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SOME NITRIFICATION STUDIES ON AN ALKALI SOIL IN IOWA

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So-called "alkali" spots are somewhat common in certain parts of Iowa. They occur mainly in the Wisconsin drift soil area but occasionally areas are also found in the Iowan drift soil area. In many cases the peat and alkali areas appear in association, the peat occurring in an old lake bed or depression while the alkali spots are found on the uplands adjacent to the peat, occasionally forming a ring around the peat bed.

A whitish deposit on the surface of the ground is the first evidence of the injurious salt accumulation which is characteristic of these alkali spots, although the high concentration of salts may be present for many years but until drainage is established the salts present remain in solution, exerting their injurious effects on crops but showing no other evidence of their occurrence.

Alkali spots appear in land following drainage of a peat area, not because of the drainage, but because the drainage system is not adequate and does not provide for removal of the excess water and salts from the spots. In dry weather the salts come to the surface with the water and are deposited, forming the whitish deposit already referred to.

In order to study the effect of certain organic and inorganic compounds on nitrification in a so-called "alkali" soil, a quantity of soil was secured from an area that was growing corn but on which the corn was only about three feet high and barren. This soil was taken to the greenhouse, sieved and placed in four-gallon pots with treatments as follows:

POT NO.	TREATMENT	RATE OF APPLICATION PER 2,000,000 LBS.
1 and 2	Check	----------
3 and 4	Straw	2 tons (dry basis)
5 and 6	Sweet Clover	2 tons (dry basis)
7 and 8	Horse Manure	2 tons (dry basis)
9 and 10	Potassium chloride	200 lbs.
11 and 12	Gypsum	500 lbs.

1 The authors express their appreciation for the reading and correction of the manuscript by Dr. P. E. Brown.

The moisture content was adjusted to 50 per cent of saturation and distilled water was added at regular intervals to keep the moisture content constant, using a special watering system devised for the purpose. The idea was to try to keep the salts evenly distributed in the pot and not to have a higher concentration at the surface than at the bottom.

Samples for analysis were taken from each pot at the end of one month, three months and five months. Nitrates were determined colorimetrically by the phenoldisulphonic acid method. The nitrifying power of the soil was determined by incubating 100 grams of soil with 30 milligrams of nitrogen as ammonium sulfate for 30 days at room temperature. The nitrate accumulation in the soils is shown in table I, and the nitrifying power in table II.

Nitrate Production

The nitrate content of all the treated soils was less than that of the check at the end of the first month, although with the potassium chloride treatment there was only a very slight decrease. The soils treated with straw showed the greatest decrease of any — practically 50 per cent. This was probably due to the fact that the addition of the straw increased the activity of the nitrate assimilating bacteria and by supplying a minimum of plant food in the form of protein also restricted nitrification. Manure and sweet clover supplied organic matter and also some nitrogen in the form of protein but there was evidently not enough to stimulate nitrification to sufficient extent to offset the reduction in nitrates brought about by the nitrate assimilators. Why the gypsum decreased the nitrate content more than the potassium chloride it is hard to say but the different effect was probably due to the reaction changes.

At the end of three months the soil receiving the straw treatment still showed the lowest content of nitrates, but there was a decided decrease in nitrates in all the treated soils and in the check soil there was the greatest drop. The soil receiving the potassium chloride treatment was only slightly higher in nitrates than the check. The soil receiving the sweet clover treatment showed the least decrease in nitrates in this sampling.

At the end of five months there was another decrease in the nitrate content of the soils. The soil under the straw treatment again showed the lowest nitrate content and the soils receiving the potassium chloride, manure and gypsum treatments were all practically the same in nitrates.

These results show that organic materials are superior to inorganic fertilizers in reducing the production of nitrates in certain

Table I — Effect of different treatments on the production of nitrates on an Iowa "alkali" soil
(Expressed in p.p.m. of NO_3 — nitrogen per 100 grams of soil at different dates of sampling)

Pot No.	October 16		November 16		January 16		March 16	
		Average		Average		Average		Average
1	107.7	107.7	282.5	254.7	80.8	93.4	27.1	22.7
2	107.7		208.6		105.9		18.4	
3	107.7	107.7	132.7	124.8	75.5	79.7	15.4	18.1
4	107.7		109.1		83.8		20.8	
5	107.7	107.7	120.3	144.1	104.4	104.7	26.0	23.2
6	107.7		168.0		105.0		20.4	
7	107.7	107.7	190.1	182.4	126.6	118.0	20.0	25.7
8	107.7		174.7		109.3		31.4	
9	107.7	107.7	258.4	241.5	95.1	93.4	24.6	25.8
10	107.7		224.7		91.6		27.0	
11	107.7	107.7	172.0	164.4	109.4	108.2	25.4	25.6
12	107.7		156.8		107.0		25.7	

Table II — Effects of different treatments on nitrification in an Iowa "alkali" soil
(Expressed in p.p.m. of NO_3 nitrogen per 100 grams of soil at different dates of sampling)

Pot No.	October 16		November 16		January 16		March 16	
		Average		Average		Average		Average
1	289.3	289.3	468.9	455.2	139.1	140.4	72.1	93.2
2	289.3		441.5		141.7		114.3	
3	289.3	289.3	425.8	421.8	135.1	134.1	111.1	111.1
4	289.3		432.7		133.1		111.1	
5	289.3	289.3	415.0	417.2	136.1	138.5	112.6	112.6
6	289.3		419.4		141.1		112.6	
7	289.3	289.3	435.5	436.2	122.0	125.5	119.4	119.4
8	289.3		436.8		123.1		119.4	
9	289.3	289.3	484.4	478.3	125.6	123.6	129.0	129.0
10	289.3		467.2		121.7		129.0	
11	289.3	289.3	467.0	459.1	129.0	129.0	137.9	129.5
12	289.3		451.2		129.0		121.2	

alkali soils in Iowa. With straw there was the lowest production of nitrates, with sweet clover the second lowest, and with manure the third lowest production. There did not appear to be much difference between the effects of gypsum and potassium chloride. There were slight differences at two samplings but the results were about the same.

NITRIFICATION

From the nitrification results it appears that at the first sampling the soil receiving the potassium chloride treatment had the highest nitrifying power, and those treated with the straw or the sweet clover had the lowest nitrifying power. This is what would be expected from the nitrate content of the soils when the nitrification tests were made.

At the second sampling the check soil showed the highest nitrifying power with the soil under sweet clover and that under straw slightly lower. The one receiving potassium chloride was the lowest of all. Some factors such as number of bacteria or reaction no doubt account for these unexpected results.

At the last sampling there was an increase in the nitrifying power of the soil receiving potassium chloride. No change occurred in the soil under the gypsum treatments and in the soils with the other treatments a decrease occurred, the soil receiving the straw treatment being the lowest.

Again it appears that the organic fertilizers were superior to the inorganic fertilizers in keeping down the nitrate production in these soils.

A chemical analysis of the soils showed that there was no black alkali present and that the calcium salts were not present to a sufficient extent to prove toxic. The reaction of all alkali soils is very favorable for nitrate production. It may be that it is the nitrates that are causing the harmful effects on crops grown on these soils. If this is true, then organic fertilizers such as straw, sweet clover and horse manure are more beneficial in reducing the nitrate content than certain inorganic materials.

REFERENCE

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