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Soil Properties Under Different Vegetation Types in Chittagong University Campus, Bangladesh

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Abstract

Soil physical and chemical properties at three layers such as top (0-10 cm), middle (10-20 cm) and bottom (20-30 cm) layers under three different vegetation types were studied. Soil samples were collected from *Acacia* forest, vegetable and fallow lands of Chittagong university campus, Chittagong, Bangladesh. Results showed that sand was the dominant soil particle followed by clay and silt fractions in all soil depths under different vegetation types. Soils of fallow land showed the highest values of bulk density while forest soils had the lowest values at three depths. *Acacia* forest soil having lowest values of dispersion ratio (DR) is less vulnerable while fallow soil with highest DR values is more vulnerable to soil erosion. The lower pH value at all soil layers in three ecosystems represented that soils under study are acidic in nature. Contents of organic matter, total nitrogen, exchangeable cations (Ca^{2+}, Mg^{2+}, K^+ and Na^+) and cation exchange capacity (CEC) were observed higher in *Acacia* forest soils compared to vegetable and fallow soils. Only soils of vegetable land had higher level of available phosphorus in three layers than that of other two land covers. The study also revealed that different soil properties were observed in three different vegetation types might be due to variation in vegetation and agronomic practices.

Key Words: vegetation types, physical properties, dispersion ratio, chemical properties

Introduction

Change in land covers and management practices may influence physical, chemical and biological properties of soils (Yifru and Taye 2011; Getahun et al. 2014). Vegetation cover change may be accelerated with the expansion of population growth in a country due to increased demand for firewood, timber, shelter and food (FAO 2015).

Changes in land coverage affect soil particle distribution, bulk density, aggregate formation (Lu et al. 2002; Armenteras et al. 2006; Biro et al. 2013), distribution of carbon, nitrogen including other nutrients, microbial activity and biomass mineralization in soils (Lemeneh 2004; Han et al. 2018). Finally, conversion of land vegetation results in destruction of natural ecosystems and consequently loss of soil quality (Hajabbasi et al. 1997; Moran et al. 2000; Clark 2012).

Agricultural practices like tillage and harvesting are associated with the losses of soil biomass, alteration of above and below-ground biodiversity and finally lead to a decline in soil quality (An et al. 2010). Overgrazing would have a significant influence on soil properties and nutrient conditions (Sun et al. 2005).

Anthropogenic activities such as trampling, illicit felling in forest lands, affect litter input, carbon stabilization, and nutrient turnover (Six et al. 2002; Haile et al. 2014; Oraon et al. 2018).

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Some studies reported that land use significantly influences soil organic carbon and total nitrogen but these nutrients are considered as the key indicators for estimating and improving soil quality (Bolin and Sukumar 2000; Zajicova and Chuman 2019).

In Bangladesh, increasing population leads to changes of vegetation cover to another one that may cause the loss of productivity through the alterations of soil properties, loss of biodiversity and ecosystem. Thus, human disturbances, overgrazing, inappropriate agricultural and management practices leave soil under few and sparse vegetation or under bare condition and finally promote soil erosion. A number of studies have been conducted on soil distributions and soil properties under different land use systems in different countries (Hajabbasi et al. 1997; Chen and Li 2003; Jiang et al. 2006; Kamusoko and Aniya 2007; Emadi et al. 2008; Khreasat et al. 2008; Han et al. 2015; Negasa et al. 2017; Park et al. 2017; Oraon et al. 2018). But little information on soil properties under different vegetation types is available in literature in Bangladesh (Islam and Weil 2000; Islam and Hasan 2011; Mamun et al. 2013; Akhtaruzzaman et al. 2015). In order to mitigate further deterioration of natural ecosystems, it is needed to focus on soil properties under different vegetation covers and to restore soil productivity.

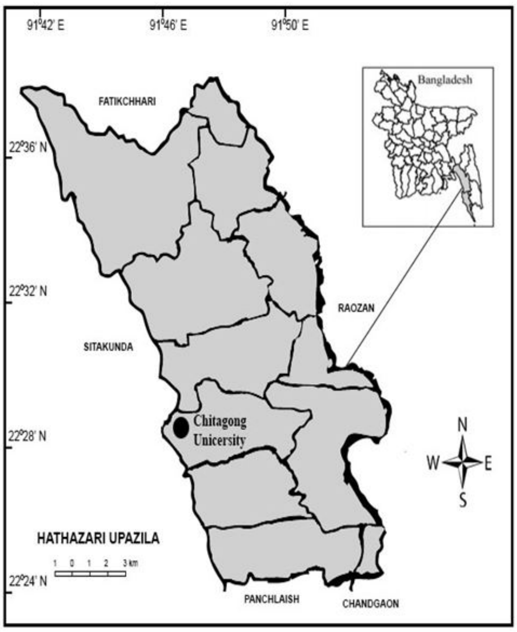

Fig. 1. Map of the study area.

Therefore, the objective of the present study is to assess some physical and chemical properties of soil under different land vegetation. This study provides information that can be useful for selecting better ways to improve soil productivity in the investigated area.

Materials and Methods

Study area

The study was conducted in different sites under three vegetation covers at the campus of Chittagong University, Hathazari, Bangladesh (Fig. 1). Geographically, the studied area of Chittagong University extends between 22°30′ to 22°47′N latitude and 91°58′ to 91°79′E longitude. The soils under present study are classified as Brown Hill Soils as general soil type. Topographical features were maintained more or less similar during soil collection. The general information on three locations was given in Table 1.

Chittagong region has a sub-tropical climate and is characterized by long summer and short winter. Mean annual precipitation ranges from 2877 to 3842 mm and mean annual temperature varies from 25.5° and 25.7°C.

The present study was carried out in the area with three different vegetation types under *Acacia* forest, vegetable and fallow lands.

In *Acacia* forest of the studied area, the vegetation is composed of akashmoni (*Acacia auriculiformis*) as the major species while mangium (*Acacia mangium*), gamar (*Gmelina arborea*), chapalish (*Artocarpus chaplasha*) etc. as minor tree species.

In the vegetable land, major winter vegetables are cabbage (*Brassica oleracea var capitata*), cauliflower (*Brassica oleracea var botrytis*), hyacinth bean (*Lablab niger*) tomato

Table 1. General description of locations under study

Location	Vegetation type	Topography	Slope (%)
Acacia forest	Forest tree species	Upland	0-4
Vegetable land	Winter and summer vegetables	Upland	0-2
Fallow land	Grasses, herbs and shrubs	Upland	0-2

(*Lycopersicon esculentum*), radish (*Raphanus sativus*), brinjal (*Solanum melongena*), bottle gourd (*Lagenaria siceraria*), red amaranth (*Amaranthus gangeticus*), while summer vegetables such as pumpkin (*Cucurbita maxima*), jinga (*Luffa acutangula*), bitter gourd (*Momordica charantia*), ribbed gourd (*Luffa acutangula*), teasle gourd (*Momordica cochinchinensis*), ladies finger (*Abelmoschus esculentus*), Indian spinach (*Basella alba*) etc. are grown. Agricultural practices such as tillage, irrigation and fertilization are also followed by the local farmers. Organic manures and chemical fertilizers are usually used in the vegetable field during growing seasons. The fallow land is dominated by grasses. Herbs like assamlata (*Mikania micrantha*), assam gas (*Grewia nervosa*) and shrubs such as lajjabati (*Mimosa pudica*), bon tejpata (*Melastoma malabathricum*) etc. are also frequent. Livestock were also found grazing in fallow land during soil collection.

Sampling method and analysis

Three plots of 10×10 m size were selected for soils under each vegetation type. Soil samples were collected in winter and summer seasons. Soils were taken from top (0-10 cm), middle (10-20 cm) and bottom (20-30 cm) layers at four sites of each plot for analysis. Three replications for single depth were followed during soil collection. Prior to laboratory analysis, the soil samples were air-dried at room temperature, crushed and passed through a 2 mm diameter sieve.

Particle size distribution of the soils was determined by hydrometer method (Day 1965). Bulk density was measured using the procedure described by Blake (1965).

The dispersion ratio (DR) was determined as a measure for structure stability. According to Middleton (1930), DR is calculated using the following equation:

$$DR = (c/d) \times 100,$$

where c is the percentage of water-dispersible silt-plus-clay determined by the pipette method when 20 g of air-dried soils was agitated end over end 20 times without dispersion agent with 1 L of distilled water in a sedimentation cylinder and d is actual silt-plus-clay amount determined by routine particle-size distribution analyses with Na-hexametaphosphate (Calgon) as a dispersing agent. Based on the criteria proposed by Middleton (1930), soils having a dispersion ratio < 15.0 are nonerosive, and soils having a dispersion ratio > 15.0 are erosive.

Cation exchange capacity (CEC) was determined after extraction of the cations with ammonium acetate (Black 1965). Soil pH was measured in soil-water suspension (1:2.5) using a corning glass electrode pH-meter. Organic carbon was determined by wet-oxidation method of Walkley-Black (1934) and the percentage of soil organic matter was calculated by multiplying value of organic carbon with 1.724, the Van Bemmelen factor (Piper 1950). Total nitrogen of soil was measured by micro-Kjeldahl method (Jackson 1973). Exchangeable calcium and magnesium were determined by EDTA method while ex-

Table 2. Textural class and bulk density of soils under different vegetation types

Soil layer	Location	Sand (%)	Silt (%)	Clay (%)	Bulk density (Mg m^{-3})
Top	*Acacia* forest	67 ± 2.27^{a}	12 ± 2.94^{a}	21 ± 1.31^{a}	1.41 ± 0.08^{a}
	Vegetable land	79 ± 1.42^{a}	7 ± 1.14^{a}	14 ± 0.54^{b}	1.48 ± 0.49^{b}
	Fallow land	82 ± 1.08^{a}	8 ± 2.73^{a}	10 ± 0.46^{c}	1.51 ± 0.42^{c}
Middle	*Acacia* forest	69 ± 2.63^{a}	9 ± 1.03^{a}	22 ± 1.18^{a}	1.44 ± 0.32^{a}
	Vegetable land	65 ± 1.41^{a}	15 ± 2.82^{a}	20 ± 1.53^{b}	1.54 ± 0.53^{b}
	Fallow land	77 ± 2.65^{b}	10 ± 1.70^{a}	13 ± 0.86^{c}	1.56 ± 0.43^{c}
Bottom	*Acacia* forest	68 ± 1.57^{a}	8 ± 1.18^{a}	24 ± 0.64^{a}	1.60 ± 0.91^{a}
	Vegetable land	63 ± 1.92^{a}	14 ± 0.68^{a}	23 ± 1.35^{b}	1.64 ± 0.84^{a}
	Fallow land	76 ± 2.30^{b}	8 ± 1.35^{a}	16 ± 0.91^{ac}	1.69 ± 0.78^{a}

Each value is the mean of soil sample under each vegetation type. The same lowercase letter within each soil depth indicates no significant difference ($p < 0.05$).

changeable potassium and sodium were determined using a flame photometer (Jackson 1973). Available phosphorus was extracted with Bray and Kurtz no.2 extractant and measured by $SnCl_2$ reduced molybdophosphoric blue color method using spectrophotometer (Jackson 1973). Significance of difference in soil properties in different land uses was tested by paired t test using Minitab (1996).

Results

Physical properties of soils

Table 2 revealed that sand is the major fraction followed by clay and silt fractions in all soil depths of different vegetation covers.

The fallow land soils had higher content of sand fraction in all depths as compared to soils of *Acacia* forest and vegetable lands. Sand fraction of fallow soils showed the significant difference with *Acacia* forest and vegetable soils at middle and bottom layers. On the contrary, *Acacia* forest soils contained higher amount of clay particle in three layers than that of other two land types and showed significant differences at top and middle layers. Clay fraction in vegetable soils also varied significantly in bottom soils with other two plant types. There is no significant difference was found at any depth of soil among different plant communities in terms of silt fraction. Sand and silt have shown a decreasing trend along the soil depth in all vegetation types while clay fraction followed an increasing trend with depth (Table 2).

The values of bulk density were found lower in soil of *Acacia* forest site and higher in soil of fallow site at three depths. Bulk density showed significant variations at top and middle soils among three vegetation types. Bulk density showed an increasing trend with soil depth in all sites under study (Table 2).

Fig. 2 revealed the lower values of dispersion ratio (DR) were observed in *Acacia* forest soil while higher values were in three layers fallow soil. At both top and middle layers, significant variations in DR values were found among soils under three ecosystems. On the other hand, at bottom layer, only *Acacia* forest soil showed significant differences in DR values with fallow and vegetable soils. DR values also showed an increasing trend with soil depth (Fig. 2).

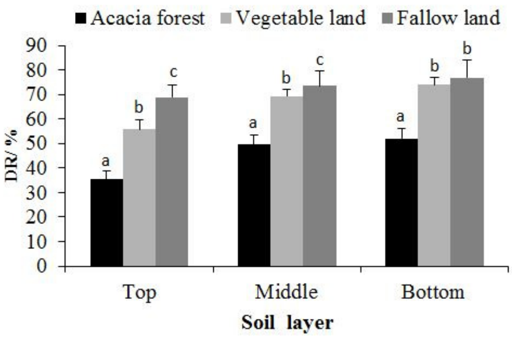

Fig. 2. Dispersion ratio (DR) of soils under different vegetation types at three layers. Each value is the mean of soil sample under each vegetation type. Error bar represents standard error. The same lowercase letter within each soil layer indicates no significant difference ($p < 0.05$).

Chemical properties of soils

The relatively lower pH at different soil layers under

Table 3. Chemical properties of soils under different vegetation types

Soil layer	Location	pH (H_2O)	Organic matter (%)	Total N (%)	Available P (mg kg^{-1})
Top	*Acacia* forest	4.98 ± 0.22^a	1.37 ± 0.15^a	0.15 ± 0.21^a	5.41 ± 1.61^a
	Vegetable land	4.19 ± 0.32^b	1.12 ± 0.10^b	0.10 ± 0.27^b	5.56 ± 1.20^b
	Fallow land	4.21 ± 0.45^b	1.03 ± 0.09^b	0.08 ± 0.13^c	4.34 ± 1.38^c
Middle	*Acacia* forest	4.62 ± 0.55^a	0.87 ± 0.07^a	0.07 ± 0.08^a	4.32 ± 1.81^a
	Vegetable land	4.32 ± 0.26^b	0.54 ± 0.12^b	0.05 ± 0.17^a	4.39 ± 1.11^b
	Fallow land	4.10 ± 0.33^b	0.49 ± 0.08^b	0.05 ± 0.13^b	2.04 ± 1.13^a
Bottom	*Acacia* forest	4.54 ± 0.76^a	0.33 ± 0.14^a	0.05 ± 0.19^a	1.74 ± 1.27^a
	Vegetable land	4.24 ± 0.48^a	0.21 ± 0.15^a	0.04 ± 0.56^a	1.80 ± 1.65^a
	Fallow land	3.95 ± 0.44^b	0.16 ± 0.19^a	0.03 ± 0.22^a	0.96 ± 1.49^a

Each value is the mean of soil sample under each vegetation type. The same lowercase letter within each soil depth indicates no significant difference ($p < 0.05$).

three vegetation types represented that soils of the studied area are acidic in reaction (Table 3). *Acacia* forest soils showed the highest pH value in three layers in comparison to vegetable and fallow soils. The pH values in top and middle soils of *Acacia* forest type showed significant differences from that of other two land types. On the other hand, pH value at bottom layer of fallow soil differed significantly from *Acacia* forest and vegetable soils. Soil pH generally decreased with increasing soil depth in all sites (Table 3).

Table 3 showed that the higher amount of organic matter was observed in all the soil layers of *Acacia* forest type and lower amount was in fallow land. Soil organic matter in forest soils differed significantly from other two vegetation types in both top and middle layers (Table 3).

Total nitrogen contents at all the soil layers were found higher in *Acacia* forest compared to soils of vegetable and fallow lands. The soils of fallow site contained lower amount of total nitrogen in all layers. There was a significant variation was observed in total nitrogen at top soils among all the three vegetation communities. Fallow soils also differed significantly in total nitrogen from the other land types in middle layers. The gradual decrease in organic matter and total nitrogen was fairly uniform with depth (Table 3).

Table 3 showed that higher amount of available P was observed in vegetable soils followed by *Acacia* forest and fallow soils in all depths. The significant difference for available P at top soils was observed among three ecosystems while available P at middle soils of vegetable site differed significantly from *Acacia* forest and fallow sites. The distribution of available P showed a decreasing trend with increasing soil depth under studied area.

Result in Table 4 showed that exchangeable Ca^{2+} was the dominant cation followed by Mg^{2+}, K^+ and Na^+ in soils of different vegetation types under study. The levels of exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) were found higher in soils of *Acacia* forest type at different layers as compared to that of vegetable and fallow land uses.

Exchangeable Ca^{2+} in surface soil of vegetable site showed significant variation with other two sites. Exchangeable Mg^{2+} in middle soils showed significant variations among three sites and at bottom soils of fallow land differed significantly with *Acacia* forest and vegetable sites. Exchangeable K^+ content at surface soils of *Acacia* forest site showed significant difference with soils of other two land types. Exchangeable Na^+ varied significantly at bottom soil of the three land types (Table 4).

CEC was significantly higher in surface soils of *Acacia* forest. In contrast, CEC was significantly lower in middle soils of fallow sites. The values of exchangeable bases and CEC showed a gradual decrease with soil depth under all vegetation covers. Exchangeable bases and CEC concentrations were generally low in soils under study (Table 4).

Table 4. Exchangeable cations and cation exchange capacity (CEC) of soils under different vegetation types

Soil layer	Location	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC
		$cmol_c kg^{-1}$				$cmol_c kg^{-1}$
Top	*Acacia* forest	1.64 ± 0.55^a	0.54 ± 0.39^a	0.32 ± 0.67^a	0.18 ± 0.82^a	12.99 ± 0.92^a
	Vegetable land	1.55 ± 0.87^b	0.43 ± 049^a	0.25 ± 0.63^b	0.09 ± 0.12^a	9.71 ± 0.61^b
	Fallow land	1.53 ± 0.62^a	0.49 ± 0.53^a	0.20 ± 0.37^b	0.06 ± 0.46^a	7.00 ± 0.56^c
Middle	*Acacia* forest	0.51 ± 0.52^a	0.28 ± 0.34^a	0.19 ± 0.45^a	0.10 ± 0.67^a	10.46 ± 0.89^a
	Vegetable land	0.49 ± 0.46^a	0.19 ± 0.27^b	0.14 ± 0.33^a	0.05 ± 0.83^a	9.59 ± 0.44^{ab}
	Fallow land	0.37 ± 0.39^a	0.17 ± 0.28^c	0.12 ± 032^a	0.04 ± 0.33^a	6.40 ± 0.63^c
Bottom	*Acacia* forest	0.24 ± 0.39^a	0.18 ± 0.14^a	0.13 ± 0.21^a	0.05 ± 0.23^a	9.09 ± 0.78^a
	Vegetable land	0.21 ± 0.29^a	0.16 ± 0.19^a	0.12 ± 0.46^a	0.03 ± 0.42^b	7.39 ± 0.58^a
	Fallow land	0.18 ± 0.26^a	0.14 ± 0.58^b	0.10 ± 0.36^a	0.03 ± 0.27^c	6.11 ± 0.67^a

Each value is the mean of soil sample under each vegetation type. The same lowercase letter within each soil depth indicates no significant difference ($p < 0.05$).

Discussion

Physical properties of soils

The soils under study are sand dominated in the three layers. Brammer (1971) reported that the brown hill soils have developed mainly from unconsolidated sandstones or sandy sediments.

The higher clay content in *Acacia* forest systems compared to other vegetation systems may attribute to the protective covers by tree crowns, litter and roots and thus reduce soil erosion. Several studies (FAO 2010; Munoz-Rojas et al. 2015; Hung et al. 2017) showed that forest cover are more effective to protect soil particles from rain drop impact which promotes the breakdown of soil aggregates and removal of soil finer particles through surface runoff and leaching.

Higher bulk density in fallow land could be linked with more sand and lower organic matter content at three depths. Several authors (Sharma and Kumar 2003; Perie and Ouimet 2008; He et al. 2009) reported that bulk density is closely related to soil organic matter and soil texture. Abiyu et al. (2011) stated that tillage activities and livestock grazing also promote higher bulk density in soil.

Soil bulk density was found increasing downward in all vegetation types due to a decline in soil organic matter as soil depth increases. Similar results were reported by some authors (Anteneh et al. 2014; Haile et al. 2014) who found a decreasing trend of bulk density with soil depth.

The lower dispersion ratio (DR) in *Acacia* forest soil compared to that of vegetable and fallow soils may be attributed to higher contents of organic matter and clay which might lead to a decline in bulk density through the formation and stabilization of aggregation in forest soil. Igwe et al. (1999) reported that dispersion ratio is related to aggregate stability in soil. Previous studies (Spaccini et al. 2001; Yan et al. 2009; Annabi et al. 2011; Liu et al. 2014; Erktan et al. 2016) showed that soil organic matter, clay content, bulk density and anthropogenic activities might influence soil aggregation. The study is in consistent with the findings of Singh and Khera (2008) who observed lower values of dispersion ratio in forest soil compared to other land uses in India.

Fallow land soils had higher dispersion ratio (DR) because grazing and removal of animal dung may enhance the loss of organic matter and an increase of DR values in soil. In vegetable site, soils had higher DR than that of forest site. This might be due to long-term agricultural practices (i.e. soil loosening, ridge-furrow preparation before sowing or planting) and withdrawal of organic residues that encourage the breakdown of soil aggregates and increased dispersion ratio. Continued cultivation practices in agricultural land are linked to the breakdown of soil aggregates and soil erosion (Kizilkaya and Dengiz 2010).

Dispersion ratio value is used as an indicator for the susceptibility of soils to erosion (Singh and Khera 2008). Therefore, the fallow soil with higher DR values is likely to be more vulnerable to soil erosion compared to the forest and vegetable soils.

Chemical properties of soils

The acidic nature of the brown hill soils of Bangladesh was also reported by other investigators (SRDI 1976; Islam et al. 2006). According to Karim and Khan (1955) the soils were acidic in nature because, higher erosion, intense weathering and leaching enhance the removal of bases during heavy rainfall in monsoon.

Higher soil pH values in different layers of forest land might be due to more input of bases through nutrient recycling. Moreover, forest covers Chen and Guo (2008) reported that forest covers also play an effective role in protecting soil nutrients and bases from leaching loss. In contrast, lower soil pH values in other two land types might be attributed to removal of basic cations from soil either by vegetable harvesting in vegetable land or by leaching in fallow land. The result is in consistent with the findings of Qi et al. (2018).

Forest litter contributed to higher amount of organic matter in *Acacia* forest site compared to other sites under study. The present study is in consistent with the findings of Panwar et al. (2011) who observed higher organic matter content in tropical forests soils compared to that of other land uses in India. In vegetable land, agricultural practices and withdrawal of organic residues may be associated with lower amount of organic matter in soil. According to some authors (Prietzel and Bachman 2012; Zhang et al. 2013), soil organic matter content depends on climate, vegetation type, land use and management practices.

Higher content of total N in soils of *Acacia* forest site may also be related to higher accumulation of forest litter. Chen and Li (2003) also found higher content of total nitrogen in forest soils than that of other vegetatizon types because of higher accumulation of plant litter in soil. Soil N level has a close relationship with soil organic matter content, root distribution (Berger et al. 2002).

In addition, many studies (Morris et al. 2011; Krisnawati et al. 2011; Jeddi and Chaieb 2012) found that nitrogen-fixing tree species such as Acacia are able to fix atmospheric N and thus significantly increase soil N level.

Vegetable soil showed lower contents of organic matter and total nitrogen although it received organic manures and chemical fertilizers. This might be due to local agricultural activities such as tillage practices, intensive cropping system and removal of soil nutrients by vegetable crops during harvesting. In addition, such agricultural practices facilitate rapid decomposition and mineralization of organic matter thereby reducing soil C and N. Islam (2008) reported that intensive agricultural practices facilitate rapid decomposition and mineralization of soil organic matter and thereby decline soil C and N in Bangladesh.

Lower contents of organic matter and total N in fallow land soil might be ascribed to the consumption of grasses and vegetation by livestock during grazing, the removal of animal dung as fuel instead of leaving in the field.

Vegetable land had higher concentrations of available P in three soil layers than in soils of other two land types. This could be explained as vegetable soils get more available P as the ultimate source from applied phosphate fertilizers during vegetable growing seasons. According to some findings (Sharpley et al. 2000; Annabi et al. 2011), agricultural practices such as tillage activities and P fertilization may increase the level of available phosphorus in arable soil.

Relatively lower level of available P in *Acacia* forest in comparison to vegetable soil could be due to plant uptake and sequestration of P in the tree biomass (Fisher and Binkley 2000). Soil phosphorus cycling and availability is controlled by a series of processes such as plant uptake, adsorption-desorption, dissolution-precipitation of inorganic P, mineralization of organic P, microbial immobilization and P fertilizer addition (Frossard et al. 2000).The phenomena of fixation and precipitation of P in soil is generally highly dependent on pH and soil type (Jones et al. 2003).

The soils under study were poor in available P. Moslehuddin et al. (1999) observed the deficiency of available P in acidic soil of hill areas. Low content of available P in soil could be the result of fixation of phosphorus by Ca in alkaline soils or by free oxides and hydroxides of Fe and Al ions in acid soils (Tunesi et al. 1999; Pierzynski et al. 2000). Previous studies (Hussain 1992; SRDI 2002) indicated that the acid hill soils are rich in Fe/Al oxides and hydroxides and the fixation of P by these compounds might be the possible reason for low P in soil.

Higher levels of exchangeable cations in *Acacia* forest soil could be associated with higher content of organic matter in soil that released a considerable amount of exchangeable cations through decomposition. Moreover, forest canopy and litter also protect soil cations to a greater extent from surface runoff and leaching. A number of studies (Hepper et al. 2006; Gogo and Pearce 2009; Zajicova and Chuman 2019) showed that the distribution of exchangeable cations in soil are directly linked with soil texture, quantity and quality of soil organic matter. On the other hand, harvesting in vegetable land and frequent surface runoff and leaching under sparse grass cover in fallow land may accelerate the losses of bases from the soil.

Higher contents of organic matter, total N, available P, exchangeable bases and CEC in surface soils than in deeper soils of land types under study were probably related to higher biological accumulation at surface from plants. Moreover, Jobbagy and Jackson (2001) reported that nutrient cycling in different ecosystems also shifts soil nutrients from deeper soil to upper soil in the form of organic matter.

Soils under present study were poor in exchangeable cations and CEC. The results are in consistent with previous findings (Brammer 1971; Ahmed 1984). According to several studies (Hassan 1991; Alam et al. 1993; Gafur et al. 2000), low concentrations of bases and CEC in hill soils of Bangladesh might be linked with sandy texture, low organic matter content and abundance of low activity clay mineral like Kaolinite of soil. Shoji et al. (1982) also reported that CEC content might be related to soil texture, mineralogical composition, accumulation of soil organic matter and degree of soil erosion.

Conclusion

The present study showed that Soils under study had poor physical and chemical properties in terms of proper production of forests or vegetable crops. Fallow soils with higher values of dispersion ratio represent more vulnerable to soil erosion compared to forest and vegetable soils. Soils under *Acacia* forest land had relatively higher content of organic matter, total nitrogen, exchangeable cations and CEC in comparison to vegetable and fallow sites. On the other hand, soils of vegetable land contained only higher amount of available phosphorus than that of other two land use types. There is a need for greater attention to improve soil characteristics. In vegetable land, proper agricultural practices should be followed to restore soil physical and chemical properties. Plantation or cultivation with suitable agricultural practices may be considered to minimize soil organic matter and nutrient loss from soil of fallow land. Further study is necessary to take proper measures to improve soil productivity and soil quality in area under study.

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