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Spatial pattern of industrial soil fertility in selected towns of Faisalabad City, Punjab Pakistan

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Abstract

Soil fertility plays a vital role in sustaining the city's ecology with respect to vegetation. It makes available ecosystem services for life. Fertile soil is responsible for healthy environment. But waste material from industries alters its mineral's composition resulting in reduction of its fertility. The monolithic studies are being conduct around the world in this regard to maintain healthy ecosystem. In this context, soil fertility variations in industrial areas of Faisalabad city were investigated. The mean graphical representation and estimated spatial variations in soil fertility were analyzed via inverse distance weighted (IDW) technique through GIS. Results revealed that Iqbal Town has more concentration of Potassium, Phosphorus, pH and EC as compared to Jinnah Town, Madina Town and Lyallpur Town. The study is helpful in determining the agricultural potential of various crops in the adjacent land of industrial areas.

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Introduction

Soil is a crucial natural resource, which is the life line of ecosystem and plays a critical role to sustain life on this Planet (Zhang *et al*., 2002). It is defined as the capacity to function within ecosystem and land use boundaries, which maintain environmental balance, biological productivity, plants growth, animal and human health (Doran & Jones, 1996). The constant conversion of vegetal areas to non-vegetal areas and techno-world reduces the soil productivity (Deekor *et al*., 2012). The studies have been made aiming at evaluating the soil resources to increase awareness that soil is an essential component of the earth, which is not only involved in the production of food and fiber, but also in the maintenance of local, regional and worldwide environmental quality (Kiflu & Beyene, 2013). It is a non-renewable resource within human time scales and anthropogenic activities are dramatically altering its properties/qualities (Zhao & Xia, 2012). Road side soil, 16 years old rubber plantation soil and a secondary forest soil from the 0-10 cm deep layer of soil in Odukpani, Nigeria represents that road side soil has low vegetation, high rate of CEC and the low OC and TN due to the landscape activities and road construction. Secondary forest soil contained high rate of organic carbon and total nitrogen (Senjobi *et al*., 2013). It is a sign that wrong use of land reduces the soil fertility. It is necessary to have deep insight about the use of land in order to reduce soil fertility decline. This has great implication on sustainable agricultural practices (Jin *et al*., 2011). On the contrary, Fertilizers input is also a drastic factor which disturbs nutrient balance in soil (Darilek *et al*., 2009). Anyhow, soil management system is very significant to keep the soil as life sustaining factor on the face of the earth (Glasener *et al*., 2002). Green technology is a cost effective method to improve the properties of soil in the polluted areas (Fiorentino *et al*., 2017).

Most parts of the world are associated with poor soil status which ultimately leads to poor food production. Cultivation in such affected soil needs fertilizers to increase the soil fertility. Not only the poor soil requires fertilizer but fertile also needs fertilizer to avoid nutrient loss due to continuous cultivation (Wiklund, 2017).

Faisalabad is the third largest city of Pakistan. It is also known as Manchester of Pakistan due to its agricultural and industrial importance. The city has seen remarkable changes in its morphology and land use patterns in the past fifty years. To meet the needs of rapidly growing population of the city various industrial sectors were developed in the various localities of the city.

The current study is also focuses to identify the level of various elements in the soil of industrial areas as the effluents of industries has a significant impact on the soil fertility. This change in the soil fertility can affect the agricultural potential of the soil in the industrial soil of the city.

Materials and methods

The main focus of this study was to reveal the level of soil fertility in industrial zones of Faisalabad City. The city was established as a small "*Mandi Town*" in 1895 and converted into an urban and industrial hub in no time. It is situated at the coordinates of 30°42' and 31°47' latitudes and 72°40' and 73°40' longitudes with mild slope of about 0.2-0.3 meters per kilometers north east to south west at the center of lower *Rechna Doab*. The city exhibits the arid climate touching two extremes of temperature in summer and winter season. The Faisalabad city covers an area of about 213sq Km^2 (Anwar & Bhalli, 2012).

Sampling Procedure

The study was conducted in quantitative manner and random sampling technique was employed to collect the soil samples. Four Towns had been selected and to collect the 48 industrial soil sample, from February 2014 to March 2014. Soil samples were collected by inserting an iron rod up to the length of 20 cm into soil layer from each Town. The samples were prepared and analyzed at "Ayub Agriculture Research Institute" Faisalabad. Laboratory results were tabulated and mean concentration of (EC, pH, Organic Matter, P, K) for each Town was calculated.

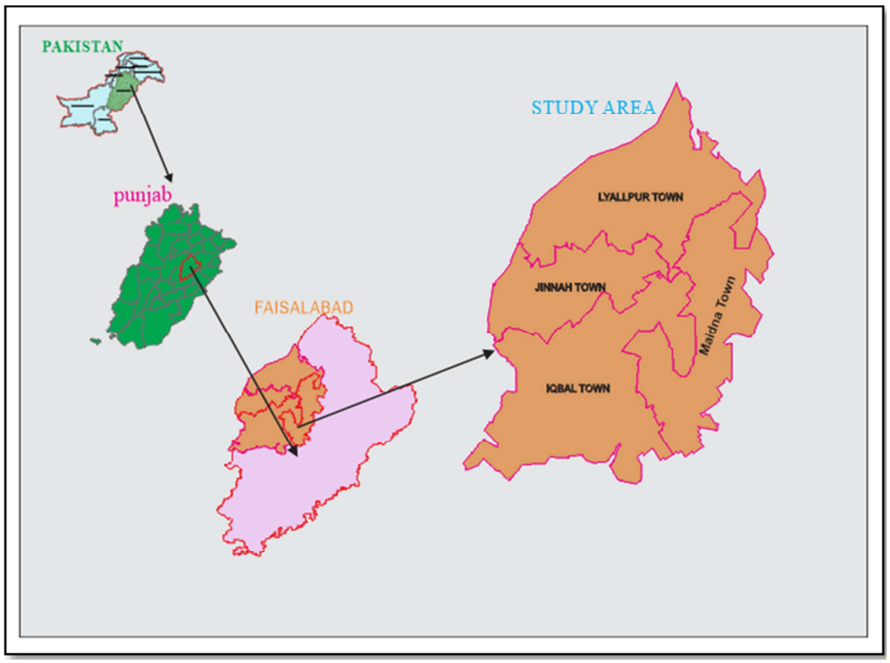


Fig. 1. Study Area.

Geo-Statistical Analysis

The GPS (Global positioning system) was used to mark the exact location of the sample sites in the selected towns of the study area. Geo-Statistical Analysis was used to measure the values of the samples and to predict values for the unsurvey locations on the bases of obtained samples. For this purpose Inverse Distance Weighting Technique was used to prepare the maps of the soil fertility and the variation among the soil samples was depicted on maps using ArcGIS 10. In Statistical analysis, the mean concentration of (EC, pH, Organic Matter, P, K) for each Town was calculated.

Results and discussion

The maps given below have been generated through the spatial analysis using (IDW) in ArcGIS 10. The Maps showing the comparison between the level of soil fertility and the variations in the soil fertility according to the selected parameters i.e. Organic Matter, Power of Hydrogen Ions and Electrical Conductivity in the selected towns of the city.

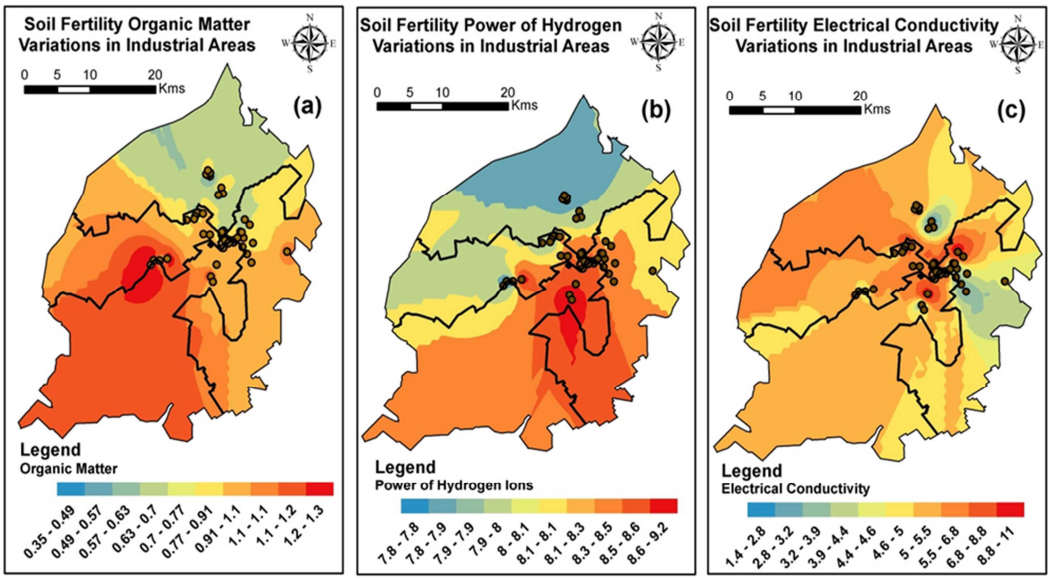


Fig. 2. IDW Maps of OM (%), pH, EC (mS/cm) in Industrial Land Use.

Data present in above Fig. 2, map (a) shows the fertility of soil in terms of organic matter in the industrial land- use in selected Towns of Faisalabad City. It can be concluded from the map (a) that Iqbal Town has the highest quantity organic matter varies from 1.12% to 1.32% as well as Madina Town also showing the high quantity of OM as compared to other towns. On the southern side between the boundary of Jinnah Town and the Iqbal Town, also contains greater amount of Organic matter as 1.12% to 1.32% in soil which is shown in red color on the map. The soil the having the quantity of Organic matter more than 1.29% is referred as good quality of soil as it is highly fruitful and the best for plantations (Institute, 2014). However as per Soil Analysis report the level of organic matter in the soil of Lyallpur Town was found to be less than desired limit. Fig. 2 and map (b) shows the soil fertility in terms of (pH) power of hydrogen variations in industrial land- use of the selected Towns in Faisalabad City. In the map red color in Iqbal Town and a minor red circle in Jinnah Town showing the high concentration of pH i.e. varies from 8.6 to 9.2. Low value of pH i.e. 7.8 is present in the northern part of the Lyallpur Town which is shown in blue color. However the small blue circle lies on the boundary of Iqbal Town and Jinnah Town also showing the low amount of soil pH in patches. The Fig. 2 map (c) displays the EC (Electrical Conductivity) variations in the Industrial land uses in selected Towns of the Faisalabad City. High concentration of EC has been noted on the northern side of Iqbal Town followed by Madina Town from 8.82 mS/cm to 10.8 mS/cm in red color. The aggregate of EC from 13 mS/cm to 15 mS/cm is not suitable for the plants growth and have great amount of salt in the soil (Institute, 2014). On the map blue color showing the low amount of EC in the soil of selected town in Faisalabad City. The level of electrical conductivity in the towns varies from 1.36 mS/cm to 2.79 mS/cm.

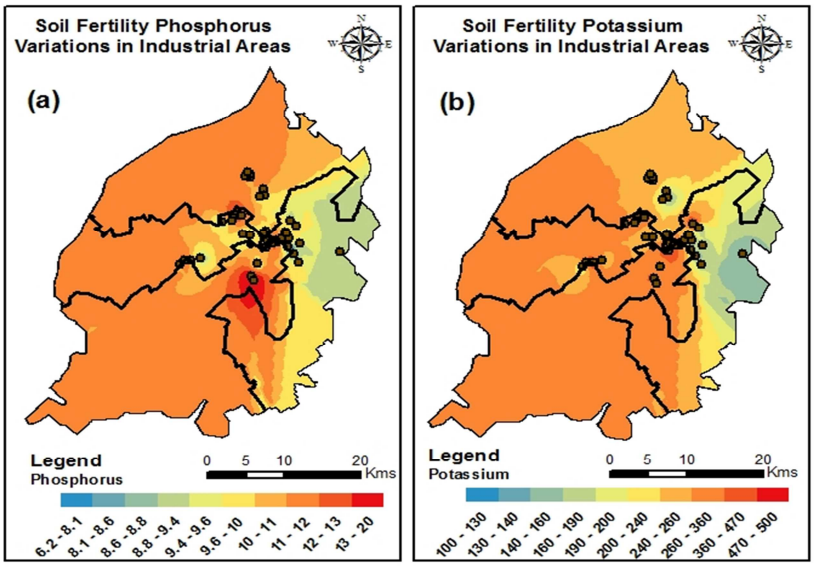


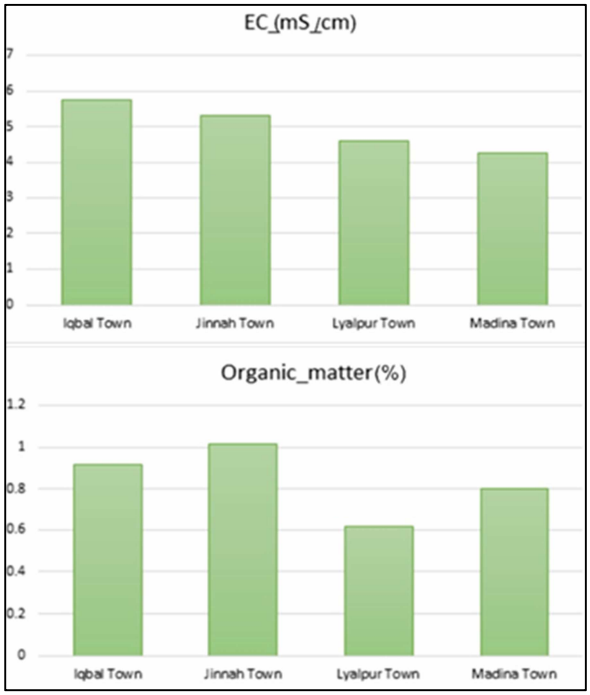
Fig. 3. IDW Maps of P (ppm) and K (ppm) in Industrial Land Uses.

Fertile Soil is basic requirement for healthy plant growth. There are many import soil nutrients i.e. Nitrogen, Phosphorus, Potassium and few others elements i.e. Calcium, Magnesium, Iron, Zinc and Copper are required in small quantity as compared to these major nutrients for plant growth. Phosphorus and Potassium are the necessary minerals for the plant growth. Phosphorus plays a vital role in the transfer of energy in the form of Adenosine Triphosphate (ATP) during the process of metabolism. It also supports plant growth during the drought and cold periods. Similarly Potassium is another vital element for the plant growth and it is used by plants more than other elements apart from Nitrogen. Phosphorus is a critical component for agriculture and if the quantity of Phosphorus is low in

the soil then the plant growth will be stunted (Foth & Ellis, 1997). In above Fig. 3, map (a) indicates the level of Phosphorus in the soil of selected Towns, such as Lyallpur Town, Jinnah Town, Madina Town and Iqbal Town. It is clear from the map that soil of Iqbal Town has high amount of Phosphorus ranging from 13.38 ppm to 20.4 ppm in red color while Lyallpur Town has also high concentration of Phosphorus as compared to other two towns in the study area. Soil that contains the more than 15 ppm of Phosphorus is considered as rich and suitable for the plantations (Institute, 2014).

Low concentrations of Phosphorus i.e. 6.2 ppm to 8.1 ppm has been found on the Western side of Madina Town and on the Northern side of Iqbal Town as shown in blue color on the map. Fig. 3 and map (b) reflects the level of Potassium in the soil of industrial land-use of selected towns in Faisalabad City. Map with the red patches showing the highest concentration of Potassium in the soil of Madina i.e. 474 ppm to 500 pp).

Soil that contains the amount of Potassium above than 180 ppm are very fertile and suitable for the plantations (Institute, 2014). The amount of Potassium is very low on Eastern side of Madina Town in blue color.



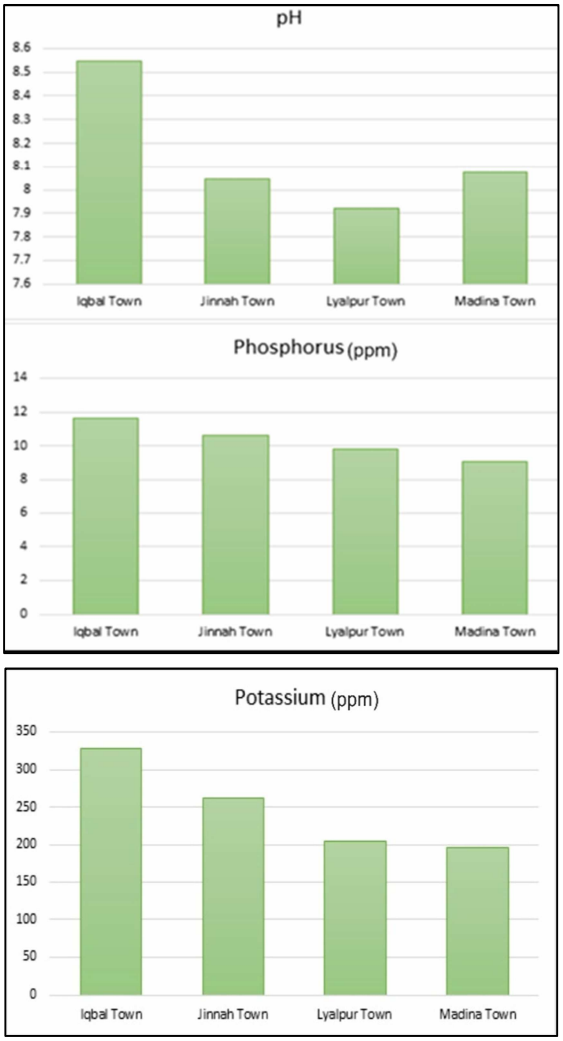


Fig. 4. Mean Concentration of EC, pH, OM, P and K in Industrial Soil.

In the above Fig. 4, graph-01 illustrates the mean concentration of Electrical Conductivity (EC) in industrial areas of four Towns of Faisalabad City. The EC represents the amount of solved minerals in the Soil. Electrical Conductivity is directly disturbing the growth of plants.

The mean values of the sampling sites represents that Iqbal Town has higher amount of EC i.e. 5.7575 mS/cm as compared with other three selected Towns. Jinnah Town ranked as second with the mean concentration of about 5.34 mS/c while, Lyallpur Town and Madina Town have almost similar means concentration of EC 4.63 mS/c 4.29 mS/c respectively. This means that the soil does not have sufficient capacity to grow wheat, rice, sugar cane and orange plants etc.

Fig. 4 and graph-02 shows the mean concentrations of pH in soil. Iqbal Town ranks at first with the mean alkalinity of about 8.5 followed by Madina Town with the mean concentration of 8.07; While Jinnah Town has low mean concentration of pH i.e. 8.05. Lyallpur Town is close to Jinnah Town with the mean concentration of pH value is about 7.92. Such amount of pH in soil is enough to cause Barite and decrease the soil fertility. It also hinders the supply of food for proper growth of plants.

On the above Fig. 4, graphs-03 represents that Jinnah Town has the large concentration of organic matter i.e. 1.019% as compared to other three Towns. Iqbal Town ranks on second with mean value of about 0.921% in terms of organic matter in the soil and Madina Town has the mean concentration of organic matter around 0.805%. On the other hand Lyallpur Town has low mean concentration of organic matter in its soil, which is 0.621%. Due to low concentration of organic matter in the soil of Lyallpur town is not fertile. It is unable to supply food properly and to maintain the amount of moisture in soil. It is also not in the state to keep harmony among nitrogen, phosphorus and potassium.

Fig. 4 and graph-04 shows the mean concentration of available Phosphorus in the industrial soil of study area. It is easy to interpert that Iqbal Town has the highest concentrations of phosphorus i.e. 11.691 ppm in soil, while in Jinnah Town the concentration of available Phosphorus was 10.675 ppm. Lyallpur Town is in the third number regarding the mean concentraion of available Phosphorus with the mean value of 9.875 ppm and Madina Town ranks on the forth number with the mean value of about 9.075 ppm. The soil with such amount of phosphorus is not suitable for cultivation and falls into moderate type of fertile soil as a result due to lack of Phosphorus in soil the crops' productivity decrease.

In Fig. 4, graph-05 proves that Iqbal Town has maximum value of Potassium i.e.328.33 ppm followed by Jinnah Town with mean concentration of about 263.33 ppm. Lyallpur Town and Madina Town are close to each other in mean concentrations of available Potassium i.e. 205ppm and 196.66 ppm respectively.

The soil which has high amount of Potassium plays a vital role to strengthen the plants. But other minerals and components in soil do not favor efficient crop productivity. However uneven concentration of ingredients in the soil disrupts the equilibrium of fertile soil and decreases the fertility of the soil.

Conclusion

The present study was focused to examine the quality of soil in industrial zones of Faisalabad City. The examined industrial soil sampled from four Towns of the city represents an uneven means concentration of minerals such as (EC, OM, pH, P and K). Though the amount of Organic matter is higher in the industrial soil of Jinnah Town as compared with other three Towns, but it is not enough to rank the soil as more fertile. Similarly Iqbal Town has great amount of Potassium, Phosphorus, pH and EC as compare to other three Towns, but it is not sufficient to support healthy vegetation. The concentration of pH is not evenly distributed in Faisalabad city. Data analysis of soil sampled clearly indicates that the soil of industrial areas has low fertility hence it is not appropriate for plantation. Trees are green lungs of our earth, without fertile soil they cannot be grown properly. To keep the lungs of earth in healthy order regular monitoring of the Industrial soil is required to check the concentration of basic nutrients for plant growth. The deficiency in the provision of basic nutrients may result in the poor vegetal cover in the area.

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