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Physico-chemical characterization of some selected soil series of Mymensingh and Jamalpur districts of Bangladesh

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Abstract

The soil physico-chemical properties have been disturbed due to long continued intensive agricultural practices. Under this situation we are approaching rapidly to a very strong future challenge in sustaining the quality of our soil. This study was conducted to evaluate the physico-chemical properties of the selected soil series. The area covered Mymensingh and Jamalpur districts of Bangladesh. Soil samples were collected randomly from different profiles of Lokdeo, Tarakanda, Silmondi and Melandah soil series during March-May, 2014 and analysed. All soils were acidic and textural classes were sandy loam, silt loam, loam, and clay loam. Organic matter and total N contents low to very low. Available S content in the upper layers of most soils were medium to optimum and in the deeper layer low to medium. The exchangeable K, Ca and Na contents were also low. The upper layers of all the locations contained higher amounts of available Zn. The available Cu and Fe contents of most soils were very high. The soils of all locations contained very high amount of available Mn except the deeper layers (45-75 cm) of Melandah which contained optimum amount of available Mn. Soil pH showed negative correlation with total N and available S. Total N showed positive correlation with soil OM, available Cu and available S. There was positive correlation between available S and available Mn.

Keywords: Soil Physico-chemical characterization, Mymensingh, Jamalpur

Introduction

Bangladesh is one of the densely populated developing countries whose economy is mainly based on agriculture. Over the past few decades, changes in various aspects in agriculture such as adoption of high yielding crop varieties along with increased irrigation and fertilization observed in the country. Changes in such factors might have exerted profound effects on the pedogenic processes resulting in the depletion of plant nutrient status of the soils in Bangladesh. Many reports indicate that crop production is declining over time due to depletion of soil fertility. Most farmers tend to exploit the soils rather than maintain a fertility status. Crops are mostly harvested at the root level and straw is used as fuel and fodder. Sometimes the stubbles are grazed or uprooted for fuel, resulting in a low level of organic matter in soil and depletion of nutrients (Islam, 1990). Deficiency of a number of macro and micro nutrients viz. sulphur, zinc, boron and molybdenum etc. in addition to nitrogen, phosphorus and potassium has already been reported from different parts of the country. Such deficiencies might be occurred due to inefficient fertilizer management by the farmers. In a study, Ali *et. al.* (1997) observed a general trend of organic matter degradation and the need to implement measures to restore the biological productivity of these soils. In Bangladesh, at present the farmers are not getting expected return from their field although they are applying increased amount of various kind of fertilizers. This indicates that the soil physico-chemical properties have been disturbed due to long continued intensive agricultural practices.

Under this situation, we are approaching rapidly to a very strong future challenge in sustaining the quality of our soil and boost the yield to meet the increasing demand of the country. The ever increasing need to increase crop yield per unit area through the balanced use of chemical fertilizers will have to look beyond immediate crop need to build up of soil fertility, so as to provide a solid base to increase crop production in future. It is therefore, also necessary to verify the updated fertilizer recommendation guide in different agro-ecological regions not only for increasing crop productivity but also for improving soil fertility. For evaluating the quality and present fertility status of soil, chemical analysis has got importance because our farmers do not know about the inherent nutrient status of the soil and they use fertilizers injudiciously. In order to minimize these problems, it is very pertinent to evaluate the nutrient status of our soils at the farmer's field level (Ahasan and karim 1998). In view of the above fact, the present study was undertaken to characterize the physico-chemical properties of some soil series of Old Brahmaputra Floodplains of Bangladesh.

Materials and Methods

The study area covered Mymensingh and Jamalpur districts of Bangladesh. Soil sample had been collected from Kashimpur, Muktagacha; Barakalar, Gouripur; Gavishimul, Gouripur of Mymensingh districts and Sadar Jamalpur location of Jamalpur districts during March-May, 2014. The representative soil series were identified with the help of Soil Resource Development Institute (SRDI). For better understanding, the sampling sites are described in Table 1. The soil sample were collected from different soil profiles from each location and taken to the laboratory for physical and chemical analyses.

The collected soil samples were dried at room temperature, ground and sieved with a 10mm sieve. Then the prepared samples were preserved in polythene bags after labeling for laboratory studies. The soil samples have been analyzed following standard method, viz. particle size distribution by a hydrometer and soil pH by glass electrode pH meter, organic carbon by wet oxidation and total nitrogen by kjeldahl method, available P by Bray and Kurtz method, available S by turbidimetric method of titration, exchangeable cations e.g. Ca, K and Na were determined by Flame photometer, available Zn, Cu, Fe and Mn were determined by Atomic Absorption spectrophotometer etc.

Table 1. Description of the soils in terms of morphology and land uses

Soil Series	Location	AEZ	Land Type	Depth (cm)	Present land use
Lokdeo	Kashimpur, Muktagacha, Mymensingh	Old Brahmaputra Floodplain	Medium Highland	0-10 10-15 15-33 33-53	Boro- T.Aman
Tarakanda	Barakalar, Gouripur, Mymensingh	,,	,,	0-9 9-23 23-40	,,
Silmondi	Gavishimul, Gouripur, Mymensingh	,,	,,	0-12 12-29 29-47	,,
Melandah	Sadar, Jamalpur	,,	Highland	0-15 15-30 30-45 45-60 60-75	Mustard-Boro-T.Aman

Results and Discussion

Soil texture

Table 2 showed the particle size distribution (sand, silt and clay contents) of the soils under study. The textural class of Lokdeo soil series was sandy loam at 0-10 cm, 10-15 cm and 15-33 cm depth. But in 33-53 cm depth, soil was silt loam. The percentage of sand, silt and clay at four depths ranged from (32.04 to 62.84), (26.06 to 50.09) and (7.16 to 17.87), respectively. The textural class of Tarakanda soil series was loam. Sand silt and clay percentage were ranged from (42.24 to 52.45), (33.43 to 34.00) and (14.12 to 23.76), respectively. The textural classes were sandy loam, loam and sandy loam in 0-12cm, 12-29cm and 29-47cm, respectively. The sand, silt and clay fraction were ranged from (52.54 to 66.35), (22.23 to 26.22) and (11.42 to 21.24), respectively. The textural classes of Melandah soil series were loam, loam, clay loam, sandy loam and loam in 0-15 cm, 15-30 cm, 30-45 cm, 45-60 cm and 60-75 cm respectively. But clay fraction is relatively high in this series. Four textural classes were identified in four locations of Mymensingh and Jamalpur districts. Among them, sandy loam was found in Lokdeo series(0-33 cm), Silmondi series (0-12 cm and 29-47cm) and Melandah soil series (45-60 cm). Silt loam was found in Lokdeo series (33-53cm). Loam was found in three different depths of Tarakanda series, Silmondi series (12-29 cm), Melandah soil series (0-30 cm and 60-75 cm). Clay loam was found at Melandah soil series (30-45 cm). These types of variations in sand, silt and clay contents of different depth might be due to movement of the clay and colloidal size particle during percolation from the upper layers to the lower layers. During the rainy season the throwing water carried finer soil particles from the upper surface to lower surface. The soil may be highly productive if it can be managed properly.

Soil pH

The results on soil pH at different soil profiles from four selected areas of Mymensingh and Jamalpur districts are presented in Table 2. The result revealed that soils were acidic. In Lokdeo soil series the soil pH ranged from 5.33-6.46. In Tarakanda soil series the soil pH ranged from 4.89-6.21. In Silmondi soil series the soil pH ranged from 5.32-6.28. In Melandah soil series the soil pH ranged from 5.82-6.19. In these location the surface soil (0-10 cm) had low pH than the deeper layer soil. According to BARC (2012), the soils of these areas were strongly acidic to slightly acidic in reactions. The upper layer of this location was strongly acidic in nature whereas the deeper soils were slightly acidic (Table 2). Bhuiyan (1988), Samad (2007), Hannan (1995) and SRDI (2009) obtained similar results in different soil series of Bangladesh. pH depends on kinds of basic rocks or parent materials. Rainfall is also a great factor to increase soil acidity. The use of continuous N fertilizers without the addition of lime contributed to decline this pH. Soil pH increased with the increase of depth. It might be happened due to the removal of basic soil materials like $CaCO_3$ and $MgCO_3$ from upper soil layer with simultaneous accumulation in lower layer through leaching (Prodhan, 2010). From agricultural point of view it was observed that the neutral soils are suitable for crop cultivation. So lime should be applied.

Organic matter content

The results on OM content of soil at different soil profiles from four selected areas of Mymensingh and Jamalpur districts are presented in Table 2. In Lokdeo, Tarakanda, Silmondi and Melandah soil series the OM content ranged from (0.33 to 1.49%), (0.89 to 2.02%), (0.31 to 1.15%) and (0.35 to 1.41%), respectively. The highest OM content was found at upper soil layer and the lowest OM content was in the deeper layer at all the locations. According to BARC (2012), most of the soils in the series named Lokdeo, Tarakanda, Silmondi and Melandah were low to very low in OM content (Table 2). The upper surface of soil contained higher OM than the lower depths. This is due to addition of OM in surface layer and the presence of compact plough pan in the surface layer. The OM content in general showed a fall with depth which might be perhaps due to the differential decomposition rates of plant and animal residues in successive layer of the profile. This variation also might be possible for addition of OM in the surface layer and presence of compact plough pan in the surface layer. Sood and Kanwar (1986), Bhuiyan (1988) and Mondal (1998) observed similar trend. OM has a close relation with the nutrient availability of soil. At least 2% organic matter content is suitable for better crop production but all the studied soils did not contain organic matter up to the mark. Soil OM status can be enriched by adding cowdung, compost and through green manuring.

Total N content

Total N content in different depths of soil from four selected areas are shown in Table 2. The percentage of total N content in Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (0.034 to 0.11%), (0.053 to 0.15%), (0.021 to 0.074%) and (0.042 to 0.084%), respectively. The highest total N content was found at upper soil layer, the lowest was in deeper layer of soil at all the locations. According to BARC (2012), the amount of total N in Lokdeo, Tarakanda, Silmondi and Melandah soil series were low to very low (Table 2). These results were very close to the findings of Portach and Islam (1984) and SRDI (1996). It is apparent from the results that the N content decreased with the soil depth (Hossain *et al*, 2003).Total N contents in these soils might be related to accelerated decomposition of organic matter in the tropical climate, less addition of organic matter, changes in cropping system, the quality and quantity of these elements in flooding water and variation in soil characteristics. Nitrogen content also decreased with decreasing organic matter content of soil.

Table 2. Textural class, pH, OM and total N contents at different depths of some selected soil series of Mymensingh and Jamalpur districts

Soil Series	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Textural Class	pH	OM* (%)	Total N (%)
Lokdeo	0-10	62.84	30.00	7.16	Sandy loam	5.33	1.49	0.11
	0-15	58.80	26.06	15.14	Sandy loam	6.11	0.78	0.07
	15-33	54.02	28.80	17.18	Sandy loam	6.32	0.52	0.05
	33-53	32.04	50.09	17.87	Silt loam	6.46	0.33	0.034
Tarakanda	0-9	52.45	33.43	14.12	Loam	4.89	2.02	0.15
	9-23	42.24	34.00	23.76	Loam	5.43	1.21	0.08
	23-40	46.13	34.00	19.87	Loam	6.21	0.89	0.053
Silmondi	0-12	66.35	22.23	11.42	Sandy loam	5.32	1.15	0.074
	12-29	52.54	26.22	21.24	Loam	6.27	0.64	0.056
	29-47	60.77	24.20	15.03	Sandy loam	6.28	0.31	0.021
Melandah	0-15	44.17	32.68	23.15	Loam	5.82	1.41	0.084
	15-30	48.89	22.01	29.10	Loam	6.18	0.89	0.056
	30-45	36.56	30.44	33.00	Clay loam	6.19	0.70	0.048
	45-60	62.34	06.23	31.43	Sandy loam	6.16	0.38	0.045
	60-75	42.09	22.15	35.76	Loam	6.12	0.35	0.042

*OM =Organic Matter

Available P content

The results on available P content of soils collected from different location of Mymensingh and Jamalpur districts have been presented in Table 3. The available P content at Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (10.45 to 31.88), (3.67 to 16.93), (7.62 to 18.91) and (3.65 to 14.33) µg g^{-1}, respectively. In Lokdeo soil series at 0-15 cm and 15-53 cm depth of soil, the available P content were medium and high to very high, respectively (BARC, 2012). Available P was very low at 0-9 cm depth in Tarakanda soil series but it was medium to optimum in deeper layers. In Silmondi series, available P content ranged from low to optimum. The soils of Melandah soil series contained medium amount of available P. The results showed that available P content decreased with the decrease of soil pH. The low pH might be responsible for the low level of available P (Table 3). Portch and Islam (1984) reported that 41% of soils of Bangladesh contained phosphorus below critical level and 35% below optimum level. The addition of P fertilizer may benefit the production in the areas where soil contained low level of phosphorus.

Available S content

The results on available S content of soils collected from different location of Mymensingh and Jamalpur districts have been presented in Table 3. The available S content at Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (9.75 to 25.13), (17.99 to 29.56), (21.48 to 7.99) and (10.77 to 24.94) µg g^{-1}, respectively.

According to BARC (2012), the soils of upper layers (0-15 cm) of Lokdeo series contained optimum to medium amount of available S but the deeper layers (15-53cm) contained low amount of available S. Tarakanda and Silmondi series contained medium to optimum and low to medium amount of available S, respectively. The upper layers and deeper layer (30-75 cm) of Melandah soil series contained medium to optimum and low amounts of available S, respectively. The available S content in the soils of upper layers in most of the studied area contained medium to optimum and in the deeper layer low to medium (Table 3). Portch and Islam (1984) reported that 68% soils of Bangladesh contained S below critical level and 14% below optimum level. The addition of sulphate fertilizer may benefit the production in these areas.

Exchangeable K content

Exchangeable K content of soils collected from different locations of Mymensingh and Jamalpur districts have been presented in Table 3. The exchangeable K content at Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (0.124 to 0.267), (0.12 to 0.132), (0.087 to 0.121) and (0.091 to 0.18) cmol Kg^{-1}, respectively. According to BARC (2012), the exch. K content was very low to low in most of the soils except the deeper layers (15-33 cm) of Lokdeo soil series which contained medium amount of exch. K (Table 3). With the increase of %clay content, exchangeable K content increase (Portch and Islam, 1984 and Bhuiyan,1988). Continuous cropping without K application was found to decrease the content of available K appreciably and increase the influence of K progressively (Ghosh and Biswas, 1978). So potassic fertilizer should be added in the high deficient areas.

Exchangeable Ca content

The results on exchangeable Ca content of soils collected from different location of Mymensingh and Jamalpur districts have been presented in Table 3. The results show that the exchangeable Ca content at Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (1.95 to 2.93), (1.03 to 3.63), (0.56 to 2.31) and (1.10 to 2.71) cmol Kg^{-1}, respectively. According to BARC (2012), the exchangeable Ca was very low to low in most of the soils except Tarakanda series (0-9 cm) (Table 3). Soil series having low Ca should be managed properly. The amount of exchangeable Ca content in different depth did not vary widely but decreased with the soil depth.

Exchangeable Na content

Data on exchangeable Na content of soils collected from different location of Mymensingh and Jamalpur districts have been presented in Table 3. The results show that the exchangeable Na content at Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (0.211 to 0.282), (0.229 to 0.264), (0.246 to 0.334) and (0.194 to 0.317) cmol Kg^{-1}, respectively. From the results we found that the studied areas contained low amount of exchangeable Na as these soils are acidic in reaction. In general, the alkaline and saline soils show superiority on exchangeable Na content over other soils (Akter, 2009).

Table 3. Available and exchangeable macro nutrient contents at different depths of some selected soil series of Mymensingh and Jamalpur districts

Soil Series	Depth (cm)	Avail. P (μg g^{-1})	Avail. S (μg g^{-1})	Exch. K (cmol kg^{-1})	Exch. Ca (cmol kg^{-1})	Exch.Na (cmol kg^{-1})
Lokdeo	0-10	10.45	25.13	0.124	2.93	0.282
	10-15	12.78	15.65	0.176	2.58	0.211
	15-33	22.67	13.23	0.189	2.73	0.246
	33-53	31.88	9.75	0.267	1.95	0.211
Tarakanda	0-9	3.67	29.56	0.12	3.63	0.229
	9-23	10.65	23.96	0.132	1.73	0.246
	23-40	16.93	17.99	0.129	1.03	0.264
Silmondi	0-12	7.62	21.48	0.087	1.25	0.334
	12-29	17.56	14.06	0.121	2.31	0.317
	29-47	18.91	7.99	0.095	0.56	0.246
Melandah	0-15	11.23	24.94	0.091	2.71	0.299
	15-30	13.65	18.82	0.093	2.53	0.317
	30-45	14.33	11.99	0.153	1.73	0.282
	45-60	12.98	12.06	0.144	1.15	0.246
	60-75	3.65	10.77	0.180	1.10	0.194

Avail. = Available, Exch. = Exchangeable

Available Zn content

The results on available Zn content of soils collected from different location of Mymensingh and Jamalpur districts have been presented in Table 4. It is observed in the table that the available Zn content at Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (2.09 to 4.92), (0.72 to 3.69), (0.80 to 1.81) and (1.31 to 2.17) µg g^{-1}, respectively. According to BARC (2012), the upper layers of all the locations contained high to very high amount of available Zn but the deeper layers contained low to medium amount of available Zn. It is required in small amounts, high yields are impossible without it. Some crops are more responsive to Zn than others. But excess amount of this nutrient is also harmful for crop production. Zn is also contained in some fungicides, and may accumulate if these are used persistently. Liming to raise the pH of the soil may alleviate the problem by reducing the concentrations of plant-available Zn. Large applications of P fertilizers may also have a beneficial effect on Zn toxicity (O'Sullivan, 1997).

Available Cu content

The results on available Cu content of soils collected from different location of Mymensingh and Jamalpur districts have been presented in Table 4. It is observed in the table that the available Cu content at Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (2.30 to 3.98), (2.74 to 5.65), (1.32 to 2.76) and (0.06 to 2.61) µg g^{-1}, respectively. The soils of all locations contained very high amount of available Cu except Melandah soil series (45-75 cm) which contained low to very low. Toxic levels of copper (Cu) rarely occur naturally in soils. However, copper may accumulate due to application of sewage sludge, pig slurries or mine slag, or more commonly through persistent use of Cu-containing fungicides or fertilizers.

Available Fe content

The results on available Fe content of soils collected from different location of Mymensingh and Jamalpur districts have been presented in Table 4. It is observed in the table that the available Fe content at Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (100.50 to 127.70), (73.68 to 113.66), (75.51 to 115.52) and (12.06 to 54.66) µg g^{-1}, respectively. The available Fe in the soils was much higher than the critical limit of Fe in soil for crop production (BARC 2012). The activity of Fe decreases with the increase in soil pH (Lindsay, 1974). Liming generally decrease the availability of this nutrient in soil. Iron toxicity is a problem associated primarily with rice crop grown on iron rich low land red and laterite soils. Under these conditions Fe^{3+} is reduced to Fe^{2+}, which is absorbed by rice plant in larger quantities and causes Fe-toxicity. Other crops grown on such soils also suffer from iron toxicity and consequent yield loss will occur. Predisposing factors for iron toxicity are acidic pH and poor nutrient status (K, P, Ca, Mg, Zn). Application of K at higher doses increases root oxidizing power of rice, which results in oxidation of Fe++ to Fe^{3+} and exclusion of this ion from uptake. This is evident from increase in intensity of iron oxide coating on rice roots at higher levels of K application.

Available Mn content

The results on available Mn content of soils collected from different location of Mymensingh and Jamalpur districts have been presented in Table 4. It is observed in the table that the available Mn content at Lokdeo, Tarakanda, Silmondi and Melandah soil series ranged from (10.55 to 28.50), (19.30 to 24.12), (4.64 to 21.26) and (2.26 to 23.15) µg g^{-1}, respectively. The soils of all locations contained very high amount of available Mn except the deeper layers (45-75 cm) of Melandah which contained optimum amount of available Mn. It is frequently an abundant constituent of soils, but its low solubility at neutral and alkaline pH prevents excessive uptake by plants. Manganese is also a component of some fungicides and may accumulate through repeated use of these fungicides, especially to crops grown on sandy soils (O'Sullivan, 1997). As Mn toxicity often results from low soil pH, it can often be corrected by application of lime or dolomite to raise the pH above about 5.3. Application of additional K can ameliorate the toxicity of Mn in rice field (Alam, 2005).

Table 4. Available micronutrient contents at different depths of some selected soil series of Mymensingh and Jamalpur districts

Soil Series	Depth (cm)	Avail.Zn (μg g^{-1})	Avail.Cu (μg g^{-1})	Avail.Fe (μg g^{-1})	Avail.Mn (μg g^{-1})
Lokdeo	0-10	4.92	3.98	127.70	28.50
	10-15	3.12	3.25	`122.12	22.90
	15-33	2.66	2.92	109.10	14.98
	33-53	2.09	2.3	100.50	10.55
Tarakanda	0-9	3.69	5.65	113.66	24.12
	9-23	1.35	4.53	109.90	21.18
	23-40	0.72	2.74	73.68	19.30
Silmondi	0-12	1.81	2.76	115.52	21.26
	12-29	0.92	1.56	86.51	19.87
	29-47	0.80	1.32	75.56	4.64
Melandah	0-15	2.17	2.61	54.66	23.15
	15-30	2.03	1.76	35.41	16.02
	30-45	1.94	0.76	23.82	9.71
	45-60	1.31	0.23	13.54	2.98
	60-75	1.71	0.06	12.06	2.26

Avail. = Available

Correlation studies between different soil paramerters

Soil pH showed a negative correlation with total N, the value of correlation coefficient was -0.893 with the regression line $y = -0.061x + 0.430$ (Fig. 1A); Soil pH showed a negative correlation with available S, the value of correlation coefficient was -0.872 with the regression line $y = -12.24x + 89.86$ (Fig. 1B). Soil OM showed a positive correlation with total N, the value of correlation coefficient was 0.953 with the regression line $y = 0.061x + 0.011$ (Fig. 1C). Total N content of soil showed a positive correlation with available S, the value of correlation coefficient was 0.917 with the regression line $y = 186.8x + 5.038$ (Fig. 1D). There was a positive correlation evident between total N and available Cu of soil, the value of correlation coefficient was $r= 0.806$ with the regression line $y = 38.93x - 0.097$ (Fig. 1E). Available S content of soil showed a positive correlation with available Mn, the value of correlation coefficient was 0.826 with the regression line $y = 1.038 – 1.728$ (Fig. 1F).

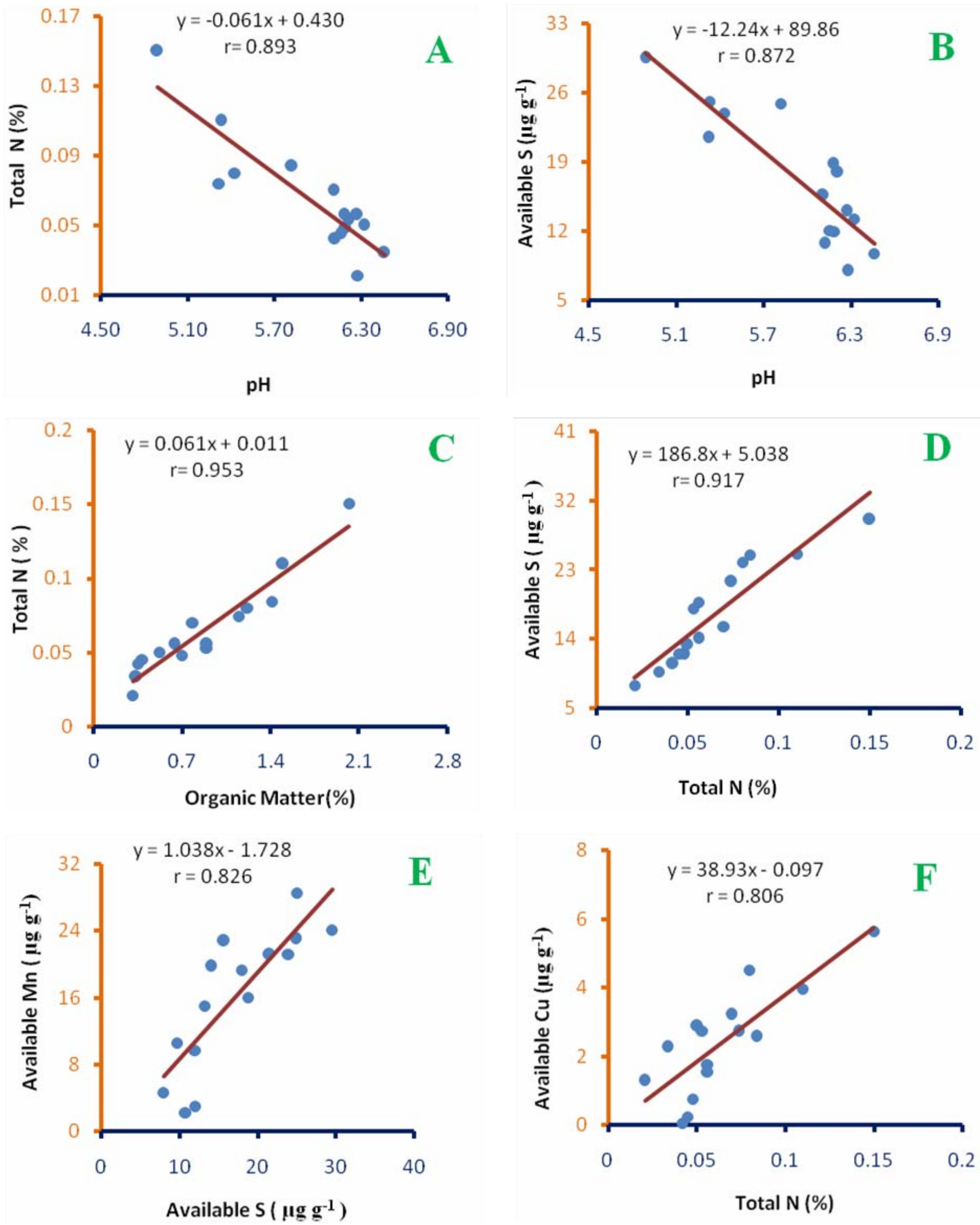

Fig. 1. Correlation between available P and total N(A), total N and available S content (B), total N and exchangeable Ca (C), total N and available Zn (D), total N and available Cu (E), total N and available Mn content (F) of some selected soil series of Mymensingh and Jamalpur district

Conclusion

The textural classes were sandy loam, silty loam, loam and clay loam in the studied areas. The soils in these locations are acidic in nature. Most of the soil contained low to very low organic matter content. Soil pH showed negative correlation with OM. The total N content in the soils of the studied area was low to very low. It showed negative correlation with soil pH. The available P content was medium to high in Lokdeo series. Though other series contained low to optimum amount of available P, it showed negative correlation with available S and total N. The available S content in the soils of upper layers in most of the studied area were medium to optimum and in the deeper layer low to medium. It showed positive correlation with total N. The exchangeable K, Ca and Na contents were low to very low in most of the soils. The upper layers of all the locations contained high to very high amount of available Zn compared to the lower layers. It showed positive correlation with total N and available S. Available Cu, Fe and Mn contents were high to very high in most of the locations. Fe showed negative correlation with total Mn. Cu and Mn showed positive correlation with total N. The results suggest that macro nutrient contents of all soils have come down to a level that the soils need external aid in the term of manures or fertilizers to produce higher crop yield.

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