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Status of some Micronutrients in Different Soils of Gazipur District as Related to Soil Properties and Land Type

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Abstract

An investigation was conducted to evaluate the status of micronutrients i.e. Iron, Manganese, Copper and Zinc and their behavior with respect to some general soil properties according to the land type in some soils of Gazipur district. A total of 114 soil samples were collected from different spots of Sripur and Kaliakair upazilas under Gazipur district which is situated in two physiograpic regions: Madhupur tract and Brahmaputra floodplain. Amount of total Fe, Mn, Cu and Zn varied significantly and ranged from 0.1817-0.3375%, 0.0094-0.0754% , 0.0028-0.0089% and 0.0080-0.1216% respectively in Sripur upazila whereas 0.1433-0.4864%, 0.0428-0.0804%, 0.0020-0.0079% and 0.0030-0.0399% in Kaliakair upazila of different land type. The content in the studied areas increases from high land to low land. The textural class in most soils is silty clay loam, silt loam, clay loam, silty clay and clay. The pH was highly acidic to moderately acidic and there was a small change of pH with the land type. Organic matter content showed an increasing trend from high land to low land of the studied soils. A significant and negative correlation observed between pH and total Mn content while other micronutrients (Fe, Cu and Zn) showed non-significant and negative relationship. Total exchangeable bases of some soils of the studied areas have positive significant correlation with micronutrients. Interaction of micronutrients with each other showed significant relationship.

Key words : Fe, Mn, Cu, Zn, Madhupur tract and young Brahmaputra floodplain

Introduction

Land and soils are the most valuable natural resources in Bangladesh. But they are either over exploited or under utilized due to poor resource management (Shaheed, 1992). It is a dynamic medium resulting from the interplay of physical, chemical, mineralogical, biological, physiographical, hydrological, human management and a host of other factors (Mannan and Rahim, 1984). Bangladesh is essentially agricultural in character perhaps one of the most intensively cultivated countries of the world. Agricultural land per capita in Bangladesh is 0.55 hectare; cropping intensity varies from144.3% to 202% with an average of 176.9% (BBS, 2004).

It is important to sustain soil fertility before seedling. It should be ascertained which soil needs which fertilizer in quantity by soil analysis. This information is not available to the farmers due to various constraints. Without this information, however balanced fertilizer use is not possible. Now a days, farmers use fertilizers to grow crops without knowing exactly the appropriate doses. So some nutrients may be added in excess, while some under the required level. Thus an imbalance could be created in soil chemical balance, which is not good for either soil or crops. For these reasons, it is very important to survey the nutrient status of soils at the farmer's level (Moslehuddin *et al,* 1997).

Micronutrients are often referred to as minor elements, but it does not mean that they are less important than macronutrients. Micronutrients deficiency and toxicity can reduce plant yield, similar to macronutrients deficiency and toxicity (Tisdale *et al.* 1995). Soil needs small quantities of micronutrients (< 50mg/kg) for plant growth.

Until 1980, farmers used only NPK- fertilizers but at present they must apply at least five kinds of chemical fertilizers including S and Zn to grow paddy crops. Following Zn and S addition of B, Mg, Mn, Cu or Ca is needed in some soils (Islam, 1992; Islam *et al.* 1992). The situation of other crops is almost similar to paddy. In recent years, the importance of micronutrients in increasing crop production has been greatly realized in Bangladesh (FAO-UNDP, 1988).

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Research papers on the micronutrients status are limited. In this report an attempt has been made to assess the micronutrients status (Fe, Mn, Cu and Zn) and behavior of different micronutrients with general soil properties according to the land type in some soils of Sripur, Kaliakair upazila under Gazipur district.

Materials and Methods

Two upazilas, namely, Sripur, and Kaliakair of Gazipur district were selected for study. Soil samples from 114 sites across the area were collected on the basis of land type, i.e. high land (HL), medium high land (MHL), medium low land (MLL), low land (LL) and very low land (VLL), as defined by (SRDI Staff (1985-1991). The samples were air-dried, ground and passes through 2 mm sieve for mechanical analysis and through 0.5 mm sieve for chemical analysis.

Mechanical analysis was done by hydrometer method and that of textural class was determined from USDA triangular coordinate system, soil pH was measured electrochemically by using corning glass electrode pH meter (Model-7) from a soil suspension (Soil:water=1:2.5) as suggested by Jackson (1962). Organic carbon content of soils was estimated volumetrically by wet oxidation method (Walkley and Black, 1934). Total exchangeable bases were extracted with 1N NH_4OAc at pH 7 as described by Jackson (1973). Na^+ and K^+ were measured by Flame analyser (Glallenkamp), and Ca^{2+} and Mg^{2+} were measured by EDTA method. The physical and chemical properties of the soils are presented in Table I.

Total Fe, Mn, Cu and Zn were extracted by the digestion with concentrated sulfuric acid, selenium powder and lithium sulphate mixture as described by Anderson and Ingram (1996). The concentration of the elements (Fe, Mn, Cu and Zn) in the extract was estimated directly by atomic absorption spectrophotometer (Pye Unicam sp, Phillips).

Table I. Some physical and chemical properties of the soils.

Location	Land type	Soil series	Texture	pH	Organic matter (%)	TEB (meq/100g)
Sripur Upazila	HL	Tejgaon	Silty clay loam	5.73	0.80	6.77
	HL	Belabo	Silt loam	5.25	0.93	6.34
	HL	Noadda	Silt loam	4.47	1.17	4.46
	HL	Chhiata	Silty clay loam	4.60	1.19	6.60
	MHL	Kalma	Silty clay loam	5.19	1.29	7.83
	MHL	Gendda	Silt loam	5.00	1.32	6.41
	LL	Khilgaon	Silt loam	4.93	1.41	6.95
	LL	Singair	Clay	4.96	1.44	8.28
	LL	Karail	Clay	4.94	1.62	7.61
	VLL	Karail	Clay	4.90	1.65	7.50
Kaliakair Upazila	HL	Tejgaon	Silty clay loam	5.75	1.23	6.45
	HL	Belabo	Silt loam	5.49	1.16	7.75
	HL	Noadda	Clay loam	5.20	1.24	7.40
	HL	Gerua	Silty clay loam	5.17	1.08	5.99
	HL	Gerua	Clay loam	5.37	0.96	4.38
	HL	Bhatpara	Silty clay loam	5.53	1.13	5.24
	HL	Chhiata	Silt loam	5.25	1.12	3.99
	HL	Melandah	Silty clay loam	5.80	1.19	8.12
	MHL	Melandah	Silty clay loam	5.72	1.24	9.69
	MHL	Kalma	Clay	5.81	1.25	6.56
	MHL	Kalma	Clay	5.02	1.23	6.50
	MHL	Dhamrai	Silty clay	5.79	1.80	9.10
	MLL	Khilgaon	Silty clay	5.84	1.84	8.10
	MLL	Dhamrai	Clay loam	5.94	1.32	10.33
	LL	Singair	Clay	5.32	1.32	12.59
	LL	Karail	Clay	5.67	1.59	8.62

Results and Discussion

In the discussion detail results converted into summery result by taking mean value according to the land type and soil series. Total Fe, Mn, Cu and Zn were presented in Table II according to land type.

Manganese: Total Mn content varied between 0.0094 to 0.0754 and 0.0428 to 0.0804% in soils of Sripur, and Kaliakair upazila respectively, increases from HL to LL. The results favorably agreed with the reported values ranging from 37 ppm to 4600 ppm. Like Fe, the soluble of Mn also increases upon flooding and submergence (Tandon, 1992a). According to Pais and Jones (1997), the Mn content in soils varies from 200 to 3000 ppm. According to Miller and Donahue (1997), easily reducible Mn contributes to plant supply, when in oxidized soils, most of Mn precipitate as insoluble MnO_2. Tisdale *et al*. (1995) also reported that soil waterlogging would reduce oxygen and lower redox potential, which increase soluble Mn^{2+}, especially in acid soils.

Table II. Total Fe, Mn, Cu and Zn on the basis of land type in some soils of Sripur and Kaliakair Upazila of Gazipur district.

Location	Land type	Total Fe (%)	Total Mn (%)	Total Cu (%)	Total Zn (%)
Sripur Upazilla	HL	0.3141	0.0721	0.0051	0.0080
	HL	0.1817	0.0291	0.0051	0.0194
	HL	0.2919	0.0094	0.0031	0.0091
	HL	0.3108	0.0589	0.0028	0.0145
	MHL	0.1852	0.0410	0.0030	0.0227
	MHL	0.2880	0.0469	0.0035	0.0136
	LL	0.2780	0.0489	0.0031	0.0169
	LL	0.3375	0.0754	0.0089	0.1216
	LL	0.3077	0.0622	0.0060	0.0693
	VLL	0.2636	0.0566	0.0052	0.0189
Kaliakair Upazilla	HL	0.1433	0.0428	0.0028	0.0096
	HL	0.1513	0.0786	0.0026	0.0132
	HL	0.2916	0.0758	0.0020	0.0035
	HL	0.1505	0.0453	0.0026	0.0169
	HL	0.2318	0.0578	0.0050	0.0030
	HL	0.1921	0.0529	0.0027	0.0058
	HL	0.2019	0.0549	0.0026	0.0051
	HL	0.2499	0.0506	0.0023	0.0269
	MHL	0.2259	0.0802	0.0025	0.0210
	MHL	0.2367	0.0622	0.0026	0.0109
	MHL	0.2209	0.0374	0.0026	0.0378
	MHL	0.2461	0.0641	0.0060	0.0110
	MLL	0.2829	0.0718	0.0037	0.0160
	MLL	0.2506	0.0651	0.0049	0.0122
	LL	0.4864	0.0804	0.0079	0.0399
	LL	0.3165	0.0703	0.0039	0.0148

Iron: Total Fe content varied between 0.1817 to 0.3375 and 0.1433 to 0.4864% in soils of Sripur, and Kaliakair upazilas respectively. In Kaliakair Upazilas Fe content increases from HL to LL. According to Pais and Jones (1997), under anaerobic conditions ferric (Fe^{3+}) is reduced to ferrous (Fe^{2+}) which significantly increases its solubility in soils. Tisdale *et al*. (1995) also reported that the presence of organic matter can increases Fe^{2+} solubility in waterlogged soils. Hussain (1992) reported that the soils of Madhupur tract contain high amount of iron and aluminium, which are highly aggregated. Of the various elements, Fe has never been reported to be deficient (Islam *et al.* 1992).

Copper: The Cu content varied significantly between 0.0028 to 0.0089% and 0.0020 to 0.0079% in soils of Sripur and Kaliakair upazilas respectively. The changes of total Cu content of the investigation area generally increases from HL to LL soils. Studies by Pais and Jones (1997), total Cu content in soils ranges from 2-100 ppm are high degree of agreement with those obtained in this study. The values are again comparable with those reported for the soils of India (Tandon, 1992a).

Zinc: Total Zn content varied significantly in HL to LL soils of Sripur, and Kaliakair upazila ranged from 0.0080 to 0.1216% and 0.0030 to 0.0399% respectively. Comparable values were also reported for Indian soils ranges from 2 to 1600 ppm, in most cases within 10 to 300 ppm (Tandon, 1992b). FAO (1986) reported that Most of the flood plain soils contain more than 40 ppm Zn.

The pH of the investigated area was low, indicating that the soils are acidic in reaction (Table I). A significant and negative correlation observed between pH and micronutrients in the studied area (Table III). According to Brady (2002), the micronutrient cations are most soluble and available under acid condition. In fact, under these conditions, the soil solution concentrations or activities of one or more of these elements (most commonly manganese) are often sufficiently high as to be toxic to common plants. At low pH values the solubility of Zn is at a maximum and tend to be dominant under highly acidic conditions. As with Zn, Mn solubility increases about 100 fold per unit pH decrease (Millar and Donahue, 1991).

A positive significant correlation was observed between TEB and the micronutrients (Table III). Toth (1965) noted that the composition of exchangeable cation population is governed by many factors. The most important being type of cations, ion concentration, nature of the anion associated with the cations and nature of the clay minerals.

It is observed that a positive significant correlation found between total Cu and total Zn in soils of Sripur Upazilla. According to Brar and Sekhon (1978) and Hulagur (1975), in soils which are low or deficient both Zn and Cu, the interaction between the two has been shown to by synergistic at low rates of their application. Fe-Mn interaction showed positive significant relationship in soils of Kaliakair Upazilla. This result could be supported by Mishra and Misra, (1969) who stated that $FeSO_4$ can effectively correct Mn deficiency in soils containing appreciable quantities of higher oxides of Mn. Available literature suggests that Fe: Mn concentration rates in nutrient medium of soybean plants and presumably also of other plant species should lie between 1.5 and 2.5 for optimal plant growth. If the ratio is above 2.5, symptoms of Fe toxicity (= Mn deficiency) would occur; and if the ratio is below 1.5, plants would suffer from Mn toxicity (=Fe deficiency) (Bansal and Chahal, 1990).

Interaction between Zn and Fe may occur under a wide range of soil conditions. In acid soils the availability of both these nutrients is quite high and in some cases the concentration of Fe in soil solution is sufficient enough to cause iron toxicity to crops (Verma and Tripathi, 1983). In many studies, extractable Mn in soil or Mn in the soil solution has reported to increase with the addition of Zn to soil (Sekhon and Chopra, 1971; venkata and Mehta 1975; Mandal and Haldar, 1980; Patra, 1981; Antil and Dahiya, 1986; Sadana and Takkar, 1988)

Table III. Simple correlation co-efficient between soil properties and nutrients level in soil

Properties	Sripur Upazila				Kaliakair Upazila			
	Fe	Mn	Cu	Zn	Fe	Mn	Cu	Zn
pH	-0.752**	-0.446**	-0.757**	-0.166	-0.129	-0.522**	0.253	-0.765**
%OM	0.031	-0.351**	0.478	-0.145	0.057	0.058	0.064	0.054
TEB	0.053	0.56*	0.568	0.536*	0.656**	0.517*	0.349	0.569*
Fe		0.450	0.398	0.242		0.914**	0.414	0.762**
Mn			0.621	0.337			0.052	0.814**
Cu				0.865**				0.169

* significant at 5% level
** significant at 1% level

Organic matter has a significant negative relationship with Mn, which observed in soils of Sripur Upazila (Table III). According to Tisdale *et al.* (1995), the low availability of Mn in high organic matter soils is attributed to the formation of unavailable chelated Mn compounds.

Conclusion

The investigation was conducted in Sripur and Kaliakair Upazila in two physiographic regions, Madhupur Tract and Brahmaputra Floodplain. Madhupur tract comprises a wide range of soils formed over the Madhupur clays, which is low in weatherable minerals. Floodplain brings large amount of sediments from their sources. These sediments are mineral rich and weather rapidly under high temperature and seasonal wet and dry conditions; and release nutrient such as Ca, Mg, K, Fe, Mn, Cu, Zn and P etc.

Results indicated that total content of Fe, Mn Cu and Zn increases from HL to LL in the studied areas. Significant and negative correlation observed between pH and micronutrients. Significant and positive correlation existed between TEB and micronutrients. Interaction of micronutrients to each other are also showed positive relationship indicated that one nutrient content effect another nutrient content.

All over the studied areas show large contents of total micronutrients (Fe, Mn, Cu, and Zn) but chemical analysis, fertilizer experiments and field survey have established that there is a large area of soils low in available micronutrients in Bangladesh. Micronutrient deficiency is likely to increase in the future with further crop intensification.

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