Supplementary material

1. Static Shaking Table Adsorption Experiment of Matrix

1.1. Adsorption Equilibrium Experiment of Phosphorus and NH_4^+-N in Matrix

In matrix adsorption equilibrium analysis experiment, 20 grams of mixed matrixes (3 paralleling samples) were taken and put into a 250 ml triangle flask. After that, KH_2PO_4 standard solution with 2 mg/L phosphorus and NH_4Cl standard solution with 8 mg/L nitrogen were added into the triangle flask for the corresponding NH_4^+-N and phosphorus adsorption equilibrium experiment. The flask was shaken on a constant temperature shaker incubator (SHZ-B, Shanghai Boxun Medical Bio Instrument Co., Ltd.). Under the condition of 200 ± 1 r/m, 25 ± 0.5 °C, the suspension was collected every 1 h to measure the corresponding change of the concentration of NH_4^+-N and phosphorus. The amount of NH_4^+-N and phosphorus adsorbed by the matrix were calculated, and the average value was used to plot the change curve of adsorption amount of NH_4^+-N and phosphorus, respectively.

2. Determination of Nitrogen and Phosphorus Absorption Rate in Water Spinach

2.1. Experiment on NH_4^+-N and P Absorption Rate in Water Spinach

The solution was prepared with NH_4Cl and KH_2PO_4 so that the NH_4^+-N concentration reached about 6 mg/L, and the PO_4^{3-}-P concentration reached about 1 mg/L to prepare a plant culture solution. The experiment set up three parallel samples. After adding 1 L of the above plant culture solution into the culture container, the culture container was placed in a constant temperature room at 30 °C, and the evaporated water was supplemented with distilled water daily. In addition, the concentration of dissolved oxygen in the culture container was higher than 2 mg/L, which could inhibit the denitrification, so the effects of denitrification on the experimental results were ignored. Apart from this, 5 mg/L nitrification inhibitor thiourea was added into the plant culture solution to prevent the effect of nitrification. During the test, 30 mL water sample was taken regularly every day to measure the concentration of dissolved NO_3^-N, NH_4^+-N, and PO_4^{3-}-P. Finally, according to the variation of concentration of NO_3^-N, NH_4^+-N, PO_4^{3-}P, and the dry weight of plants, the adsorption rate of nitrogen and phosphorus in water spinach was calculated. The experiment was in a relatively closed environment and the culture apparatus had a small exposure area, so the effect of NH_4^+-N volatilization in the experiment was ignored.

2.2. Experiment on NO_3^--N and P Absorption Rate by Water Spinach

The solution was prepared with KNO_3 and KH_2PO_4 so that the NO_3^--N concentration reached about 5 mg/L, and the PO_4^{3-}-P concentration reached about 1 mg/L to prepare a plant culture solution. The experiment set up three parallel samples. After adding 1 L of the above plant culture solution into the culture container, the culture container was placed in a constant temperature room at 30 °C. During the test, a 30 mL water sample was taken regularly every day to measure the concentration of dissolved NO_3^-N and PO_4^{3-}-P. Finally, according to the variation of concentration of NO_3^-N and PO_4^{3-}-P and the dry weight of plants, the absorption rate of N and P in water spinach were calculated.

3. Nitrification and Denitrification Intensity Test

3.1. Nitrification Intensity Test

Firstly, 10 g mixed substrates were taken from the CW, and then the mixed substrates were added into 250 mL flasks. 100 mL (25 mg/L) NH_4^+ N culture medium was added into the flask. Then flasks were plugged with a rubber stopper (or cotton wool) with holes. The flask was shaken on a constant temperature shaker incubator (SHZ-B, Shanghai Boxun Medical Bio Instrument Co., Ltd.,

Shanghai, China) (constant temperature 20 °C). The suspension was collected every 24 h to measure the concentration of NO_3^--N after filtration or centrifugation. Each time, the culture medium would be supplemented after sampling. The intensity of soil nitrification is calculated by the change of NO_3^- concentration before and after culture. The method has a short culture time, which is not sufficient to cause the nitrifying bacteria to multiply. The anaerobic environment is prevented by shaking the soil or gravel suspension to inhibit the denitrification process, so it can be used to estimate the potential of testing soil nitrification. Liquid culture solution: potassium dihydrogen phosphate solution 0.2 $mol \cdot L^{-1}$, dipotassium hydrogen phosphate solution 0.2 $mol \cdot L^{-1}$, ammonium sulfate solution 0.050 $mol \cdot L^{-1}$, and they are formulated in a ratio of 3:7:30 by volume, and adjusted to pH 7.2 with a dilute solution of H_2SO_4 or NaOH.

3.2. Denitrification Intensity Test

Firstly, 10 g of mixed substrates were taken from the CW, and then the mixed substrates were added into 250 mL plastic bottles. 100 mL NO_3^- culture medium were added into the bottles. Then flasks were plugged with a rubber stopper. The flask was shaken on a constant temperature shaker incubator (SHZ-B, Shanghai Boxun Medical Bio Instrument Co., Ltd.) (constant temperature 20 °C). The suspension was collected every 24 h to measure the concentration of NO_3^--N after filtration or centrifugation. Each time, the culture medium will be supplemented after sampling. The intensity of soil denitrification is calculated by the change of NO_3^- concentration before and after culture. Liquid culture solution: potassium dihydrogen phosphate solution 0.2 $mol \cdot L^{-1}$, dipotassium hydrogen phosphate solution 0.2 $mol \cdot L^{-1}$, potassium nitrate solution 0.03 $mol \cdot L^{-1}$, glucose 0.02 $mol \cdot L^{-1}$, and they are formulated in a ratio of 3:7:30:10 by volume with the C:N ratio is about 3:1, and adjusted to pH 7.2 with a dilute solution of H_2SO_4 or NaOH.

The nitrification and denitrification intensity were determined based on the Equation (1).

$$W(n) = (C_2 - C_1) \times (V_1 + V_2)/(t \times m \times k) \quad (1)$$

W(n) — Nitrification intensity/Denitrification intensity (mg/kg.h)
C_2 — The concentration of NO_3^--N after culture (mg/L)
C_1 — The concentration of NO_3^--N before culture (mg/L)
V_1 — The volume of culture medium (L)
V_2 — The volume of water in the mixed substrates (L)
t — Culture time (h)
m — Sample quality (kg)
k — Moisture coefficient