NITRATE STUDIES ON PURDUE ROTATION FIELD No. 6.

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Nitrate formation in the soil, although primarily a chemical transformation of protein nitrogen to nitrate nitrogen, is occasioned by the activities of certain groups of micro-organisms in the soil. Since the transformation is so dependent on the life processes of these organisms it is subject to the factors which ordinarily control living matter as well as those which regulate simple chemical phenomena. The following factors seem, from a study of the literature, to be most important:

Kind of soil, organic matter content of the soil, soil reaction, temperature, moisture, aeration, presence of suitable organisms, and the kind of crop grown. It was the latter point, the effect of the kind of crop and cropping system, that has been considered primarily in this study, although the other factors have been taken into consideration to a certain extent.

The plots on which this study was made, Purdue Rotation Field No. 6, were admirably adapted to the work, as they have been cropped and fertilized under a definite system since 1889, giving time enough for the soil conditions to have reached a constant in so far as these factors are concerned.

The work reported here is a continuation of work started in 1920 and first reported in the 1921 Proceedings of the Indiana Academy.[1] Inasmuch as this is purely a continuation of the work reported in the above paper and the technic used in the work is the same as that previously employed, with one exception, reference will be made to that paper for a résumé of the literature and a discussion of the technic employed.

In any study of nitrate formation, the data secured from a one year study of the problem are subject to considerable error as climatic and cultural conditions influence the process so markedly. In continuing the study over a series of years using the same plots, it is hoped to minimize the inconsistencies due to factors which vary from year to year and more closely narrow the problem down to a study of the one factor of crop influence on nitrification.

Tests were made every two weeks throughout the growing season in this work, instead of every month throughout the year as in the work previously reported. From past experience it seems that this is a more accurate measure of the factors concerned.

Effect of Various Crops on Nitrifying Power of Soil.

The following set of tables shows the moisture content, and nitrates in parts per million for the various rotations. The nitrates in all cases

[1] Baldwin, I. L., Coble, U. L., and J. W. Chamberlain. Crop rotation as affecting nitrate production. Proc. Ind. Acad. Sci., 1921 (1922), pp. 283-293.

"Proc. Ind. Acad. Sci., vol. 33, 1923 (1924)."

were calculated on a dry basis of the soil. The incubated samples were calculated on a basis of 21.5 per cent of moisture as that was found to be optimum, and it was endeavored to incubate them under as nearly optimum moisture conditions as possible. The incubated samples without ammonium sulphate added are shown in these tables as I; those with ammonium sulphate as II.

TABLE I.—Series 1 East

DATE	Plot 1 Wheat (Clover)				Plot 2 Corn			
	Moisture Per Cent	Nitrates—Parts per Million			Moisture Per cent	Nitrates—Parts per Million		
		Fresh	Incubated			Fresh	Incubated	
			I	II			I	II
April 21	28.50	5.37	14.50	17.04	29.01	4.06	8.04	17 28
May 6	24.81	3 46	9.32	18.28	24 73	2.98	8.64	22.46
May 20	21.80	1.64	8.30	22.64	23.15	3.76	16.21	32.14
June 3	15.36	2.26	13 06	21.20	19 27	6.18	28.60	33.09
June 17	13.43	6.22	19.15	25 62	19 13	12.25	32.44	42.81
July 1	13.48	9 61	22 81	28.67	18.64	18.64	39 82	48 25
July 15	16.08	11 06	23.20	27.84	20.19	20.77	40.24	46.60
July 29	13.12	10.48	19.91	31 68	18.92	22.04	42.60	48.00
Aug. 12	11.93	8 54	17.43	26.91	16.57	16.56	39.27	40.76
Aug. 26	17.94	12 26	19.84	24.62	21.06	18.63	39.88	43.66
Sept. 9	14.65	7.95	17.60	22.98	17.82	14 80	32.29	35.75
Sept. 23	12.11	6.43	16.19	19.89	14.68	18.92	21.84	33.78
Oct. 14	24.43	1.70	12.04	18.46	23 76	11.52	18.60	33.09
Oct. 30	22 76	1.66	10.23	15.61	22 20	8.21	16.74	27.36
Average	17 88	6.19	15.97	22.96	20 65	12 81	27.52	36 07

DISCUSSION OF SERIES 1 EAST (CORN AND WHEAT).

(Table I.)

The fresh nitrate content of the wheat plot was low during May and the early part of June at which time the crop was draining heavily on nitrates. By July 10 it had reached nearly 10 parts per million and remained at this point with minor fluctuations until about September 1, when it gradually went down because of dry, cool weather and the withdrawal by the clover crop. The incubated samples were consistently higher than the fresh. Those with ammonium sulphate averaged about 65 per cent higher than those without, which fact seems to indicate that suitable nitrogenous materials and not absence of sufficient organisms was the limiting factor.

The fresh nitrate curve of the corn plot is much the same as that of the wheat, but it is higher at all times except early in the season. The highest point of 22.04 parts per million was reached on July 29. Rains during the season, when not hard enough to leach out the nitrates, caused a rise in the fresh nitrate content. The incubated samples were much higher in nitrates than the fresh samples during the whole season. During the middle of the summer the addition of ammonium sulphate had little effect, which fact tends to show that the efficiency of the nitrifying organisms in the soil at that time was greater than at other seasons of the year. This instance seems to confirm the general theory

that it is in the early spring that crops need applications of quickly available nitrogenous fertilizers.

TABLE II.—Series 1 West

DATE	Plot 3 Clover and Timothy				Plot 4 Corn			
	Moisture Per Cent	Nitrates—Parts per Million			Moisture Per Cent	Nitrates—Parts per Million		
		Fresh	Incubated			Fresh	Incubated	
			I	II			I	II
April 21	27.70	3.54	14.62	18.26	27.99	6.57	13.96	19.30
May 6	26.71	3.49	7.60	23.90	24.48	3.76	11.52	20.62
May 20	25.09	2.56	10.08	19.40	24.30	6.76	23.48	24.61
June 3	16.08	1.86	10.90	20.82	19.41	8.32	24.81	33.18
June 17	12.32	3.68	13.12	24.52	19.01	14.06	34.21	43.80
July 1	11.23	4.12	16.71	26.40	18.90	16.45	36.21	45.01
July 15	13.87	5.58	17.05	31.96	19.23	26.09	41.19	41.86
July 29	11.43	6.08	19.25	29.61	17.64	18.64	38.40	44.71
Aug. 12	10.31	7.02	22.03	26.30	16.38	19.21	38.99	45.87
Aug. 26	16.96	5.98	20.41	25.86	20.53	24.33	39.45	43.72
Sept. 9	13.19	5.74	16.36	24.91	15.93	21.40	38.50	39.74
Sept. 23	11.36	5.42	16.77	18.40	13.51	19.90	30.61	38.20
Oct. 14	24.96	5.01	11.43	12.62	22.61	6.82	27.92	34.33
Oct. 30	22.89	1.65	9.69	11.45	21.43	5.43	20.57	25.06
Average	17.44	4.41	14.72	22.46	20.10	14.12	29.99	35.72

TABLE II.—Series 1 West—Continued

DATE	Plot 5 Oats				Plot 6 Wheat			
	Moisture Per Cent	Nitrates—Parts per Million			Moisture Per Cent	Nitrates—Parts per Million		
		Fresh	Incubated			Fresh	Incubated	
			I	II			I	II
April 21	25.75	5.03	11.48	16.28	27.68	2.65	14.70	16.44
May 6	23.76	1.98	13.06	20.09	25.08	1.71	8.21	9.02
May 20	21.58	2.45	12.73	22.50	24.79	1.57	8.96	16.34
June 3	16.21	1.94	13.92	20.30	15.52	1.98	12.80	17.06
June 17	13.03	3.26	14.37	26.04	13.21	7.57	17.85	24.23
July 1	11.11	4.06	14.63	27.05	12.70	7.30	18.72	22.33
July 15	13.81	6.74	16.20	29.03	15.97	9.36	18.99	25.07
July 29	11.47	6.20	16.92	28.62	12.84	10.01	17.83	26.90
Aug. 12	10.13	6.42	14.49	25.87	11.27	9.87	21.02	26.45
Aug. 26	17.59	4.06	14.52	23.90	18.00	11.78	20.68	25.54
Sept. 9	15.76	4.22	12.83	23.06	14.96	7.81	19.98	23.19
Sept. 23	14.41	4.78	11.95	14.44	12.37	7.63	19.06	23.38
Oct. 14	23.45	2.67	9.06	13.97	24.33	2.54	15.27	19.16
Oct. 30	22.31	3.38	8.60	10.21	22.74	3.70	13.63	15.09
Average	17.17	4.09	13.20	21.53	17.96	6.11	16.26	20.73

DISCUSSION OF SERIES 1 WEST (CORN, OATS, WHEAT, CLOVER AND TIMOTHY). (TABLE II).

The fresh nitrate content of the clover and timothy plot (about 9/10 timothy and 1/10 clover) was low throughout the season. It was exceedingly low in May and June at which times the crop was drawing heavily on the nitrates. The highest point of 6.08 parts per million was reached July 15. The incubated samples showed fairly high throughout the season. The addition of ammonium sulphate caused a great

increase, which fact tends to show that lack of suitable organic matter was one of the limiting factors.

The corn plot showed a higher fresh nitrate content at all times than did any of the other three plots. The highest point of 26.09 parts per million was reached on July 15. This high point as well as the high point on August 26, can be partly explained by the rains preceding both dates. The two incubated sets showed relatively little difference, which fact tends to show that the organisms present were able at this time to easily change organic matter into nitrates.

The fresh nitrate content of the oat plot was low during the whole season, being the lowest during May and June when the crop was using the most. The incubated samples ran much like those of the clover and timothy plot, the addition of ammonium sulphate causing a substantial increase. None of the incubated samples, however, reached the high point reached by the corn plot.

The wheat plot was low in fresh nitrates in May and the beginning of June. The highest point, of nearly 12 parts per million, was reached on August 26 following the rain which fell a few days previously. Mention may be here made that probably one reason why most of the plots showed a fairly uniform nitrate content during the whole summer is that no hard rains were received which would tend to leach out the nitrates which were above that used by the crops. Therefore, the nitrates stayed fairly high during the whole summer until the rains of late September washed them out. Although very little nitrates were produced in the non-cultivated plots during the dry season, the samples still showed a fairly high content.

TABLE III.—Series 2 East

DATE	Plot 7 Wheat				Plot 8 Corn				Plot 9 Oats			
	Moisture Per Cent	Nitrates—Parts per Million			Moisture Per Cent	Nitrates—Parts per Million			Moisture Per Cent	Nitrates—Parts per Million		
		Fresh	Incubated			Fresh	Incubated			Fresh	Incubated	
			I	II			I	II			I	II
Apr. 21	28.42	2.68	12.08	17.16	27.93	2 66	13.98	16.78	27.35	10.57	12.24	13.96
May 6	25.16	2.56	6.92	20.90	25.23	3.85	17.64	24.56	24.76	6.38	10.68	22.89
May 20	23.30	2.50	9.54	26.39	25.21	6.85	22.87	35.40	23.00	4.98	22.55	20.19
June 3	15.15	1.43	12 60	23.89	19.31	7 20	26.86	34.72	16.93	2.76	13.64	21.54
June 17	14.04	8.73	13.95	28.83	18.94	10 47	27.61	36.20	13.42	3 08	11.72	24 67
July 1	12.87	12.41	17.88	30.43	18.48	25 19	33.53	42 26	12.36	4.88	13.65	28 50
July 15	16.70	14.62	19.07	31.70	21.07	26 12	29 56	39 81	16 03	6.04	10.95	29.86
July 29	12.09	10 86	22.10	32 08	19.09	21.09	22 81	36 51	12.61	7 02	13.80	33.14
Aug. 12	10.76	9.32	23.29	33.39	17.11	15.42	22.20	38.94	10.45	6.65	12.61	32.46
Aug. 26	17.20	7.85	22.44	30.50	21.93	17.81	25.49	37.63	17.97	5.21	13.43	30.42
Sept. 9	14.11	5.76	22.81	30.81	16 89	15.06	21.16	32 45	16.05	6.39	12.18	25.10
Sept. 23	12.61	6 06	17.66	26.62	14.68	14.43	21.23	30.14	15.59	6.93	10.83	19.64
Oct. 14	25.21	3.94	14.19	20.28	21.95	9.81	19 95	22.70	24.27	3.38	7.06	18.78
Oct. 30	23.07	4.08	13 08	16.85	21.18	6.23	17.54	19.67	22 32	3.94	5.16	12.75
Average	17.91	6.63	15.54	26 43	20.64	13.01	23.12	34 13	18.08	5.59	12.16	23.85

DISCUSSION OF SERIES 2 EAST (CORN, OATS, WHEAT). (TABLE III.)

The wheat plot was low in fresh nitrates during May, in the first part of June, and reached its highest point of 16 parts per million on

July 15. From then on until the last sample was taken it steadily went down, differing in this respect from the previous wheat plots discussed. The addition of ammonium sulphate to the incubated samples caused a large increase, more at the beginning of the period than toward the end. This instance again seems to show that it is in the beginning of the season that crops need applications of quickly available nitrogenous fertilizers.

The nitrate content of the fresh samples of the corn plot was also highest on July 15. The curve goes down with a few fluctuations until October 30, being similar in this respect to the wheat plot in this series. No explanation can be offered for this difference from the plots of the other series. The incubated samples with ammonium sulphate showed a much larger increase over those without ammonium sulphate than in the case of the previous corn plots. This condition may have been due to the fact that there is no clover and timothy crop in this rotation; and hence there was not as much available nitrogen present (in previous years the stand of clover was better than this past season).

For some reason, not apparent, the fresh nitrates of the oat plot were higher on April 21 than at any other time during the season, and this in view of the fact that there had been a period of almost incessant rain immediately preceding that time. During the rest of the season the fresh nitrates were low, being lowest during the period when the crop was drawing most heavily on them. The incubated samples with ammonium sulphate were on the average about 100 per cent higher than the samples without it. Therefore, it seems that an application of some nitrogenous fertilizer would be beneficial. An interesting point in connection with this plot is that after being plowed for wheat about August 26, the moisture content stayed up whereas the moisture content of the unplowed wheat plot went down rapidly.

TABLE IV.—Series 2 West

Date	Plot 10 Cl. & Tim.				Plot 11 Corn				Plot 12 Wheat			
	Moisture Per Cent	Nitrates—Parts per Million			Moisture Per Cent	Nitrates—Parts per Million			Moisture Per Cent	Nitrates—Parts per Million		
		Fresh	Incubated			Fresh	Incubated			Fresh	Incubated	
			I	II			I	II			I	II
Apr. 21	29.62	3.18	13.84	20.16	27.79	6.24	13.30	14.86	27.22	5.71	10.75	13.04
May 6	26.37	2.16	10.42	25.75	27.27	6.59	20.08	23.26	24.50	2.01	9.28	25.60
May 20	26.02	3.46	22.69	29.74	25.15	6.84	27.92	29.96	23.91	2.52	21.16	27.88
June 3	16.71	2.42	14.06	23.28	20.96	12.41	29.62	27.90	15.03	1.48	17.76	28.52
June 17	12,72	4.36	18.59	29.73	19.37	16.64	39.84	40.09	13.78	7.64	18.73	27.49
July 1	11.61	4.63	19.20	32.34	19.71	17.29	43.73	48.69	12.76	7.69	19.26	33.05
July 15	16.40	8.94	22.46	36.30	22.11	25.45	41.53	44.89	16.53	14.02	22.57	38.40
July 29	11.96	9.12	21.55	32.64	19.49	21.17	42.32	42.49	13.01	13.16	21.95	40.21
Aug. 12	9.97	9.26	18.22	35.20	17.31	18.42	37.68	44.70	11.56	13.43	21.71	39.50
Aug. 26	16.41	7.47	21.08	33.60	21.34	24.26	37.98	40.22	17.18	10.81	19.82	35.66
Sept. 9	12.98	5.31	20.37	30.67	16.77	23.13	30.16	35.43	12.22	7.03	18.22	34.57
Sept. 23	11.01	4.76	15.30	21.24	13.89	24.09	30.40	35.12	10.87	6.84	16.74	30.19
Oct. 14	23.25	3.33	14.04	21.46	24.38	10.88	20.77	25.19	25.05	2.76	10.45	21.55
Oct. 30	22.09	4.62	9.61	17.46	22.41	8.90	17.44	23.39	23.46	2.89	8 82	13.69
Average	17.69	5.00	17.25	27.83	21.28	15.88	31.56	34.01	17.65	7.00	16.94	29.24

DISCUSSION OF SERIES 2 WEST (CORN, WHEAT, CLOVER AND TIMOTHY). (Table IV.)

The clover and timothy soil showed a low fresh nitrate content, being especially low in May and the early part of June. The highest point was reached immediately after the harvesting of the crop. In comparing the incubated samples, it can be seen that the addition of ammonium sulphate materially increased nitrification, which fact seems to show that there was a deficiency of easily available nitrogenous materials.

The corn plot reached its high point on July 15, and stayed rather uniformly high until October 1. The addition of ammonium sulphate to the incubated samples did not show much of an increase. This condition may have been due, no doubt, to the fact that clover sod had been plowed under, and there was, therefore, a fairly large supply of easily available nitrogen present. The ability of the nitrifying organisms to change organic matter into nitrates was also probably enhanced about this period.

The fresh nitrates of the wheat soil were low in May and early June, reached their highest points in July and early August, and then fell off gradually. The presence of the clover in the stubble probably caused the fresh nitrates to fall sooner than they otherwise would have done. The addition of ammonium sulphate caused a marked increase in the nitrification in the incubated samples, indicating a deficiency in easily available nitrogenous materials.

TABLE V.—Series 3 East

DATE	Plot 13 Wheat (Unlimed)				Plot 14 Wheat (Limed)			
	Moisture Per Cent	Nitrates—Parts per Million			Moisture Per Cent	Nitrates—Parts per Million		
		Fresh	Incubated			Fresh	Incubated	
			I	II			I	II
April 21	27.55	3.53	9.82	15.06	27.93	5.33	10.88	18.34
May 6	24.33	2.52	8.98	20.32	25.10	2.63	8.16	21.05
May 20	22.62	3.58	8.60	14.52	22.25	6.09	12.08	20.67
June 3	15.43	1.62	9.22	16.18	15.51	3.21	11.48	19.62
June 17	13.64	7.47	11.66	22.07	13.05	6.12	17.15	23.83
July 1	12.23	9.32	13.43	26.91	12.86	10.60	18.23	25.42
July 15	15.89	9.81	17.20	25.60	16.01	12.19	18.08	28.73
July 29	11.89	10.46	15.98	27.72	12.77	10.09	16.94	28.83
Aug. 12	10.49	9.84	15.86	28.14	11.03	10.62	16.08	29.36
Aug. 26	17.86	12.24	13.21	27.43	17.74	13.96	14.66	28.96
Sept. 9	16.47	19.29	16.43	27.62	16.26	16.36	14.47	25.18
Sept. 23	15.83	16.85	16.60	26.84	15.73	14.27	15.33	25.04
Oct. 14	23.15	5.31	11.27	20.80	24.04	7.03	11.85	20.77
Oct. 30	21.96	6.02	10.26	18.63	22.38	7.86	11.09	18.14
Average	17.81	8.41	12.61	22.70	18.05	9.03	14.03	23.13

DISCUSSION OF SERIES 3 EAST (CONTINUOUS WHEAT). (Table V.)

The two plots in this series have been in continuous wheat since 1889. Since 1911, plot 14 has received an application of lime every four years, while plot 13 has received nothing. The fresh nitrate content of both ran close during the whole season. The limed plot was slightly

ahead of the unlimed plot most of the time. Both plots showed a low nitrate content in May and early June. Both plots were plowed for wheat about August 20. The increase in conservation of moisture and aeration resulting from the plowing probably caused the great increase in nitrification in September. In both cases the incubated samples with ammonium sulphate showed a substantial increase in nitrification over the samples without it. This condition was probably caused by a deficiency of quickly available organic nitrogen, resulting from the continuous cropping. By comparing the two plots, it would seem that liming tends to increase nitrification.

TABLE VI.—SERIES 3 WEST

Date	Plot 15 Continuous Corn (Rye)			
	Moisture Per Cent	Nitrates—Parts per Million		
			Incubated	
			I	II
April 21	26.55	3.92	8.96	15.60
May 6	23.53	9.38	11.80	28.65
May 20	23.90	11.56	19.86	24.93
June 3	20.91	12.13	22.58	26.85
June 17	19.46	11.20	21.70	36.18
July 1	19.19	24.49	27.80	43.92
July 15	22.03	25.76	23.22	44.29
July 29	19.49	17.64	21.80	46.77
Aug. 12	17.61	15.23	21.96	43.44
Aug. 26	21.06	9.61	19.67	38.76
Sept. 9	17.96	7.48	15.26	32.49
Sept. 23	16.09	11.52	16.94	31.55
Oct. 14	24.76	9.24	16.38	26.87
Oct. 30	23.28	3.46	12.60	25.82
Average	21.12	12.33	20.61	33.22

Discussion of Series 3 West (Continuous Corn). (Table VI.)

This plot, like plots 13 and 14, has been continuously cropped. Rye has been sown in the corn in the autumn and plowed under in the spring. The moisture content was about optimum during May as a result of the heavy growth of rye that had been turned under which permitted the surface water to soak in more quickly, while the soil from the other corn plots was above optimum in moisture. The above explanation probably accounts for the fresh nitrate content being higher at that time than in the case of the other corn plots. The highest point

was reached on July 15. The incubated samples with ammonium sulphate showed much higher nitrification than those without, indicating a deficiency in available nitrogenous materials in the soil.

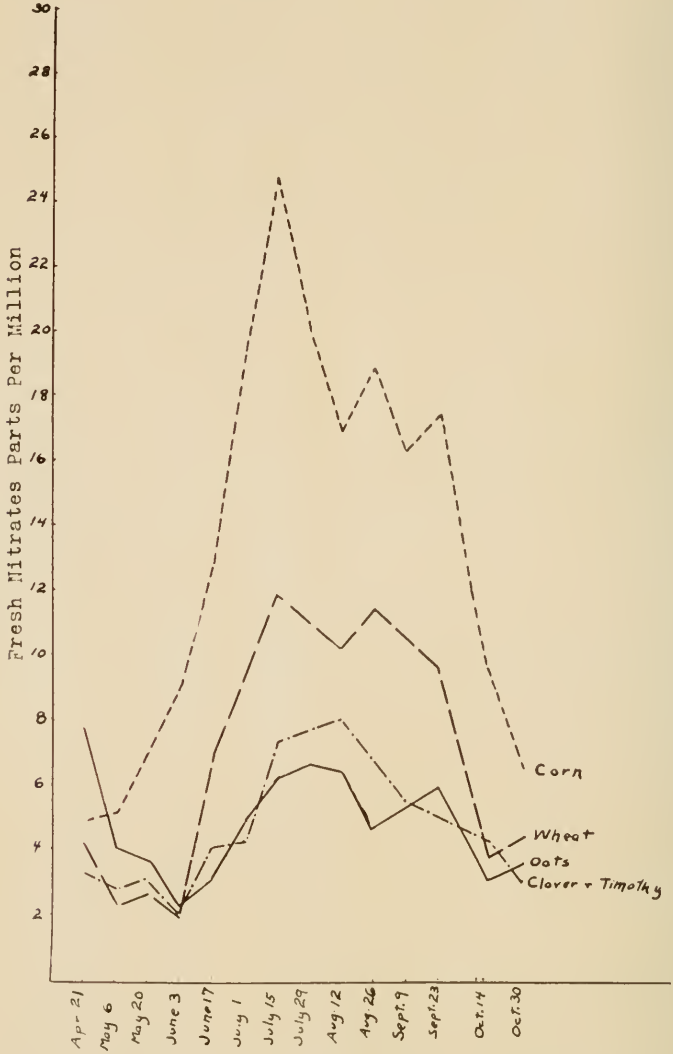

Fig. 1. Average fresh nitrates of the various crops.

COMPARISON OF THE AVERAGES OF THE VARIOUS CROPS.

The fresh nitrate content of the soils from all the plots in the same crop were averaged for each date of sampling. The accompanying graph shows these averages for the four crops.

By reference to figure 1 it will be noticed that the fresh nitrate content of the corn soil was highest of all soils throughout the season. The highest point of nearly 25 parts per million was reached on July 15, after which date the nitrate content dropped off until the end of

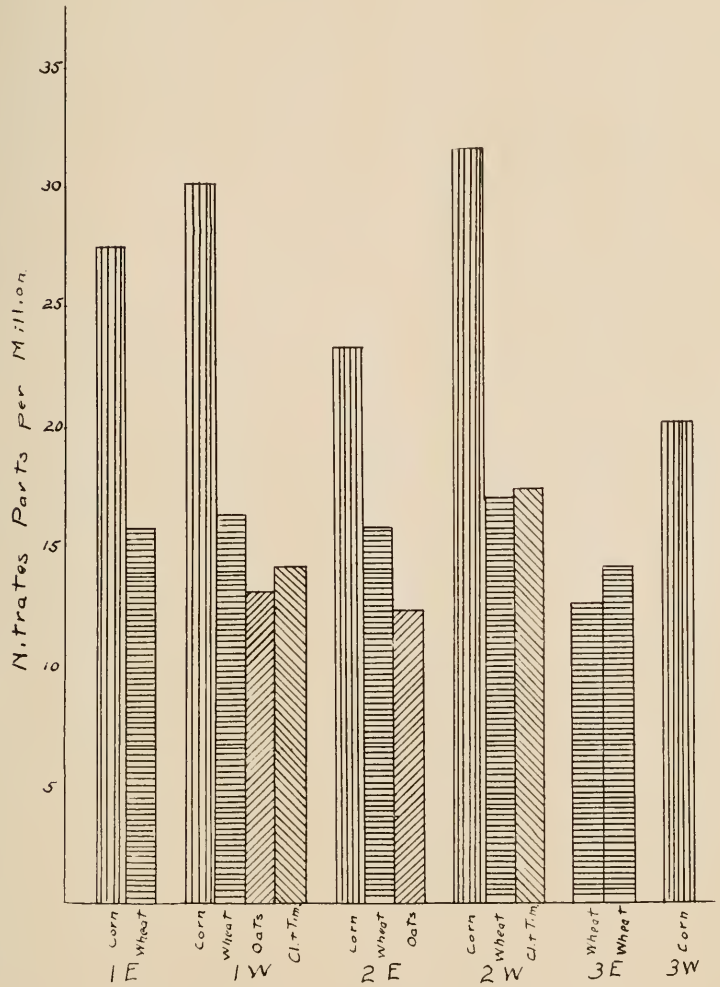

Fig. 2. Comparison of the effects of the various rotations on nitrification.

the season. The increases on August 26 and September 23 can be explained by virtue of the rain immediately preceding those dates.

The soil from the wheat plots was low in nitrates during May and early June, but went up materially during latter June and early July, reaching the highest point on July 15 as the corn soil did. The depression on August 12 was probably due to the extremely dry weather immediately preceding that date.

The oat soil was highest of all the soils on April 21, but went down in nitrate content during May and June. During July there was an increase, but compared with wheat and corn the nitrate content was low all season.

The timothy and clover plots showed a low nitrate content throughout the season, being very similar in this respect to the oat plots. The highest point of 8 parts per million was reached on August 12.

The curves on the graph of the clover and timothy and oat plots only represent the averages of two plots, while the ones for wheat and corn represent the average of six and five, respectively; hence the two former curves are probably not as reliable for those particular crops as are the ones of wheat and corn.

The following general conclusions can be drawn:

(1) Corn soil shows higher nitrifying power than do wheat, oat or clover and timothy soils.

(2) Wheat soil shows a higher nitrifying power than oat or clover and timothy soils.

(3) Clover and timothy and oats seem to have a depressing effect on nitrification processes in the soil.

TABLE VII.—AVERAGE NITRATE CONTENT

Series	Crop	Plot No.	Nitrates—Parts per Million		
			Fresh	Incubated 2 wks.	
				I	II
1E	Corn	2	12.81	27.52	36.07
1W	Corn	4	14.12	29.99	35.72
2E	Corn	8	13.01	23.12	34.13
2W	Corn	11	15.88	31.56	34.01
3W	Corn	15	12.33	20.61	33.22
1E	Wheat	1	6.19	15.97	22.96
1W	Wheat	6	6.11	16.26	20.73
2E	Wheat	7	6.33	15.54	26.43
2W	Wheat	12	7.00	16.94	29.24
3E	Wheat	13	8.41	12.61	22.70
3E	Wheat	14	9.03	14.03	23.13
1W	Oats	5	4.09	13.20	21.53
2E	Oats	9	5.59	12.16	23.85
1W	Cl. & Tim	3	4.41	14.72	22.46
2W	Cl. & Tim	10	5.00	17.25	27.83

Effect of Crop Rotation on Nitrifying Power of Soil.

Table VII gives the average nitrate content during the whole season for all the plots. The same crops are grouped together so that direct comparisons can be made.

The graphical comparison, figure 2, shows more clearly the comparison between the same crops, as well as the effect of the various rotations on the nitrifying power of the soil.

Because of the fact that the fresh nitrate content of a soil is only that part of the nitrate above that which is leached out and used by the crop, the nitrate content of incubated samples is more indicative of the effect of a crop or cropping system on the nitrifying power of the soil.

To illustrate this point it will be noticed that the average fresh nitrate contents of plots 13 and 14 (continuous wheat) are higher than any of the other wheat plots. Turning back to the previous tables, the fact can easily be seen that this high average was a result of the stimulus given to nitrification in late August and September following the plowing of these plots for wheat.

It was primarily for the purpose of determining the effect of the various crop rotations on the nitrifying power that the determinations of the nitrate content of incubated samples No. 1 (those without ammonium sulphate) were made. The purpose of the incubated samples with ammonium sulphate has already been implied in the previous discussions, i. e., to determine whether easily available nitrogenous materials were or were not a limiting factor in the nitrification processes in the various plots.

In table VII the averages for all three sets of samples are given, but only the averages for incubated samples I will be discussed for the reasons already given.

Plot II showed the highest average of all the corn plots with an average nitrate content of 31.56 parts per million; plot 12, wheat, showed the highest average of all the wheat plots with 16.94; and plot 10, clover and timothy, showed the highest nitrate content of the two clover and timothy plots with 17.25 parts per million. It would seem then that the corn, wheat and clover and timothy rotation was the most efficient in nitrifying power.

Plot 4, corn, was second in nitrate content to plot II with an average of 29.99 parts per million; plot 6, wheat, was second of all the wheat plots with 16.26 parts per million; and plot 5, oats, with 13.20 had the highest nitrifying power of the two oats plots. The above facts seem to indicate that the corn, oats, wheat and clover and timothy rotation had the second greatest effect on nitrification.

Plot 2, corn, with 27.52 parts nitrate per million, was third highest in nitrate content of the corn plots, and plot 1, wheat, was the third highest of the wheat plots with 15.97 parts nitrate per million.

Plot 8, corn, was fourth in average nitrate content with 23.12 among the corn plots; plot 7, wheat, was fourth among the wheat plots with 15.54; and plot 9, oats, was lowest of the two oats plots with 12.16 parts of nitrate per million.

Plots 13 and 14 (continuous wheat, unlimed and limed respectively) were lowest in average nitrate content of all the wheat plots.

Plot 15, continuous corn, was lowest of all the corn plots with only 18.61 parts of nitrates per million.

From the above facts the following conclusions can be drawn:

(1) It seems that the following rotations are effective in producing high nitrifying power of the soil, in the order named: (1) Corn, wheat, clover and timothy; (2) corn, oats, wheat, clover and timothy; (3) corn and wheat; and (4) corn, oats and wheat.

(2) Soil continuously cropped to either wheat or corn shows a lower nitrifying power than soil cropped to any of the above rotations.

(3) The present crop has more influence on nitrification than previous crops.