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Some aspects of the purification efficiency of *Phragmites australis* in a root zone system

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ABSTRACT Today natural wastewater treatment technologies gain more importance. Root zone systems are real alternatives for the purification of the sewage of smaller settlements. Focusing on the importance of the role of the plant in these systems we tried to learn more about these systems. This paper compares the differences of the element- and nutrient-elimination efficiency of the gravel and the reed beds of the system in Szügy and gives some observations concerning the element- and nutrient-accumulation of the different parts of the reed (*Phragmites australis*). Our results indicate the annual differences between the two treatments and those of the accumulation of the reed. The reed beds prove to function better in removing phosphorus, NH4-N and most of the metals. **Acta Biol Szeged 46(3-4):61-62 (2002)**

KEY WORDS

Phragmites australis
reed bed technology
wastewater
purification

The spreading of reed bed wastewater treatment systems was hindered by the lack of experience concerning planning and maintenance. Their new introduction was enhanced by Kickuth (1977) from the middle of the 1970's. Today there are several root zone systems in Europe and in the world as well. The success of these systems show that it is recommended to deal with wastewater treatment technologies in which water plants are applied. As there is not enough information about the Hungarian systems, the aim of this work is to obtain more knowledge about root zone systems and the role of plants in these systems.

As far as the role of the plant is concerned scientists are not always in accordance. Some of them says that the main role of the plants is to provide oxygen, while the soil and the microorganisms are much more effective in the purification processes. Others say that plants play a really important role in the elimination of nutrients and other elements (Reed and Brown 1995).

Materials and Methods

The system under investigation is located in Szügy (1200 inhabitants), Nógrád county, Hungary, where the root zone system has been in operation from 1994. The capacity of the system is 100 m^3/day. The purification process involves the following units: chemical pre-precipitation, Imhoff tank, reed beds (parallel with them 2 gravel beds), septic tank (not in use) and a small pond for final NH4-N removal (Szilágyi 1997).

The treatment beds (both the reed and the gravel ones) are isolated with waterproof foils and consist of several gravel and sand layers. All the beds receive settled wastewater. The filter beds are connected parallel with each other and the water flows through them vertically.

Water, soil and plant samples are taken monthly. The following water quality parameters are measured in 6 points of the system (raw wastewater /1/, settled wastewater /2/, water flowing out from the gravel /3/ and the reed beds /4/, water getting into the pond /5/ and water flowing into the receiving creek /6/) and their changes are followed: total N, NH4-N, NO3-N, P, Al, Ca, Cd, Cu, Fe, K, Mg, Mn, Na, Ni and Zn.

For taking the plant and soil samples the 2 reed beds were divided into 25-25 squares of 4x4 metres, from which 5-5 were selected at random. Samples are taken from 9 points of each square. Whole reed plants are collected. Soil samples are taken with a soil sampler, which reaches down as far as 40 cm. In case of soil the sampling points and the sampling method are the same as those of the plant samples. The elements examined are also the same.

The preparation and digestion of the samples are done according to the Hungarian standard (MSZ 21470-50). The element concentrations of the samples are analysed by ICP in the laboratory of the Department of Horticulture and Food Industry of the Szent István University. The analyses of N are made in the laboratory of the Research Institute for Soil Science and Agro-chemistry (TAKI).

Results and Discussion

The concentration values of the settled wastewater and those of the water flowing out from the gravel and reed beds were compared to see the difference between the two treatments. From the data of the water samples it can be seen that the P-content of the settled wastewater is changing (6,45-15,79 μg/ml) during the year, however, the concentrations of the samples taken after the gravel beds follow the changes, while those of the samples taken after the reed beds are extremely small, in many cases they cannot be detected (Fig. 1).

In case of NH4-N the concentrations of the settled wastewater also show changes during the year, which is well followed by the values of the samples taken after the gravel beds., but the outstanding values are not reflected so extremely (Fig. 2). Taking into consideration the results of

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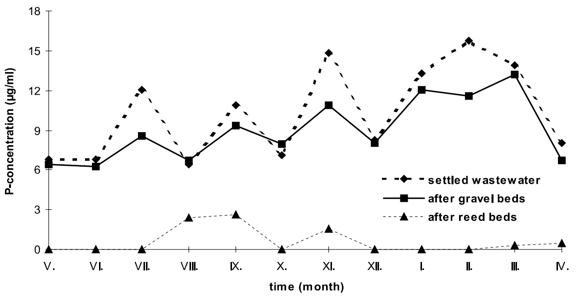

Figure 1. P concentrations of the water samples (µg/ml).

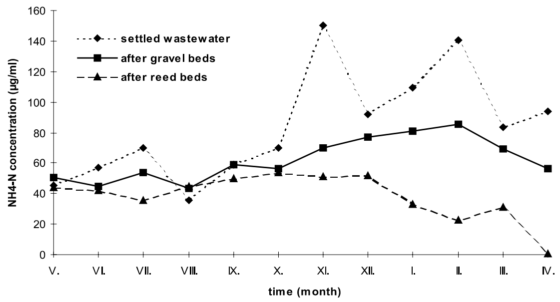

Figure 2. NH4-N concentrations of the water samples (µg/ml).

the water samples taken after the reed beds it can be concluded that this treatment works better than the previous one. In case of the reed beds it can be seen that from November the measured concentration values show a decline, while those of the settled wastewater increase. It can be due to the fact that oxygen gets to the rhizomes and roots through the cut stems, which results in aerobic conditions around them in the soil, and thus NH4-N is oxidised into NO3-N leading to the decrease in the NH4-N content of the water flowing out from the reed beds. From the point of view of the operation of the system the depth of the roots is an important factor as the anaerobic layer below the root zone does not play a role in the elimination of the nitrogen and the other components of the wastewater (Reed et al. 1988). It can be established that from November the NH4-N eliminated better in aerobic conditions is present in form of NO3-N in the water flowing out from the reed beds in higher concentrations. As at that time the vegetation period is over and the reed was harvested, a large amount of the previously mentioned NO3-N is not taken up by the plants. In case of total N the tendency is similar.

In the settled wastewater significant amounts of Al and Zn were measured. In case of both metals it can be noticed that reed beds function well in the elimination, and the efficiency of the elimination follows the variations of the concentration values of the settled wastewater. As far as the other elements are concerned the concentrations of the settled wastewater did not reach the limit values of the detection, or there were so little of them that there was not a significant difference between the two treatments.

By analysing the elimination efficiency of the two treatments concerning the elements and nutrients it turns out that the P-elimination of the reed beds is 93% averagely, while that of the gravel beds is 11%. In the first case the smallest value was measured in August (63%), while there is a 100%-elimintaion efficiency in 7 months (V, VI, VII, X, XII, I, II).

In case of NH4-N the concentration values of the water taken either after the reed beds or the gravel beds follow the variations of those of the settled wastewater, meaning that the elimination efficiency is better if the concentration is higher. The average elimination efficiency of the reed beds is 43%, while that of the gravel beds is 19%. The better elimination efficiency beyond the vegetation period can be explained by the fact that a large amount of the NH4-N is converted into NO3-N due to the aerobic conditions.

Nitrogen and phosphorus are accumulated in the leaf in the largest amount (Dinka 1986). The P-content of the subsurface parts of the reed is nearly steady, but in case of the rhizome a small increase can be noticed from September. The P-content of the leaf and the stem gradually decreases from May, but in case of the stem the rate of the decline is larger. As far as the total N-contents of the different parts of the plant are concerned the differences in the concentration are smaller than in case of the phosphorus, but the tendency is similar and the rate of the changes is smaller. The leaf accumulates the N in the largest amount, and it is followed by the rhizome and the stem.

A significant amount of Al is accumulated in the roots. Roots are the most significant accumulators of Cd, Fe, Mg, Mn, Na, Ni and Zn. In case of Mg and Mn there are high concentrations in the leaf as well (Kiss et al. in press). It can be concluded that the higher element- and nutrient-contents of the environment are also reflected in the larger uptake by plants (Podani et al. 1979).

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