, which has a population of about 2500. The town is without manufacturing industries, which eliminates excessive smoke contamination of the air. Every precaution was taken to prevent contamination. Samples were collected on the morning following the precipitation and analyzed as soon thereafter as was possible.

Altogether, 46 samples were analyzed, of which 36 were rain-water, and 10 were snow. There were 45 inches of snow and 18.50 inches of rain. This represents 22.25 inches of rain, considering 12 inches of snow equivalent to one (1) inch of rain. There have been furnished during the period 511.74 pounds of chlorine, 1.509 pounds of sulphates (as SO_3), and 5.2790 pounds of nitrogen per acre. The phosphates (as P_2O_5) supplied only .0086 pound per acre.

The tables appended do not include the sulphates and phosphates, as only fifteen samples produced sufficient sulphates for determination, and only eleven other samples showed a slight trace. The largest yield, from a sample collected on February 28, was only .262 parts per million. The average for the period is .03 parts per million. An unduly mild winter, with the atmosphere comparatively free from smoke and soot, no doubt accounts for this low average.

Five samples showed a trace of phosphates, while only four supplied a sufficient quantity for determination. The largest amount, on March 4, was only .03 parts per million. The average is .002 parts per million.

Table I gives the parts per million of the several nitrogen compounds and the chlorine content; the total for each precipitation; and the number of pounds supplied per acre.

The chlorine content averages 11.12 parts per million. It varies from 6.10 to 25.70 parts per million. Its presence in the atmosphere has been ascribed by Doctor Knight to salt particles carried in the air from the Atlantic ocean. No increase was experienced due to wind preceding or accompanying a precipitation.

The average of total nitrogen supplied for each precipitation is 1.046 parts per million. The totals for the 46 precipitations are fairly constant. Strong winds and severe electrical discharges on May 6, and on June 1 and 3, did not increase the amounts of nitrogen, but the total amount of nitrogen supplied on those dates is unusually high, especially on May 6 and 7 — the highest of the period.

The average parts per million for Free Ammonia is .407; for Albuminoid Ammonia, .366; for Nitrates, .255; and for Nitrites, .018.

Of the total nitrogen supplied during the period, 38.85 per cent is in the form of Free Ammonia; 34.99 per cent, Albuminoid Ammonia; 24.42 per cent, Nitrates; and 1.74 per cent, Nitrites.

The amount of the precipitation determines largely the total number of pounds of nitrogen supplied per acre. But an examination of the pounds of nitrogen supplied per acre by each of the 46 precipitations reveals a remarkable uniformity. When reduced to pounds per acre for one inch of rain, 43 of the 46 precipitations come within the narrow limits of .15 to .40 pounds per acre. The wide variance in the amounts of rain — .05 to 2.00 inches — indicates a marked degree of concentration in the smaller showers. The same standard reveals the fact that during continued precipitations, such as occurred June 1 to June 6, the total

TABLE I. NITROGEN AND CHLORINE IN RAIN AND SNOW

Parts per Million, Total for Each Precipitation and Pounds per Acre

Precipitation			Nitrogen in Parts Per Million						Chlorine	
Date	Kind	Amount in Inches	Free Ammonia	Albuminoid Ammonia	Nitrates	Nitrites	Total	Pounds Per Acre	Parts Per Million	Pounds Per Acre
1918—October 27....	R	.50	.450	Trace	.900	.007	1.357	.1539	21.40	2.4268
November 7...	R	.05	.450	.350	.800	0.50	1.650	.0187	21.40	0.2427
November 16..	R	.05	.925	.685	.500	.025	2.135	.0242	25.70	0.2914
November 17..	R	.34	.450	.275	.200	.002	0.927	.0701	10.20	0.7711
November 28..	S	.83	.500	.215	.300	.005	1.020	.1927	8.65	1.6283
December 8....	R	.40	.450	.600	.600	.010	1.660	.1506	10.20	0.9253
December 12...	R	.50	.475	.350	.240	.008	1.073	.1217	6.10	0.6917
December 13...	R	.10	.450	.365	.220	.005	1.040	.0236	8.65	0.1962
December 22...	R	.10	.450	.365	.140	.005	0.960	.0218	10.20	0.2313
December 24...	S	.67	.500	.365	.100	.004	0.969	.1464	8.65	0.1314
December 31...	S	4.00	.340	.275	.100	.007	0.722	.0545	6.10	0.4565
1919—February 2....	R	.10	.765	.525	.700	.045	2.035	.0562	No test	No test
February 13...	R	.70	.450	.215	.150	.010	0.825	.1410	8.65	1.3732
February 14...	R. & S.	.30	.515	.100	.150	.014	0.779	.0630	10.20	0.6940
February 15...	S	4.00	.195	.115	.100	.004.	0.414	.0413	9.00	0.6736
February 20...	S	4.00	.190	.110	.180	.020	0.500	.0478	10.20	0.7630
February 22...	S	4.00	.090	.040	.120	.028	0.278	.0310	15.13	1.1301
February 24...	R. & S.	.10	.300	.095	.120	.030	0.545	.0223	16.00	0.3629
February 26...	S	2.00	.210	.095	.230	.007	0.542	.0305	10.90	0.4201
February 28...	S	2.00	.215	.090	.300	.006	0.611	.0331	12.00	0.4627
February 28...	S	4.00	.120	.090	.250	.003	0.463	.0447	11.90	0.8906
March 4.......	S	3.00	.090	.750	.200	.002	1.042	.0691	6.10	0.2075
March 13......	R	.10	.450	.300	.500	.030	1.280	.0394	10.20	0.2813
March 14......	R	.25	.445	.090	.280	.007	0.822	.0566	10.20	0.6283
March 16......	R	2.00	.210	.275	.070	.001	0.556	.2522	8.87	4.1694

TABLE I—*Continued*

Precipitation			Nitrogen in Parts Per Million						Chlorine	
Date	Kind	Amount in Inches	Free Ammonia	Albuminoid Ammonia	Nitrates	Nitrites	Total	Pounds Per Acre	Parts Per Million	Pounds Per Acre
April 7........	R	.50	.340	.350	.200	.009	0.899	.1018	17.75	4.1697
April 9........	R	.75	.340	.340	.150	.005	0.835	.1521	10.15	1.7765
April 11.......	R	.10	.380	.400	.300	.028	1.108	.0351	14.20	0.4221
April 15.......	R	.90	.340	.250	.190	.004	0.784	.1700	17.75	3.6731
April 16.......	R	.13	.460	.400	.400	.007	1.267	.0461	10.15	0.2992
April 22.......	R	.20	.380	.430	.400	.010	1.220	.0653	7.10	0.3220
April 23.......	R	1.00	.320	.300	.260	.007	0.887	.2112	7.10	1.6602
May 1.........	R	.60	.575	.687	.110	.006	1.378	.1075	11.36	1.5459
May 3.........	R	1.80	.242	.320	.150	.005	0.717	.3027	11.36	4.6368
May 4.........	R	.80	.320	.200	.150	.002	0.672	.1319	10.15	1.7325
May 6.........	R	.20	.510	1.420	.150	.015	2.095	.1050	13.49	0.6119
May 7.........	R	.70	.850	1.500	.150	.001	2.501	.4070	7.10	2.2540
May 22........	R	.30	.420	.365	.020	.009	0.814	.0654	11.36	0.7729
May 23........	R	.34	.365	.320	.150	.006	0.841	.0736	7.10	1.0948
June 1........	R	.15	.240	.320	.500	.020	1.080	.0467	14.20	0.4830
June 2........	R	1.75	.650	.540	.130	.150	1.470	.5934	11.36	4.5080
June 3........	R	.27	.550	.420	.480	.200	1.650	.1110	11.36	0.6955
June 4........	R	1.10	.300	.300	.200	.002	0.822	.2151	7.10	1.8260
June 6........	R	.50	.500	.610	.150	.010	1.270	.1540	7.10	0.8300
June 6........	R	.65	.610	.285	.040	.001	0.936	.1480	17.75	2.6167
June 6........	R	.18	.320	.365	.035	.004	0.724	.0396	10.15	0.4123
Totals....................		22.25	18.717	16.875	11.765	0.836	48.175	5.2790	511.74	46.0334
Averages..................		.48	.407	.366	.255	.018	1.046	.1147	11.12	1.0007
Percentages of total Nitrogen.........			38.85	34.99	24.42	1.74				

TABLE II. MONTHLY RECORD OF PRECIPITATION AND AVERAGE NITROGEN CONTENT

Precipitation in Inches					Average Nitrogen in Parts per Million					
Month	No. of Precipitation	Snow	Rain	Total	Free Ammonia	Albuminoid Ammonia	Nitrates	Nitrites	Total	Pounds per Acre
1918—October	1	—	.50	.50	.450	Trace	.900	.007	1.357	.1539
November	4	10	.43	1.27	.581	.381	.450	.020	1.432	.3057
December	6	12	1.10	2.10	.444	.386	.233	.007	1.070	.5186
1919—February	10	20	1.20	2.87	.305	.147	.230	.017	0.699	.5109
March	4	3	2.35	2.60	.298	.354	.262	.010	0.925	.4173
April	7	—	3.58	3.58	.365	.362	.271	.010	0.998	.7816
May	7	—	4.73	4.73	.469	.687	.126	.006	1.288	1.2832
June	7	—	4.60	4.60	.455	.405	.219	.055	1.134	1.3078
Monthly average				2.78	.434	.339	.336	.017	1.113	0.6599

nitrogen supplied gradually diminishes — in this case from .40 to .20 pounds per inch of rain.

Table II is a monthly record of precipitation and it presents a few noteworthy features.

There is a gradual increase in the number of inches of precipitation from October, with .50 inches, to June, with 4.60 inches for the first half of the month.

Beginning with February, there is a gradual increase of total nitrogen in parts per million — .699 to 1.134. This, with the increased amount of rain in inches, furnishes an increasing supply of nitrogen per acre to the soil during the main growing season. The increase in pounds per acre during this period is from .3057 in November to 1.3078 in June.

The 45 inches of snow supplied 13 per cent of the total 5.2790 pounds of nitrogen per acre, or .6911 pounds. The rain supplied 87 per cent, or 4.5879 pounds per acre. The rain is thus found to be richer in total nitrogen content than the snow.

The work of Messrs. F. T. Shutt and R. L. Dorrance, mentioned above, has been of assistance in summarizing results.

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