Transport of Nitrogen in Homogeneous Soil Column

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Displacement experiment at constant temperature were carried out from Loamy Soil and Sand columns of two kind of Nitrogen i.e. $Ca(NO_3)_2$ and NH_4Cl and there different pore water velocity, i.e. 6.3 cm/d, 12.6 cm/d and 25.3 cm/d. In general the breakthrough curve for ammonium display the same characteristics as the nitrate curve even though it is displaced to the right and flatter. The smaller pore water velocity produces a gradual initial breakthrough and flatter curve. The result shows that for nearly the similar pore water velocities from sand column, both ammonium and nitrate appears in the effluent solution ahead.

Introduction

Modern agriculture uses substantial quantities of fertilizers, pesticides and other chemicals that are beneficial only in the upper part of the soil profile. Translocation of these chemicals with water to the subsoil makes them not only unavailable for plant uptake, but also poses a threat to quality of underlying groundwater systems (VAN GENUCHTEN and WIERENGA, 1986). In order to predict the fate of surface applied chemicals, the process of the simultaneous movement of solute and water has been well understood.

When a fluid containing a tracer in solution is displaced by the same fluid without a tracer, this type of miscible displacement results in a tracer concentration distribution in which depends upon microscopic flow velocities, tracer diffusion rates and other chemical and physical processes (KIRKHAM and POWERS, 1972).

Material and methods

Laboratory experiments were performed on 30 cm long and 10 cm inner diameter cylindrical Plexiglas columns. Two soil textures were used namely loamy soil and sand. The dry soil weight and volume were determined gravimetrically for each column in order to determine the bulk density and porosity. The soil column was slowly saturated from the bottom with 0.01 M $CaCl_2$. They were weighted when the solution starts appearing from outlet to determine the water content of the column. The steady stated flow required for obtaining a given pore water velocity was now adjusted by measuring the effluent volume with respect to time. At the same time the relative concentration of both calcium and chloride were measured. After establishing the head for a given pore water velocity and the relative concentration both of calcium and chloride are constant in 1.00, the input line was changed (t=0) to the reservoir containing displacing solutes, i.e. Ca $(N0_3)_2$ and NH_4Cl 0.01 M. Three different pore water velocities were established in this experiment (6.3 cm/d, 12.6 cm/d and 25.3 cm/d). To obtain the effective value of water content of soil, weight of each soil column was determined at the end of an experiment. The saturated hydraulic conductivities also measured.

Result and discussion

Two soil textures were used, loamy soil (total nitrogen 0.32 %, organic carbon 1.46%, humus 2.52 %, electrical conductivity 0.23 ms/cm, CEC 14.09 mmol/100g and pH 7.88), sand (total nitrogen 0.03 %, no organic carbon and humus, electrical conductivity 0.1 ms/cm, CEC 0.44 mmol/100g and pH 7.19). The soil column data are summarized in *table 1*. It shows that columns filled with a given soil have nearly the same hydraulic conductivity, bulk density, porosity and water content.

BTCs in *figure 1* shows that for ammonium display the characteristics as the nitrate curve even though it is displaced to the right and flatter. This is expected because of ammonium ion exchanging for calcium ion.

BTCs in *figure 2* and *3* show that for slower pore water velocities, both nitrate and ammonium are appearing in the effluent solution ahead of the higher pore water velocities. However, it is requiring more relative displacement volumes for attaining a constant relative concentration.

BTCs from sand columns in *figure 4* are more steep for a given pore water velocity. This is probably due to the convective flow takes place through the bigger

Tabel 1: **Soil column data experiment**

No.	Soil	Impulse	Bulk density	Porosity	Water content	Pore water velocity (cm/d)	Ksat (cm/d)
1	loam	$Ca(NO_3)_2$	1.4631.	0.4479	0.4069	6.3	2.136
2	loam	$Ca(NO_3)_2$	1.4611.	0.4486	0.4073	12.6	2.112
3	loam	$Ca(NO_3)_2$	1.4629	0.4481	0.4081	25.3	2.136
4	sand	$Ca(NO_3)_2$	1.5605	0.4111	0.3541	6.3	149.232
5	sand	$Ca(NO_3)_2$	1.5612	0.4109	0.3543	12.6	141.456
6	sand	$Ca(NO_3)_2$	1.5593	0.4116	0.3551	25.3	134.688
7	loam	NH_4Cl	1.4629	0.4479	0.4064	6.3	2.041
8	loam	NH_4Cl	1.4615	0.4485	0.4077	12.6	2.184
9	loam	NH_4Cl	1.4620	0.4483	0.4073	25.3	2.064
10	sand	NH_4Cl	1.5596	0.4115	0.3555	6.3	140.448
11	sand	NH_4Cl	1.5612	0.4109	0.3548	12.6	134.568
12	sand	NH_4Cl	1.5582	0.4121	0.3559	25.3	149.976

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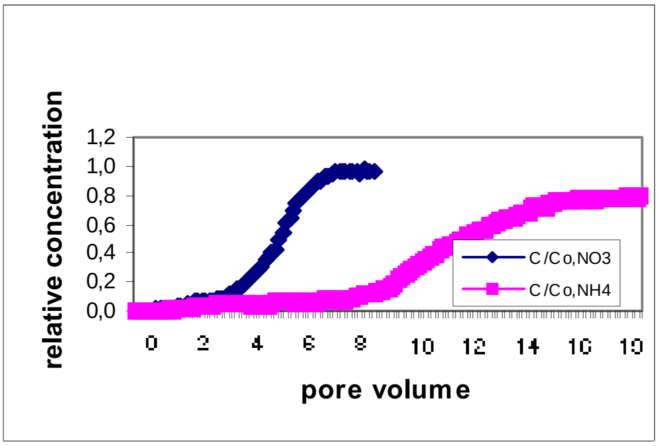

Figure 1: **BTCs of Nitrate and Ammonium from Loamy Soil Column**

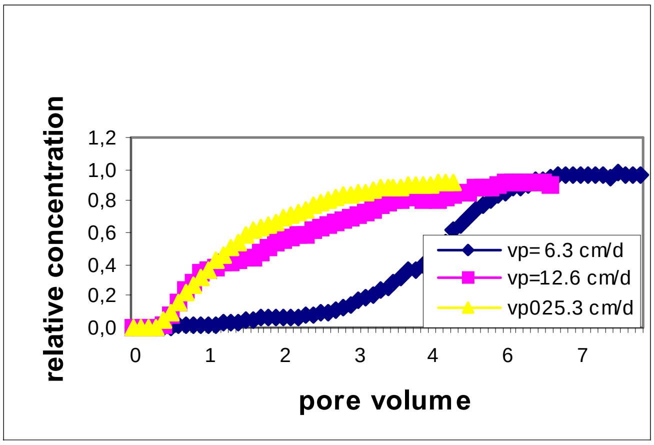

Figure 2: **BTCs of Nitrate at different pore water velocity**

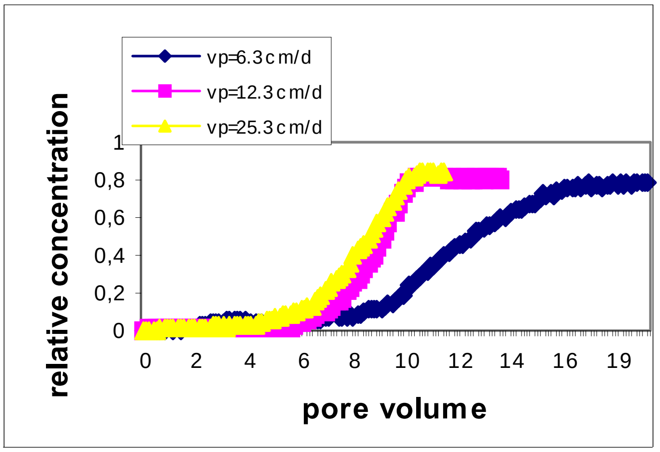

Figure 3: **BTCs of Ammonium at different pore water velocity**

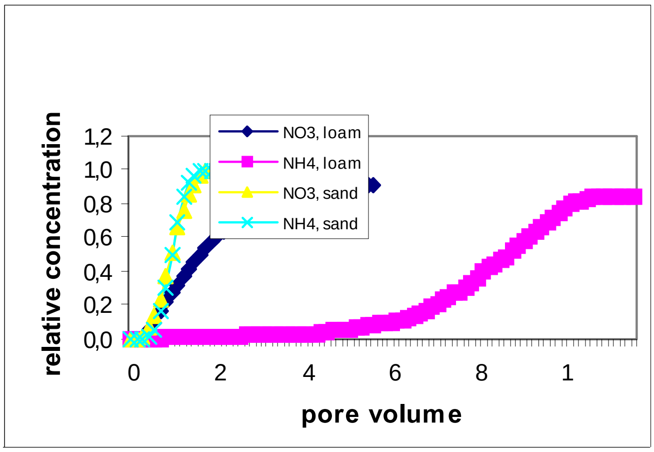

Figure 4: **BTCs of Nitrate and Ammonium from different soil texture**

soil particles. The finer texture is more actively conducting fluid which tends to mask the effect of diffusions which has occurred. The peaks of both nitrate and ammonium BTC from sand columns are slightly higher than the corresponding both nitrate and ammonium peaks from loamy soil columns.

Conclusions

It may be conclude that nitrate appears earlier than ammonium in effluent solution. The slower pore water velocity produces a gradual initial breakthrough and flatter curve. The finer texture is more actively conducting fluid.

References

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VAN GENUCHTEN, M. Th. and P.J. WIERENGA, 1986: Solute dispersion coefficients and retardation factors. p1025-1054. In: A. Klute (ed.). Methods of soil analysis. Part 1. 2nd ed. Agron. Monogr. 9. ASA and SSSA, Madison, WI.