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SOIL NUTRIENT STORAGE UNDER MAJOR ECOSYSTEMS OF COLD DESERTS OF HIMACHAL PRADESH

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ABSTRACT

The present investigation was carried out at Goshal village of Lahaul and Spiti cold desert district of Himachal Pradesh during the year 2014 to compare soil chemical properties in three major ecosystems *viz*; forest ecosystem, alpine pasture ecosystem and agro ecosystem which have been affected as a result of land use changes . The study area was demarcated into three main ecosystems for conducting soil studies. Average soil nutrient status for all the three ecosystems was studied and our study depicted that nitrogen was found 277.5 kg/ha, 421.5 kg/ha, 457.15 kg/ha, phosphorus was found 15.5 kg/ha, 16.51 kg/ha 19.95 kg/ha and potassium was found 132.92 kg/ha, 125.44 kg/ha and 166.33 kg/ha respectively for forest ecosystem, alpine pasture ecosystem and agro ecosystem. Our study revealed that in general, the soils are nearly neutral in reaction, having no salt problem and fields in agro ecosystem where peas and pulses were planted possessed higher nitrogen contents (457.15 kg/ha) than forest and alpine ecosystem (277.5 kg/ha, 421.5 kg/ha) due to the fixation of atmospheric nitrogen besides other nutrients such as P, K, Na and Ca.

INTRODUCTION

An ecosystem is a community of living organisms (plants, animals and microbes) in conjunction with the non living components of their environment (air, water, soil minerals, *etc*.), interacting as a system. These biotic and abiotic components are regarded as linked together through nutrient cycling and energy flow. Some ecosystems are fairly robust and are less affected by a level of human disturbance. Others are highly fragile and are disturbed by human interferences. Mountain ecosystems are highly fragile as simple degradation of forest cover leads to severe soil erosion and even changes in river courses (Anonymous, 2003). Deserts are arid regions of the earth generally distinguished by scarcity of vegetation and low population density (Annonymous, 1974). In *general* deserts are arid areas, which because of dryness or cold may be characterized as having low potential as a human habitat. The term is applied to two kinds of areas. Firstly, the area with arid climate, sparse to no vegetation cover, angular landforms and with an absence of full flowing rivers and secondly the lands on the polar fringes. This phenomenon was termed as desertification during United Nations Conference on Desertification (Anonymous, 1977) and also explains land degradation as a change in the global ecosystems that threatens human welfare now and/or in the future, which is fast spreading worldwide.The cold desert of India is located mainly in two states, *viz*., Himachal Pradesh and Jammu and Kashmir. In Himachal Pradesh, the cold deserts are restricted to the districts of Lahaul and Spiti, parts of Kinnaur (Sumdo side) and Pir Panjal in Chamba district. The topography of Lahaul and Spiti district is entirely hilly. The region is characterized by low precipitation, a short growing season, low primary productivity and high stocking density (Mishra, 2000). Soil physical and chemical properties of a site are soil quality indicators (Doran and Parkin, 1994). It is imperative to compare the soil chemical properties of the site which have been altered due to recent land use changes. (Abbasi *et al*., 2010).Therefore we carried out our study by demarcating the study area into three main ecosystems for conducting soil studies *viz*; Forest ecosystem, alpine pasture ecosystem and agro ecosystem, to support the hypothesis that land use changes affects soil properties. Thus the objective of the present study is to compare soil chemical properties of these three major ecosystems.

MATERIALS AND METHODS

The present investigation was carried out at Goshal village of Lahaul and Spiti District of Himachal Pradesh. The climate of Goshal (Lahaul) valley is extremely dry and cold with high diurnal temperature variations. During different months, the mean atmospheric temperature ranges between -11.30ºC to 26.03ºC. Similarly, the minimum range of relative humidity ranges between 33.67 per cent in December to 59.33 per cent in August. The residents of the village Goshal follow agro pastoral livelihood and with the age old experience had developed their own land use pattern depending upon availability and quality of land, availability of water for irrigation plus their requirements for growing of crops, grazing areas for their husbandry and forest areas for other uses. The entire study site as per Revenue records and the adjoining alpine pastures and forest areas under the usage of village residents was differentiated as per the khasra number for: Forest ecosystem, Alpine ecosystem, Agro ecosystem. Forest near Goshal is located at mean altitude and longitude of 32°32′28.85″N and 76°57′29.94″E with mean elevation of 11,542 ft. above the grazing pasture on higher reaches of the village. Coniferous forest of Cedrus deodara, Pinus wallichiana and Betula utilis with mixed shrubby vegetation like Ephedra and Junipers with some herbs and grasses is found. Alpine pasture is located just below the forest area between 32°32′54.48″N and 76°57′48.47″E with mean elevation of 9,965 ft. This ecosystem was found uncultivable with minimum productive potential. The area as per the revenue records was categorized as the agro ecosystem, which was located at mean longitude and attitude of 23°33′06.25″N and 76°58′12.54″ E with mean elevation of 9,584 ft. Each ecosystem (forest ecosystem, alpine pasture eco system and agro ecosystem) was divided into nine different grids for sampling. Sampling in each grid was carried out following quadrate method. Three quadrates of (1X1 m) were laid in each grid in all the three ecosystems and soil samples were collected from each quadrate. For soil chemical properties quantitative estimations of various elements in soils, air dried samples were used. The soil samples in all the three ecosystems were dug out from each quadrate at three different depths (0-10, 10-20 and 20-30 cm). The samples were packed in different cloth bags, brought to laboratory, air dried and sieved through 4 mm mesh. These samples were analyzed for their nutrient contents by collecting the samples from each of the quadrate sites at three different depths (0-10, 10-20, 20-30 cm) with three replications in each field These soil samples were packed in cloth bags, marked and brought to the main campus, air dried, made free from plant material and gravels, *etc*., passed through a sieve of 4 mm mesh and again stored in cloth bags separately. The nutrient estimation were carried out through following techniques: Available nitrogen was determined through Macro Kjeldahl method (Subbiah and Asija, 1956). Air dried soil (1g) was digested with sulphuric acid, ammonia evolved absorbed in boric acid and titrated against standard hydrochloric acid and amount of nitrogen calculated accordingly. Available phosphorus was extracted by sodium bicarbonate method and determined through colorimetric method following Olsen *et al*. (1954) and the blue colour developed was read at 660 nm within 20 minutes on Spectronic-20 against a blank. The amount of available phosphorus was calculated from the standard curve prepared from KH2P04. The quantitative estimations of potassium, sodium and calcium were carried through ammonium acetate extract following Richards (1968). The leachates were diluted to desired amount and treated as stock solution. The estimations were carried out through Flame Photometer against their respective filters. Standards for K, Na and Ca were prepared from KCL, NaCI and CaCo3, respectively.

RESULTS AND DISCUSSION

Soil nutrient status at three different depths (0-10 cm, 10-20 cm and 20-30 cm) for each ecosystem in all the quadrates was estimated for N, P, K, Na and Ca. All the alluvial soils are put under use for a minimum of six months (single cropping), followed by grazing of the remaining aboveground and crop parts by the domestic glaziers during the month of October and then left as such (fallow) during long freezing winters. It is observed that although only the root system remains in the soil after the harvest and grazing during the long winters for decomposition. Average soil nutrient status for all the three ecosystems depicted that nitrogen was 277.5 kg/ha, phosphorus 15.5 kg/ha, potassium 132.92 kg/ha, sodium 153.5 kg/ha and calcium 458.55 kg/ha for forest ecosystem. In alpine pasture ecosystem nitrogen was 421.5 kg/ha, phosphorus 16.51 kg/ha, potassium 125.44 kg/ha, sodium 148.5kg/ha and calcium 457.55 kg/ha; while nitrogen was 457.15 kg/ha, phosphorus 19.95 kg/ha, potassium 166.33 kg/ha, sodium 198.57 kg/ha and calcium 541.65 kg/ha in agro ecosystem. The fields where peas and pulses were planted were found to be possessing higher nitrogen contents than other areas due to the fixation of atmospheric nitrogen. However, the concentration of other nutrients such as P, K, Na and Ca was also found higher in agricultural soils thus showing that agricultural soils are very good and which have developed as a result a continuous cultivation plus the annual addition of farm yard manure and other fertilizers during the cropping season; associated with different annual crop rotation and long fallow period of nearly six months each year. Mean soil nutrient status of all the three ecosystems are shown in the Figure. Singh *et al*. (1998) have also studied the K, P, Ca and Na content of upper Sutlej and Spiti Valley soils (30 cm depth) with wide variations. Datt *et al*. (2003) studied the effect of NPK fertilization with and without farmyard manure on productivity, yield attributes, uptake of nutrients, organic carbon content of soil and available nutrients (N, P, K) in the Lahaul valley with Azad P1 vegetable pea (*Pisum sativum* L. var arvense Poir.).

The NPK fertilization in combination with farmyard manure increased all these characters significantly. A consistent increase in pod yield, uptake by nutrients and improvement in fertility status was observed with each increment in NPK fertilizers along with a constant level of farmyard manure. Nutrient cycling occurs to varying degree in all landuse systems (Roswall, 1980). Nair (1989) also suggested that agro forestry and other tree based agro ecosystems are commonly credited with more efficient nutrient cycling and in turn, a greater potential to improve soil fertility than many other systems because of the presence of woody perennials in the system and their suggested beneficial effects on soil. In addition to

Table1: Overall soil nutrient status in different ecosystems in village Goshal

	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Sodium (kg/ha)	Calcium (Kg/ha)
Forest ecosystem	277.5	15.5	132.92	153.5	458.55
Alpine pasture ecosystem	421.5	16.51	125.44	148.5	457.55
Agro ecosystem	457.15	19.95	166.33	198.57	541.65

translocation of nutrients from soil layers beyond the reach of annual crops enhancement of nutrient status beneath tree canopies is attributed to canopy capture of precipitation (Kellman, 1979). Yamoah *et al*. (1996) reported that even without addition of pruning, maize performed between near to alleys than those in middle of alleys, implying that there was transfer of nutrients by root turnover or some other means of below ground improvement. Rao *et al*. (1988) reported that increase in soil fertility is due to nitrogen input into the system through biological nitrogen fixation, reduced soil erosion, reduced leaching of nutrients and uptake from deep soil layers. Hua *et al*. (2007) investigated chemical properties of three soil layers (0 to 10, 10 to 20 and 20 to 30 cm) at three locations in two prominent shrub communities. The results showed that the soils in three layers at the clump centre exhibited significantly higher contents of organic carbon (SOC), total N, total P and lower pH value compared to the inter shrub space. Their study shows that shrubs play a vital role in accumulating SOC and nutrients and maintaining soil fertility in Alxa desert steppe. Maiti *et al*. (1993) reported that the N, P and K content of soil was appreciably reduced after harvesting of nonleguminous crops like maize, sorghum and mustard but nitrogen content increased with cowpea. Similar observations were also reported by Thind *et al*. (1979) and Misra *et al*. (1985). Lalithya *et al*. (2014) in their study found that macro nutrient and silicon content was more in the treatment with foliar application of potassium silicate at 8 ml per litre resulted in more yield and quality of fruits. Sharma *et al*. (2013) in their study on the effect of integrated nutrient management on yield, nutrient uptake, protein content and soil fertility of wheat in a vertisol revealed that the conjunctive use of inorganic fertilizers and organic manure along with biofertilizers and micronutrients gave highest available N, P, K, S and Zn in soil as compared to other treatment combinations. Thus, integrated resource management improved the crop yields, produces quality grain as well as improved the soil fertility.

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