

Using cation exchange membrane for measuring soil nitrogen supplying power in anaerobic condition

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Objectives:

This study was conducted to test the potential use of cation exchange membrane (CEM) for measuring soil NH₄-N supply in anaerobic incubation condition.

Materials and methods

Experiment 1: 10g of three moist soils from long-term fertilizer trial plots of the Experimental Station, Seoul National University (sieved through 2mm) were incubated with 15ml of deionized water and 2cm² of CEM in 50-ml centrifuge tubes at three levels of temperature (15, 27 and 35°C). After 4, 9, 14 and 19 days of incubation, incubation tubes were removed for separate analysis of soil NH₄-N and NH₄-N adsorbed to CEM. Each treatment was replicated three times.

Experiment 2: The same incubation procedure of Experiment 1 was used. The applied treatments included two soils with and without NPK addition (42N: 90P₂O₅: 63K₂O/ha equivalent).

Experiment 3: The same incubation procedure of Experiment 1 was used. The applied factor was different CEM (cm²): soil (g) ratios (0: 8, 1: 8, 2: 8 and 4: 8).

Data from three experiments were pooled for regression analysis to determine effects of each testing factor on relationship between CEM-adsorbed NH₄-N and standard incubation method and data from each experiment was used for analysis of variance separately to compare soil ammonium supplying power among different soils, levels of fertilizer and CEM: soil ratio.

Results and Discussion

In investigating the relationship between CEM-adsorbed NH₄-N and soil NH₄-N after incubation, incubated duration is the most influential factor on the correlation (Fig. 1). Coefficient of determination (r^2) of regression equation between CEM-adsorbed NH₄-N (y) and soil NH₄-N (x) was 0.04, 0.77, 0.87 and 0.91 for 4, 9, 14 and 19 days of incubation, respectively. Longer time of incubation with soil (14-19 days) is more favorable for CEM measurement. This may be related to slow release of NH₄-N from organic matter and soil colloid. Figure 2 shows that the regression equations of two soils with and without NPK addition are very similar ($r^2 = 0.80$ and 0.85 for without and with fertilizer, respectively). The gradual change in slope of the regression equations for different soils and temperature levels may result from variation in soil concentration and movement velocity of ammonium from soil to CEM among soils and incubation temperature levels (Fig. 3, 4). The trend of increasing NH₄-N (extracted from soil plus CEM) with increases of ratio CEM: soil reflects that depletion of soil NH₄-N adsorbed by CEM during incubation tends to stimulate nitrogen release from soils. We suggest that CEM may be better than traditional incubation method in measuring soil NH₄-N supply because it counts for not only nutrient amount but also nutrient movement and dynamics.

Analysis of variance shows that CEM, in comparison to traditional standard method, is a reliable method for comparing NH₄-N among soils, fertilizer treatments, incubated temperature levels.

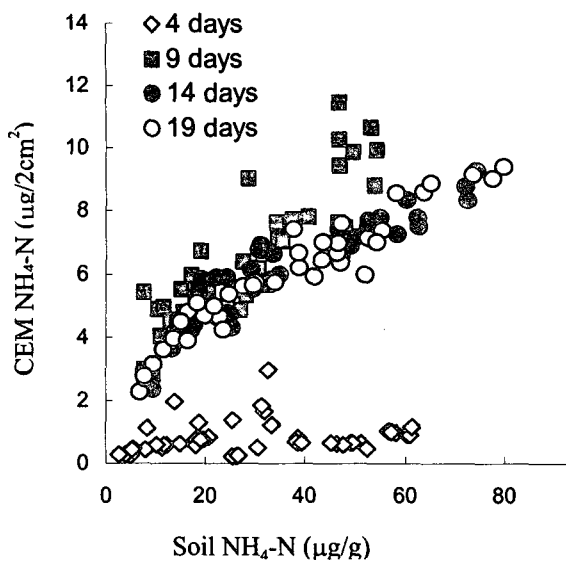


Fig. 1: Correlation between soil $\text{NH}_4\text{-N}$ and CEM $\text{NH}_4\text{-N}$ at different incubation duration

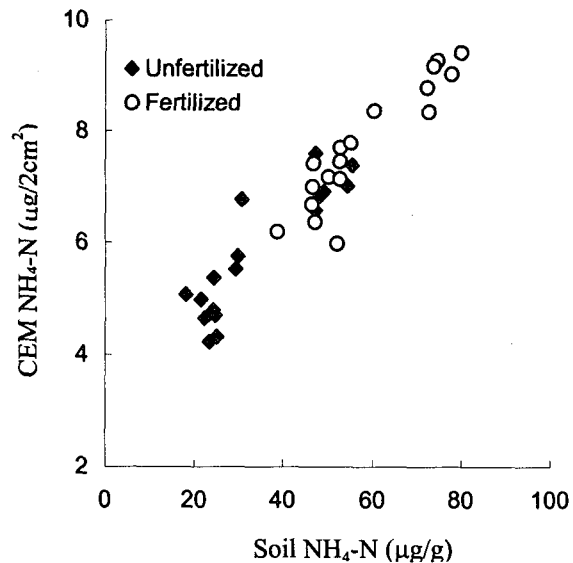


Fig. 2: Correlation between soil $\text{NH}_4\text{-N}$ and CEM $\text{NH}_4\text{-N}$ at two levels of fertilizer

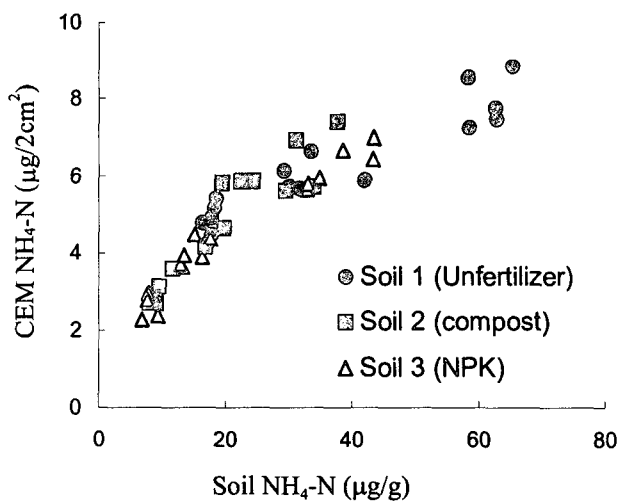


Fig. 3: Correlation between soil $\text{NH}_4\text{-N}$ and CEM $\text{NH}_4\text{-N}$ at three soils

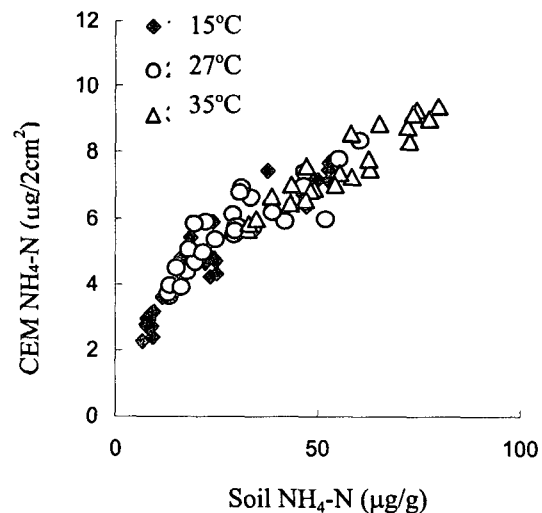


Fig. 4: Correlation between soil $\text{NH}_4\text{-N}$ and CEM $\text{NH}_4\text{-N}$ at three incubation