International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 07 | July 2022 www.irjet.net p-ISSN: 2395-0072

Effects of laundry greywater on soil properties

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Abstract - *Pressure on freshwater resources has resulted in greater greywater reuse for plant irrigation. Laundry greywater is one of the largest streams of domestic greywater. The irrigation of laundry greywater on soil has several adverse effects on their composition. In this study, the soil was irrigated with powdered and liquid detergent laundry greywater to determine the changes in soil properties in comparison to soil irrigated with tap water. Also the effects of powdered and liquid detergent laundry greywater on soil properties are compared. The result showed that high values of soil characteristics were found in powdered detergent laundry greywater irrigated soil in comparison to liquid detergent laundry greywater.*

Key Words: Detergents, Greywater reuse, Laundry greywater, Soil properties, Surfactants

1. INTRODUCTION

The shortage of freshwater resources is an ever-increasing concern worldwide [5]. The use of greywater for landscape irrigation is becoming increasingly common due to the scarcity of fresh water, especially in arid and semi-arid regions [2]. Countries that experience water shortages may reuse greywater for irrigation or toilet flushing. This can reduce potable water requirements within a household by up to 50% [3].

Greywater is defined as the generated wastewater from household activities, which include bathroom, showers, laundry, and kitchen but not black water from the toilet. The percentage of greywater generated from household activities represents 50–80% of the total water usage [4]. Irrigation water quality has a large impact on soil properties. Although greywater is generally less polluted than other wastewaters, it can be environmental hazardous due to the salts, alkalinity and micro pollutants it contains.

Any land application of greywater is likely to have environmental impacts, which may be positive and/or negative. Greywater may contain plant macronutrients, particularly nitrogen and phosphorus. If these nutrients are present in the right quantities, greywater may act in the same manner as a fertiliser and benefit plant growth. In the context of greywater disposal, these benefits do not typically apply, as the application rate is too high and the nutrients are condensed in one small area [3].

Laundry greywater is one of the largest streams of domestic greywater that is also relatively easy to capture and apply for garden irrigation. The drainage hose of a washing machine can be easily extended to allow direct irrigation of the garden [1]. The main composition of laundry greywater are cations such as, Ca, Mg, K, nitrate, sulphate anions, carbonate, and chloride as well as organic micro pollutants (OMPs) resulting from the detergents[4].

Application of laundry greywater for irrigation may affect soil chemistry. Surfactants present in detergents are of concern due to their toxicity on plants and soil organisms. The main objective of this study is to study and compare the effects of liquid laundry detergent (LD) and powdered laundry detergents (PD) greywater effect on s greywater oil properties in comparison with tap water (TW). Changes to soil pH, electrical conductivity (EC), organic carbon (O.C) content, available phosphorus (P), pottasium (K) and micronutrients contents were investigated and studied.

2. METHODOLOGY

2.1 Soil Sample Collection

Soil samples were collected from Eranholi (11°46′30.0′′N 75°29′51.9′′E), which is approximately 5 km from Thalassery city in Kannur, Kerala. The samples were collected by first eliminating the top 10–15 cm of top soil and the samples were dug for 30 cm depth of soil and samples were collected in polyethylene bags.

2.2 Laundry Greywater Collection

Powdered and liquid detergents were used in the washing process of clothes and production of laundry greywater. The detergents were obtained from a local supermarket and greywater solutions were prepared using the manufacturers recommended dosage rates. A fix of ten clothes washed with recommended dosage of detergents. The laundry greywater generated was collected and used to irrigate the soil samples [4].

2.3. Laundry Greywater Application Setup

In this experiment, a laboratory soil column infiltration experiment was used to investigate the effect on soil properties by LD and PD laundry greywater in comparison to tap water. Soil columns were constructed from PVC piping.

End caps with five equally- spaced large holes (4 mm diameter) were glued to the bottom of each column. The inner walls of the soil columns were coated with a 1:1 fine and medium sand mixture adhered with PVC glue to minimize preferential flow along the sides. A 15 mm layer of washed gravel (2–4 mm ø) was place at the bottom of each soil column to promote free drainage of leachates to prevent soil loss through the drainage holes [1].

Fig -1: Laundry greywater application setup

Soil was placed in the columns, and soil column was treated with a total amount of 200 mm of TW, LD and PD greywater. Greywater application setup is shown in Fig 1. Then the column was dismantled and the samples were subjected to air-drying and were passed through a 2-mm mesh sieve before being stored in polyethylene bags for subsequent tests.

2.4 Soil Properties Analysis

The analysis is done in soil laboratory in Kannur. The samples were subjected to air-drying and were passed through a 2-mm mesh sieve before being stored in polyethylene bags for subsequent tests. The analysis includes determination of pH, electrical conductivity (EC), organic carbon (O.C), phosphorus (P), potassium (K), sulphur(S), iron (Fe), zinc (Zn), manganese (Mn) and copper (Cu).

3. RESULTS AND DISCUSSIONS

In this study, the collected soil is irrigated with TW, raw and treated laundry greywater to analyse the effect of laundry greywater in comparison with tap water. Irrigation water quality has a large impact on soil physical, chemical and biological properties. The area which is irrigated with greywater shows the most impact. Nutrients in laundry greywater are present in varying concentrations depending on the detergent type and the cleanliness of the clothes being washed. The effect on soil properties irrigated with TW, LD and PD greywater are illustrated in Table 1.

Soil pH is so important to plant growth because it determines the availability of almost all essential plant nutrients. Most mineral nutrients are readily available to plants when soil pH is near neutral. It was determined that the pH of soil irrigated with TW is 6.54. The soil pH increased from 6.54 to 7.76 and 8.29 after irrigation with LD and PD greywater respectively. It indicates that the long-term application of laundry greywater will increase soil alkalinity. The O.C percentage in soil after irrigation with TW, LD and PD greywater was 0.21%, 0.33% and 0.48% respectively.

Table -1: Soil parameters after irrigated with TW, PD and LD greywater

SOIL PARAMETERS	TW	LD	PD
pH	6.54	7.76	8.29
EC (mhos/cm)	0.08	0.19	0.32
O.C (%)	0.21	0.33	0.48
P (kg/ha)	2.37	7.42	12.53
K (kg/ha)	133.3	165.56	188.14
S (ppm)	6.58	12.3	17.94
Fe (ppm)	5.68	8.23	9.89
Zn (ppm)	0.519	0.723	0.894
Mn (ppm)	0.57	0.83	1.08
Cu (ppm)	0.38	0.56	0.713

EC is normally considered to be a measurement of the dissolved salts in a solution. EC of soil irrigated with TW was found to be 0.08 mhos/cm. After irrigation with LD and PD greywater, EC increased from 0.08 mhos/cm to 0.19 mhos/cm and 0.32 mhos/cm respectively. The maximum EC was recorded in the soil irrigated with PD.

The available phosphorus (P) in soil after irrigation with tap water is 2.37 kg/ha. P increased from 2.37 kg/ha to 7.42 and 12.53 after irrigation with LD and PD respectively. Maximum P content was recorded in soil irrigated with PD greywater. It was determined that the pottasium (K) content in soil after irrigation with tap water was 133.32 kg/ha. It is then increased to 165.56 kg/ha and 188.14 kg/ha after irrigation with LD and PD respectively.

The sulphur (S) content in soil after irrigation with TW is 6.58 ppm. S increased from 6.58 ppm to 12.3 ppm and 17.94 ppm after irrigation with LD and PD respectively. The maximum S content was recorded in the soil irrigated with LD greywater and was followed by the soil irrigated with LD greywater.

The Iron (Fe) content in soil irrigated with TW is 5.68 ppm. After irrigation with LD and PD greywater, Fe content increased from 5.68 ppm to 8.23 ppm and 9.89 respectively. The zinc (Zn) content in soil was observed as 0.519, 0.723 and 0.894 ppm respectively after irrigation with TW, LD and PD.

Similarly, the manganese (Mn) content in soil increased from 0.57 ppm to 0.83 ppm and 1.08 ppm after irrigated with LD and PD respectively. The maximum Mn content was recorded in the soil irrigated with LD greywater.

The cu in soil irrigated with TW is 0.38 ppm. After irrigation with LD and PD greywater, Cu content increased from 0.38 ppm to 0.56 ppm and 0.713 ppm respectively.

3. CONCLUSIONS

The short term effect of powdered and liquid detergent laundry greywater on soil properties in comparison with tap water was studied. The irrigation with LD and PD greywater increased the soil pH, EC, O.C, P, K, S, Fe, Zn, Mn and Cu content. The chemical properties of any water used for irrigation will change the chemical properties of the soil to which it is applied. High values of soil characteristics were noted in PD greywater irrigated soil in comparison to LD greywater irrigated soil. i.e., compared to LD, PD greywater produces more negative effect on soil characteristics. A proper management for greywater should be adopted in order to prevent the destruction of soil characteristics.

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