TRANSFERMATION OF AMMONIUM APPLIED TO SANDY SOIL AS AFFECTED BY SOIL pH, MOISTURE LEVEL AND AMMONIUM TO NITRITE RATIOS

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SUMMARY

A laboratory experiment was conducted to study the effect of different pH values, moisture contents and NH_4: NO_2 ratios on the transformation of ammonium (as ammonium sulphate) applied to a sandy soil.

The results obtained could be summarized as fallows:

1- At low pH (6.5), the nitrification process proceeded slowly without being effected by moisture content or NH_4:NO_2 ratios .

2- At pH near neutrality (7.25), the nitrification process had taken place by increasing the soil moisture content up to 90% W.H.C (10.8% soil moisture content), while NH_4:NO_2 ratios had no effect .

3- Loss of gaseous N forms had taken place by raising the pH values to 7.75. The recorded loss was appraximately the same at all NH_4:NO_2 ratios and different soil moisture contents (30, 60 and 90% of W.H.C) .

INTRODUCTION

Ammonia resulting from its applications or from the breakdown of nitrogenous organic materials does not accumulate in the soil but in most soils it is biologically oxidized in two successive steps to nitrate (Alexander,1979) . Nitrite may appear during several nitrogen transformation processes but it does not accumulate in high concentrations in soils (Van Cleemput and Baert,1978) .

The nitrifying bacteria are known to be peculiarly sensitive to a wide variety of environmental factors such as oxygen supply,moisture content,pH,temperature,organic matter and concentration of the energy-yielding salts .

The present work was under taken to provide further information about the effect of certain changes in the soil environmental conditions namely;pH,moisture content and ammonium:nitrite ratios on the transformation of applied ammonium through the nitrification process .

MATERIALS AND METHODS

A sandy soil having the following properties was used:water - holding capacity 12%,cation-exchange capacity 3.8 meq/100g,organic matter 0.69%,$CaCO_3$ 1.65%,EC_e 1.5 dS/m and pH 7.25. The soil contained 0.64,0.40 and 0.48 mg/100g of NH_4-N,NO_2-N and NO_3-N,respectively. The experimental treatments are shown in table 1.

The original soil pH 7.25 was changed to pH 6.5 and 7.75 using phosphate buffer. Ammonium nitrogen was added as $(NH_4)_2SO_4$ (AS) and nitrite-nitrogen as $NaNO_2$. Total nitrogen was calculated to be 5mgN/50g soil for each treatment .

The soil systems were incubated at 28°c for two weeks, after which NH_4-N,NO_2-N and NO_3-N were determined in three replicate samples using the method described by Bremner and Keeney (1965) .

Table (1) Treatments used in the experiment

Soil pH	Moisture % or	W.H.C. %	NH_4^+ : NO_2^- Ratios
6.5	3.6	30	0:0
6.5	7.2	60	0:0
6.5	10.8	90	0:0
6.5	3.6	30	100:0
6.5	7.2	60	100:0
6.5	10.8	90	100:0
6.5	3.6	30	90:10
6.5	7.2	60	90:10
6.5	10.8	90	90:10
6.5	3.6	30	80:20
6.5	7.2	60	80:20
6.5	10.8	90	80:20
7.25	3.6	30	0:0
7.25	7.2	60	0:0
7.25	10.8	90	0:0
7.25	3.6	30	100:0
7.25	7.2	60	100:0
7.25	10.8	90	100:0
7.25	3.6	30	90:10
7.25	7.2	60	90:10
7.25	10.8	90	90:10
7.25	3.6	30	80:20
7.25	7.2	60	80:20
7.25	10.8	90	80:20
7.75	3.6	30	0:0
7.75	7.2	60	0:0
7.75	10.8	90	0:0
7.75	3.6	30	100:0
7.75	7.2	60	100:0
7.75	10.8	90	100:0
7.75	3.6	30	90:10
7.75	7.2	60	90:10
7.75	10.8	90	90:10
7.75	3.6	30	80:20
7.75	7.2	60	80:20
7.75	10.8	90	80:20

RESULTS AND DISCUSSION

I. Without Nitrogen Application :

At soil treatments adjusted to 30% of WHC, increasing the pH value from 6.5 to 7.25, NH_4^+ and NO_2^- had decreased from 5.103 and 1.958 mg/100 g soil to 0.949 and 0.119 mg/100g soil, respectively, while NO_3^- increased from 0.653 to 4.094 mg/100 g soil . In other words, 3.441 mg N/100 g soil of NH_4^+ $+NO_2^-$ were transformed to NO_3^-, these result demonstrated the relation between NO_3^- production and pH. Alexander, 1977 reported that in acid environment, nitrification proceeds slowly even in the presence of an adequate supply of substrate .

Further increase in soil pH to 7.75 resulted in a slight loss of - 0.037 mg N/100 g soil, as the initial tatal mineral nitrogen which was 1.520 mg/100 g soil and remained almost constant (1.483mg N/100g soil) .

As soil water content increased from 30 to 60 and 90% of the WHC, the soil mineral nitrogen gain was decreased from 6.194 to 4.038 and 4.441 mg/100 g soil at pH 6.5. While a very slight loss or gain was observed by raising the soil pH at 7.75 when soil moisture was increased .

At pH value of 7.25, the mineral N gain in soil was 3.642 and 3.918 mg /100 g soil at soil moistnre 30 and 60% of WHC and increased to 5.762 mg N/100g soil under 90% WHC. These results, generally, indicated that no nitrogen loss occurred due to raising the soil pH to 7.25, while a slight loss was recorded by raising the soil pH value to 7.75. These results agrees with those of Martin et.al. (1942) who found that ammonia is not completely oxidized to nitrate in alkaline desert soils until the pH has been reduced to a value of 7.7 ± 0.1 .

II. With the nitrogen application

When 10 mg N were applied to 100 g soil in the form of NH_4^+, the amounts of NH_4-N after incubation with the soil was around 15mg/100g soil. Applying $NH_4^+ + NO_2^-$, the NH_4^+-N decreased according to $NH_4:NO_2$ raties used, i.e. 90:10 and 80:20.

As shown in table (2), regardless the soil moisture content, the soil system at pH 6.5 recorded a very slight decrease in the amounts of ammonium present in the system at all $NH_4:NO_2$ ratios used as compared by its initial amounts. In this acid environment, it seems that nitrification proceeds slawly even in the presence of an adequate supply of ammonium sulstrate (Alexander, 1977), he also stated that the responsible mocrocrganisms (nitrifiers) are rare or totally absent at great acidities .

Table (2) : Mineral-N fractions (mg/100g soil) and gain(+) or loss (-) (mg/100g soil) or percent from initial amount (1.52 & 11.52 mg/100g soil for soil and soil + N, respectively) as affected by the soil P^H, moistur content and ratios of NH_4-N : NO_2-N added.

NH_4-N : NO_2-N added	fractions	pH 5.50			pH 7.25			pH 7.75		
		30% W.H.C	60% W.H.C	90% W.H.C	30% W.H.C	60% W.H.C	90% W.H.C	30% W.H.C	60% W.H.C	90% W.H.C
					I- Without Nitrogen Application					
0 : 0	NH_4-N	5.103	5.140	5.299	0.949	0.538	0.963	0.593	1.195	1.143
	NO_2-N	1.958	0.00	0.000	0.119	0.000	0.782	0.178	0.179	0.181
	NO_3-N	0.653	0.418	0.662	4.094	4.900	5.537	0.712	0.179	0.181
	Total	7.714	5.558	5.961	5.162	5.438	7.232	1.483	1.553	1.505
	Loss or gain mg/100g	+6.194	+4.038	+4.441	+3.642	+3.918	+5.762	-0.037	+0.033	-0.015
	%	407.5	265.7	292.2	239.6	257.8	379.1	-2.4	2.2	[illegible]
					II- With Nitrogen Application					
a) 100 : 0	NH_4-N	15.308	14.942	15.046	3.085	0.897	0.722	1.780	2.929	3.190
	NO_2-N	0.297	0.000	0.000	2.077	2.929	0.000	0.297	0.239	0.181
	NO_3-N	0.297	0.538	0.361	4.094	6.754	12.999	0.237	0.478	0.241
	Total	15.902	15.480	15.407	9.256	10.580	13.721	2.314	3.646	3.612
	Loss or gain mg/100g	+ 4.382	+ 3.960	+3.887	- 2.264	- 0.94	+2.201	-9.206	-7.874	-7.908
	%	38.0	34.4	33.7	- 19.7	- 8.2	+19.1	-79.9	-68.4	-68.6
b) 90 : 10	NH_4-N	14.003	14.404	14.335	0.717	0.482	0.482	1.958	1.614	2.889
	NO_2-N	0.534	0.000	0.000	3.916	3.945	0.000	0.831	0.956	0.241
	NO_3-N	0.712	0.598	0.231	5.459	6.977	12.940	0.831	0.418	0.301
	Total	15.249	15.002	14.566	10.710	11.639	13.422	3.620	2.988	3.431
	Loss or gain mg/100g	+ 3.729	+3.482	+3.035	-0.810	+0.119	+1.902	-7.900	-8.532	- 8.089
	%	32.4	30.2	26.3	-7.00	1.0	16.5	-68.6	-74.10	- 70.2
c) 80 : 20	NH_4-N	12.875	13.029	12.939	3.085	0.179	1.384	1.543	1.554	2.648
	NO_2-N	0.237	0.000	0.482	2.017	1.304	0.000	0.475	0.418	0.542
	NO_3-N	0.297	0.658	1.023	3.560	10.519	12.458	1.068	1.435	0.181
	Total	13.409	13.687	14.444	8.662	12.002	13.842	3.086	3.407	3.371
	Loss or gain mg/100g	+ 1.889	+2.167	+2.924	-2.898	+0.482	+2.322	-8.434	-8.113	-8.149
	%	16.4	18.8	25.4	-24.8	4.2	20.2	-73.2	-70.4	-70.7

At pH 7.25, the amount of NH_4-N present after an incubation period of two weeks indicate that a considerable in NH_4 amounts had occurred and was associated with high amount of NO_3 . Also appearance of NO_3 was associated with the soil moisture content. In other wards, it is evident that ammonium was oxidized to ritrate without the accumulation of nitrite and this process (nitrification.) was encouraged by raising soil moisture content to 90% WHC (10.8% soil moisture content) . The NH_4:NO_2 ratios had no clear effect. Sabey (1969) stated that because moisture affects the aeration regime of soil, the water status of the microbial habitate has marked influenced on nitrate production; also Alexander (1977) reported that the optimum moisture level varies considerably with different soils, but nitrate generally appears most readily at one half to two thards the moisture halding capacity .

Another trend was observed in the soil system under pH 7.75. At all the the three NH_4:NO_2 ratios had used, a significant decrease in the NH_4 amounts was occurred without appearance of significant amounts of NO_2 or NO_3, and the total mineral nitrogen . This means that, the recorded loss of ammonia was not attributed to the nitrification process but it could be attributed mainly to ammonium valatilization which was encouraged by raising the pH value to 7.75 without any effect due to varying the soil moisture content .

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