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THE SIGNIFICANCE OF THE HYDROGEN-ION CONCENTRATION IN SOIL NITRIFICATION STUDIES

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Although considerable work has been reported in the literature which shows some correlation between nitrification and the crop-producing power of soils, very little attention has been given to the significance of the soil reaction in nitrification studies.

The object of this paper is to consider this problem and data are presented which show the relation of the reaction of the soil or its hydrogen-ion concentration to its nitrifying capacity.

EXPERIMENTAL

The soils used for this study were obtained from plots on the Agronomy Farm of the Iowa Agricultural Experiment Station. These plots have been under definite cropping systems and have received various fertilizer treatments regularly since 1914. All of the plots selected for this study were located on Carrington loam. The treatments of the plots and the rotations were as follows:

PLOT NUMBER	TREATMENT	ROTATION
817	Check	
818	Manure and Lime	Three year rotation
820	Crop Residues and Lime	Corn, Oats and Clover
822	Check	
823	Check	
824	Manure and Lime	Three year rotation
826	Crop Residues and Lime	Corn, Oats and Clover
828	Check	
905	Check	
906	Manure	Continuous Corn
907	Manure and Lime	
908	Lime	
1000	Check	Five year rotation
1001	Manure	Wheat, Clover, Corn,
1002	Manure and Lime	Alfalfa and Oats
1005	Check	
1012	Manure	
1012	Manure and Lime	
1016	Check	
1018	Crop Residues and Lime	

Manure was applied at the rate of 10 tons per acre. Lime was supplied in sufficient amounts to neutralize the acidity indicated by the Truog test, at the time the manure was applied.

The continuous corn received this treatment once every four years; the three year rotation once during the rotation ahead of the corn; and the five year rotation was treated once during the rotation just before seeding of the alfalfa.

On July 12, 1926, twenty samples were taken from each plot to the depth of 4-6 inches and thoroughly mixed in the field. A composite sample of the soil of each plot was then taken to the laboratory and moisture determinations made.

The nitrification studies were carried out in the manner described by Waksman (2).

Six samples of each soil equivalent to 100 grams of dry soil, were weighed into tumblers and brought up to the optimum moisture content, which was considered to be fifty percent of saturation. These samples were treated as follows:

1. Two samples were incubated to determine the nitrification of the soil's own nitrogen, that is, the samples were incubated at room temperature and at optimum moisture for thirty days without any treatment.

2. Two samples were incubated to determine the nitrification of ammonium sulfate in the soil. To these samples 30 milligrams of nitrogen in the form of ammonium sulfate were added to each 100 grams of soil. All were incubated as in (1).

3. The two remaining samples were treated with ammonium sulfate as described above, and in addition 210 milligrams of calcium carbonate were added, in order to determine the power of the soil to nitrify ammonium sulfate in the presence of the theoretical amount of calcium carbonate needed to neutralize the acids formed by the complete oxidation of the ammonium sulfate.

The amount of nitrates present before and after incubation was determined by the phenol-disulfonic acid method, and they are reported as milligrams of nitrogen per 100 grams of dry soil.

The initial and final reactions of the soils were determined by measuring the hydrogen-ion concentration by means of the quinhydrone electrode, as described by Biilman (1).

RESULTS

The results obtained in this study are presented in figure 1. The initial reaction of the soils was found to vary from as low a pH as 5.16 to as high a pH as 7.18. This is considerable variation for

soils of the same type and there is a good opportunity, therefore, to study the effect of the reaction of each sample on nitrification after incubation of the soils with the various treatments. It will be seen that in general, there is a fairly regular difference between the reaction of the soils before and after incubation. However, the difference tends to be greater when the initial acidity is comparatively low, than if the soil is already quite acid. This in turn is reflected in the amount of nitrates formed.

The indications are that nitrification goes on until a pH of 4.4 to 4.8 is reached while from then on it proceeds very slowly. Whenever the final pH is below 4.2 the amount of ammonium sulfate nitrified is small.

The data show that when calcium carbonate is added nitrification is increased considerably. This is due, no doubt, to the more favorable reaction obtaining in the soil throughout the period of incubation. On the whole though, the final reaction of the soils is somewhat more acid than the initial reaction; which seems to indicate that a somewhat larger amount of calcium carbonate than the theoretical amount is necessary to completely neutralize the acidity produced.

A few irregularities may be noted, which are probably due to differences in such factors, as previous cropping and treatment of the soil, the amount of organic matter and other buffer materials present, as well as differences in the available plant food content.

There is also a very good correlation between treatments and nitrification. Manure plus lime gives the greatest increase in nitrification, closely followed by lime with crop residues and lime alone. Manure alone had no appreciable effect. The effect of rotation is also noticeable, nitrification in the soil on the plots under continuous corn is considerably less than where three and five year rotations are practiced. Also the correlation between soil acidity and nitrification is not nearly as good.

On the whole, however, there is a close correlation between the soil reaction and the amount of ammonium sulfate nitrified. The results would seem to confirm Waksman's (2) statement, that, "when we compare the nitrifying capacity of two soils by the common method of adding ammonium sulfate to 100 grams of soil and determine the nitrates found after incubation, we actually measure not the nitrifying capacity of the two soils, but merely, in a roundabout way, the initial reaction, the buffer content, and the presence of neutralizing substances in the soil."

LITERATURE CITED

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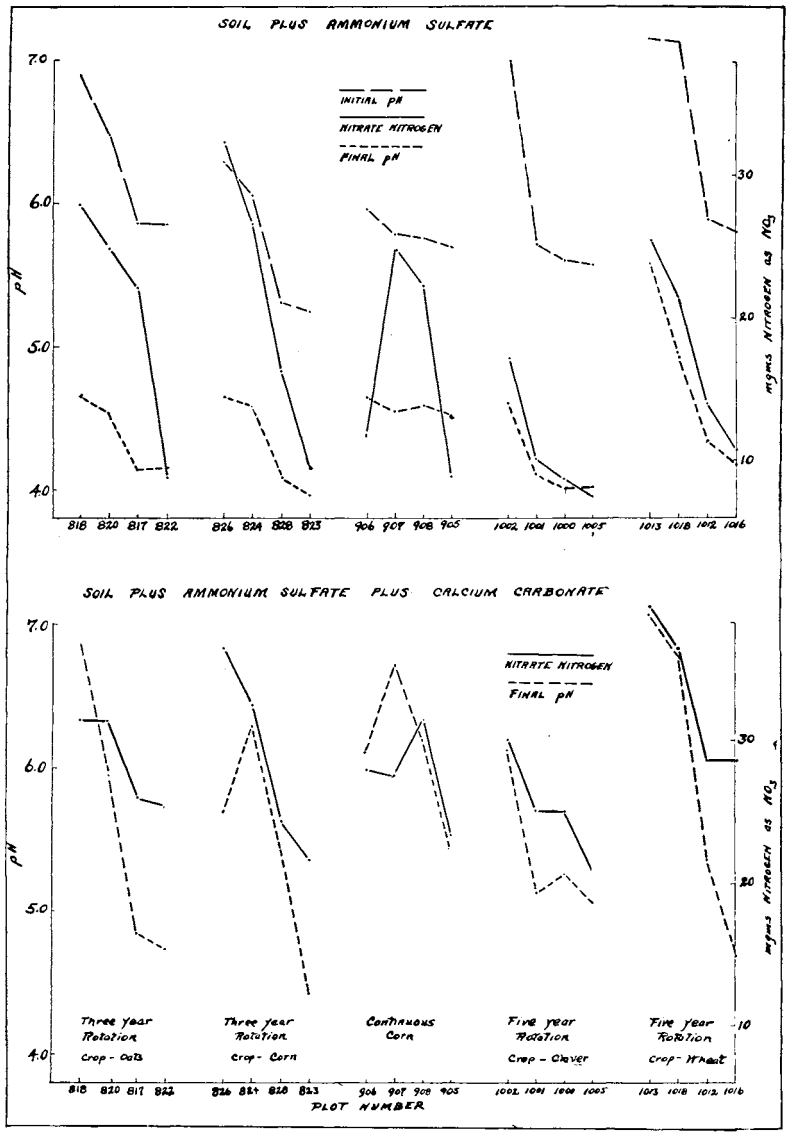

Figure 1. Showing correlation between nitrification and the reaction of the soils before and after incubation.