COMPARISON OF EXTRACTANTS FOR ASSESSING Fe, Mn, Cu AND Zn AVAILABILITY IN SOILS

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Abstract: The available status of Fe, Mn, Cu and Zn in two soils (Melandaha-Silt loam and Dhamrai–Silty clay loam) was determined by two extraction methods (0.5 M DTPA and 0.1 N HCl). The soils previously treated with various composts and/or compost plus fertilizer and *Amaranthus* was grown upto 42 days. After harvest of *Amaranthus,* the soils were extracted with 0.5 M DTPA and 0.1 N HCl and the extracts were analyzed for trace elements contents. The availability of trace elements varied significantly with the extractants used and the highest values were found for 0.1 N HCl.

Key words: Availability; Extractants; and Trace elements

Introduction

Metals having atomic number greater than 23 and densities more than 5 g c^{-3} are called heavy metals (Brady, 1995). The availability of heavy metals in soil depends on several factors e.g. pH, clay and organic matter (OM) etc. Compost is a good source of organic matter. The availability of a heavy metal largely depends on the chemical composition of compost and the characteristics of soil. Ion availability is related to intensity, quantity and replenishment factors in soil (Khasawneh, 1971). Again, the assessment of element availability depends on the types of extractant used. In this study Diethylene triamine penta acetic acid (0.5 M DTPA) and 0.1 N HCl were used to determine the Fe, Mn, Cu and Zn availability in soils amended with various composts. The DTPA soil test was developed by Lindsay and Norvall (1978) and the 0.1 N HCl method by Nelson *et al.* (1959). In acid soils 0.1 N HCl may extract Cu, Zn, Ni and Cd held by organic matter.

Materials and Methods

A pot experiment was conducted on two soils representing two soil series (Melandaha- Silt loam and Dhamrai –Silty clay loam). The soils were treated with different doses of composts (aerobic and barrel) and /or composts plus fertilizer (Urea and TSP) (Table-1 and Table-2). *Amaranthus* was grown upto 42 days and after harvesting, the soils were collected and processed to determine the available content of some trace elements (Fe, Mn, Cu and Zn) by 0.5 M DTPA and 0.1 N HCl extraction methods (Page *et al.*1990). The elements in the extracts were determined directly by atomic absorption spectrophotometer.

Results and Discussion

The availability of some trace elements (Fe, Mn, Cu and Zn) changes due to different extractants and different composts of different doses is discussed here.

Fe Availability: Control treatment of Melandaha soil contained 8.92 mg kg^{-1} and 29.74 mg kg^{-1} available Fe for DTPA and 0.1 N HCl extractants respectively (Table-1) but for Dhamrai soils it was 11.56 mg kg^{-1} and 34.69 mg kg^{-1} respectively (Table-2). The DTPA extractable Fe in Melandaha soil varied from 6.94 to 9.58 mg kg^{-1} depending on the compost / fertilizer treatments, while the element in the same soil extracted by 0.1 N HCl ranged between 25.77 and 39.65 mg kg^{-1} (Table-1). In Dhamrai soil, the DTPA- Fe content was 10.74 to 14.54 mg kg^{-1} and the 0.1 N HCl-Fe was 32.21 to 39.65 mg kg^{-1} over the treatments. It appeared that the 0.1 N HCl extracted about 2 to 4.5 times more Fe than the 0.5 M DTPA did.

Mn Availability: Control treatment of Melandaha soil contained 30.84 mg kg^{-1} and 253.09 mg kg^{-1} available Mn for DTPA and 0.1 N HCl extractants respectively (Table-1) but for Dhamrai soils it was 27.31 mg kg^{-1} and 116.90 mg kg^{-1} respectively (Table-2). The DTPA extractable Mn in Melandaha soil varied from 27.10 to 30.84 mg kg^{-1} depending on the compost / fertilizer treatments, while the element in the same soil extracted by 0.1 N HCl ranged between 212.42 and 275.69 mg kg^{-1} (Table 1). In Dhamrai soil, the DTPA-Mn content was 20.12 to 27.86 mg kg^{-1} and the 0.1 N HCl-Mn was 111.48 to 129.56 mg kg^{-1} over the treatments. It appeared that the 0.1 N HCl extracted about 4 to 10 times more Mn than the 0.5 M DTPA did.

Cu Availability: Control treatment of Melandaha soil contained 4.41 mg kg^{-1} and 30.65 mg kg^{-1} available Cu for DTPA and 0.1 N HCl extractants respectively (Table-1) but for Dhamrai soils it was 5.82 mg kg^{-1} and 23.50 mg kg^{-1} respectively (Table-2). The DTPA extractable Cu in Melandaha soil varied from 4.24 to 7.76 mg kg^{-1} depending on the compost / fertilizer treatments, while the element in the same soil extracted by 0.1

N HCl ranged between 30.27 and 56.09 mg kg^{-1} (Table-1). In Dhamrai soil, the DTPA- Cu content was 5.12 to 6.33 mg kg^{-1} and the 0.1 N HCl-Cu was 21.01 to 26.01 mg kg^{-1} over the treatments. It appeared that the 0.1 N HCl extracted about 4 to 7 times more Cu than the 0.5 M DTPA did.

Table-1 DTPA and 0.1 N HCl extractable Fe, Mn, Cu and Zn in Melandaha soil

Treatment	Fe (mg kg^{-1})		Mn (mg kg^{-1})		Cu (mg kg^{-1})		Zn (mg kg^{-1})	
	DTPA	0.1NHCl	DTPA	0.1NHCl	DTPA	0.1NHCl	DTPA	0.1NHCl
Control	8.92	29.74	30.84	253.09	4.41	30.65	2.71	19.60
AC_1	9.58	27.75	30.84	216.94	4.72	32.99	2.76	17.71
$AC_{1.5}$	8.76	39.65	30.63	275.69	4.50	31.55	2.94	22.02
AC_2	6.94	28.74	27.40	248.57	4.24	30.27	2.81	19.99
AC_1 F	8.26	27.75	28.14	225.98	4.46	32.11	3.02	17.86
$AC_{1.5}$ F	7.60	29.74	27.59	248.57	4.28	30.97	2.93	20.96
AC_2 F	7.76	29.74	28.55	225.98	4.39	31.52	3.10	19.84
BC_1	8.26	25.77	29.94	225.98	4.39	31.52	3.06	18.05
$BC_{1.5}$	8.26	29.74	30.21	239.53	4.72	33.01	3.14	19.46
BC_2	7.60	28.25	28.42	239.53	4.50	31.98	3.27	19.36
BC_1 F	8.76	29.74	29.59	244.05	4.37	31.40	2.76	15.44
$BC_{1.5}$ F	9.42	29.24	28.90	212.42	4.76	33.09	2.91	13.55
BC_2 F	7.43	30.73	27.10	262.13	4.26	30.53	2.81	13.89
F	9.09	27.26	30.35	225.98	7.76	56.09	3.00	10.26

A = aerobic compost, B = barrel compost, C_1 = compost 1 t ha^{-1}, $C_{1.5}$ = compost 1.5 t ha^{-1}, C2 = compost 2 t ha^{-1}, F = fertilizer.

Table-2 DTPA and 0.1 N HCl extractable Fe, Mn, Cu and Zn in Dhamrai soil

Treatment	Fe (mg kg^{-1})		Mn (mg kg^{-1})		Cu (mg kg^{-1})		Zn (mg kg^{-1})	
	DTPA	0.1NHCl	DTPA	0.1NHCl	DTPA	0.1NHCl	DTPA	0.1NHCl
Control	11.56	34.69	27.31	116.90	5.82	23.50	2.96	16.94
AC_1	14.54	36.18	27.45	117.51	6.27	25.87	2.61	15.25
$AC_{1.5}$	13.55	34.69	27.86	113.29	6.15	24.55	2.42	14.81
AC_2	13.55	39.15	25.24	113.89	6.33	26.01	2.55	16.12
AC_1 F	12.72	33.70	25.44	117.51	6.09	24.59	2.68	15.39
$AC_{1.5}$ F	14.21	32.21	23.92	111.48	6.11	24.85	2.47	14.81
AC_2 F	12.89	35.19	25.44	115.40	5.96	23.90	2.95	16.31
BC_1	14.04	32.71	27.17	111.48	6.33	25.41	3.30	16.46
$BC_{1.5}$	13.38	33.21	27.40	122.93	6.04	25.00	2.76	15.00
BC_2	12.39	36.76	25.79	129.56	6.11	25.95	3.00	16.46
BC_1 F	14.21	39.65	26.07	129.56	6.11	25.80	2.81	16.17
$BC_{1.5}$ F	11.56	35.19	20.12	122.93	5.98	24.01	3.13	18.49
BC_2 F	11.56	34.20	22.47	126.55	5.21	21.36	2.57	16.46
F	10.74	32.21	21.64	122.33	5.12	21.01	2.89	16.31

A = aerobic compost, B = barrel compost, C_1 = compost 1 t ha^{-1}, $C_{1.5}$ = compost 1.5 t ha^{-1}, C_2 = compost 2 t ha^{-1}, F = fertilizer.

Zn Availability: Control treatment of Melandaha soil contained 2.71 mg kg^{-1} and 19.60 mg kg^{-1} available Zn for DTPA and 0.1 N HCl extractants respectively (Table 1) but for Dhamrai soils it was 2.96 mg kg^{-1} and 16.94 mg kg^{-1} respectively (Table 2). The DTPA extractable Zn in Melandaha soil varied from 2.71 to 3.27 mg kg^{-1} depending on the compost / fertilizer treatments, while the element in the same soil extracted by 0.1 N HCl ranged between 10.26 and 22.02 mg kg^{-1} (Table-1). In Dhamrai soil, the DTPA- Zn content was 2.42 to 3.30 mg kg^{-1} and the 0.1 N HCl-Zn was 14.81 to 18.49 mg kg^{-1} over the treatments. It appeared that the 0.1 N HCl extracted about 3 to 7.5 times more Zn than the 0.5 M DTPA did.

It was found that the availability of Fe, Mn, Cu and Zn was higher in case of 0.1 N HCl than DTPA. The availability of Fe, Mn, Cu and Zn was about 2-4.5 times, 4-10 times, 4-7 times and 3-7.5 times higher respectively for 0.1 N HCl than DTPA. Cox and Wear (1977) reported critical Zn soil test levels for corn (*Zea mays* L) and rice (*Oryza sativa* L) for three methods e.g. DTPA; 0.1 N HCl, and the double acid (0.05N HCl and 0.025N H_2SO_4). For corn the critical soil test levels were 0.5 ppm of Zn for DTPA, 1.4 ppm of Zn for 0.1 N HCl and 0.8 ppm of Zn for double acid. For rice the values were 0.7, 1.8 and 1.4 ppm respectively. So, this experimental result of the present study was more or less similar to those of Cox and Wear (1977). They found that when 0.1 N HCl was used the availability of Zn was 2.8 times higher in case of corn and 2.57 times higher in case of rice then DTPA. Finally it can be said that the HCl extracted higher amount of Fe and other elements due to acidic reaction. However, the 0.5 M DTPA (pH 7.3) might be more suitable for extracting elements in neutral or alkaline or calcareous soils and similarly 0.1 N HCl in acidic soils. In principle, the pH of an extractant should be close to the soil pH as possible.

Conclusion

The available status of Fe, Mn, Cu and Zn varied significantly between soils and also between extractants used. The 0.1 N HCl extracted more Fe, Mn, Cu and Zn compared to 0.5 M DTPA (pH 7.3).

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