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# Physico-Chemical Analysis of Kasur Land Soil Reclaimed After Pretreatment of Tannery Wastewater

**M.R.Khan[1]*and S. Zafar[2]**

1. Department of Environmental Science and Policy, Lahore School of Economics, 19-km Burki Road, Lahore, **PAKISTAN**
2. Department of Environmental Science and Policy, Lahore School of Economics, 19-km Burki Road, Lahore, **PAKISTAN**

Email: drrafiq@lahoreschool.edu.pk

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## ABSTRACT

*Four hundred acre land of Kasur, Pakistan contaminated by tannery effluent has been reclaimed by installation of pretreatment plant. The reclaimed land soil was subjected to phyeico-chemical analysis as an effort to determine its status with reference to its suitability for agricultural practices and results are are reported in this article. The concentrations of the parameters such as pH, Electrical Conductivity (EC), Organic Matter (OM), Organic Carbon (OC), Available Phosphorus (P), Potassium (K), and Sodium (Na) were determined by standard methods of analysis. The results were computed and compared with various international standards for agriculture recommended by international organizations, groups of experts and or individual researchers. The results revealed that pH, EC, OM, OC, K and Na are in accordance with the prescribed limits but P in soil exceeds the range of P for agricultural soil. Thus, the reclaimed soil in Kasur can be inferred fit for the purpose of agricultural activities.*

**Keywords:** Analysis, Tannery Wastewater, Reclaimed, Soil, Kasur, Pre treatment.

## INTRODUCTION

Soil is the most important component of the environment, but it is the most undervalued, misused and abused earth's resource. Soil pollution has become a major subject of concern in all industrialized areas of Pakistan. Soil is the abode of certain microorganisms or animals and it also provides nutrients required for the growth and development of the plants. The eventual sink for the released pollutants in nature is soil which poses deleterious impacts on soil life [1]. The presence of high salt and organic content and highly toxic metal such as chromium makes the tannery effluents distinctive from others [2]. The extensive and unrestricted discharge of untreated tannery wastewater is one of the chief problems in Pakistan because it has harmful effects not only on human beings but also on agricultural practices being carried out in the area [3].

Kasur is a district of Central Punjab in Pakistan which has a large agriculture land area. Cotton, corn, wheat, sugarcane and rice are the cash crops of Kasur. This city accommodates around 50% tanneries of

Pakistan. All the effluents are released into the nearby drain "Rohi Nala" and open land area to convert these productive soils into large lagoons of stagnant tannery wastewater [4]. The stagnant pools have been constantly flooding the surrounding land of more than 400 acres and unfavorably influencing crop fields on extended 311 acres of land, during monsoon time of the year [5]. The deleterious substances from these effluents penetrate into the soil, leaving it unfit for agriculture [6]. In response to the critical ecological and health risks and the occupational safety and environment problems, Kasur Tanneries Pollution Control Project (KTPCP) was commenced. KTPCP was considered to deal with stagnant pools evacuation with several other project goals to attain environmental safety in Kasur [7]. The reclaimed but contaminated land is now being used for agricultural practices which is detrimental for living beings because toxic substances may transfer to crops grown on land and then may enter the food chain to cause different diseases. The major diseases prevailing among the people living around tannery clusters are Diarrhea, Typhoid, Respiratory problems and Dysentery [8].

With reference to the background highlighted above, this study was undertaken with the aim to determine the status of the reclaimed soil for suitability of agricultural practices with respect to certain basic parameters.

## MATERIALS AND METHODS

**Study Area:** The study area covers approximately 400 acres of tannery wastewater contaminated land in Kasur district, Pakistan. Major contaminated sites covered include lands around Mangal Mandi Road, Deen Garh, Deepalpur Road, Ali Garh and Tannery Wastewater Pre-treatment Plant, Kasur as shown in figure1.

**Soil Sampling:** US-EPA Field Sampling Guidance Document #1205 was used as a reference for the guidelines to carry out soil sampling. The study area was divided into grids (one grid covered an area of 9 acres) and 34 soil samples were collected from whole area. Sample labeling was done with sample identification number, date, time, sample type, and grid number. All the equipment used was sterilized and decontaminated. A steel auger was used to collect Grab samples which were transferred into a container to make a homogenized sample by mixing thorough. The unwanted materials like roots, stones, pebbles and gravels were removed. About half to one kilogram of sample was collected in clean polythene bag.

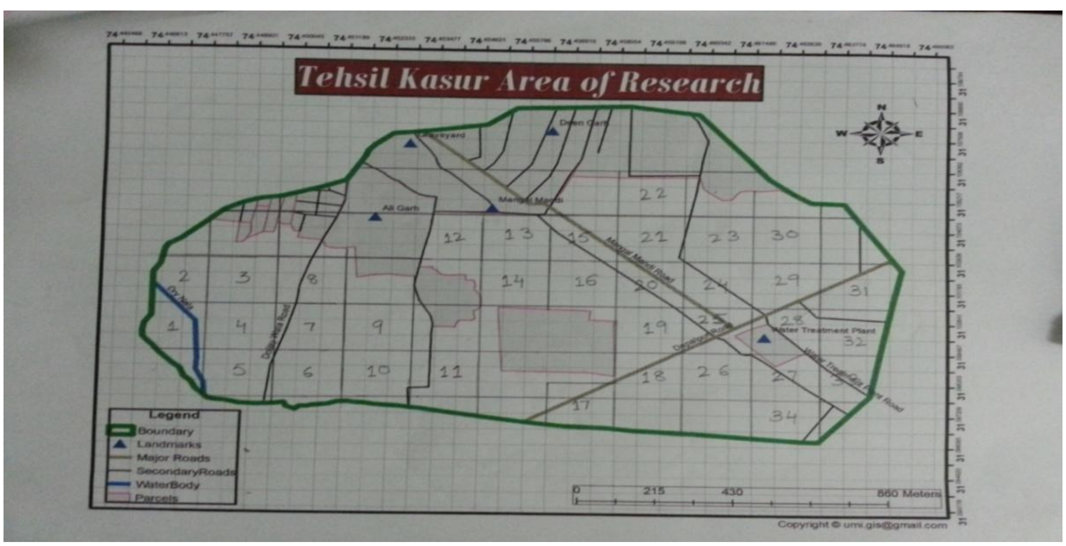


**Fig.1:** Map of Kasur research area showing grid and sampling sites

**Laboratory Analysis:** Each soil sample had three replicas.

**Parameters determined:** The selected parameters for the physicochemical analysis of reclaimed soil were pH, Electrical Conductivity (EC), Organic Carbon (OC), Organic matter (OM), Phosphorus (P), Sodium (Na) and Potassium (K).

**pH:** pH of soil samples was determined by HANNA HI 2210 pH meter [9].

**Electrical conductivity:** EC of soil samples was measured by HANNA HI8633 Conductivity meter [10].

**Organic Matter:** Chromic Acid method was used to find organic matter content in soil [11].

**Organic Carbon:** Organic carbon was calculated by the formula: % OC = % OM / 1.724

**Sodium and Potassium:** Na and K in soil samples were determined using a Flame Photometer [10].
Sodium (ppm) = Reading of flame photometer (ppm) × 20
Potassium (ppm) = Reading of flame photometer (ppm) × 20

**Extractable Soil Phosphorus:** Olsen's method was used to determine extractable phosphorus in soil samples [12].

**Data analysis and interpretation:** After the analysis the results were compared with international standards. Mean and standard deviation for each soil sample were also calculated for and one way ANOVA (Analysis of Variance) was also applied. The data was presented in the form of graphs.

## RESULTS AND DISCUSSION

The results of chemical analysis of soil samples of Kasur have shown variability in concentrations of all the determined parameters.

In Pakistan, the soils have generally pH above 8 [13]. Fig.2 reveals that maximum mean value of pH is 8.80± 0.021 at the grid $G_{28}$ and minimum is at grid $G_{12;}$ 7.36± 0.042. The permitted range for pH is 4 to 8.5 [14]. pH values for all the grids lie within permissible limit except grids $G_{15}$ and $G_{28}$.

Fig.3 shows that the grid $G_{30}$ has highest mean value of EC i.e. 1.45± 0.035 (mS/cm) while grid $G_{27}$ has lowest mean value i.e. 0.143± 0.030 (mS/cm). The values for electrical conductivity recorded for all the grids are within the standard limit i.e. 4.0 (mS $cm^{-1}$) [14]. The present study is in agreement with the study of Sinha *et al* (2006) in which EC reported in the treated tannery wastewater soil is 0.53-1.44 mS $cm^{-1}$ [15].

Fig.4 illustrates that OM is within the standard limit in all the soil samples which is 3.4% prescribed by European Union, 2009[16].The highest mean value is observed at grid $G_{16}$ which is 2.5± 0.020% while the lowest mean value is observed at grid $G_{33}$ which is 0.50± 0.050%. Sinha et al., (2013) reported 0.49-2.5% OM in the tannery effluent contaminated soil which is almost similar to the reported results [17].

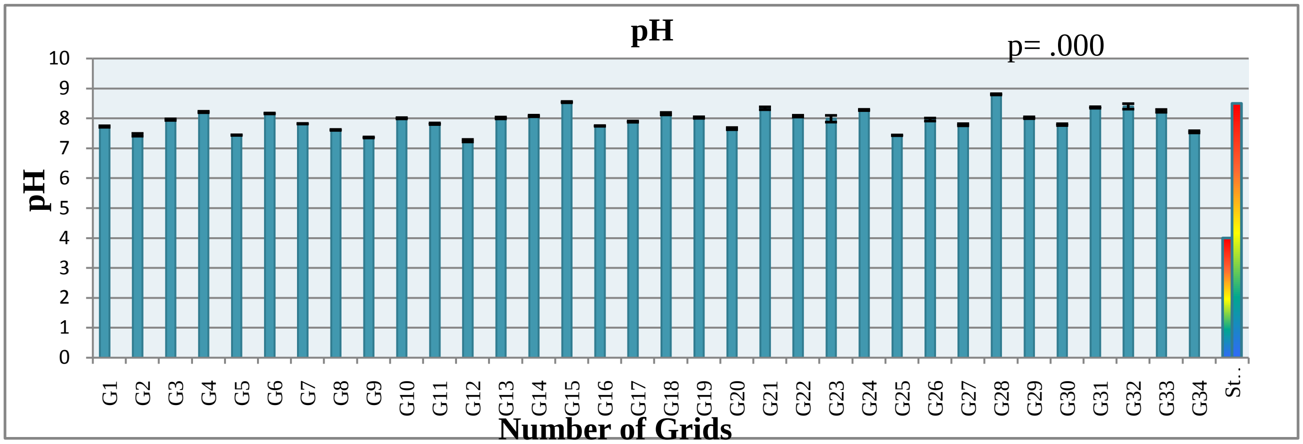


**Fig.2**.Graph illustrating the mean values of pH for soil samples from all grids and their comparison with the proposed standard of pH by International Agricultural Soil Standards (Alloway, 1990).

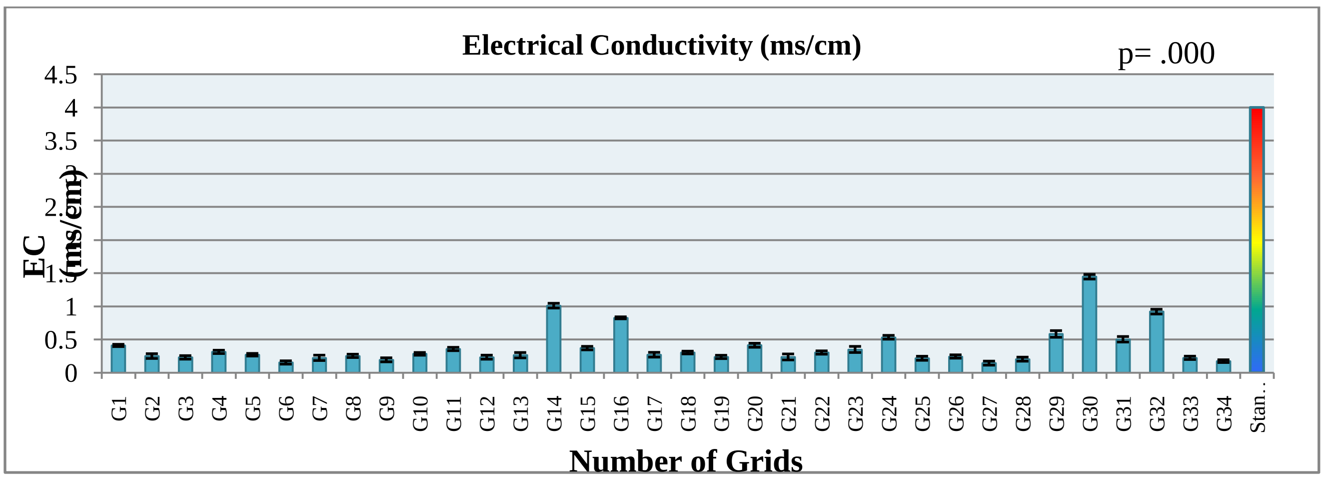


**Fig.3**: Graph illustrating the mean values of EC for soil samples from all grids and their comparison with the proposed standard of EC by International Agricultural Soil Standards (Alloway, 1990).

The Fig.5 shows the graph which represents that the OC at grid $G_{16}$ has the greatest mean value i.e. 1.53± 0.025% while grid $G_{33}$ has lowest mean value 0.21± 0.03%. The standardized limit for organic carbon is 2% according to European Union, 2009 and all resulted values of this research are below the limit [16]. The reported organic carbon content in contaminated soil due to tannery waste disposal by Mahimairaja et al (2011) is 0.47%, which lies within the range of conducted study [18].

Fig.6 reveals that the lowest mean value of phosphorous is observed at $G_{33}$ which is 7.05± 0.08 (mg $kg^{-1}$) and the highest mean value of phosphorous is observed at $G_{15}$ which is 148.61± 0.10 (mg $kg^{-1}$). According to standard 1, the permissible limit value is >7 (mg $kg^{-1}$) and according to Standard 2, the satisfactory range of phosphorus in soil is 7-14 (mg $kg^{-1}$) [14] and [19]. All the resulted values of phosphorus for current studies are far higher than the prescribed limits given by both standards. Sinha et al *(*2006) reported that the available phosphorus in different soils receiving treated tannery wastewater ranged from 2.72-56.82 mg $kg^{-1}$ which is slightly in line with the determined values of P [20].

The available K content of soil increases significantly by the sewage and tannery water application [21]. Fig.7 depicts the greatest mean value of potassium at $G_{30}$ which is 920.03± 0.02 (mg $kg^{-1}$) and lowest mean value at $G_6$ which is 40.08± 0.13. In standard 1, the permissible limit is >80 (mg $kg^{-1}$) while in standard 2, satisfactory value of K was considered as 90-180 (mg/kg) [14] and [19]. With respect to standard 1 only grid $G_6$, $G_{10}$, $G_{16}$ and $G_{33}$ are in permissible limit. According to standard 2, most of the readings are in permissible limit except grids $G_1$, $G_2$, $G_4$, $G_5$, $G_7$, $G_9$, $G_{22}$, $G_{23}$, $G_{24}$, $G_{29}$, $G_{30}$, $G_{31}$ and $G_{32}$.

The water logging and salinity is the cause of enrichment of Na, Ca, Mg, Al in soil [22]. In Fig. 8 the graph represents the highest mean value of Sodium at grid $G_{32}$ i.e. 1360.217 ± 0.351(mg $kg^{-1}$) while lowest mean value at grid $G_8$ i.e. 99.99 ± 0.15 (mg $kg^{-1}$). It is noted that each reading of sodium is below the detrimental range of sodium in soil which is 1550-2300 (mg $kg^{-1}$) [23].

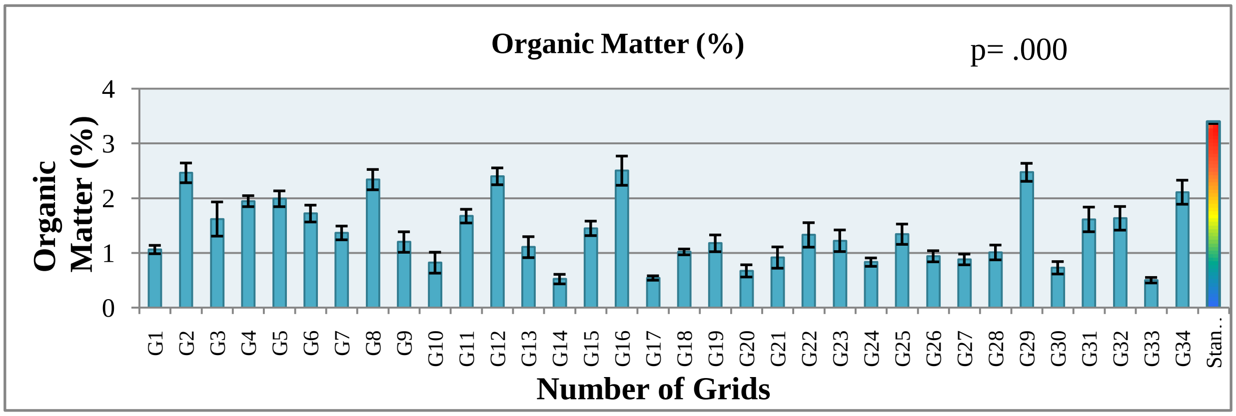


**Fig. 4:** Graph illustrating the mean values of Organic Matter for soil samples from all grids and their comparison with the proposed standard of Organic Matter in soil by European Union, 2009

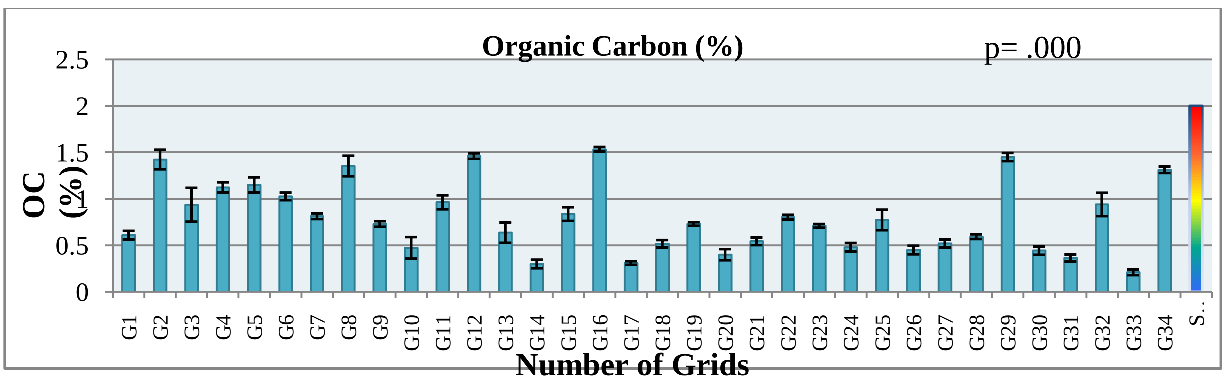


**Fig. 5:** Graph illustrating the mean values of Organic Carbon for soil samples from all grids and their comparison with the proposed standard of Organic Carbon in soil by European Union, 2009

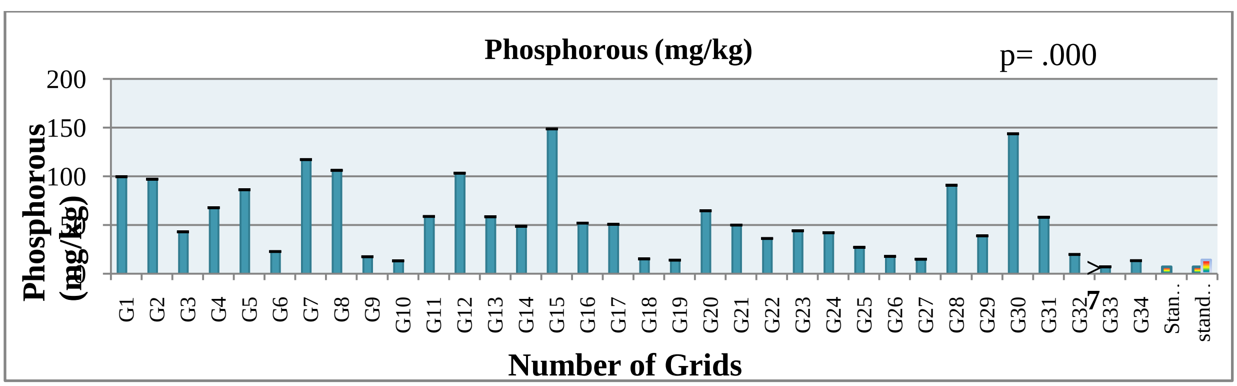


**Fig.6:** Graph illustrating the mean values of Phosphorus for soil samples from all grids and their comparison with the proposed permissible limits of Phosphorus in soil by *Standard 1 and **Standard 2
*Standard 1: International Agricultural Soil Standards (Alloway, 1990) **Standard 2: Malik et al., 1984 and Motsara, 2002

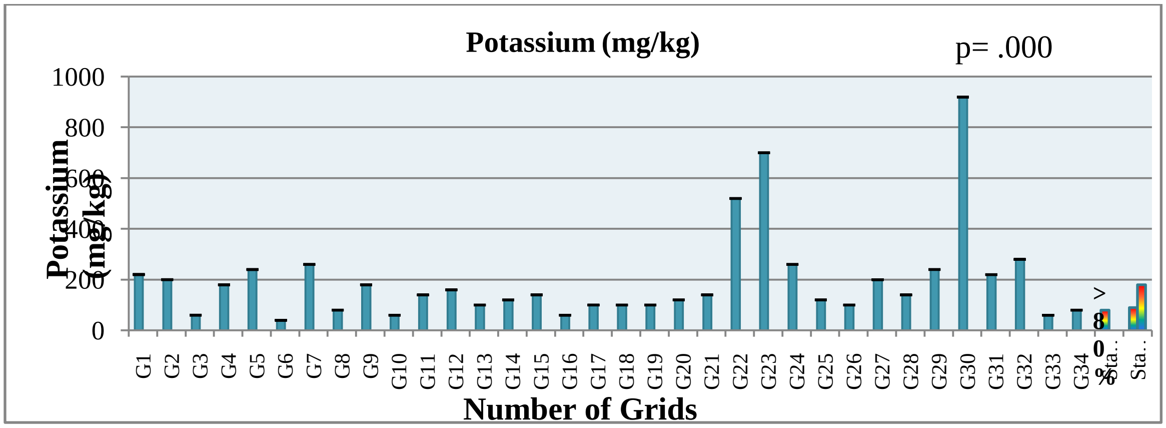


**Fig.7:** Graph illustrating the mean values of Potassium for soil samples from all grids and their comparison with the proposed permissible limits of Potassium in soil by *Standard 1 and **Standard2 as above

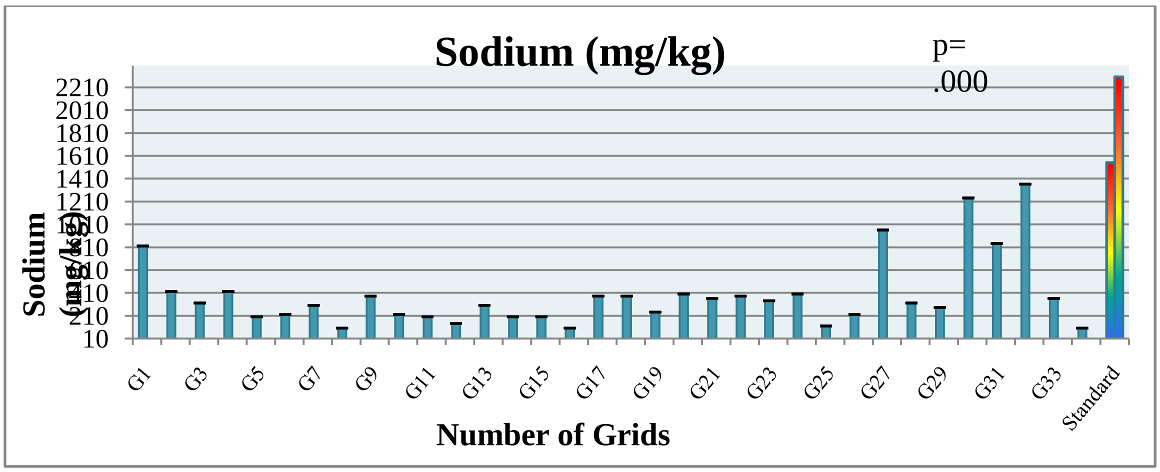


**Fig.8:** Graph illustrating the mean values of Sodium for soil samples from all grids and their comparison with the proposed permissible limits of Sodium in soil by Marschner, 1986

## APPLICATIONS

The results of the work being reported provide the information to the farmers of the investigated area whether the reclaimed land is fit for agricultural crops; first by conducting its physicochemical analysis to determine different parameters such as pH, EC, OM, OC, etc, and comparing the results with international standards for its fitness.

## CONCLUSIONS

From the discussion done above, it may be concluded that the Kasur tanneries reclaimed land area is almost appropriate for agriculture practices. In most of the studied agricultural soil samples, the mean values of all the determined parameters are within permissible limits prescribed by most of the compared standards with very few samples exceeding limits. As cultivation is difficult in few areas where concentrations of parameters exceed, phyto-remediation or other such as chemical-remediation may be considered to bring the exceeding parameters within limit.

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