International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 12 | Dec 2018 www.irjet.net p-ISSN: 2395-0072

APPLICATION OF WATER HYACINTH (EICHHORNIA CRASSIPES) IN WASTEWATER TREATMENT- A REVIEW

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Abstract - *Domestic wastewater is a great environmental nuisance. To overcome this problem, many techniques are developed by researchers. Phytoremediation has developed as a dominant and popular method for the wastewater treatment which decreases the pollutant by utilizing plants. This treatment technique is cost-effective and sustainable as compared to other approaches. Water hyacinth (Eichhornia crassipes) having fast growth rate characteristics in the polluted areas which has been used for many research activities. Anatomical parts of water hyacinth containing some chemical constituents which are capable to remove several impurities. The concentration of contaminants has been reduced by water hyacinth. Different physio-chemical parameters like TSS, TDS, COD, BOD in municipal wastewater can be minimized. Water hyacinth is having a high nutrient removal ability. Enhancement in efficiency can be achieved by using diffused aeration or gravel based media. This paper reviews beneficial information of effectiveness of water hyacinth for a removal of the contaminants from wastewater.*

Key Words: Domestic wastewater, Diffuse aerator, Phytoremediation, Municipal wastewater, Water hyacinth.

1. INTRODUCTION

Wastewater effluent is a serious threat to the ecosystem throughout the world. Water pollution is becoming serious issue. The growth of industrialization, civilization increases the rate of wastewater generation, which becoming harmful to environment. Rapid population growth is important factor which responsible for this phenomenon. As a result pollution level in the water bodies is increasing all the time (16). The amount of waste present in water bodies contain harmful impacts on aquatic life. Many researches were carried out in last few years for obviation of pollution in water bodies and deliberation of aquatic life (20). The reduction in harmful impacts of the pollution from wastewater can be done by removing main nutrients such as nitrogen and phosphorous as well as organic content of wastewater. Several conventional treatment technologies were developed for the wastewater treatment. But the working expanses and maintenance factor of these technologies are more.

Constructed wetland is one of the artificial technologies which is helpful in wastewater treatment. This system consisting of aquatic plants in shallow pond. The system consisting natural microbial, biological, physical and chemical process for treatment of wastewater. The Unique advantage possessed by these treatment technologies over conventional system with simple structure requiring less skill to operate and maintain (6).

water hyacinth (Eichhornia crassipes) is a free floating aquatic plant adopted in constructed wetland for wastewater treatment. The plant has a unique ability to treat wastewater by absorbing nutrients and other substance from water and hence pollution levels are toned down. The roots of water hyacinth participate actively in treatment of wastewater. Uptake of contaminants in the plant occur primarily through the root system. The root system consisting of principal mechanisms which inhibit the toxicity of the contaminants. Enormous amount of surface area provided by roots which absorbs and accumulate pollutants (5).

This phytoremediation technique reduces the organic and inorganic contaminants from industrial wastewater effluent by using the aquatic plants. The Plant is helpful to remove different types of contaminants such as metals, pesticides, explosive and oil. However, the working of plants depends on the concentration of the contaminants. The performance of the plant appears to be good in lower concentration of contaminant as compare to high concentration. This affects plant growth takes too long to clean-up (29). A variety of plants, use biological processes and physical treatment as phytoremediation for treatment of various contaminant. (26) (29).

2. CHARACTERISTIC OF PLANT

It is a perennial, aquatic plant, anchored in shallow water and free floating herb perpetuating by means of stolon. The plant height is 100 to 200 mm and can grow up to height of 1 m forming a dense mat shape. Plant having long fluffy roots and leaves are shiny green in color. It contains distinctive erect swollen bladder like petioles.

Flowers having size of about 50 mm in diameter and pale violet or blue in color (13). Water hyacinth is found in both alkaline and acidic water but the neutral water bodies possess maximum growth of the plant (12). It was observed that there were no any detrimental effects on the plant morphology in domestic wastewater. Also, the relative growth rate of plant was assessed to be 1.15% per day (4).

Table -1: Morphological Characteristics of the Plants

Parameter	Initial	After 10 days
Number of Leaves	7.80±1.92	10.40±1.36
Size of Leaves (cm^2)	17.00±3.36	20.24±3.41
Number of Roots	47.40±10.14	92.20±9.23
Longest Root (cm)	9.66±1.24	12.04±1.31
Dry Weight (g/plant)	0.90±0.13	1.01±0.11
Ash Weight (g/plant)	0.07±0.006	0.15±0.005

3. WASTEWATER TREATMENT

3.1 Domestic Wastewater

Water hyacinth has adequate capacity to remove pollutant from domestic wastewater. The treatment by water hyacinth is most common. Specific objectives are elaborated on principles upholding the purification of domestic wastewater. Coliform count is observed to get drastically reduce on application of water hyacinth treatment. The turbidity reduction was observed 26% and PH value reduces from 8.58 to 7.81 during treatment period of 28 days. Pungent odour of raw sewage gradually disappears with time. Total dissolved solid gets minimized by the water hyacinth treatment (11). In their recent research paper, chaithra K. S. et al., (2016), observed that pH was gradually increases after treatment. Turbidity was reduced to 2.81 NTU and reduction in BOD and COD were 87.1% and 70% respectively in duration of 27 days. Domestic wastewater containing ammonia nitrogen can be treated by water hyacinth. It has large nitrogen uptake capacity. High concentration of ammonia nitrogen may cause the plant death. While adopting water hyacinth for treatment, different parameters like PH and salinity are also important (30).

S. R. M. Kutty et al., (2009) were studied on undesirable amount of nitrate and phosphorus concentration presents in municipal wastewater. It is observed that removal efficiency of water hyacinth for COD, ammonia, phosphorous and nitrate were 49%, 81%, 67% and 92% observed respectively. It was also observed that the growth rate of water hyacinth in 6 days was 0.33 shoot/day and kept developing up to 0.38 shoot/day at end of 24 days.

Rajendra B. Magar et al., (2017) was analyzed that Water hyacinth can be used to treat wastewater within the range of 750-850mg/lit of effluent standards.

3.2 Industrial Wastewater

Phytoremediation of industrial effluent by utilization of aquatic macrophyte has become more popular due to low cost and energy intense treatment technology. Phytoremediation is one of the most feasible method for the treatment of industrial effluent and municipal wastewater (3). The water hyacinth can be used for effective treatment of paper mill effluent. Different pollutants like TKN, PO_4^{3-}, Na^+, K^+, Ca^{2+} and Mg^{2+} contents by effluent of paper mill which associated with the micronutrients in lower contents but they produced toxicity when present in higher concentration (29). The presence of plenty of nutrient in the pulp and paper mill are responsible for the growth of water hyacinth. It significantly removes amount of nitrogen which is known as hyper accumulation of nutrient. The amount of PH decreases for higher N level treatment, also denser growth of algae was observed and it consider as significant component in N removal (15). Crude oil pollution is major problem to aquatic considered as plant nutrients while the heavy metals like Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn are considered as micronutrients. Aquatic plants contents synthesis of different biochemical components and catalyzed by various biochemical process ecosystem. It is responsible to decrease DO content in wastewater. Also increase turbidity, temperature, conductivity and salinity. The absorption of pollutants by the plants reduces PH, conductivity, temperature, conductivity and salinity. The growth rate of water hyacinth in wastewater containing pollutant is more. The tolerance level of water hyacinth is good related to other aquatic plant (19).

N. S. Gamage et al., (2001) treated the textile wastewater effluent from textile mill. The wastewater was rich in different types of contaminants. It was observed that drastically reduction in contaminants occurred while treating with water hyacinth. The reduction in different parameters like suspended solids (46.6%), BOD (75%), COD (81.4%), TN (83.5%) and Po_3^{4-} (52.9%) were observed.

3.3 Heavy Metal Removal

Effluent of textile industry contains a dyes which are most serious pollutant for our environment. As far as pollution of water due to color is concerned. The removal of color from dye containing effluent is one of the major problem due to typical treatment process of color removal. Conventional methods are unable to achieve good efficiency in color removal from wastewater. Phytoremediation is used for removing heavy metals and other pollutant. This method is an established technique. Water hyacinth contains dye absorption characteristics. It contains dye absorption along with good rate development, low maintenance in contaminated region. Water hyacinth has the ability to removal harmful pathogenic bacteria (25). Activity of Photosynthetic and growth rate of plant play significant role for phytoremediation process.

Table -2: Reduction in parameters of domestic wastewater from different sources

Detention Time	Treatment Process	Reduction in Parameters	References
4 days	Semi continues flow	Reduction in BOD and COD were 96% and 72.6% respectively.	Y. Zimmels et al., 2006
-	Continuous flow	Average reduction in BOD and COD were 50.61 % for both parameter.	M. Shaha et at., 2015
21 days	Batch treatment	Average BOD and COD reduction were 61.85% and 81.47% respectively. Also, 39.20% of TDS reduction was observed.	Anil khare et al., 2017
24 hours	Batch treatment	Average COD reduction was observed 65.5% in duration of 22 days.	Bhadresh R. Sudani et al.,
14 hours	Continuous flow with attach microbial growth	Mean BOD and COD reduction were 86% and 80% respectively.	Alireza Valipour et al., 2015
12 hours	Batch treatment	Average BOD removal was 49.5±47.5%.	K. H. Sameera M. Dharmadasa et al., 2018
3 weeks	Batch treatment	COD reduction was found 59.02%. also, reduction in ammonia-nitrogen, nitrite-nitrogen and phosphate-phosphorus were 92.24%, 54.67% and 85.03% respectively.	C. O. Akinbile et al., 2012

Water Hyacinth effectively removes color from dye solution. Six days of treatment gives 95% of removal efficiency of color from dye solution. Bio absorption ability of water hyacinth responsible for removal of aqueous dye. Absorption of dye molecule were take place by different parts of water hyacinth, *i.e*. root, shoot and leaves of the plant. Plant tissues are mainly responsible for uptake of nutrient from wastewater (28). Water hyacinth has ability to absorb heavy metals like chromium and copper from wastewater. The decrease in Cr and Cu concentration were observed in treatment process of water hyacinth with the removal efficiency of 65% (18). The reduction in chloride content from the wastewater depends on the density of wastewater consumption of iron content is rapid in initial days of water hyacinth pond treatment, which decreases after few weeks of treatment. water hyacinth effectively removes copper from the wastewater but contains poor removal capacity of manganese. The fluoride content rate falls after few weeks of treatment (3). Water hyacinth can be effectively employed for the removal of zinc from wastewater. Fresh weight of plant marginally decreases with increase in concentration. On exposure to higher concentrations of zinc the growth is always exhibits (23). Abdul W et al., (2014) has examined the heavy metal uptake capacity of water hyacinth. Accumulation of Cd was found 3529 mg/kg, Cu uptake in water hyacinth was 2959 mg/kg. least accumulation of Pb was observed in water hyacinth (1004 mg/kg).

Priyanka Saha et al., (2017) treated the wastewater effluent from mines area which was containing high levels of toxic hexavalent chromium (Cr VI). While treatment with

Water hyacinth it was found that reduction in BOD and COD were 50% and 34% respectively. At lower concentration of 0.5 ppm, water hyacinth was very efficient in reducing 99% of Cr (VI) from wastewater. It was observed that only minimum time of 8 days was required for the removal of 99% of hexachrome from wastewater.

Shoot powder of water hyacinth containing ability to removes heavy metals from wastewater. The raw water hyacinth shoot powder removes the 98% of Cr and Cu content from tannery effluent. The efficiency for removal of pollutants from industrial wastewater using shoot powder of water hyacinth is more (17). Dr. D. V. S. Bhagavanulu et al., (2017) treated the industrial wastewater using powdered form of water hyacinth. Powdered form of dry water hyacinth parts which includes root stem and leaves can be treat industrial wastewater on different doses and detention time. It was observed that COD of wastewater was reduced from 480 mg/l to 320 mg/l on addition of powdered root of water hyacinth with dosage of 1.0 g/l in a contact period of 15 min.

3.4 Advance Treatment Techniques

Presence of microbial population improves the phytoremediation. The matrix mesh type structure increases the surface area for growth of microorganism also increases

the treatment efficiency. This biofilm media included in water hyacinth treatment reduces the odour related problem (4).

Additional systems like diffused aeration can be adopted for wastewater treatment. The enhancement in efficiency can be achieved by modifying the treatment. Tripathi DM et al., (2017) has compare the efficiency of water hyacinth by including aeration in the treatment. The reduction in BOD, COD, TKN and TP were found 85.49%, 85.71%, 80.32% and 80.92% respectively.

4. CONCLUSION

The effective treatment of wastewater can be achieved by phytoremediation. It is observed that aquatic plants having suitable characteristics reduces the pollutants from waste. The water hyacinth has an ability to absorb nutrients from wastewater. Reduction in COD, BOD and TSS are found in phytoremediation of wastewater. It is a cost effective treatment system. More studies have been done on water hyacinth by many researchers. These plant can be used effective for the treatment of wastewater.

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