Zeolites Regulate Nitrogen Release from Manure-Amended Soil

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Nitrogen Losses

Corn has high **N demand** and is relatively **inefficient**, recovering only **30 - 40%** of our annual fertilizer N input (Sims et al., 1995).

Most of the **NO_3 leaching** occurs during the fall and early spring months when the soil is fallow in the typical **corn-soybean** rotation of the U.S. Midwest (Owens et al, 1995).

About **18% of the N fertilizers** applied leaves in the form of produce.

Remaining **82%** is left behind

Concern relates to reactive N (nitrate) formation and environmental pollution

(http://people.oregonstate.edu/~muirp/eutrophi.htm)

Zeolite and organic matter amendment has recently been proposed as a novel approach to minimize reactive N formation and off-site movement from agricultural fields.

When Zeolite is mixed with poultry manure, after a week 42% of the ammonia volatilised from the manure was retained (Witter and Kirchmann 1989)

The name **“zeolite”** was introduced by the Swedish mineralogist Cronstedt (1756) for certain silicate minerals (Greek *zeo* = boil; *lithos* = stone).

Commercial deposits - Arizona, California, Idaho, Nevada, New Mexico, Oregon and Texas.

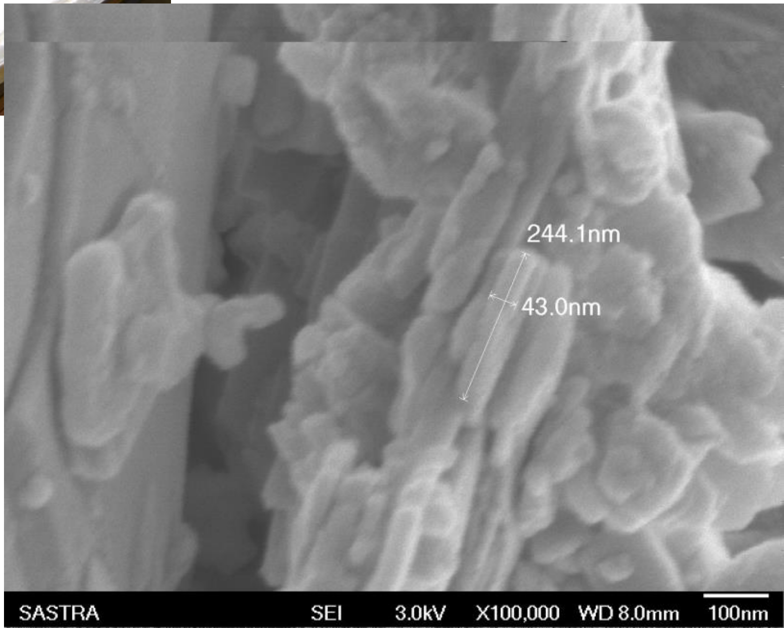
Most commonly mined are chabazite, **clinoptilolite**, and mordenite.

ZEOLITE mine
in New Mexico

CLINOPTILOLITE is the most abundant zeolite in nature.

$(Na, K, Ca)_{2-3} Al_3(Al, Si)_2Si_{13}O_{36}$-$12H_2O)$

Great affinity for NH_4^+ and other ions

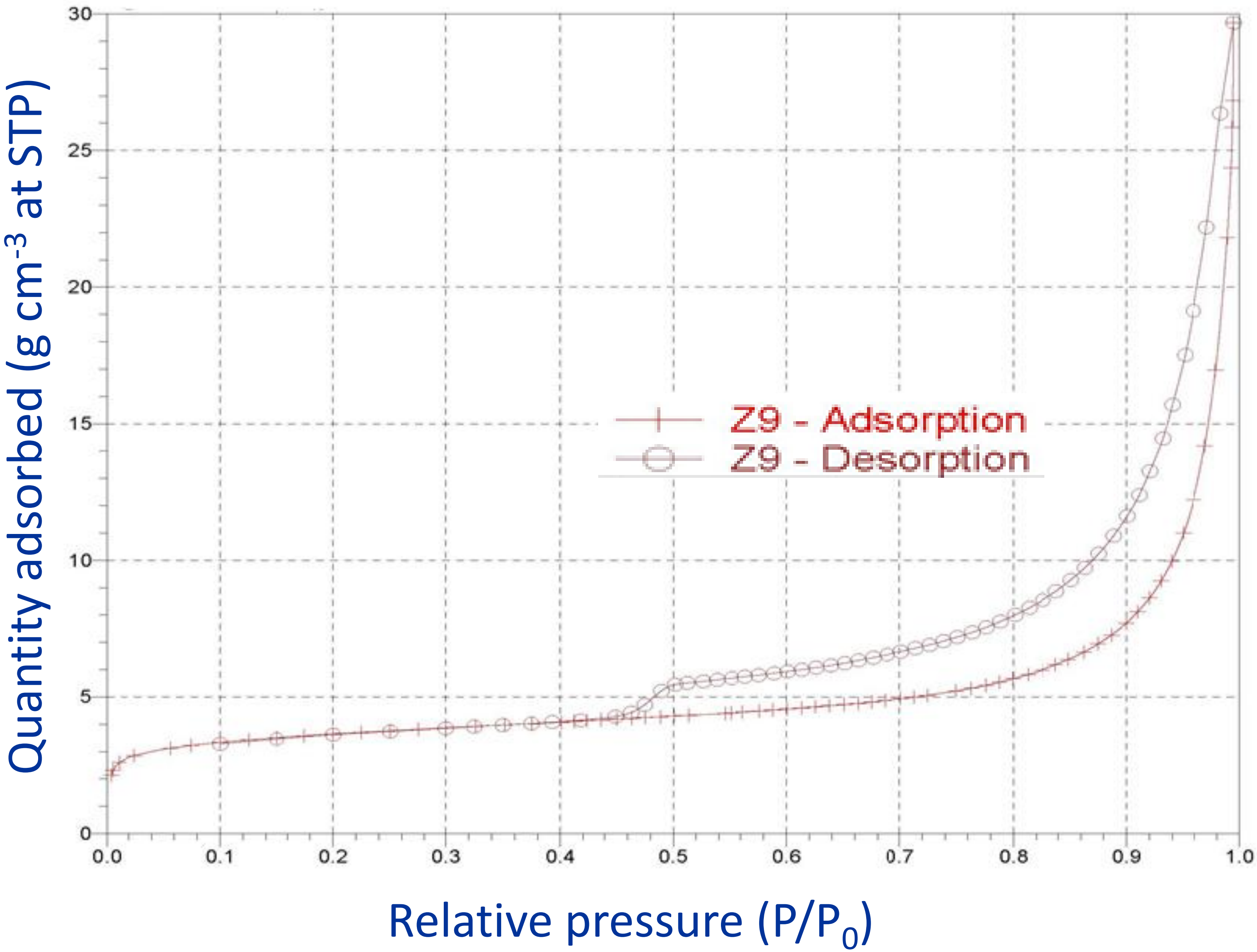


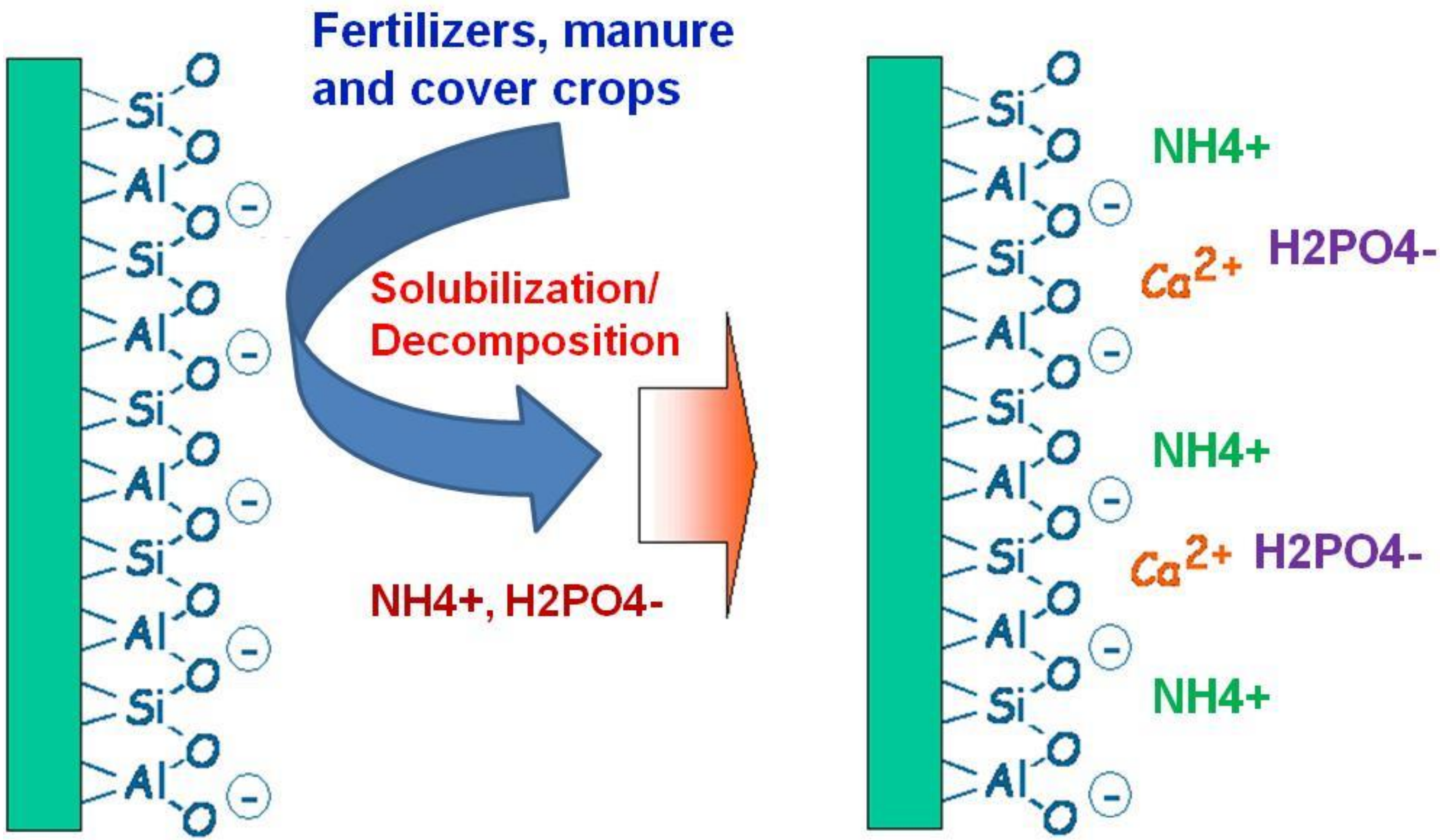
50 natural and 150 synthetic Zeolite

Have large reactive surface area

CEC 2.25 milliequivalent/g

Isothermal adsorption/desorption plot





Fertilizers, manure
and cover crops
Solubilization/
Decomposition
NH4+, H2PO4-
Si
Al
O
NH4+
Ca2+
H2PO4-
NH4+
Ca2+
H2PO4-
NH4+

Objectives

- Effect of different ratios of composted dairy manure and zeolite on N release

- Suitable extractant to measure N release from composted dairy manure and zeolite mixtures over time

- Composted dairy manure and zeolite effects on growth of buckwheat (as a test crop)

Materials and Methods

Experiment 1: Zeolite and composted dairy manure (CDM)

Design: Completely randomized design

- Soil + Zeolite (0) + CDM (0)
- Soil + Zeolite (1) + CDM (5)
- Soil + Zeolite (1) + CDM (10)

Incubation period: 7 days

Replications: 4

Experiment 2: Extractant used for soil + composted dairy manure + Zeolite mixtures

- Water extraction
- 1 M KCl extraction
- 2 M KCl extraction

Replications: 6

Experiment 3: Effect of soil + composted dairy manure (CDM) + zeolite on buckwheat

Factor A: Zeolite

Z_0: Control (Only soil)
Z_1: 2.5% of soil weight
Z_2: 5.0% of soil weight
Z_3: 10.0% of soil weight

Factor B: Composted dairy manure (CDM)

M_0: Control
M_1: CDM (50 kg N/ha)
M_2: CDM (100 kg N/ha)
M_3: CDM (150 kg N/ha)

Completely Randomized Design. Replications: 4

Results and Discussion

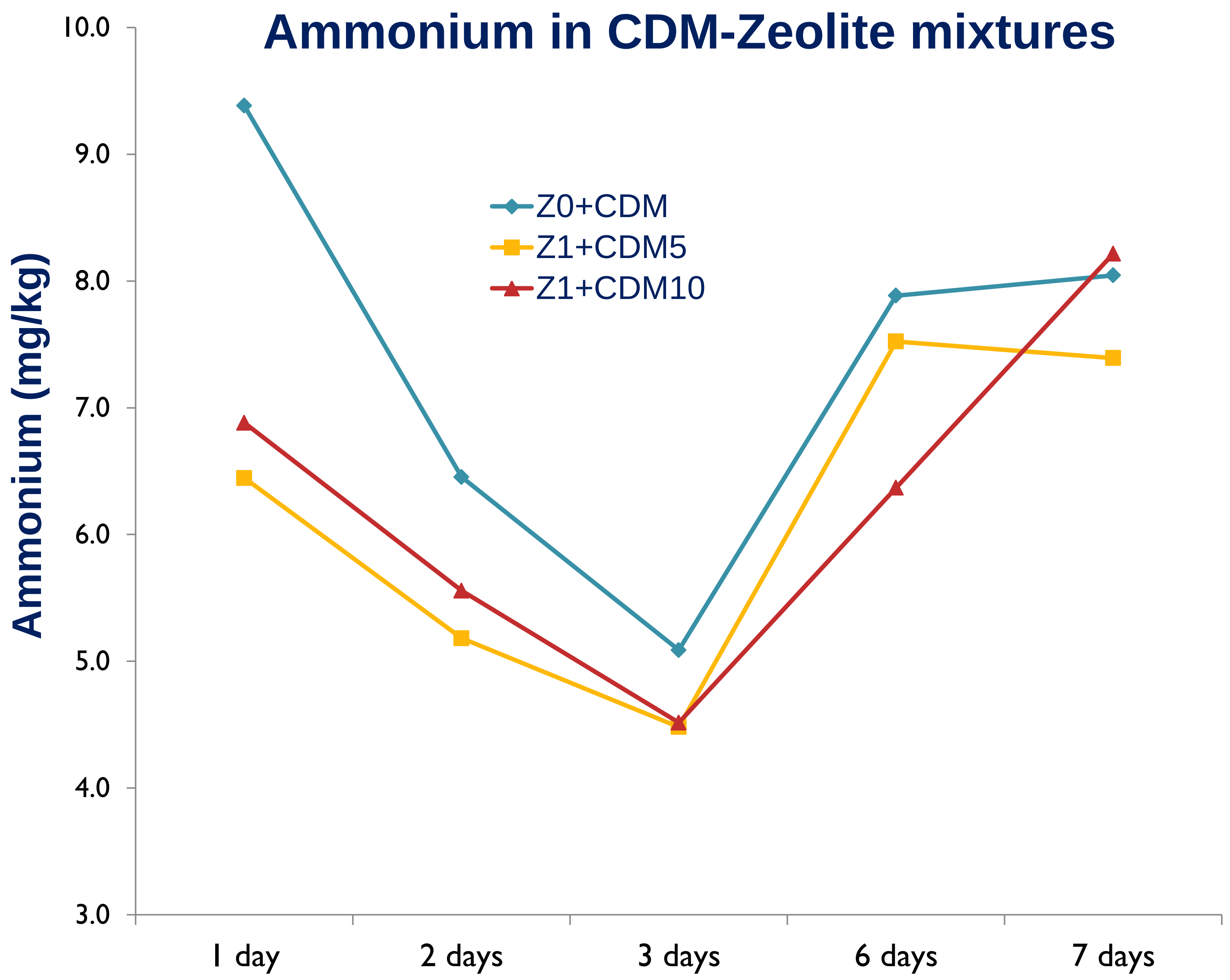
Experiment 1: Zeolite and composted dairy manure (CDM)

Design: Completely randomized design

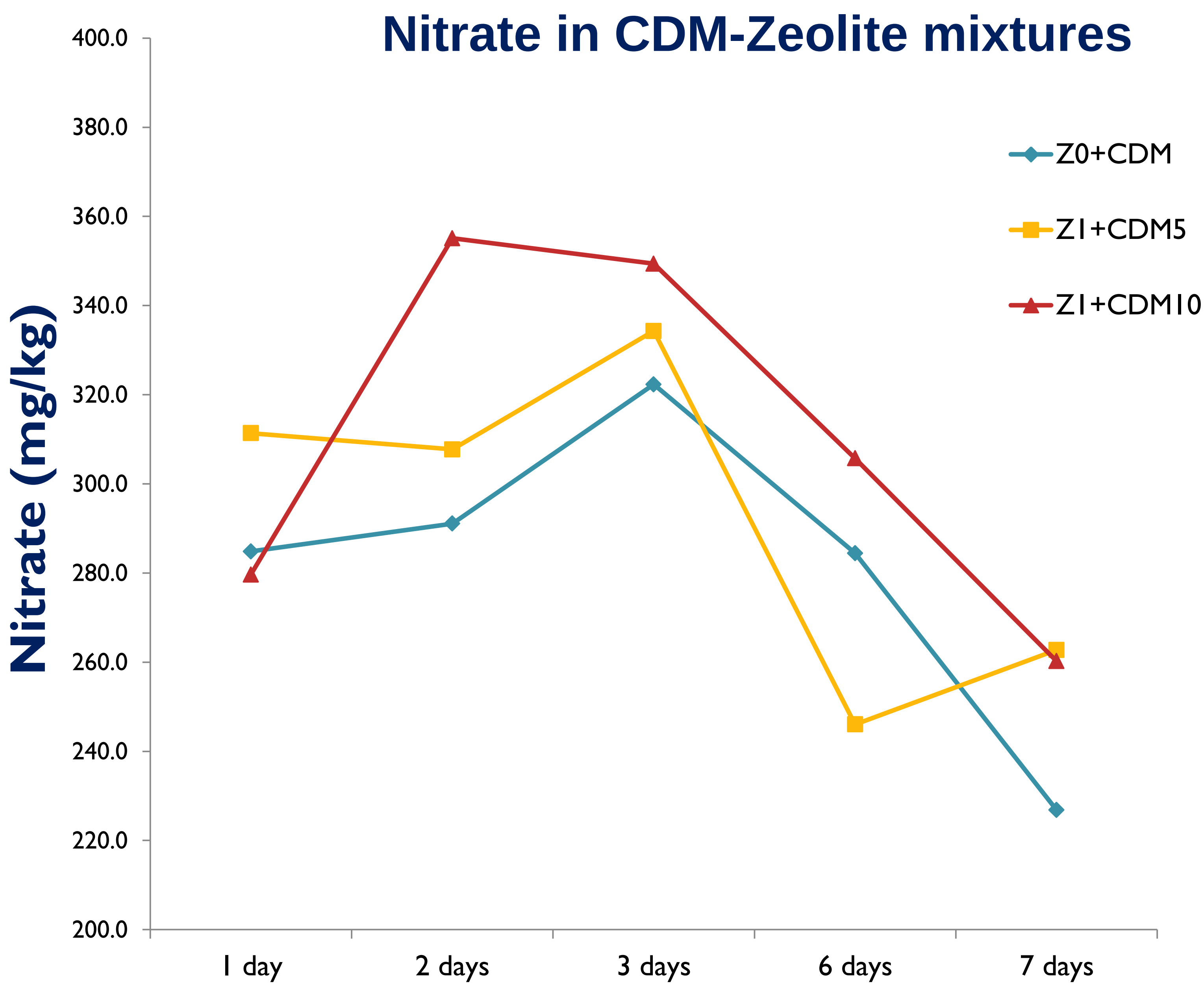
- Soil + Zeolite (0) + CDM (0)
- Soil + Zeolite (1) + CDM (5)
- Soil + Zeolite (1) + CDM (10)

Incubation period: 7 days

Replications: 4



Ammonium in CDM-Zeolite mixtures
Ammonium (mg/kg)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
Z0+CDM
Z1+CDM5
Z1+CDM10
1 day
2 days
3 days
6 days
7 days

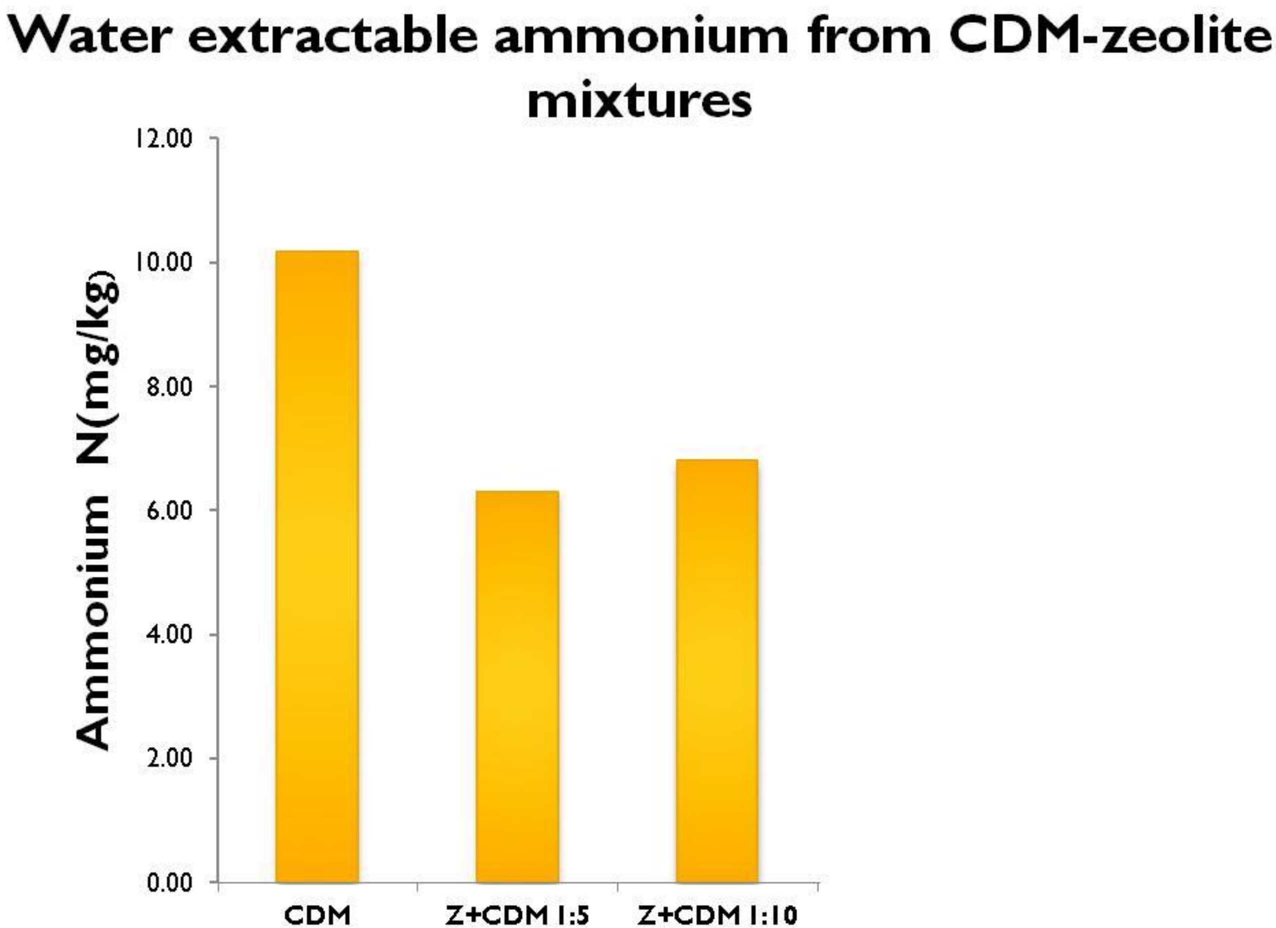


Nitrate in CDM-Zeolite mixtures
Nitrate (mg/kg)
400.0
380.0
360.0
340.0
320.0
300.0
280.0
260.0
240.0
220.0
200.0
1 day
2 days
3 days
6 days
7 days
Z0+CDM
Z1+CDM5
Z1+CDM10

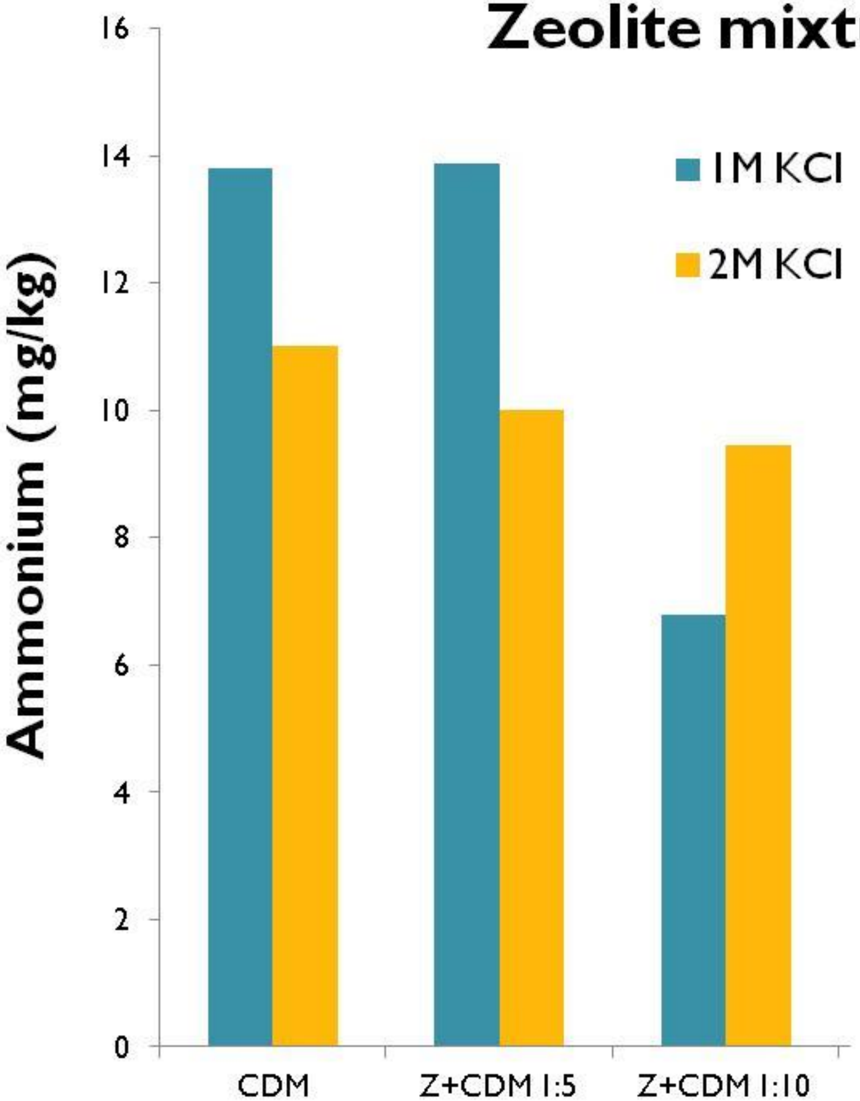
Experiment 2: Extractant used for soil + composted dairy manure + Zeolite mixtures

- Water extraction
- 1 M KCl extraction
- 2 M KCl extraction

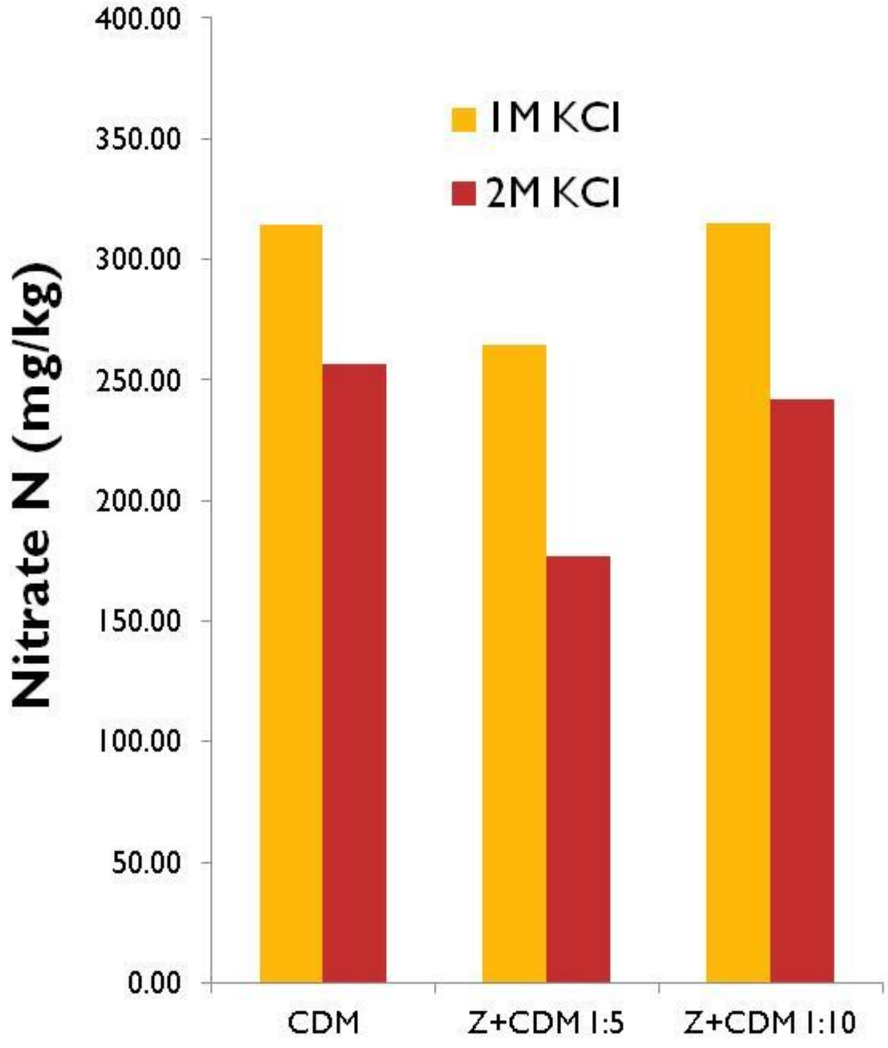
Replications: 6


Water extractable ammonium from CDM-zeolite mixtures
Ammonium N(mg/kg)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
CDM
Z+CDM 1:5
Z+CDM 1:10

KCl extractable ammonium from CDM-Zeolite mixtures



Nitrate extracted from CDM-Zeolite mixtures



Experiment 3: Effect of soil + composted dairy manure (CDM) + zeolite on buckwheat

Factor A: Zeolite

Z_0: Control (Only soil)
Z_1: 2.5% of soil weight
Z_2: 5.0% of soil weight
Z_3: 10.0% of soil weight

Factor B: Composted dairy manure (CDM)

M_0: Control
M_1: CDM (50 kg N/ha)
M_2: CDM (100 kg N/ha)
M_3: CDM (150 kg N/ha)

Completely Randomized Design. Replications: 4

Effect of soil + CDM + zeolite on buckwheat

Conclusions

Soil fertilized or amended with organo-zeolite mixtures regulated N release

Ammonium adsorbed by Zeolite was not extractable by water

Zeolite minimized reactive N (**NO_3^-**) formation

Conclusions…….

Zeolite increased plant growth

Use of Zeolite is expected to reduce (1/3rd to ½) N fertilization

Questions?