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The Relationship Between Soil pH and Micronutrients, Western Nepal

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***Abstract* – Soil pH and micronutrients are important soil parameters influencing soil sustainability. Considering this factor, the study was conducted to determine relationship between soil pH and available Boron, Iron, Zinc, Copper and Manganese. The total 172 soil samples were collected from the three sites of western region at 0-20 cm depth. The collected samples were analyzed by standard method in soil science division, Khumaltar. To compute the relationship between soil pH and the micronutrients, simple linear correlation and regression were preformed. The result revealed soil pH was significantly and negatively correlated with available B (r=-.50**), Fe(r=-.28**), Cu (r=-.19*) and Mn(r=-.35**). While, there was non- significant and negative correlation between soil pH and available Zn (r=-0.005). In addition, with the increase on soil pH by one unit, available B, Fe, Cu and Mn decreases by 0.61, 11.32, 0.15 and 2.88 units, respectively and vice-versa. Therefore, maintenance of optimum soil pH (neither acidic or alkaline) is important for reducing B, Fe, Cu and Mn deficiency as well toxicity problem in western Nepal.**

***Keywords* – Correlation, Micronutrients, Regression, Soil pH.**

I. Introduction

Soil is the uppermost layer of variable depth of the earth consisting of loose material, which is the main support for natural vegetation and other life forms of our planet.

Fertility of soil is the most important factors which regulates growth and yield of crops. Micronutrient plays a vital role in maintaining soil fertility and also productivity of crops. Micronutrients are needed in smaller quantities than macronutrients, a deficient supply will make it impossible to obtain maximum yields, even if the supply of the macronutrients is balanced and high yielding varieties are grown (Yadav, 2011).

Soil pH is a measure of the soil solutions acidity and alkalinity. Technically, pH refers to the hydrogen ion concentration in soil. The pH scale is not linear but logarithmic in scope. Soil pH can impact plant growth based on its influence on the availability of essential plant nutrients and on the concentration of elements toxic to plants (Brady and Weil, 2002). The majority of micronutrients like Cu, Fe, Mn and Zn are more available within a pH range of 4 to 6. These micronutrients are very tightly bound to the soil at high pH and are therefore more available at low pH levels than high pH levels (Havlin *et al.*, 2010).

Plants take their nutrients mostly from soil. It is well known that the optimum plant growth and crop yield depends not only on the total amount of nutrients present in the soil at a particular time but also on their availability which in turn is controlled by physico-chemical properties like: soil texture, organic carbon and calcium carbonate, Cation exchange capacity, pH and electrical conductivity of soil (Bell and Dell, 2008). Similarly, Gupta (1968) reported that soil pH, specific surface area, clay and organic carbon contents influenced water soluble boron in soil.

Sustainable management of soil is possible only after understanding chemistry of interrelating soil properties. Therefore, considering these factors the study was done to determine relationships between soil pH and micronutrients content in the soil samples collected from three sites of western Nepal.

II. Materials and Methods

2.1 *Site Description*

The study was conducted in the three sites of western region, Nepal. The three sites were Regional Agricultural Research Station, Lumle, Kaski; Horticulture Research Station, Malepatan, Kaski and National Wheat Research Program, Bhairahawa, Rupandehi (Figure1). The Regional Agricultural Research Station, Lumle is situated at the latitude 28°17’51.89”N and longitude 83°49’2.87”E as well altitude 1750 m above sea level. The Horticulture Research Station, Malepatan is geographically situated at the latitude 28º13’07”N and longitude 83º58’21”E as well altitude 850 m above sea level. The National Wheat Research Program, Bhairahawa is geographically situated at the latitude 27º31’49”N and longitude 83º27’36”E as well altitude 82 m above sea level.

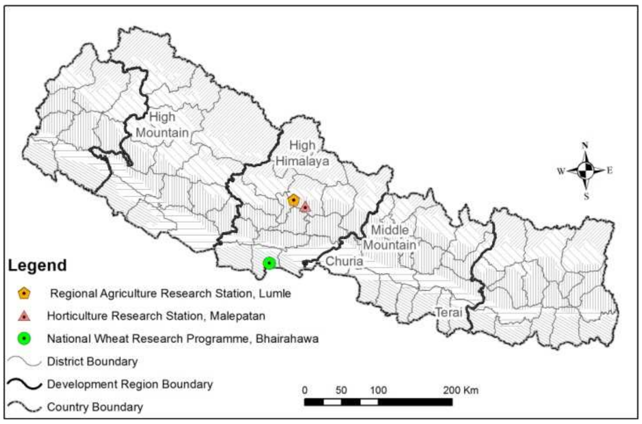

Fig. 1. Location Maps for the Study Area of Western Regions, Nepal

2.2 *Soil Sampling*

The total one hundred seventy two (172) soil samples were collected randomly at 0-20 cm depth during 2014. The sampling points were determined based on the variability of the land on each site.

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2.3 *Laboratory Analysis*

The collected samples were dried at room temperature and ground in powder form and analyzed in the laboratory for the determination of different studied chemical properties at Soil Science Division, Khumaltar. The different methods adopted for chemical properties determinations are listed in the table 1.

Table 1. Methods Adopted For the Laboratory Analysis at Soil Science Division, Khumaltar

S.N.	Parameters	Methods
1.	**Chemical**	
1.1	Soil pH	Potentiometric 1:2 (Jackson, 1973)
1.2	**Micro-nutrients**	
1.2.1	Available Boron	Hot water (Berger and Truog, 1939)
1.2.2	Available Iron	DTPA (Lindsay and Norvell, 1978)
1.2.3	Available Zinc	DTPA (Lindsay and Norvell, 1978)
1.2.4	Available Manganese	DTPA (Lindsay and Norvell, 1978)
1.2.5	Available Copper	DTPA (Lindsay and Norvell, 1978)

2.4 *Statistical Analysis*

Correlation and regression analyses were carried out to detect functional relationship between soil pH and micronutrients. The data analyses were done using a statistical software package SPSS 16.0 and Microsoft Office Excel 2007.

III. Result and Discussion

The results relating relationship between soil pH and micronutrients is shown on the table (2-3) and figure (2-6).

Table 2. Summary Statistics of the Studies Soil Samples

Parameters	Mean*	Standard Deviation	Standard Error	Minimum	Maximum
Soil pH	6.4	1.5	0.10	3.69	8.34
Available B	2.0	1.79	0.14	0.01	7.02
Available Zn	3.31	1.96	0.15	0.3	8.5
Available Fe	80.99	59.89	4.57	8.73	368
Available Cu	2.31	1.11	0.08	0.93	7.53
Available Mn	11.37	11.84	0.90	1.27	71.8

*Mean of one hundred seventy two samples

Table 3. Correlation coefficient (r) of micronutrients with pH on the studied soil samples

Micronutrients	r	N
Available B ppm	-.50**	172
Available Zn ppm	-0.005	172
Available Fe ppm	-.28**	172
Available Cu ppm	-.19*	172
Available Mn ppm	-.35**	172

** indicate significant at 1%,* indicate significant at 5% and N means number of studied samples

3.1 *Relationship Between Soil pH and Available Boron*

The result relating correlation revealed that the available boron **(r=**-.50**)** were significantly and negatively correlated with soil pH (Table 3). This suggested that pH accounted for about 25% of the total variability in available boron (Figure 2). Similarly, by the increase on pH, available boron decreases progressively and vice-versa. In addition to this, with the increase on soil pH by one unit, available boron decreases by 0.61 unit and vice-versa. With the increasing pH conversion of more available form of boron i.e. $B(OH)_3$ to less available $B(OH)_4^-$ might be the reason for such kind of result. The similar result was also reported by Sharma *et al.* (2003).

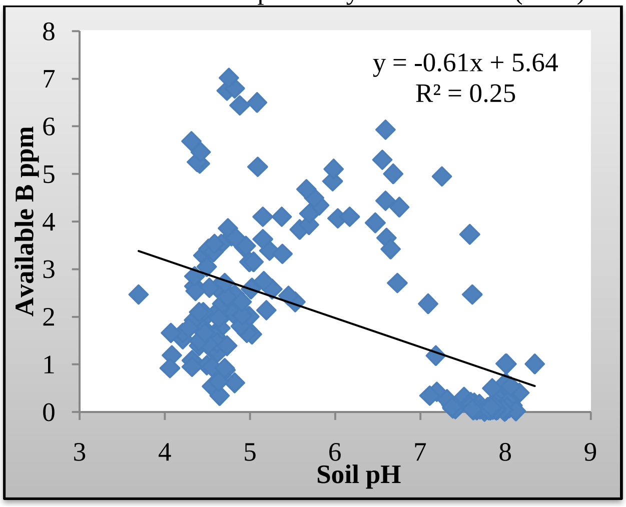

Fig. 2. Regression Relationship between pH and Available Boron on Studies soil samples

3.2 *Relationship Between Soil pH and Available Zinc*

The result regarding correlation showed that the available zinc (r=-0.005) were non- significant and negative in correlation with soil pH (Table 3). In contrast to this, the various researcher Sharma *et al.* (2003); Mathur *et al.* (2006); Yadav (2008); Yadav and Meena (2009) and Sidhu and Sharma (2010) found significant and negative correlation between soil pH and available zinc.

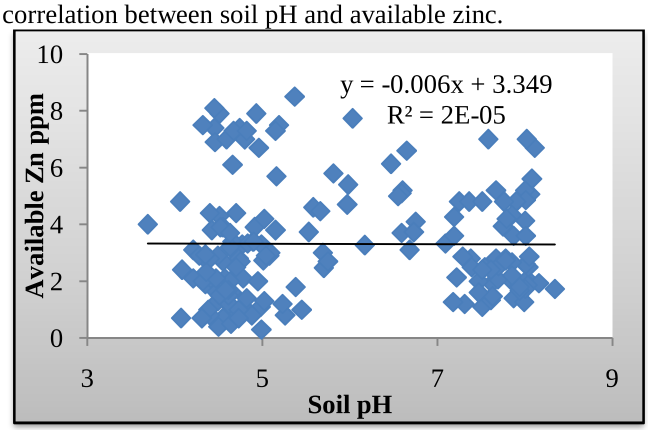

Fig. 3. Regression Relationship between pH and Available Zinc on Studies soil samples

3.3 *Relationship Between Soil pH and Available Iron*

The result involving correlation revealed that the available iron **(r=**-.28**)** were significantly and negatively

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correlated with soil pH (Table 3). This suggested that pH accounted for about 8% of the total variability in available iron (Figure 4). Similarly, by increase on pH, available iron decreases progressively and vice-versa. In addition to this, with the increase on soil pH by one unit, available iron decreases by 11.32 unit and vice-versa. Yadav (2011) who suggested that the reduced Fe-availability with increasing pH might be attributed to the conversion of Fe^{2+} to Fe^{3+} ions. The ferric ion (Fe^{3+}) compounds have low solubility in solution and so are less bio-available (Landon, 1984). The determined result is accordance with the result obtained by Sharma *et al.* (2003); Mathur *et al.* (2006); Yadav (2008); Yadav and Meena (2009) and Sidhu and Sharma (2010).

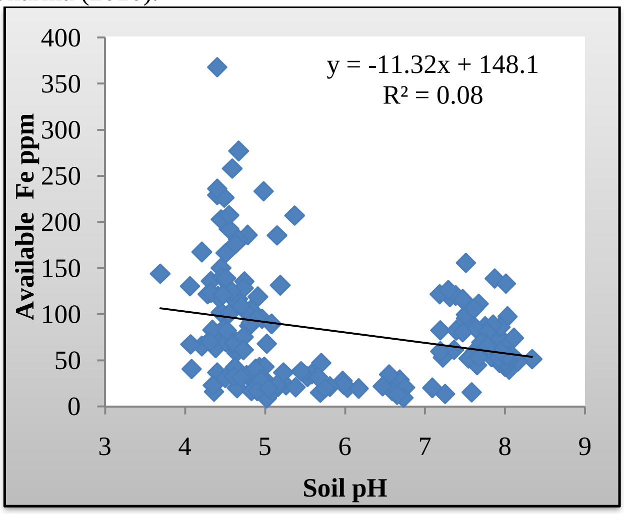

Fig. 4. Regression Relationship between pH and Available Iron on Studies soil samples

3.4 *Relationship Between Soil pH and Available Copper*

The result of the study presented in Table 3 indicated that available copper **(r=**-.19*) were significantly and negatively correlated with soil pH. This suggested that pH accounted for about 4% of the total variability in available copper (Figure 5). Correspondingly increasing pH, decreases available copper gradually and vice-versa. In addition to this, with the increase on soil pH by one unit, available copper decreases by 0.15 unit and vice-versa. The decrease on concentration of available copper might be due to precipitation of Cu $(OH)_2^0$ and $CuOH^+$ with the increase on pH (Das, 2000). The result is confirmatory with the result obtained by Sharma *et al.* (2003); Mathur *et al.* (2006); Yadav (2008); Yadav and Meena (2009) and Sidhu and Sharma (2010).

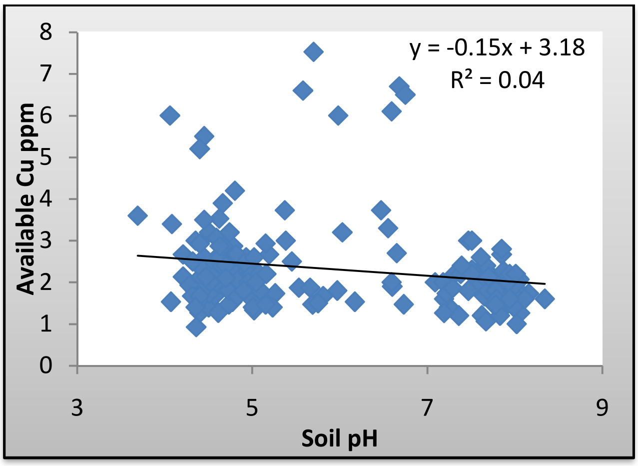

Fig. 5. Regression Relationship between pH and Available Copper on Studies soil samples

3.5 *Relationship Between Soil pH and Available Manganese*

Data presented in Table 3 showed that available manganese **(r=**-.35**) were significantly and negatively correlated with soil pH. This suggested that pH accounted for about 13% of the total variability in available manganese (Figure 6). Correspondingly increasing pH, available manganese decreases gradually and vice-versa. In addition to this, with the increase on soil pH by one unit, available manganese decreases by 2.88 unit and vice-versa. With increasing soil pH, Mn^{2+} is converted into its higher oxides (Mn^{3+} and Mn^{4+}) which are insoluble in water might be the reason for decreasing concentration of available Mn with increasing pH . Similarly, the solubility of Mn bearing minerals like pyrolusite, manganite etc. increases with decrease in pH resulting greater release of Mn^{2+} in the soil solution (Das, 2000). Similar result was also reported by Sharma *et al.* (2003); Mathur *et al.* (2006); Yadav (2008); Yadav and Meena (2009) and Sidhu and Sharma (2010).

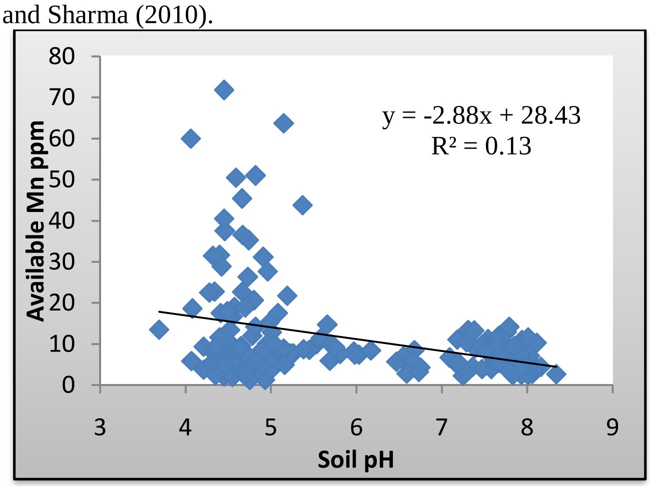

Fig. 6. Regression Relationship between pH and Available Manganese on Studies soil samples

IV. Conclusion

The soil pH is a key component of soil fertility. The significant and negative correlation was observed between soil pH and available B, Fe, Cu and Mn. With the increase on soil pH, available B, Fe, Cu and Mn decreases gradually and vice-versa. Thus, the soil pH can control the availability of B, Fe, Cu and Mn. High availability at low pH may cause toxicity and low availability at high pH may cause deficiency problem for these four micronutrients. Therefore, maintenance of optimum soil pH (neither acidic or alkaline) is imperative for reducing B, Fe, Cu and Mn deficiency as well toxicity problem in western Nepal.

V. ACKNOWLEDGEMENT

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