Al-Azhar University Civil Engineering Research Magazine (CERM)
Vol. (43) No . (3) July . 2021

Municipal Sludge Treatment Using Constructed Wetlands"Green Technology" By Ryegrass Plant

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الملخص العربى :

إستخدام نظام الأراضي الرطبة في معالجة الحمأة الناتجة من معالجة مياة الصرف الصحي يسمي بالتكنولوجيا الخضراء لأنها تستخدم كمعالجة بديلة لحمأة الصرف الصحي في جميع أنحاء العالم. بشكل عام، يوفر CW حلا صديقا للبيئة، بتكلفة منخفضة. الهدف الرئيسي من الدراسة هو تقييم الأراضي الرطبة المقامة لنزح المياه من الحمأة وإعادة تدوير النفايات السائلة المنتجة في CW بعد المعالجة. تمت معالجة حمأة الصرف الصحي باستخدام نبات ryegrass خلال فصل الشتاء عن طريق الري باستخدام المياه العذبة ومياه الصرف الصحي المعالجة. يحتوي نبات ryegrass على أعلى قيم للعناصر عن طريق الري باستخدام مياه الصرف الصحي المعالجة إذا ما قورنت بالمياه العذ بة.

ABSTRACT

Constructed wetland is called green technology an alternative sewage sludge treatment all over the world. Overall, CW provides environmentally friendly solution, are low cost. The main objective of the study was the evaluation of Constructed Wetlands for sludge dewatering and recirculation of the effluent produced into the CW after treatment. Sewage sludge was treated using ryegrass plant through winter season by irrigation using fresh water and waste water treated. ryegrass plant had the highest values of elements by irrigation using waste water treated if compared with the fresh water.

Keywords: sludge; sewage sludge; sewage treatment; wastewater; waste water treatment

1. Introduction

Water shortage problem is considered one of the most important problems in many countries all over the world. It is expected that Egypt suffers from water shortage problem during the next few decades due to Poor sanitation especially in rural areas [1].

One of these environmental problems is Municipal sewage sludge in the world with regards to human health and environmental pollution [2]. Municipal sewage sludge is a rich in macro and micronutrients consisting of organic and inorganic materials as well as trace elements that are essential for plant growth [3].

Constructed wetlands are considered one of the consists of green infrastructure, which is increasingly demanded and it is environmentally friendly and for urban environments and it can provide low-cost solutions for multiple ecosystem services [4,5].

Sludge treatment wetlands are sealed basins, filter consisting of several layers of stone and gravel fractions, in which plants such as Phragmites australis (common reed) are planted.

The sludge is pumped on the basins surface and part of it is drained through the sludge residue, filter and the other is evapotranspirated by plants and the sludge residue remains on the surface where, it is again spread after a few days and starting the feeding cycle again [6].

There-for, this study focuses of sludge treatment wetlands by ryegrass plant in Egypt.

It is an alternative and environmentally friendly technology.

2. Materials and Methods

2.1 Place of Study

WWTP is located in Kafr El - Shahawi Khater, it is part of Kafr Shukr center of Qalyubia Governorate in Egypt. WWTP serves number the population of Kafr Shukr center and its affiliated villages. The population census 194,647 (statistic 2019). the first phase consists of a purification plant with a capacity of 10.000 m^3 / day and the outlet of wastewater about 8.679 m^3 / day, Treatment method- extended aeration (Kruger System), the second phase with a capacity of 20.000 m^3 / day, Treatment method (SBR System). as shown in Fig.1.

Wastewater treatment plant in Kafr El-Shahawi Khater produce quantities of sludge annually estimated with (400 m3 per year). WWTP consists of Bar screens - Grit chambers - Final sedimentation basins - Biological treatment - Chlorination basins - Thickener tanks - Drying beds.

Fig. 1. Kafr El - Shahawi Khater WWTP

2.2 Ryegrass plant

Common name perennial ryegrass (Lolium perenne), [7] winter ryegrass is a grass from the family Poaceae and it is native to Europe, Asia and northern Africa, but is widely cultivated around the world and it is an important plant for pasture and forage. Also in Britain, it is used with nonspecies-rich grassland and outcompetes the rarer plants and grasses. [8] as shown in Fig.2.

Fig.2. ryegrass plant (water and treated)

2.3 Sampling

Most wastewater, fresh water, wet sludge samples were collected in either plastic or glass containers and then transported to Central laboratories by dedicated boxes from the Kafr El-Shahawi Khater WWTP. Dry sludge samples were collected from drying basins and its should be sent in a sealed plastic bag. Plant samples were taken and transported to the laboratory directly in paper bags. Seeds of plants were taken from the Field Crops Research Institute - Agricultural Research Center in Giza.

2.4 Analysis methods

Samples were analyzed for wet and dry sludge in soil, samples water and plants, heavy metal concentrations according to Methods of Soil Analysis [9]. Physico-chemical and biological parameters were measured for Raw sludge (pH, EC, TKN, TP and heavy metal concentrations). Total solids were measured by heating the dish for ≥1 h in a 103–105°C oven. While volatile solids were measured by igniting a clean evaporating dish at 550 ± 50°C For ≥15 min in a muffle furnace and cooling the sample in desiccator to ambient temperature and weighting with wet and dry soil. Analysis of Chemical Oxygen Demand (COD) by Sample preparation and digestion at 150°C for 2h, Cooling and measuring the sample according to Standard Methods for the Examination of Water and Wastewater [10].

3. Results and Discussion

3.1 Winter agriculture

Table (1) and figures (3 and 4) showed that the lowest values of nitrogen and potassium are 1.142 (%) and 29.32 (%) respectively. While the highest values of phosphorus, magnesium and calcium are 4.362 (%), 0.375 (%) and 0.003 (%) respectively. The highest values of copper and cobalt are 0.341 (mg/kg) and 0.053 (mg/kg) respectively. Equal values of lead and cadmium are 0.231 (mg/kg) and 0.311 (mg/kg) respectively. While the lowest values of chromium, zinc, manganese, nickel and iron are 0.051 (mg/kg), 0.059 (mg/kg), 0.145 (mg/kg), 0.048 (mg/kg) and 0.127 (mg/kg) respectively with ryegrass plant if compared with the treated wastewater.

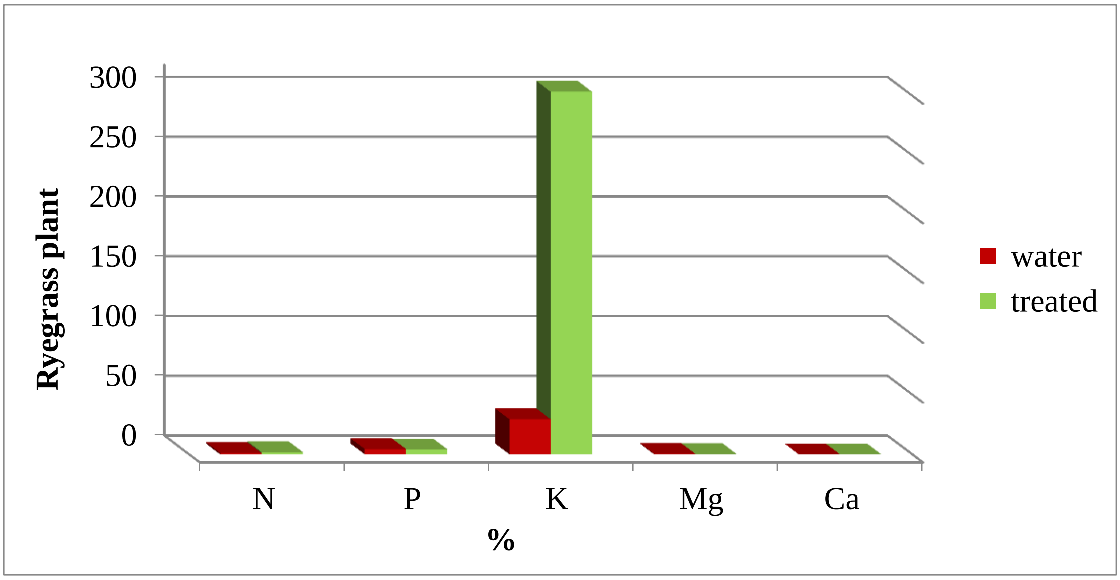

Fig.3. Nitrogen, Phosphorus, Potassium, Manganese and Calcium concentrations in the ryegrass plant

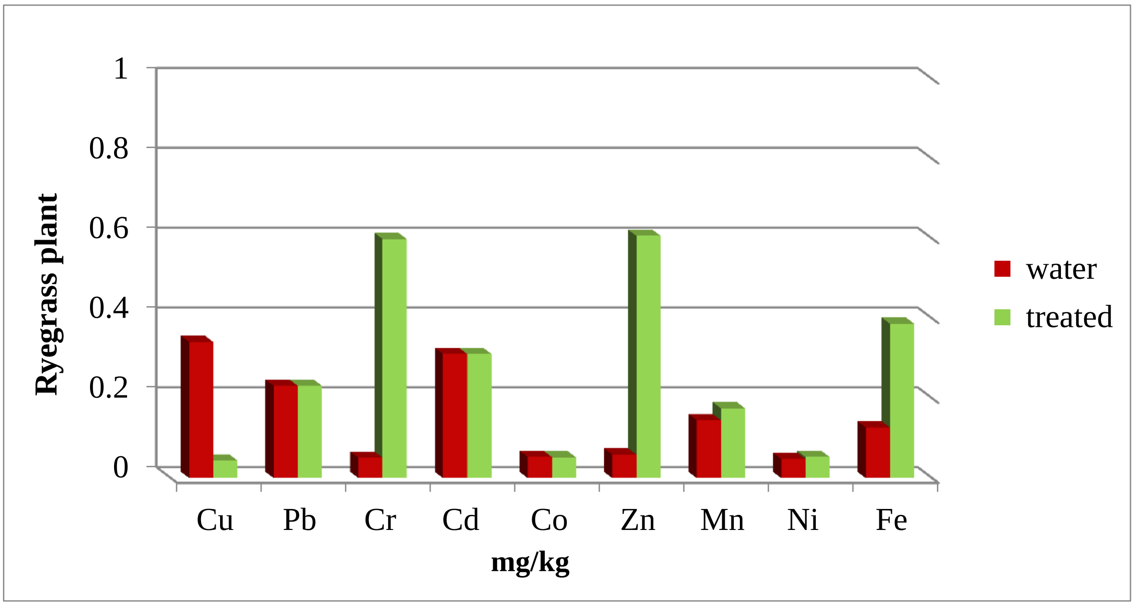

Fig.4. Copper, Lead, Chromium, Cadmium, Cobalt, Zinc, Manganese, Nickel and Iron concentrations in the ryegrass plant.

Table 1. heavy metals concentrations in winter

Parameter / Plant	N	P	K	Mg	Ca	Cu	Pb	Cr	Cd	Co	Zn	Mn	Ni	Fe
	%					mg/kg								
	winter agriculture													
Ryegrass (water)	1.142	4.362	29.32	0.375	0.003	0.341	0.231	0.051	0.311	0.053	0.059	0.145	0.048	0.127
Ryegrass (treated)	1.876	4.161	303.30	0.266	0.001	0.044	0.231	0.599	0.311	0.052	0.607	0.175	0.053	0.387

3.2 Ryegrass plant in winter agriculture with wet sludge soil

Comparing results represented generally in figure (5) show that ryegrass has the highest values of elements from P, Mg, Ca, Cu and Co for 4.362%, 0.375%, 0.003%, 0.341% and 0.053% by irrigation using fresh water. While, ryegrass has the highest values of elements from 1.876%, 303.30%, 0.599%, 0.607%, 0.175%, 0.053% and 0.387% for N, K, Cr, Zn, Mn, Ni and Fe by irrigation using treated waste water. Ryegrass has equal values of elements from Pb and Cd for 0.231 (mg/kg) and 0.311 (mg/kg) respectively with wetted sludge soil in winter season. This was similar results obtained by [11], they used two sludge drying reed beds, planted with Phragmites australis. Samples were collected and analyzed at the end of the remaining phase of every cycle.

This is in accordance with the results by [12], they used eight drying reed beds ($2m^2$) planted with Phragmites australis and two filtration layers of either vegetal compost or sand were tested.

3.3 Ryegrass plant in winter agriculture with dry sludge soil

Ryegrass plant is growing slower with dried sludge soil by irrigation using treated waste water. While, ryegrass plant has not developed at all by irrigation using fresh water. This is in accordance to the results obtained by [13], Four crops were tested in soils fertilised with converted and dried sludge.

The current study confirmed that winter ryegrass was a good quality for economic fodder production. This was similar results obtained by using berseem, barley and ryegrass to determine the best grass- legume combination for high yield and better forage quality at Agricultural Research Station, (ARC). Results showed that total fresh forage yield of pure stand ryegrass was better than barley. [14]

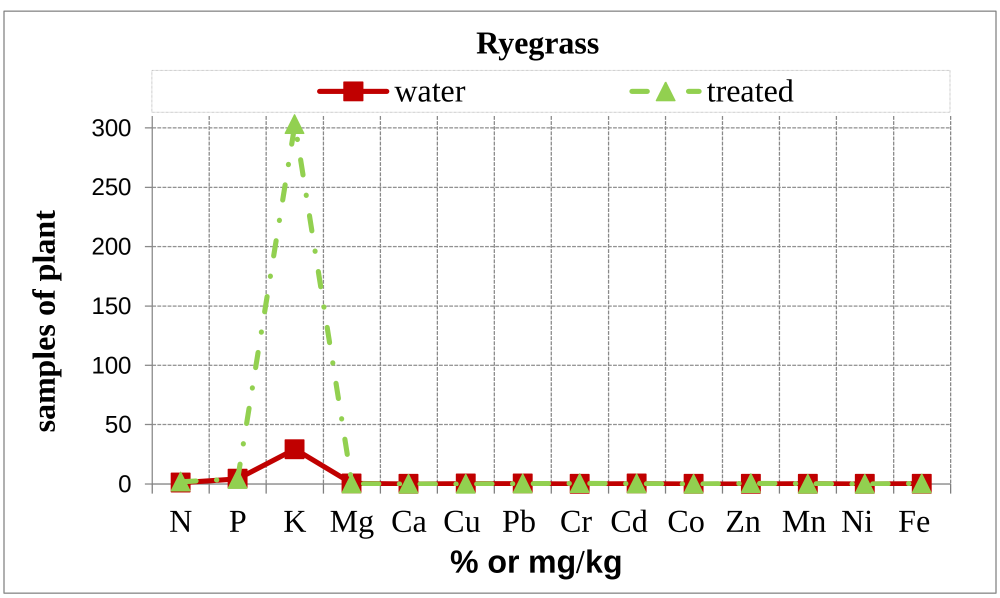

Fig.5. heavy metal concentrations % (mg/kg) with ryegrass plant

Conclusion

This present study characterised the sewage sludge treatment using ryegrass plant through winter season by irrigation using fresh water and treated wastewater. It is concluded from the results that it is better to use ryegrass plant by irrigation using treated waste water if compared with the fresh water. It is a good plant with wet sludge soil if compared with dry sludge soil. Our results need further studies on constructed wetland for municipal sewage sludge treatment in Egypt. It is recommended to use ryegrass plant as green fodder in sewage sludge. It has a high benefit economic return.

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