Nitrogen and Phosphorus Removal Efficiency of 7 Types of Wetland Plants

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Objectives

Small-scale artificial wetland systems are considered the best sanitation facilities for rural areas and are widely used for rural domestic sewage treatment. Wetland plants play a vital role in the removal of nitrogen and phosphorus in artificial wetland systems. In this study, 7 types of wetland plants were selected to determine their efficiency and mechanism to remove nitrogen and phosphorus from rural domestic sewage, including *Myriophyllum verticillatum* (*MV*), *Arundo donax* (*AD*), *Typha orientalis* (*TO*), *Acorus calamus* (*AC*), *Iris tectorum* (*IT*), *Scirpus validus* (*SV*), and *Nymphaea tetragona Georgi* (*NTG*). We provides a theoretical basis for selecting plant species that efficiently purify sewage in wetlands.

Methods

In this experiment, a small-scale potted wetland plant system was constructed to simulate an artificial wetland. Test wastewater was prepared according to the water quality standards specified in the “Technical Guidelines for Water Quality Purification in Artificial Wetlands”.

Water samples were collected, and water quality parameters were measured on days 0, 1, 2, 3, 5, 10, and 15 to analyze the removal efficiency of wetland plants for NH_4^+-N, NO_2^--N, NO_3^--N, TN, and TP in the wastewater. The wetland plant's removal efficiency for TN and TP were calculated as follows:

$$P = (C_{Ki} - C_i) \times V_i / (C_0 \times V_0) \times 100\%$$

where: C_{Ki} is the concentration on the i-th day in the control group (mg/L), C_i is the concentration on the i-th day in the plant group (mg/L), V_i is the volume of water on the i-th day (L), C_0 is the initial influent concentration (mg/L), V_0 is the initial volume in the apparatus (L), and *P* is the removal efficiency (%) for each indicator.

Results

The experimental results showed that the water purification effect of the wetland plant treatment group was significantly higher than that of the control group. The details are as follows:

1. All seven different wetland plants demonstrated good removal capabilities for NH_4^+-N, TN, and TP, as shown in the Figure 1-3. At first 0-5 days, the concentrations of NH_4^+-N, TN, and TP decreased rapidly, at 5-15 days, the decrease rate slowed down gradually.

2. In the wetland plant treatment group, *Myriophyllum verticillatum* group showed the best removal ability, with the concentrations of NH_4^+-N, TN, and TP reaching GB 3838-2002 surface water quality standard Class I on the 1st, 5th, and 5th days, respectively. *Arundo donax* group performed second best, with the concentrations of NH_4^+-N, TN, and TP reaching GB 3838-2002 surface water quality standard Class I on the 3rd, 3rd, and 10th days, respectively.

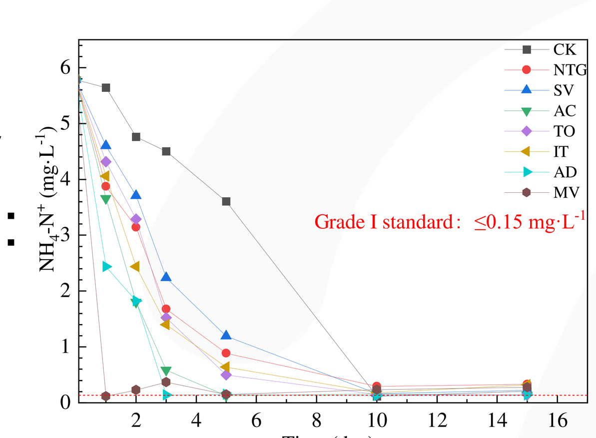

Figure 1 Concentration Changes of NH4+-N in Different Treatment Groups

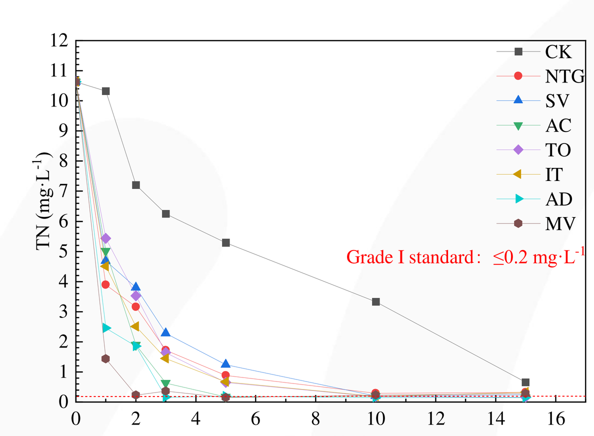

Figure 2 Concentration Changes of TN in Different Treatment Groups

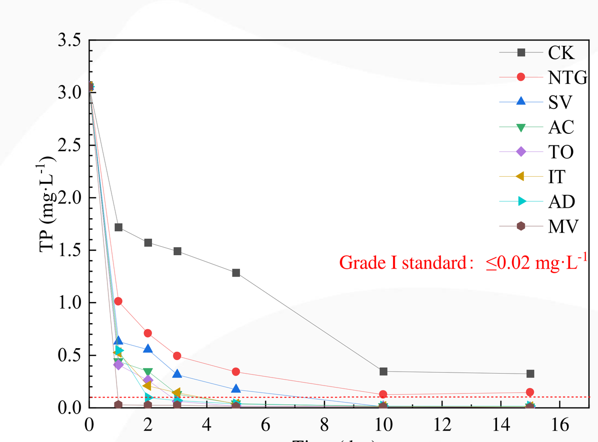

Figure 3 Concentration Changes of TP in Different Treatment Groups

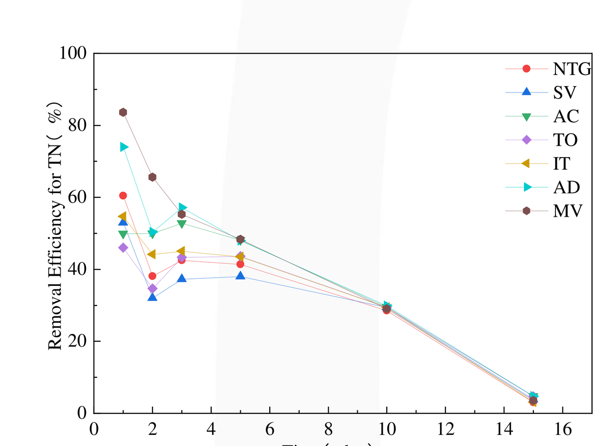

Figure 4 Removal efficiency of TN by different types of wetland plants

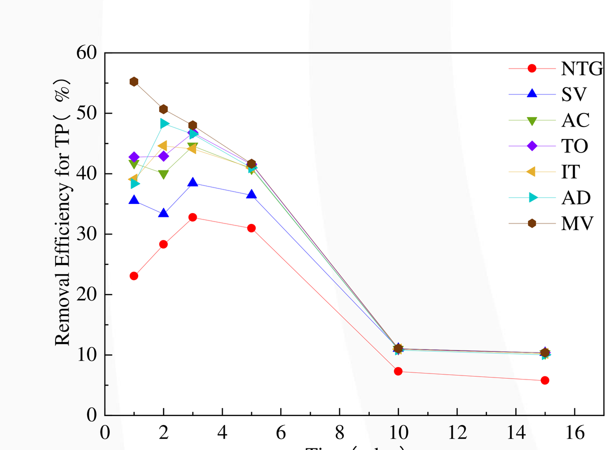

Figure 5 Removal efficiency of TP by different types of wetland plants

3. Compared to the control group, the wetland plant treatment group showed an improvement in TN and TP removal efficiency by 5.79% to 55.22% and 3.08% to 83.60%, respectively. Figure 4 and Figure 5 represent the removal efficiency of TN and TP by different types of wetland plants respectively. As shown in Figure 6, the efficiency of TN removal by different wetland plants is as follows: submerged plants(*Myriophyllum verticillatum*) > other plants (*Arundo donax* > *Acorus calamus* > *Iris tectorum* ~ *Typha orientalis* > *Nymphaea tetragona Georgi* > *Scirpus validus*).As shown in Figure 5, The removal effect of wetland plants on TP was observed throughout the entire experimental period (1-15 days). The efficiency of TP removal by different wetland plants is as follows: submerged plants (*Myriophyllum verticillatum*) > emergent plants (*Arundo donax* > *Acorus calamus* > *Iris tectorum* ~ *Typha orientalis* > *Scirpus validus*) > floating-leaved plants (*Nymphaea tetragona Georgi*).

Conclusions

Taking into consideration the removal efficiency for both nitrogen and phosphorus, *Myriophyllum verticillatum* (submerged plant), *Arundo donax*, *Acorus calamus* (emergent plants), and *Nymphaea tetragona Georgi* (floating-leaved plant) are preferred as wetland plants for sewage purification in the rural areas in northern China. Combining three different types of wetland plants to increase the diversity of wetland plants and improve nitrogen and phosphorus removal efficiency.