Nutrient Release of NPK-dipped Porous Ceramics

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Abstract

The use of porous ceramic as a substrate for the NPK is investigated for controlling and regulating the release of Nitrogen, Phosphorus, and Potassium macronutrients into the soil. Using a commercially available soil testing kit, results were found on the three macronutrient release. The soil test kit provides a color chart to compare the test results with and through the use of ImageJ, a more accurate result was determined by setting the scale of the histogram of the color chart as the independent variable while the test result color as the dependent variable. Results have shown that porous ceramics absorb macronutrients compared to nonporous ceramic materials. However, air packets or air bubbles formed within the pores of the porous ceramic that decreased the absorption rate of the macronutrients during the dipping method. Considering the fact that even with air packets, porous ceramics still had high nutrient release rate of 162 mg/L for phosphorus and 285 mg/L for potassium. Hence, porous ceramics could be utilized to be a substrate for producing controlled-release or slow-release fertilizers.

Introduction

Macronutrients for plant growth

- **N** — **Nitrogen**: for plant color and growth
- **P** — **Phosphorus**: for fruit and flowers
- **K** — **Potassium**: for strong roots

Overuse →

Nutrient Loss via

1.1. Ammonia volatilization

$CO(NH_2)_2 + H^+ + 2H_2O \rightarrow 2NH_4^+ + HC_3^-$
$+ H^+ \leftrightarrow CO_2\uparrow + H_2O + NH_4 \leftrightarrow NH_3\uparrow + H^+$

1.2. Nitrogen denitrification

$NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$

2. Phosphorus and potassium fixation

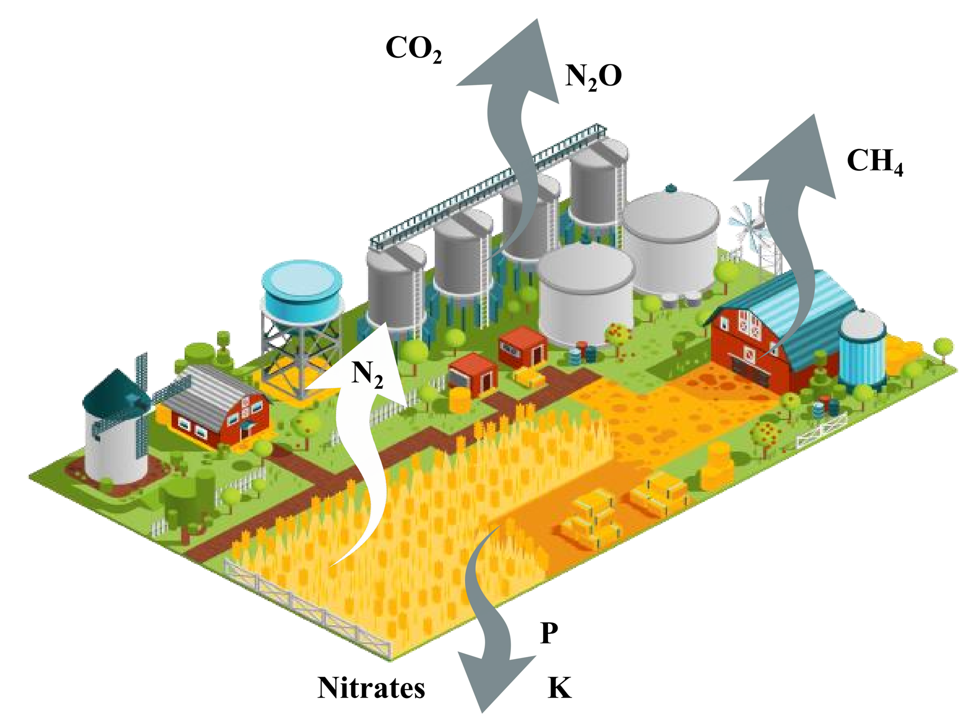
3. Leaching

Denitrification rates from saturated soil

Time (days)	Temperature (°F)	N loss (%)
5	55-60	10
10	55-60	25
3	75-80	60

*Denitrification loss will be less with soils less than 1% organic matter.

Diagram of Nutrient Loss



Methodology

1. Preparing supersaturated solution of NPK (200g of NPK + 250mL water)
2. Sonication of Ceramic Test Subjects
3. Airdrying of Ceramic Test Subjects
4. Dipping method for nutrient embedding
5. Airdrying of Dipped Ceramic Test Subjects
6. Nutrient Testing via Soil Test Kit

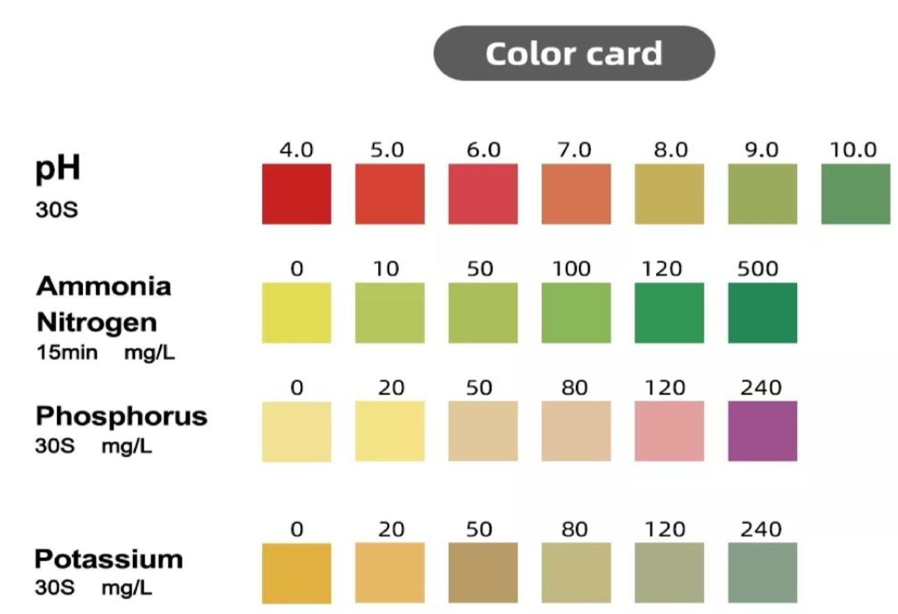
Results and Discussions

Ceramic sample after immersion in a supersaturated solution of NPK which will then be airdried prior to nutrient testing.

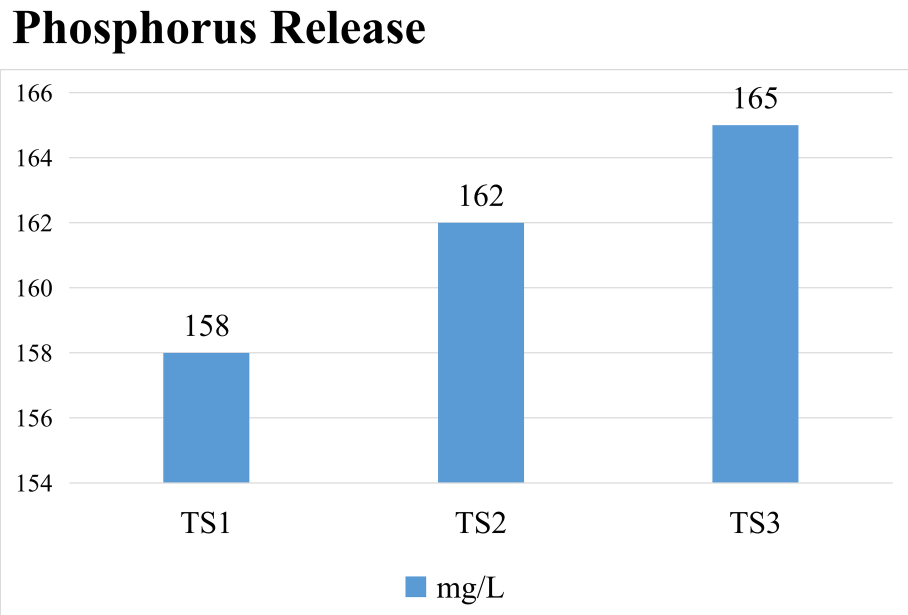
Phosphorus Test

Potassium Test

Nitrogen Test



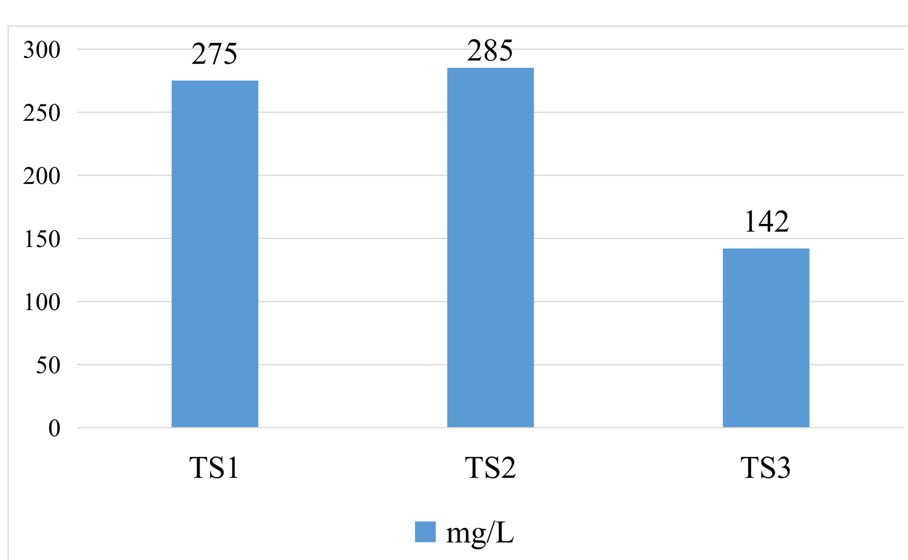
Phosphorus Release



TS1 = Commercial ceramic test subject
TS2 = Fabricated porous ceramic test subject
TS3 = Fabricated non-porous ceramic test subject

- TS3 released the **most phosphorus** which is 165 mg/L.
- TS2 formed air bubbles in the pores which suggests that it could have embedded more phosphorus if there was no formation of air bubbles.

Potassium Release



- TS2 released the **most potassium** which is 285 mg/L.
- Similarly, it is observed that TS2 **formed air bubbles** in the pores

Nitrogen release

- Tests have shown **zero nutrient release** which is probably caused by ammonia volatilization where nitrogen diffuses into the atmosphere from Ammonium (NH4+) into Ammonia (NH3), and conversion of nitrates (NO3) to nitrogen gas (N2) called denitrification.

Conclusion

Results have shown that porous ceramics absorbed and released ample amount phosphorus and potassium from the supersaturated NPK solution. Hence, porous ceramics can be utilized to be a substrate for producing slow-release or controlled-release fertilizers by installing it into the soil and removing the fertilized porous ceramics after optimal nutrient release is achieved.

Acknowledgement

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