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Soil quality assessment using selected physico-chemical indicators in Altit Hunza, Gilgit-Baltistan

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Abstract

Soil is the most vital non-renewable natural resource, which perform major environmental functions. Soil is an actively living system which consist diversity of micro and macro fauna and flora, which plays major role in maintaining the soil quality. Soil micro organisms are responsible for the decomposition of organic matter in soil, thus soil quality assessment is very important to maintain the ecological processes in soil. Soil chemical and physical properties can be used as indicators of soil quality assessment. That's why soil quality assessment is important for agro sustainable development. The aim of this study is to provide base line information set, on soil quality assessment of Altit Hunza. Physiochemical and fertility status of Altit soil Hunza-Nagar of Pakistan were investigated during 2013-2014. The whole location was divided into four clusters, form each cluster soil samples were collected from agriculture, orchards and forest area. Total 120 soil samples have been collected, 30 soil samples from each cluster. The investigated soil properties were pH, Soil Organic Carbon (SOC), Nitrate-Nitrogen (NO_3-N), Electrical Conductivity (EC), Available Phosphorus (P), Exchangeable Potassium (K). Two way ANOVA was applied to determine the significant differences of soil properties with respect to Clusters and land use. Soil pH, EC, TN and K showed highly significant differences $p<0.01$, $p<0.01$, $p<0.05$ and $p<0.01$ with respect to clusters.

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Introduction

Soil is a natural resource entity on which our agricultural productivity is based. It is important to keep healthy and productively soil to continue our soil to function optimally. Soil quality defines as capacity of soil to maintain ecological productivity, promote plant and animal health and sustain environmental quality. The ecological productivity of soil reduces the non renewable inputs as well as polluting outputs and ensuring optimal productivity for long term (Scoot and Cooper, 2002). Soil quality assessment is the most controversial topic ever debated by the soil sciences community (Karlen *et al.,* 2008). Good quality of soil not only support the growth of plant but it also prevent the air and water pollution by resisting the soil erosion and by degrading and immobilizing the agricultural chemicals and other potential waste (Reganold 1995). But the constant use of conventional farming practices which based on the large tillage has great soil erosion losses and resources based in soil have been gradually deteriorated. This can happens especially when tillage get progress with the insitu burning of crop residue (Montgomery, 2007). According to Ikemura and Shukla 2009, the vital goal of sustainable agriculture is sustain a non negative trend in agriculture productivity along with maintain the soil quality. The biological activity is an important soil property to which affecting the agricultural productivity and soil sustainability. Mostly unusual land management practices can lead to loss in soil quality by minimizing in the abundance and variety of microorganism in soil (Morugán-Coronado *et al.,* 2014). Large proportion of earth terrestrial surface has converted from natural ecosystems to human dominated system. These land uses changes affect the ecosystem soil quality (Paz-Kagan, *et al.,* 2014). The growing population and increasing in socio-economic necessities creates pressure on land use/land cover, this increases pressure results in unplanned and uncontrolled changes in LULC (Seto, 2002). Soil can be characterized on the basis of organic matter content whether it is organic or mineral soil. Globally crop productivity has generally resulted in the decline of soil organic matter (SOM) and thus decline in soil fertility status. The land use conversion of natural grass land and forest ecosystems in to arable agriculture results in the loss of 30% of soil organic carbon (Bot & Benites, 2005). Soil fertility and its nutrient management effect vegetable production, food security and livelihoods (Perveen, *et al.,* 2010). Soil Organic carbon plays a vital role for the assessment soil quality (Shukla, *et al.,* 2006). The management practices that improve soil organic carbon content through plant and animal residue, such as farmyard manure, crop residue mulching and reduced tillage, could increase the diversity soil organisms while improving the fertility status and production of the land (Begum, *et al.*, 2013). The present study aimed to assess soil quality using selected soil physico-chemical indicators and also to evaluate the soil quality at different locations. This study also provides baseline data for future research.

Materials and methods

Study Area

The study was carried out in Altit village; district Hunza Nager, Gilgit Baltistan, Pakistan, geomorphic ally the area is mountainous faming having small slopes with small hills. The hilly areas are covered with forest. The study area is more suitable for different crops, but major crops grown in study area are wheat, corn, maize and vegetables such as potato, mustard, pulses and bean etc. And the natural vegetation of Altit valley consists of tress, grasses and bushes. The major plant species found in study area are, Willow, Populous, Mulberry, Apricot and Russian olive.

Sampling Design

The study area was divided into four clusters. From each cluster 30 soil samples have been selected. Soil samples were carried out during the month of October 2012. The samples were collected from top soil up to depth 0 to 15cm. 30 soil samples were collected from each cluster, so that 120 soil samples were collected from the entire village. Small spades with a hand trowel were used to dig up the soil, and then soil samples were put into polyethylene bags. Soil samples were air dried, crushed and passed through 2mm sieve before laboratory analysis. The chemical and fertility status of soil were analyzed at Mountain Areas Agriculture Center (MARC) in Juglote in Gilgit-Baltistan. Soil pH was measured with 1:1 soil and water (McKeague, 1978; McLean, 1982). EC was measured by (electrical conductivity meter) the methodology which is given in US Handbook 60 (Richards, 1954). Soil organic carbon was measured by (Walkley, 1947). Soil NO_3-N, P, K was determined by the Ammonium Bicarbonate – DTPA extractable method by (Soltanpour and Schwab, 1977).

Analysis of Data

All the data regarding soil physical and chemical properties were recorded in respective excel spread sheet and SPSS (16). The main statistical tests applied were two way ANOVA to determine significant difference with respect to land use and Clusters. This paper dealt with only land use data.

Result and discussion

Influences of difference location on soil physiochemical properties

Physiochemical and fertility status of soil was analyzed by location wise difference. Our results indicated that location have significant impact on soil physio-chemical properties. ANOVA results indicated that soil pH, EC, NO_3-N and K showed highly significant differences $p<0.01$, $p<0.01$, $p<0.05$ and $p<0.01$ with respect to clusters, soil organic carbon and available phosphorus were not significant with respect to location wise (Table 1).

Table 1. ANOVA result of relevant Parameters by Location wise.

	pH	EC	SOC	NO_3-N	Av-P	Ex-K
Locations	5.24**	3.72**	1.90 "ns"	3.18*	1.04 "ns"	5.13**

Note: *, **, ***, and "ns" indicates $p<0.05$(5%), $p< 0.01$(1%), $p<0.001$ and "ns" non-significant respectively SOC; Soil Organic Carbon, Nitrate-Nitrogen; NO_3-N, P; Phosphorus, K; Potassium, EC; Electric conductivity.

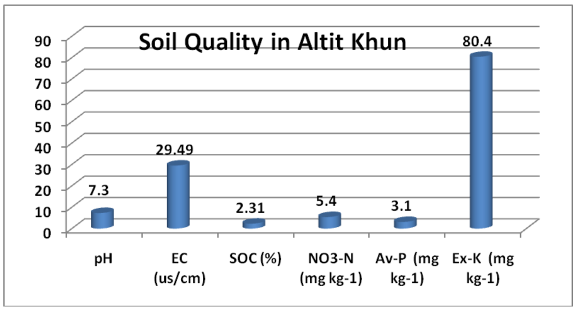

Fig. 1. Shows selected soil quality indicators in KHUN of study area.

From the past decade soil quality research has been increased exponentially throughout the world (Karlen, *et al.*, 2003).Soil pH is considered as one of the important soil chemical parameter to identify the impact of land use change (Idowu, *et al.*, 2009; Schindelbeck, *et al.* 2008), since the nutrient availability of plant is highly depends on it (Begum, *et al.*, 2009). The soil pH was highly significant with respect of cluster wise, the mean soil pH of Altit Khun was slightly (Alkaline 7.3). EC was (29.49 us/cm), the mean SOC content with respect to cluster wise was (2.31 %) in Altit Khun, while NO_3-N, Av-P and Ex-K was (5.4mg kg-1), (3.1 mg kg-1) and (80 mg kg-1) respectively.

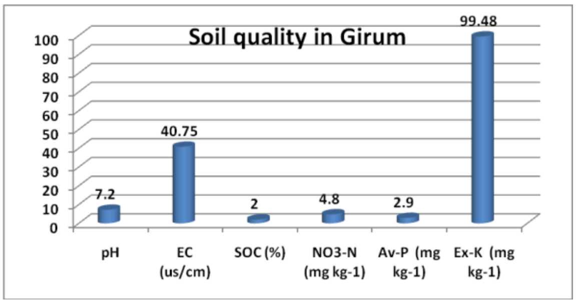

Fig. 2. Shows selected soil quality indicators in Girum of study area.

Soil pH, Soil organic Matter, salinity, Phosphorus, Cation Exchange Capacity (CEC) and nutrient cycling are important chemical conditions that affect the plant growth and their development (USDA Natural Resources Conservation Service, 1996). Many studies indicate the changing in the soil properties with respect to topographic positions (Chen *et al.*, 1997; Tsui *et al.,* 2004; Begum *et al.,* 2010). The mean soil pH and EC was (7.2) and (40.75 us/cm) respectively. SOC was slightly lower as compared to Altit Khun, the mean SOC was (2%), while the soil fertility status NO_3-N, Av-P and Ex-K was (4.8 mg kg-1), (2.9 mg kg-1) and (99.48 mg kg-1) respectively.

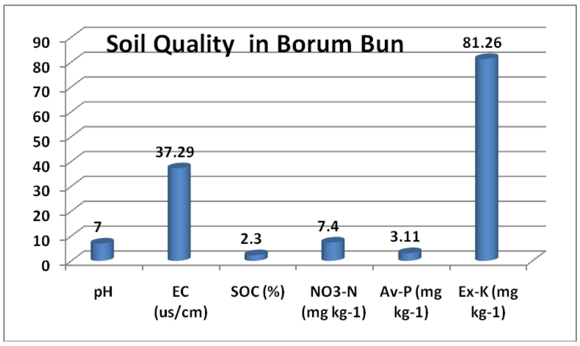

Fig.3. Shows selected soil quality indicators in Borum bun of study area.

Soil organic carbon (SOC) is an important parameter affecting soil quality and agriculture sustainability (Guangyu, *et al.,* 2010). Globally crop productivity has generally resulted in the decline of soil organic matter (SOM) and thus decline in soil fertility status (Bot & Benites, 2005). The mean SOC content of Borum Bun areas was (2.3%), it may because of high use of local fertilizers like animal manure and dung, while fertility status slightly differ to the other areas of Altit. NO_3-N, Av-P and Ex-K was (7.4 mg kg-1), (3.11 mg kg-1) and (81.26 mg kg-1) respectively. The mean soil pH and electrical conductivity was (7) and (37.29 us/cm).

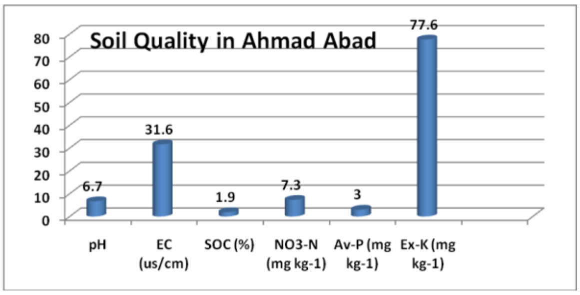

Fig. 4. Shows selected soil quality indicators in Ahmad Abad of study area.

The pH of soil directly affact the growth of plant and because indirectly it affact the other plant nutreints. The mean pH was (6.7), which is an ideal range for palnt growth. The Ec was (31.6 us/cm) while the SOC content was slightly lower from other areas of altit, (1.9%). Soil fertility and its nutrient management effect vegetable production, food security and livelihoods (Perveen, *et al.,* 2010). Decline in the soil organic matter content (SOC), it will decrease the nutrient value and also the exchangeable bases (Atiku & Noma, 2011). The fertility status of Ahmad Abad was NO_3-N (7.3 mg kg-1), Av-P (3 mg kg-1) and Ex-K (77.6 mg kg-1).

Conclusion

The current study shows some physiochemical and fertility status of Altit Hunza soil. it was revealed from this study that, location have significant impact on soil physio-chemical properties. The soil pH, EC, NO_3-N and K showed highly significant differences $p<0.01$, $p<0.01$, $p<0.05$ and $p<0.01$ with respect to clusters, soil organic carbon and available phosphorus were not significant with respect to location wise. The soil of study area has an ideal pH range for pant growth. The SOC content and fertility status of study area was also ideal, due to input use of local fertilizers like manure and dung.

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