Poll Res. 40 (2) : 559-561 (2021)

ISSN 0257–8050

ROLE OF SOIL ORGANIC MATTER IN PLANT GROWTH FOR HORIZONTAL FLOW SUBSURFACE CONSTRUCTED WETLANDS FOR WASTE WATER TREATMENT

ARVIND KUMAR SWARNAKAR*[1] AND SAMIR BAJPAI[1]

[1]*National Institute of Technology Raipur, Chhattisgarh, India*

(Received 17 September, 2020; Accepted 3 November, 2020)

ABSTRCTS

In the Horizontal Flow Subsurface Constructed Wetland (HFSCWs), wastewater flows through the substratum, which may comprise of various types of filter media such as soil, sand and aggregate. This filter media provides root zone for the vegetation used in HFSCWs. Analysis of Organic Matter (OM) in filter media is necessary part for the HFSCWs and requires regular measurement as a crucial indicator of the substrata (soil) health. The Soil Organic Carbon (SOC) improves the aeration, water filtration and water availability for the plant growth. Although organic, matter parameters Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are reduced by Constructed wetland. In the present paper, importance of the filter media and their organic matter are discussed. Various types of locally available soils such as entisol, insepti soils, alfisoles and vertisoles were collected for the analysis. The soil samples compare with the size and types of gravel. Additionally, one of the industrial slag sample is also analyzed for the comparison study.

KEY WORDS : Constructed wetland, Soil, Organic Matter

INTRODUCTION

As compared to other treatment system, constructed wetlands are a cost-effective option to treat wastewater. These are defined as man-made systems, which involve the growth of plants (e.g. duckweeds or common reeds) in a pond. The oxygen is being produced by the use of sunlight, which is used by micro-organisms to break organic matter in the wastewater. This physicochemical and biological interaction of plants, micro-organisms and soil leads to natural processes (Vymazal *et al.*, 2005). A schematic in Fig. 1 shows the HFSCWs. The organic material provides the microbial activity for the growth of plant by changing the pH of the substrates. The SOM consumes the oxygen (provide anoxic condition), which is used in nitrogen reduction and acid neutralization (Luise Davis, 2014). The OM deposition provides a long-term storage of nitrogen, phosphorus (nutrients), and a sustainable supply of C for the microbial denitrification (Reddy *et al*., 1996). The OM is required for the growth of the plant in initial stabilization of constructed wetland.

LITERATURE REVIEW

There are published literature show different time period for growth of plant depending on the filter media. For example, a study by Upadhyay *et al.* (2016). It took over 3 months for growth and stabilization of the plant in gravel sand base HFSCWs using the tab water. Singh *et al.* (2016) used 50 days to develop microorganism and plant growth in gravel sand base HFSCWs. However, Kadam *et al.* (2009) used laterite soil-base filter (CSF) in municipal wastewater treatment with including three to four spells of rainfall showed growth of plants in 30days time line. Kruti *et al*. (2019) observed that plant growth fully stabilized in laterite soil within 2 months.

The OM in soil enhances sulfate reduction and ionic adsorption (Luise Davis, 2014). Wong *et al.* (2017) have performed the studies on good removal

efficiency of Total Suspended Solids (TDS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia, Total Nitrogen (TN), Total Phosphorus (TP) on horizontal subsurface flow CWs. The United States Environmental Protection Agency (USEPA) has design manual for constructed wetlands and aquatic plant systems for municipal wastewater treatment and its design for Root-Zoon-Method (RZM) for soil media system. All soil base constructed wetland provide carbon and nutrients for the denitrification and the biomass growth, its OM increases NO_3—N treatment by Burchell *et al*. (2017). Soil has huge anion area, which binds cation pollutants (pesticides and metals) and transferred into the surface water (Cox e*t al*., 1998; Bajeer, 2012; Cabrera *et al*., 2012).

MATERIALS AND METHOD

All four samples were collected from near around Raipur Chhattisgarh, India. Aggregates (2 types by color), sand and soils (entisol, inseptisoils, alfisoles and vertisoles) were collected as samples. The loss of ignition method is used for determination of organic matter in the aggregate sample. The method being used for collecting the samples was described by Salehi *et al.* (2011). The desiccated samples were combusted at 550 °C (360 °C for aggregate) for 2hr in a muffle furnace gradually after measuring their weight. The organic matter was calculated by using below formula;

$$\text{Organic Matter} = \frac{\text{Sample weight of after combustion - Oven dry sample weight}}{\text{Oven dry sample weight}}$$

Soil samples were air dried and passed through 2mm sieve. Afterwards, all samples were oven-dried at 105 °C overnight. The Indian Standard IS: 2720 (Part XXII) – 1972 PART is used for determination of organic matter in soil samples. The OM in aggregate use Indian Standard IS: 2386 (Part II) - 1963 (Reaffirmed, 2011) methods of test for aggregates for concrete.

RESULTS AND DISCUSSION

The results of tested samples are summarized in Table 1. The sample A, 20 mm aggregate (Gray color) has less % OM compared with the Inceptisols (yellow soil), which has high % OM. The result shows that the aggregate has less OM compared with soil irrespective of the size. The antisole (red soil) is graded as a laterite, which has less % OM in the soil category. The anisole is being used as a cover in aggregate base HFSCWs by several researchers. The OM enhanced the water holding capacity of soil in substrates. The plants take its nutrients from the soil, which is time consuming process with aggregates. Further, the OM in soil base HFSCWs also gives good results for nitrate removal. The treatment of phosphorus efficiency is high in soil compare to sand base substrates CWs.

CONCLUSION

All types of filter media used as substrate were studied in HFSCWs. Soil are the easily available and economical material as compared to coarse and fine aggregate. The soil substratum provides a good physicochemical and biological treatment process. Soil organic matter provides a health rhizome network in root zone, for the vegetation in constructed wetland. The present study showed that soil contains higher organic material comparing with other filter media. Therefore, the conclusion being drawn that soil base HFSCWs is good and time saving option for initial stabilization and plant growth.

Table 1. Various media for substrate and their organic matter

S.No.	Media for Substratum	Colour	Organic Matter (%)	Method
1	20 mm Aggregate	Gray	0.18	Los on Ignition
2	Sand	Yellow	0.28	Los on Ignition
3	10 mm Aggregate	Red	0.32	Los on Ignition
4	Slag	Black	0.46	Los on Ignition
5	20 mm Aggregate	Red	0.92	Los on Ignition
6	Antisols	Red	8.6	IS 2720 Part 22-1972
7	Alfisoles	Brown	10.4	IS 2720 Part 22-1972
8	Vertisoles	Black Cotton	11.0	IS 2720 Part 22-1972
9	Inseptisoles	Yellow	11.3	IS 2720 Part 22-1972

REFERENCES

Bajeer, M. A. 2012. Adsorption and leaching potential of imidacloprid pesticide through alluvial soil. *American Journal of Analytical Chemistry*. 03: 604-611.

Burchell, M. R., Skaggs, R. W., Lee, C. R., Broome, S., Chescheir, G. M. and Osborne, J. 2007. Substrate organic matter to improve nitrate removal in surface-flow constructed wet lands. *Journal of Environmental Quality*. 36.

Cabrera, Á., Trigo, C., Cox, L., Celis, R., Hermosin, M.C., Cornejo, J. and Koskinen, W.C. 2012. Sorption of the herbicide aminocyclopyrachlor by cation-modified clay minerals. *European Journal of Soil Science*. 63 : 694-700.

Cox, L., Koskinen, W. C., Celis, R., Hermosin, M. C., Cornejo, J. and Yen, P. Y. 1998. Sorption of imidacloprid on soil clay mineral and organic components. *Soil Science Society of America Journal*. 62 : 911.

Defu Xu, Jianming Xu, Jianjuan Wu and Akmal Muhammad, 2006. Studies on the phosphorus sorption capacity of substrates used in constructed wetland system. *Chemosphere*. 63 : 344-352.

EPA Design Manual – Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment, 1988 P;05.

IS: 2720 (Part XXII) – 1972 PART XXII.

IS: 2386 (Part II) - 1963 (Reaffirmed 2011).

Kadlec, R.H. and Wallace, S.D. 2009. *Treatment Wetlands*, second ed. CRC Press, Boca Raton, Florid.

Kadam A.M., Pravin D. Nemade, G.H. Oza and Shankar, H.S. 2009. Treatment of municipal wastewater using laterite-based constructed soil filter. *Ecological Engineering*. 35 : 1051-1061.

Kruti J., Bajpai, S. and Chaudhari, P. K. 2019. Phosphorus Retention in Lateritic Soil Constructed Wetland Treatment of Domestic Sewage. Urbanization Challenges in Emerging Economies. *ASCE*. 38-246.

Luise Davis – *A Handbook of Constructed Wetlands*, 2014 Volume-1, P. 30.

Salehi, M. H., Hashemi Beni, O., Beigi Harchegani, H., Esfandiarpour Borujeni, I. and Motaghian, H.R. 2011. Refining Soil Organic Matter Determination by Loss-on-Ignition. *Pedosphere*. 21 (4) : 473-482.

Singh, R.S., Jiaguo Wu and Dafang, Fu, 2019. Purification of water contaminated with Hg using horizontal subsurface constructed wetlands. *Environmental Science and Pollution Research*. 26 (10) : 9697-9706.

Reddy, K.R. and.Angelo, E.M. 1996. Biogeochemical indicators to evaluate pollutant removal efficiency in constructed wetlands. *Water Sci. Technol*. 35 : 1-10.

Upadhyay, A.K., Singh, N. K., Bankoti, N.S. and Rai, U.N. 2016. Designing and construction of simulated constructed wetland for treatment of sewage containing metals. *Environmental Technology*. http://dx.doi.org/10.1080/09593330.2016.1273396.

Vymazal, J. 2005. Horizontal subsurface flow and Hybrid constructed wetlands systems for wastewater treatment. *Ecol. Eng.* 25 : 478-490.

Wang M., Dong Qing Zhang, Jian Wen Dong and Soon Keat Tan, 2017. Constructed wetland for wastewater treatment in cold climate –A review. *Journal of Environmental Science*. 57 : 293-311.