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Management of waste water through aquatic weed - based phytoremediation system

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Introduction

The aquatic weed based phytoremediation system transforms contaminated water into irrigation water. This system made up of three different weed treatment tanks, where weed are grown in tank and contaminated water is passed through this weed growing tanks. The weedy plants by virtue of their nature extract and stabilize contaminants through their roots and other plant parts. After passing through different weed treatment tanks, contaminated water is transformed into suitable irrigation water.

The technology uses either a single weed, generally semi aquatic or free-floating aquatic weed plants. Earlier models used single plants. With time, the system was modifies to increase efficiency. The latest system uses 3 different weed species, (*Typha latifolia/Arundo donax- Eichhornia crassipes – Hydrilla verticillata)* with varying individual potential to accumulate to extract contaminants from water, were used in sequence. The sequence follows : semiaquatic-free floating-submerged weeds.

Combinations successfully implemented:

1. Arundo donax- Eichhornia crassipes – Hydrilla verticillata

2. Typha latifolia - Eichhornia crassipes – Hydrilla verticillata

3. Arundo donax- Pistia stratiotes– Hydrilla verticillata

4. *Typha latifolia - Typha latifolia - Typha latifolia*

Methodology

a. Components (Figure 1)

water input system,

primary storage tank

weed treatment tank

output system

b. Preparation of treatment tanks

- Collection of weed plants from various localities
- Semiaquatic plants require a base to stand on the water, hence, are tied along horizontal columns inside the tank.
- Free floating and submerged species do not require any specific arrangement in the tanks. They are simply put in the tanks and let multiply.

once weeds multiply and cover the entire treatment tanks, the system is ready to operate.

- The tanks are inter-connected through connector pipelines.
- It is important to follow the weed sequence in tanks as this weed sequence is designed keeping in view that, semiaquatic weed is efficient at higher heavy metal concentration (> 500 µg /L); whereas free floating is efficient at low to medium concentration (<100 µg/L). Submerged weed is equally efficient at very high to very low concentration.

c. Procedure

- When the primary storage tanks get filled up with contaminated water, it is transferred to weed treatment tanks subsequently one after another.
- Contaminated water first transferred to first tank and retained for 5 days.
- After 5 days, treated water moved to second tank and again retained for 5 days.
- After 5 days, treated water transferred to third and final tank.
- At the end of 15 days, up to 96% of heavy metals are found to be removed from water, making it suitable for irrigation.

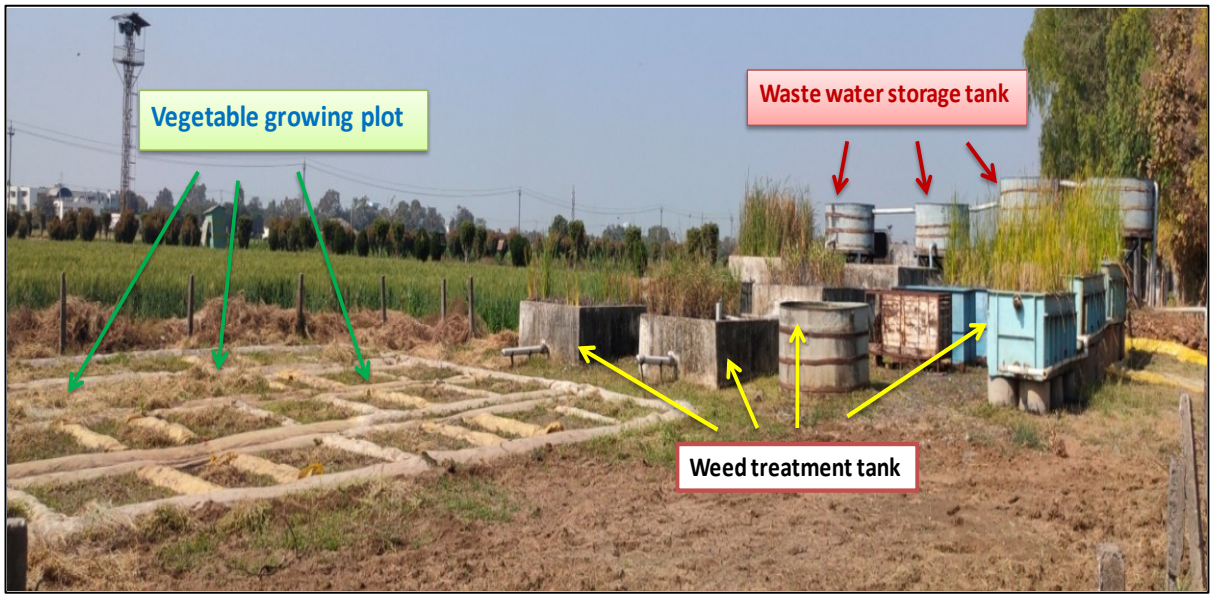

Fig.1 Wetland system constructed at ICAR-DWR, Jabalpur

Results

Performance

- The latest phytoremediation system successfully reduced arsenic (As) content from artificially contaminated water with 96% As removal efficiency as compared to initial concentration (1000 µg/L).

- In earlier experiments with single aquatic species, Arundo donax reduced Ni, Cd and Pb content by 63, 48 and 77% respectively.
- Typha latifolia treatment showed that, content of Fe, NO_3^{2-}, Cu, PO_4^{3-} and Cd were reduced by 89.15%, 80.39%, 56.9%, 42.6% and 26.24% respectively.

Efficiency

- This system can generate minimum 5000 litres of suiable irrigation water from contaminated water within 15 days.

Fig.2 Treated water being used for irrigating leafy vegetables

Benefits

- Recycling of waste water itself is a water saving technique.
- The cost of treatment is also reduced due to free availability of aquatic weed species.
- This system is basically water and cost saving technology.
- This system reduces the risk of soil pollution through irrigation with contaminated water.
- Easy to adopt and replicate at farmers' field.
- Not location specific and can be adopted in any part of the country.

Upscaling strategies

- The technology holds huge commercial potential in treatment of large-scale municipal waste and sewage water, and treated water can be supplied for public use as well as for irrigation.
- Further research may focus on collecting the phytoremediation biomass and processing them for safe disposal as well as extraction of valuable metals of economic importance.
- The system has been successfully demonstrated in rural areas of Jabalpur and has shown successful results.
- The *Eichhornia crassipes* (water hyacinth) and *Pistia stratiotes* (water lettuce) based phytoremediation systems were constructed and their performance were demonstrated in Urdua village.
- In both systems waste water coming from Jabalpur city was used for treatment purpose.
- Both the systems significantly reduced turbidity, sodium, chloride, sulphate, chromium and phenol content within 7 days.
- Compared to untreated waste water, water hyacinth treated water showed 97, 70, 40, 55 and 76 % lesser turbidity, Na, Cl, SO_4, Cr and phenol content respectively.

Fig.3 Free floating weed-based phytoremediation model constructed in Urdua village, Jabalpur

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