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Impact of changing vegetation cover on some of the physical characteristics of forest soils of Langate Forest Division of Kashmir Himalaya

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Abstract

The aim of the present study was to evaluate changes in some of the physical properties of soils after change in vegetation cover in the forests of Langate Forest Division of Kashmir Himalaya. The study area was divided into four territorial forest rages. From each of the four territorial forest ranges, the composite soil samples were collected from different vegetation covers like trees, shrubs and herbs. The soils under the different vegetation covers varied in all physical parameters in all the four territorial forest ranges. The soils under the different vegetation covers varied in texture from clay-loam (reported under trees) to sandy-loam (reported under shrubs) to silt-loam (reported under herbs). The soils under tree canopies depicted higher values of moisture content and water-retaining capacity as compared to the soils under shrubs and herbs. On the contrary, the soil temperature showed an inverse relationship with soil moisture, being higher for the soils under herbs as compared to the soils under shrubs and trees. The soils under different vegetation covers depicted highly significant negative correlation at P=<0.05 between temperature and moisture content (r=-0.394; r=-0.457; r=-0.497) for trees, shrubs and herbs respectively.

Keywords: Composite soil sample; *Kashmir Himalaya; Langate Forest Division; Moisture content; Physical properties; Territorial ranges; Vegetation cover; Water-holding capacity*

Introduction

Soil may be defined as a thin layer of earth's crust which serves as a natural medium for the plant growth. It is the unconsolidated mineral matter that has been subjected to, and influenced by genetic and environmental factors-parent material, climate, organisms and topography all acting over a period of time (Acharya, 2018). The nature of the parent material has been found to influence development and characteristics of soils. The soils are crucial for ensuring the continued growth of natural and managed vegetation. The ability of a soil to support plant growth depends on its physico-chemical and biological properties which have been found to play significant roles in crop production (Umeri, *et al.,* 2017).

Forests have been the primary source to rejuvenate productivity of land by improving soil health through the action of root system and addition of organic matter through litter fall. The decomposition of forest litter and recycling of nutrients made soil physico-chemical and biological properties favourable for plant growth. The quality of soils does not depend on its ability to supply adequate nutrients alone but the nutrients must be in the right proportion as needed by the plants (Ayeni *et al.*, 2011).

Soils are put under tremendous pressure and their risk of degradation increases greatly with the increase in the demand for vegetation, animal feed and vegetation by-products such as wood. Land-cover changes have a drastic effect on physic-chemical and biological properties of soil and hence change the quality of soil (Irshad *et al*., 2015; Jaiarree *et al*., 2011). The improper agricultural practices coupled with overgrazing reduce the soil to the forces of erosion (Alkharabsheh *et al*., 2013; Conant *et al*., 2016; Recanatesi, 2015). The unsustainable land-use and land-cover changes are recognized as the main factors in the process of soil resource degradation, which can be defined as "a long-term decline in ecosystem functions and measured in terms of net primary productivity caused by disturbances from which land cannot recover unaided'' (Bai *et al*. 2008). Managing vegetation sustainably, whether in forests, pastures or grasslands will boost its benefits, including timber, fodder and food, in a way meets society's needs while conserving and maintaining the soil for the benefit of present and future generations.

Material and Methods

The Langate Forest Division falls in the north-western part of the Kashmir valley between 34° 15' and 34° 45´ N latitude and 73° 45' and 74° 45' E longitude. The forests extend over an area of 360.60 km^{-2} and occupy north-eastern slopes of Kazinag and Shamsabri ranges. The altitudinal zonation varies from 1590-4093m a.s.l. The entire area is divided in to four territorial ranges viz., Rafiabad, Mawar, Rajwar and Magam. These four forest ranges selected to represent the four different sites (Sites I, II, III and IV) respectively for the present investigation (Fig. 1).

Survey of the study area and collection of composite soil samples from different study sites of the four forest ranges was carried out on seasonal basis. Composite surface soil samples were collected at random from the study sites under differential vegetation covers (trees, shrubs and herbs) at a depth up to 10 cm and stored in polyethylene bags for analysis in the laboratory. The physical parameters studied included texture, temperature, moisture content and field capacity. The soil texture was determined by using the sieves of different meshes size. The USDA particle size classes viz., sand (2.0-0.02mm), silt (0.02-0.002) and clay (<0.002) were followed while assigning textural classes (Lemenih *et al*., 2005). The temperature was measured with the help of a soil thermometer provided with a scale-graduated up to 50°C. Probe of the thermometer was inserted five centimeters deep into the soil and average of five findings recorded.

The soil moisture content was measured by gravimetric method following the procedure prescribed by Gupta (2004). 5g of soil was weighed in a shallow stoppered weighing bottle and the bottle unstoppered for 24 hours was placed in a drying oven at 105°C. The sample was allowed to cool. The covered bottle was shifted to a dessicator, weighed and again oven dried to a constant weight. The difference between two weights gives the amount of moisture present in the soil sample. The percentage of moisture content was calculated as under:

$$\textbf{\% Moisture} = \frac{\text{Loss in weight}}{\text{Oven dry weight of soil sample}} \times 100$$

The field capacity was measured by Field Method following the procedure adopted by Gupta (2004). A uniform plot measuring 1m x 1m was selected and weeds, pebbles, etc., if any, were removed. The plot was bunded from all sides. Sufficient water was applied to the plot to completely saturate the soil to the desired depth (5-7 cm). The plot was covered with a polyethylene sheet to check evaporation and left undisturbed for 24 hours. Soil sample was taken from the center of the plot from 5-7 cm depth. Moisture content was determined by gravimetric method on daily basis till the values of two successive days were found to be nearly equal. The daily readings were plotted on graph paper and the lowest reading was taken as the value of field capacity of the soil.

Results

A detailed study of the physical characteristics of soils in Langate Forest Division under different vegetation covers was carried out and the results of soil analysis are depicted in Figures 2-5.

Soil Texture

The soil texture under various plant communities is depicted in Table 1. The soils varied in texture from clay-loam to sandy-loam to silt-loam. The more common textural classes were silty-loam and clay-loam. Though the sand and silt fractions showed wide variations, yet the clay content, in general, showed slight variations, being maximum under tree soils against the minimum for the soils under shrubs and herbs. The higher concentration of sand was recorded for the soils under shrubs as compared to the soils under trees and herbs at all the study sites. Likewise, the soils under herbs recorded greater concentration of silt at all the sites. In general, the soils under trees are clay-loam compared to the soils under shrubs and herbs which are sandy-loam and silt-loam respectively (Figure 2).

Soil Temperature (0C)

The soil temperature (°C) under different vegetation covers in different seasons is presented in Figure 2a-b. At Site I, the maximum temperature was reported for the soils under herbs in summer season (24 °C) and minimum temperature for the soils under shrubs in winter (4°C) during 1st year of the study while as during 2nd year the maximum temperature was reported again for the soils under herbs in summer (25°C) and minimum for the soils under trees in winter (4°C). The soil temperature at Site II appeared to range between 3 °C for the soils under trees in winter and 23 °C for the soils under herbs in summer season during 1st year and between 4°C for the soils under trees in winter and 21°C for the soils under herbs in summer during the 2nd year of the study. At Site III, the soil temperature fluctuated between 2°C for the soils under shrubs in winter and 26 °C for the soils under herbs in summer and between 4°C for the soils under trees in winter and 20°C for the soils herbs in summer for the 1st and 2nd years of the study respectively. At Site IV, the soils under trees recorded lowest temperature of 3 °C in winter and the highest temperature of 22°C for the soils under herbs in summer season during the 1st year while as the values fluctuated between 5°C for the soils under trees in winter and 20°C for the soils under herbs in summer during the 2nd year of the study. The overall annual mean values for soil temperature fluctuated between a minimum of 8.75± 6.23 for tree soil (site IV) and a maximum of 13.25± 7.54 for herb soil (site I) during the 1st year of the study period and between a minimum of 8.75±3.59 for tree soil (Site I) and a maximum of 12.75±6.55 for herb soil (Site II). In general, the soils under trees and shrubs depicted lower values for soil temperature as compared to the soils under herbs (Fig.3c).

Moisture content (%)

Soil moisture content (%) of the soil samples collected from different study sites of the Langate Forest Division under various plant communities in different seasons of the study period is depicted in Figure 4a-b. The soils under trees depicted higher moisture content as compared to the soils under shrubs and herbs and the percentage moisture content ranged from 10.65 to 27.0 during the 1st year and from 11.15 to 30.50 during the 2nd year of the study. The lowest value for percentage moisture content was reported in summer at site I (10.65) for the soils under herbs and the highest in winter (27.0) for the soils under trees during 1st year while as during 2nd year the lowest value for percentage moisture content was reported in summer (11.15) for the soils under shrubs and the highest in winter (27.50) for the soils under trees. On the other hand, the percentage moisture content recorded at Site II ranged from 12.20 (herb soil) in summer to 25.75 (tree soil) in spring and 14.10 (herb soil) in summer to 30.50 (tree soil) in autumn for 1st and 2nd year of the study period respectively. At Site III it varied from a minimum of 15.95 for herb soils in winter to 22.0 for tree soils in the same season during 1st year and from a minimum of 17.30 for herb soils in summer to a maximum of 27.60 for shrub soils in autumn during 2nd year. At Site IV, it fluctuated between a minimum of 13.15 in spring (herb soil) and a maximum of 21.10 in autumn (tree soil) during 1st year while for 2nd year, a range of 13.10 for herb soils during autumn to 23.40 for tree soils during summer was obtained. The overall annual mean value of soil moisture content ranged from 14.10±0.99 for herb soil at site IV to 23.00±2.82 for tree soil at site II during 1st year of the study and from 14.85±1.93 for the soils under herbs at Site IV to 24.75±4.29 for the soils under trees at Site II during 2nd year of the study (Fig. 4c). In general, the soils under trees and shrubs showed comparatively higher content of moisture than the soils under herbs at all the study sites of the Division.

Field Capacity (%)

A perusal of data depicted in Figure 5a-c revealed that the annual mean values for field capacity ranged between a low of 32.50±3.11 for shrub soil at Site II and a high of 41±4.69 for tree soil at Site III and between 31.50±2.89 for herb soil at Site I and 40.25±4.50 for tree soil at Site III during the two consecutive years (Fig.5a-c). In general, the soils under trees revealed higher values for field capacity than shrub and herb soils. However, there were significant temporal and spatial variations. Thus, at Site I the field capacity values showed a range of 31.0 (for shrub soils in spring) to 45.0 (for the tree soils in autumn) during the 1st year while for the 2nd year it ranged between 28.0 (for the herb soils in autumn) and 41.0 (for the tree soils in spring). At Site II, the maximum field capacity was found to be 40.0 for the soils under trees in winter and a minimum of 30.0 for the shrub soils in autumn during 1st year and during the 2nd year its maximum (44.0) was found for the soils under trees in autumn as against the minimum (28.0) for the soils under herbs in winter. At site III, the field capacity exhibited a range of 31.0 (for the soils under shrubs in winter) to 47.0 (for the soils under trees in winter) during the 1st year while for the 2nd year it fluctuated between 30.0 for the soils under herbs in summer and 44.0 for the soils under trees in autumn. At Site IV the values of this parameter fluctuated between 30.0 for the soils under shrubs in autumn and 43.0 for the soils under trees in both spring and autumn seasons of 1st year of the study and between 29.0 for the soils under shrubs in spring and 43.0 for the soils under herbs in summer of 2nd year of the study.

Discussion

Soil being the most important medium for plant growth revealed marked variations in various physical characteristics under different vegetation covers during the present study. The distributional pattern of soil textural classes revealed that with a decrease in the vegetation cover soils are left naked, thus becoming vulnerable to erosion, a process that deprives them of finer soil particles and gives them a silt loam character (Buckman and Brady, 1967; Yadav, 1967). The past records indicate that the whole area was once covered by dense coniferous forests (Kawosa, 2001). Assuming the soil texture at all the sites having been initially similar, there is a possibility that with decrease in canopy cover from coniferous forests to scrubs and subsequently to grasslands due to various disturbances, the clay-loam type (reported under tree cover) are replaced by sandy-loams (reported under scrub), which further due to erosion of finer soil particles get replaced by silt-loams that have been reported under herbs during the present investigation. Soil texture exerts a strong influence on many hydrological and biogeochemical processes in forest ecosystems by affecting the ability of soils to retain carbon, water and other nutrient ions (Jenny, 1980).

It was also found that the soils under tree canopies depicted higher values of moisture content as compared to the soils under shrubs and herbs. This is due to the fact that both the forest and litter covers have a conserving effect on soil moisture. The shady conditions that prevail in the forest floor due to canopy cover and overlying litter slows down evaporation and transpiration and thus results in the less loss of moisture. The soils under shrubs also showed somewhat higher values of moisture content as compared to herb soils due to blanketing effect of leaves and branches of shrubs that undoubtedly reduce the rate of evaporation from the soil by their influence in retarding wind movement. Soil moisture controls plant growth through its function as a solvent and carrier of nutrients, its direct function as a nutrient, and its numerous relations to chemical processes and microbial activities in the soil.

The soil temperature, in general, showed an inverse relationship with soil moisture. The soils under different vegetation covers depicted highly significant negative correlation between temperature and moisture content ($r = -0.394$; $r = -0.457$; $r = -0.497$) for trees, shrubs and herbs respectively. All the values are significant at $P < 0.05$. The soil under herbs showed higher values for temperature as compared to the soils under shrubs and trees. This is attributed to inadequate sheltering effect of herbaceous vegetation. The tree canopy and forest floor contribute to moderate extremes of soil temperatures protecting the soil from extremely high soil temperatures by intercepting solar radiations. During the present investigation, it was also found that the soils under trees had more water-retaining capacity as compared to shrub and herb soils. This is due to the fact that tree soils contain finer particles than the shrub and herb soils, providing more film surface for the retention of water (Yadav and Pathak, 1969). Likewise, greater the proportion of colloidal constituents, clay and humus, the more water there will be held. The more absorptive power of soil colloids for water is due to the extremely large surface exposed by matter in the colloidal state. Thus, the water-retaining power of the soils is determined by a number of factors including soil texture (or size of particles), soil structure (i.e. the arrangement and compactness of particles) and the amount of expansible organic matter and colloidal clay. Organic matter affects water content directly by retaining water in large amounts on the extensive surfaces of its colloidal constituents and holding it like a sponge in its less decayed portions.

Conclusion

The principal objective of the present study was to determine some of the physical characteristics of soils of Langate Forest Division under different vegetation covers. The results from the present study showed that the soils varied considerably with the change in the vegetation cover from trees to shrubs to herbs. The overall impact of changing the vegetation cover has degraded the quality of the soils. Therefore, sustainable forest conservation should be practiced in order to maintain the biodiversity, soil quality and restoration of degraded areas for the benefit of present and future generations.

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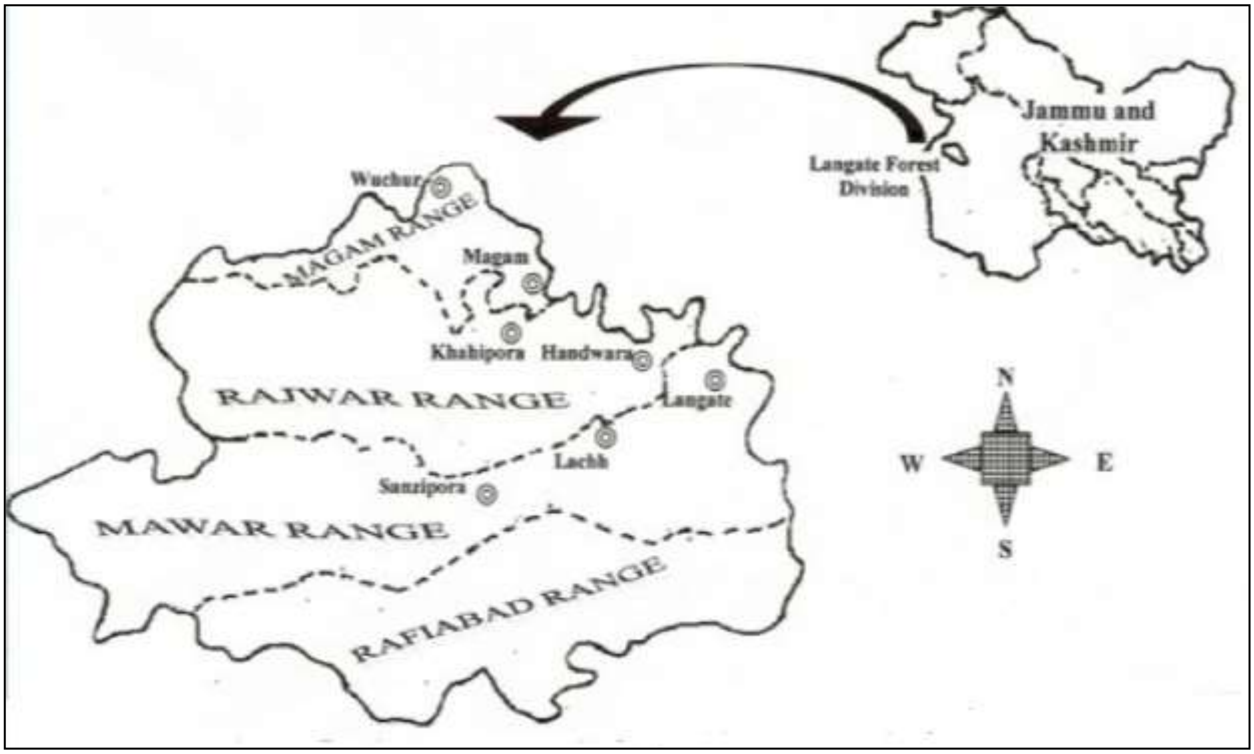

Fig. 1. Location map of the study area showing different study sites.

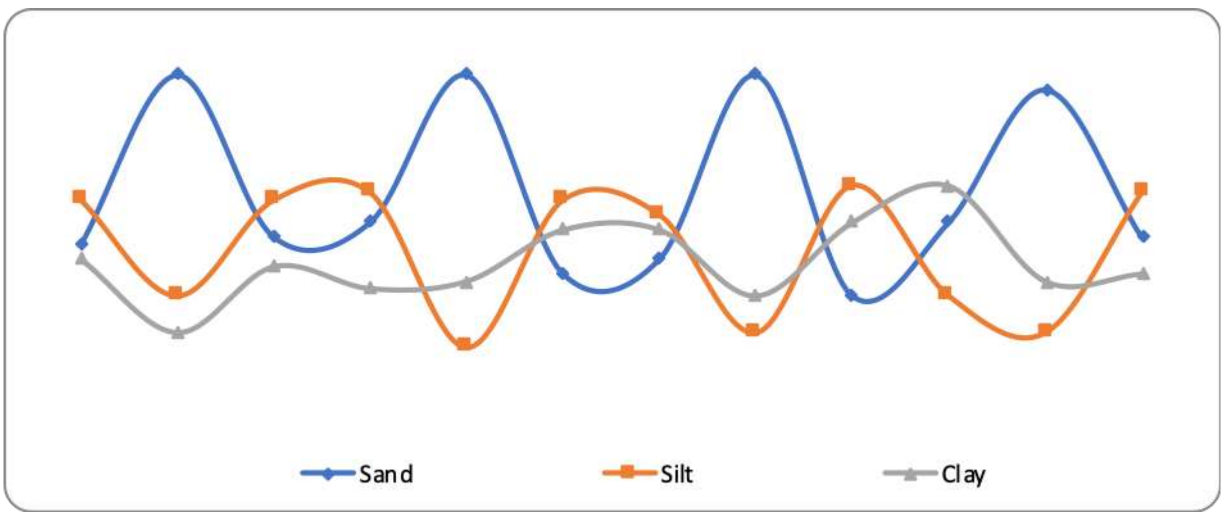

Fig. 2a. Percentage of sand, silt and clay in soils at different study sites under various canopy covers. texture of soils of the study area

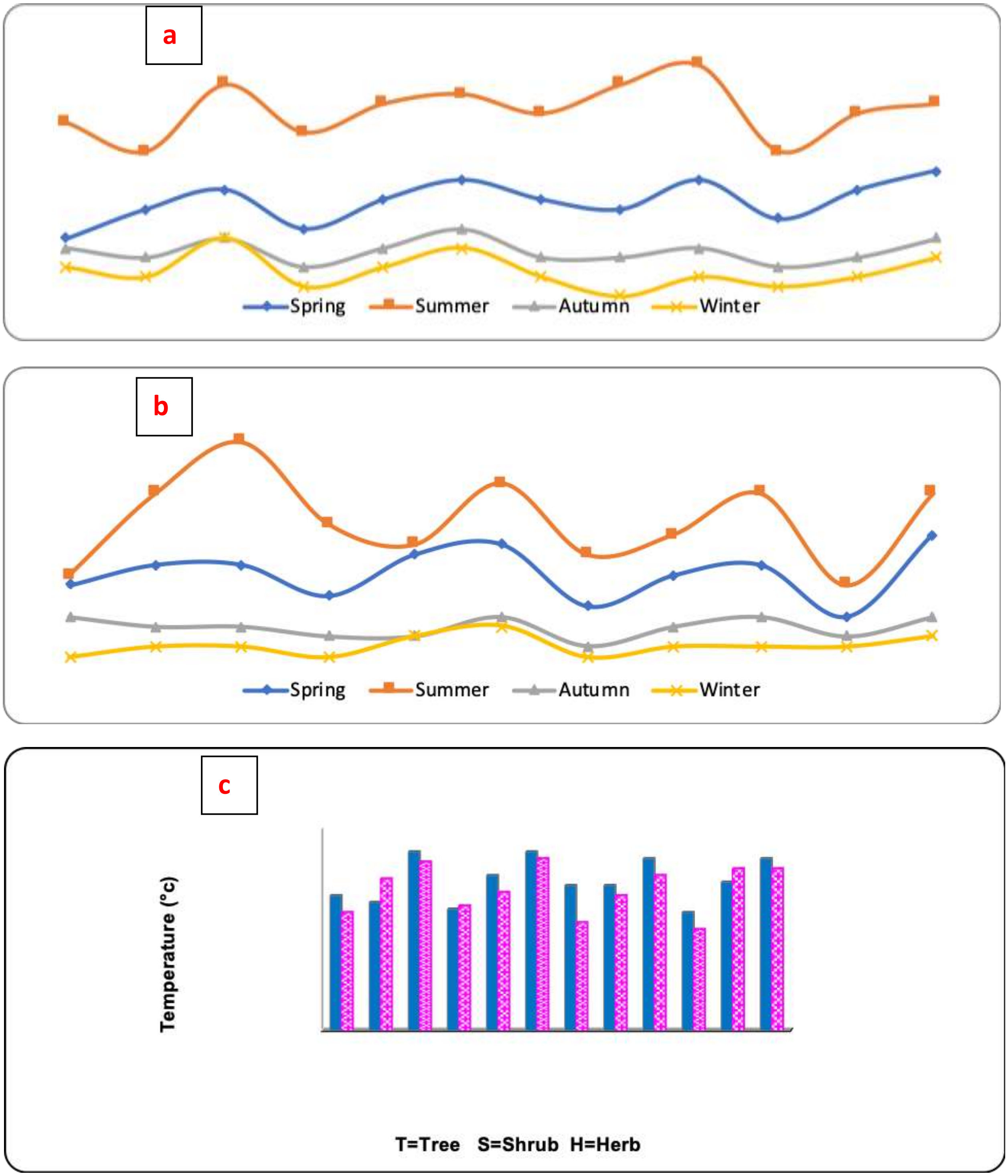

Fig. 3. Seasonal variations in temperature (°C) under different vegetation covers at various study sites (a) 1st Year, (b) 2nd Year and (c) annual mean temperature during the 1st and 2nd year by blue and pink bars respectively.

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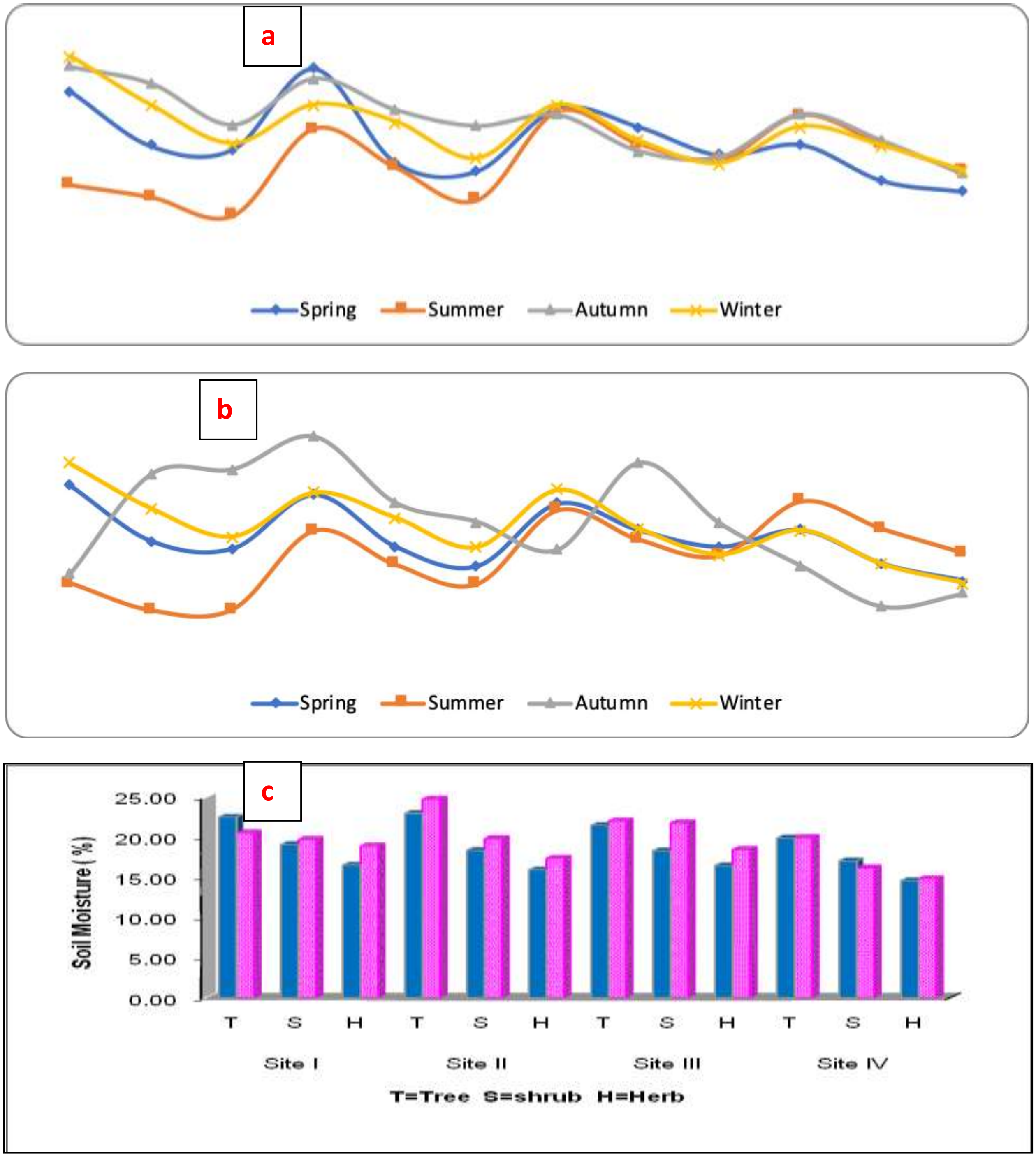

Fig. 4. Seasonal variations in moisture (%) under different vegetation covers at various study sites (a) 1st Year, (b) 2nd Year and (c) annual mean temperature during the 1st and 2nd year by blue and pink bars respectively.

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Vol 11 No. 3 (2021)

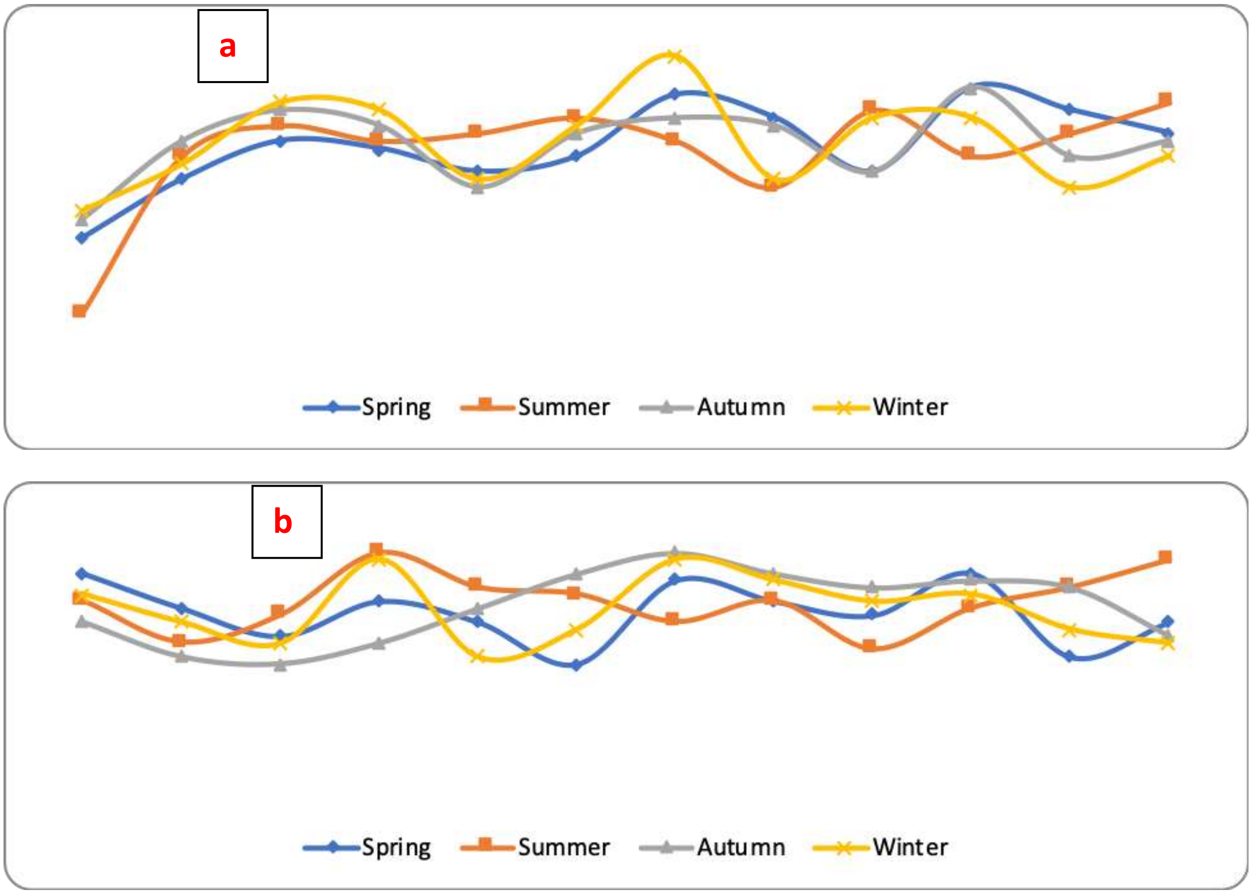
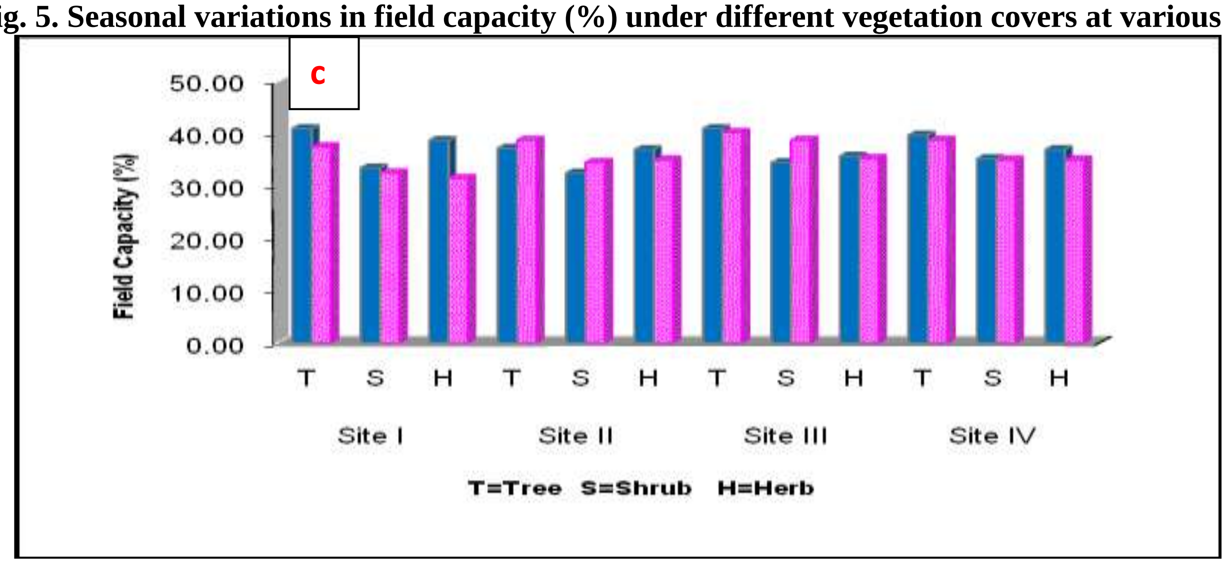


Fig. 5. Seasonal variations in field capacity (%) under different vegetation covers at various



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