Egypt J. Soil. Sci. 47, No. 4, pp. 385 - 399 (2007)

Valuing of some Methods Used to Extract some Soil Available Micronutrients

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TWENTY soil samples (0-30 cm) were collected from different Governorates of Egypt (20 locations in 7 Governorates) to study the preferability of some methods used to extract soil available Fe, Mn and Zn under Egyptian conditions. The methods of Olson were chosen in this study. In addition, a biological test was carried out in order to study the correlation between the extracted amounts of available Fe. Mn and Zn and their contents in barley plants.

The obtained data could be summarized in the following points:

1. The extraction power of the investigated methods for available -Fe could be arranged in the order of: Lakenen & Ervio > Knudsen > Soltanpour and Schwab > Olsen & Carlson >Lindsay & Norvell.On the other hand, the amounts of Mn- extracted could be declined in the order of: Lakenen & Ervio > Olsen & Carlson > Soltanpour and Schwab > Lindsay & Norvell> Knudsen While the powerful of the extraction methods of available-Zn could be take the order of: - Lakenen & Ervio, > Knudsen > Lindsay & Norvell > Soltanpour and Schwab > Olsen & Carlson.

2. With respect to the correlations between Fe, Mn and Zn contents in barley plants and those amounts in soils, extracted by the methods under study, significant relations with positive trends between themes were noticed. The superiority of these correlations related with the type of element under investigation.

3. The obtained data cleared that the role of indigenous soil parameters, *e.g.*, $CaCO_3$, EC, pH, O.M and soil texture contents, on the powerful of the studied extractants depending on the type of extracting agent and the element under investigation.

4. The correlation coefficients between the studied methods each other were calculated for each studied micronutrient. The most positive coefficients were significant while the negative ones were insignificant

Keywords: Soils samples, Nutrients extracting methods, Barley.

The aim of any extracting method was how to obtain a value of the available nutrient most appropriate to plant absorption availability under the different soil properties. Olsen & Carleson (1950) and Knudsen *et al.* (1982) used 1 N ammonium acetate at pH 4.8 and 7.0, respectively, while Lakenen & Ervio (1971) used ethylene di amine tetra acetic acid (EDTA) in ammonium acetate at pH 4.65 for extracting soil. From other wise di- ethylene tri amine pent acetic acid (DTPA) was suggested with ammonium bi- carbonate at pH 7.6 by Soltanpour & Schwab (1977) or alone at pH 7.3 by Lindsay & Norvall (1978) as extracting agents.

Define the indigenous soil parameters, affect vigorously on the available amounts of Fe, Mn and Zn in the soils, help in chosen the suitable methods that used in extracting these available amounts. As well as defining, the correlations between these methods and growing plants considered the very important steps in manipulation the deficits of these micronutrients in the soils of Egypt.

Hegazy *et al.* (1991) found highly significant correlation coefficients between the amounts of Fe-extracted by AAAC-EDTA, NH_4OAC, EDTA+ $CaCl_2$, DTPA and AB+ DTPA and all significantly correlated with iron content in Sorghum plants (r-values = 0.957^{**}, 0.933^{**}, 0.890^{**}, 0.850^{*} and 0.848^{**}, respectively). Also, Shahandeh *et al.* (1995), found that DTPA and AB+DTPA extractable Fe-values were significantly correlated together and both procedures extracted relatively comparable amounts of soil Fe.

Abd El-Rasoul (1995) found a negative correlation between available-Fe and $CaCO_3$ content of soil. A significant relationship was observed between soil available-Fe in negative trend with soil pH and in positive relation with soil EC and O.M % of soil through the researches of Sadana *et al.* (1990). In addition, Manal (2000) found that the statistical analysis show positively high significant correlations between DTPA extractable – Fe and organic matter content (O.M) r= 0.524**. Abdel – Kader (2000) showed that available – Fe was positively highly significantly correlated with silt % and clay %.

Sillanpaa (1982) reported significant correlation coefficients between Mn extracted by AAAC- EDTA and Mn content by wheat plants r= 0.390*. Hegazy *et al.* (1991) found that the amounts of Mn extracted by different extractants from the calcareous soils declined in the order of: AAAC–EDTA > NH_4OAC > DTPA > AB+DTPA. They also found significant relationships between Mn-extracted by the extracting solutions and Mn content by sorghum plants (r= 0.77 *, 0.968**, 0.77** and 0.829** respectively).

El-Damaty *et al.* (1971) found highly positive correlation between all forms of Mn in soil and both of O.M content and silt percentage in soils, but highly significant negative correlation with soil pH value. Such results may induce the suggestion that soil pH could be one of the most important indigenous soil parameters influencing soil Mn extractability. Raja *et al.* (1989) reported a positive significant correlation between DTPA– extractable Mn and O.M., while negative correlation with sand percentage and Lime.

Mohamed (1990) reported those extractable-Zn ranges between 0.4-2.4 ppm and 0.2-1.2 ppm in the alluvial and calcareous soils, respectively. Salem (2001) found a significant correlation between soil available-Zn extracted by Soltanpour & Schwab (1977) method and Zn - concentration in barley plant with r-value = 0.214*. Hegazy *et al.* (1991), found a highly significant correlation coefficients between Zn -extracted by Lakenen & Ervio (1971); Lindsay & Norvell (1978) and Soltanpour & Schwab (1977) and Zn- content of sorghum plants with r-values of 0.892**, 0.975** and 0.77** , respectively.

Soil reaction is one of the most important factors affecting Zn availability in soils. In the soils of Egypt, Abdel–Razik (1999) found negative and highly significant correlation between Zn and soil pH (r= -0.412**). Available-Zn extracted by DTPA showed significant positive correlation with organic matter (O.M) Brown *et al.* (1971). Sadana *et al.* (1990) concluded that soil available-Zn significantly was related and positively with EC. Abdel- Kader (2000) showed that available-Zn was positively highly significant cor3relation with silt % and negatively highly significantly correlated with sand %.

Material and Methods

Twenty surface soil samples (0-30 cm layer) were collected from seven Governorates in Egypt. These soil samples were air dried, crushed, sieved through a 2mm stainless steel sieve, thoroughly mixed and stored in plastic jars for pot experiment and laboratory analysis. Table 1 presented some properties of the collected soil samples. The routine analyses of different soil samples indicated in these tables were carried out according to the convention methods outlined by Black (1965).

Available micronutrients in soils were extracted using different reagents as follows:

Available micronutrients in soil were extracted using different reagent as follows:

1. NH_4OAC, buffered at pH 4.8 (Olsen & Carlson 1950): 20-ml solution was added to 5 grams soil, shaken for 30 min. then filtered (in abridgement Olsen method).
2. Acid ammonium acetate+EDTA (AAAC+EDTA) 0.5N with respect to both ammonium acetate and acetic acid; pH adjusted to 4.65 and 0.02M NaEDTA Lakenen & Ervio (1971): 50 ml solution was added to 5grams soil, shaken for 1 hour then filtered.
3. Ammonium bicarbonate - DTPA (AB+DTPA) 0.005M DTPA +1M NH_4HCO_3, pH 7.6 Soltanpour & Schwab (1977): 40 ml solution was added to 20 grams soil, shaken for 15 minutes the extracts are then filtered through Whatman No. 42 filter paper.
4. DTPA solution 0.005M DTPA, 0.1M TEA and 0.01M $CaCl_2$ pH 7.3(DTPA+TEA+$CaCl_2$) Lindsay and Norvell, (1978): 20 ml solution was added

to 10 grams soil, shaken for 2 hr then the contents were filtered through Whatman No.42 filter paper.

5. Ammonium acetate 1N NH_4OAC pH 7.0 (Knudsen *et al.*, 1982): 60 ml solution was added to 3 grams soil, shaken for 30 min then filtered (in abridgment Knudsen method) (Table 1).

TABLE 1. Some chemical and physical characteristics of the soil samples.

No	Locations	Governorate	pH (1:2.5)	EC (dS/m) soil paste	*Particle size distribution (%)*				Texture	$CaCO_3$ %	OM %
					*C.S %	**F.S %	Silt %	Clay %			
1	Bahig	Alexandria	7.9	11.5	29.7	24.9	2.2	43.2	SC	22.4	1.4
2	Phlastin	El-Beheera	8.3	16.8	15.4	38.2	13.5	33.0	SCL	36.8	2.6
3	N-phlastin	El-Beheera	8.0	7.2	20.0	33.7	25.3	31.0	CL	33.2	2.3
4	El-Noubaria	El-Beheera	7.7	2.6	14.0	46.7	16.2	23.2	SCL	25.9	1.0
5	El -Boston	El-Beheera	8.0	8.4	45.6	39.1	3.7	11.7	LS	13.6	1.0
6	Tag-Eleaz	El-Dakahlia	7.4	11.0	2.9	10.0	33.0	54.2	C	1.2	1.9
7	Ashmoun	El-Monofia	7.7	2.2	5.2	10.4	34.9	50.0	C	2.0	2.6
8	El -Sadat	El-Monofia	7.9	2.5	53.4	35.5	1.0	10.1	LS	6.4	0.7
9	El-Hezania	El-Kaluobia	7.5	1.9	21.4	13.6	22.0	43.1	*C*	3.6	2.2
10	Kafr Hamza	El-Kaluobia	8.1	2.4	5.0	7.5	11.3	76.3	*C*	4.0	2.7
11	Bahtim 1	El-Kaluobia	7.2	5.0	0.6	17.3	32.0	50.1	*C*	0.4	2.5
12	Abo Zable	El-Kaluobia	8.0	1.7	48.0	20.8	6.2	25.1	*SCL*	2.0	1.5
13	EL- Lateg	El-Kaluobia	8.2	2.8	40.2	15.0	2.8	42.0	*SC*	2.8	1.7
14	Bahtim 2	El-Kaluobia	7.5	16.2	2.3	2.3	41.7	53.7	*Si.C*	5.8	2.3
15	Bahtim 3	El-Kaluobia	7.4	10.7	1.6	14.1	69.0	15.3	*Si.L*	2.5	3.4
16	Elmanashi 1	El-Giza	8.2	1.0	3.2	12.2	34.8	49.9	C	2.9	2.1
17	Elmanashi 2	El-Giza	7.7	1.5	4.2	12.4	35.4	48.1	*C*	1.6	1.7
18	Fayoum 1	El-Fayom	8.0	3.3	4.3	6.0	31.2	58.5	C	11.5	1.2
19	Fayoum 2	El-Fayom	8.1	6.3	4.9	15.0	24.9	55.3	C	3.2	2.4
20	Fayoum 3	El-Fayom	8.0	9.9	3.7	16.8	28.8	50.8	C	6.1	1.4

**C.S: Coarse sand   **F.S: Fine sand   C: clay   SCL: sandy clay loam*
LS: loamy sand   SC: sandy clay   Si.C: silty clay   Si.L: silty loam   CL: clay loam

A greenhouse pot experiment, with three replicates, was conducted in Bahtim experimental research station (Agric.Res.Center), to study the relations between Fe, Mn and Zn contents in plant and their amounts extracted from different studied soils by the different chemical methods under investigation. Barley plants (*Hordeum vulgare* L.) cv Giza 128 were grown as a test plant.

Each pot with 15 cm diameter and 17 cm depth, was filled with one-kilogram of air- dried soil. After complete emergence, the seedlings were thinned to ten plants in each pot. The experiment was arranged in a complete randomized design with three replicates.

At the end of the experiment, 60 days from sowing plants of each pot were harvested by cutting them 1 cm above the soil surface. The plants were washed with deionized water; oven dried at 70°C, weighted, ground and kept in paper bags for chemical analysis. 0.2gm plant samples were digested in mixture of $HClO_4$ and H_2SO_4 according to the procedure of Chapman & Pratt (1961). Then Fe, Mn and Zn in the digested plant solutions and in the different soil extractants were determent by using atomic absorption spectrophotometer.

The obtained data were exposed to proper statistical analysis of simple correlation coefficients and regression equations and stepwise regression equations by using the Minitab program (Barbara & Brain, 1994). In addition, contribution factors were mathematically calculated.

Results and Discussion

The extracting power of the used methods

Extractable-Fe

The powerful of the extraction methods for extracted - Fe could be arranged in the order of: Lakenen & Ervio, (100.70 mg/kg soil) > Knudsen *et al.*, (42.75 mg/kg soil) >Soltanpour and Schwab (12.37 mg/kg soil) > Olsen & Carlson (7.43 mg/kg soil) >Lindsay & Norvell, 1978 (5.95 mg/kg soil) (Table 2) .

TABLE 2. Available Fe (mg/kg soil) extracted by different methods and their contents (mg/kg DM) in shoot of barley plants.

Soil No	Olsen	Lankenen	Soltanpour	Lindsay	Kundsen	Shoot Content
	Soil Extractable Fe (mg/ kg soil)					
1	9.00	30.00	12.53	2.90	27.63	2160
2	6.96	46.66	14.16	6.00	77.33	1987
3	9.83	60.00	6.10	5.30	71.66	1327
4	2.16	80.00	21.26	10.00	37.33	1587
5	8.00	80.00	7.16	3.30	27.33	1869
6	9.93	140.00	33.50	12.66	40.66	1250
7	3.36	42.33	2.10	1.33	5.23	110
8	5.53	67.77	8.26	3.70	74.33	1295
9	8.00	135.33	10.90	6.63	26.56	1420
10	6.43	133.60	14.80	6.00	27.66	1697
11	10.20	70.33	11.30	4.60	50.00	1545
12	5.73	95.33	14.16	6.60	37.03	1168
13	6.83	61.66	8.60	6.00	38.50	913
14	8.00	182.33	13.26	7.30	80.00	2368
15	8.69	143.66	7.20	5.00	33.60	1220
16	7.00	134.00	9.00	4.10	33.40	1069
17	6.30	127.30	11.70	6.36	29.57	1280
18	15.16	157.30	15.16	4.00	34.96	2060
19	6.63	98.66	11.50	7.30	35.36	2450
20	5.03	128.00	14.83	10.00	36.96	2283
Mean	7.43	100.70	12.37	5.95	42.75	1569

The correlation coefficients among the previous extraction methods showed high significant correlation between the values of available Fe-extracted by Soltanpour & Schwab method and both of the values extracted by the methods of Lindsay & Norvell (r = 0.787**) and Lakenen & Ervio (r =0.357**). In addition, high significant correlation was noticed between Lindsay & Norvell, and Lakenen & Ervio, methods (r = 0.378**). The results showed also that the correlation between the two extraction methods of Lakenen and Olsen was highly significant with r =0.339**.

Similar results were found that DTPA and AB- DTPA extractable -Fe values were significantly correlated together and both procedures extracted relatively comparable amounts of soil Fe. In addition, Salem (2001) found that extractable - Fe values with Lakenen & Ervio, method were highly significantly correlated with the same values extracted with Lindsay & Norvell, and Soltanpour & Schwab, whereas the (r) values were 0.728** and 0.857** respectively. In addition, he found high significant level with r = 0.712** between the two methods of Lindsay &Norvell and Soltanpour & Schwab.

Extractable-Mn: So, the extraction powerful of the methods used to extract Mn could declined in the order of: Lankenen & Ervio (125.8 mg/kg soil)> Olsen & Carlsonn (31.65 mg/kg soil) > Soltanpour and Schwab (15.40 mg/kg soil) > Lindsay & Norvell (10.74 mg/kg soil) > Kundsen *et al.* (4.38 mg/kg soil) (Table 3) .

TABLE 3. Available Mn (mg/kg soil) extracted by different methods and their contents (mg/kg DM) in shoot of barley plants.

No	Olsen	Lankenen	Soltanpour	Lindsay	Kundsen	Shoot Content
1	19.13	50.00	13.63	9.06	2.00	89.30
2	26.80	61.33	22.76	12.60	2.00	80.00
3	19.06	71.00	21.00	15.06	4.00	99.30
4	21.20	77.33	18.13	10.40	21.20	64.66
5	16.10	16.66	9.30	8.53	2.00	45.33
6	35.00	211.00	21.66	13.45	10.00	95.66
7	21.00	141.33	10.31	10.53	4.66	59.33
8	65.00	163.00	10.57	5.03	6.66	149.00
9	22.00	79.16	19.00	12.33	8.00	70.66
10	26.60	155.00	12.20	12.06	4.66	66.66
11	32.33	189.00	11.83	6.50	4.00	76.66
12	28.66	53.00	17.73	7.86	4.00	39.33
13	33.23	160.66	9.13	5.20	2.00	100.00
14	45.06	21.80	20.90	16.40	5.33	80.00
15	42.80	138.00	27.00	21.52	5.00	126.60
16	21.00	85.0	11.50	9.16	6.66	6.33
17	25.00	123.00	17.16	9.70	4.77	98.66
18	23.60	12.50	5.23	42.46	23.46	48.66
19	36.26	23.00	17.50	12.85	36.26	63.33
20	73.00	206.66	11.54	14.10	73.00	98.00
Mean	31.65	125.80	15.40	10.74	4.38	80.74

As for the correlation between these different methods for extracting available-Mn, data showed high significant trend between the values of available Mn- extracted by Soltanpour & Schwab method and both of the same values extracted by Lindsay & Norvell and Knudsen *et al.* methods, (r = 0.794** and 0.280*, respectively). In addition, the results showed high significant correlations between available Mn -extracted with Lakenen & Ervio methods and both of the same values extracted by Olsen & Carlson and Knudsen *et al.* methods (r = 0.461** and 0.387** respectively). Similar results were reported by Salem (2001), who found very high significant correlation between Soltanpour & Schwab and Lindsay & Norvell with r = 0.759*** with respect to Mn -extractability.

Extractable-Zn

Regarding the powerful of the extraction methods for extracting Zinc. It could be put in the order of: - Lakenen & Ervio (mean of extracted-Zn 9.70 mg/kg soil)> Knudsen et al., (mean of extracted-Zn 4.11 mg/kg soil) > Lindsay & Norvell (mean of extracted-Zn 3.25 mg/kg soil) > Soltanpour and Schwab (mean of extracted-Zn 3.08 mg/kg soil) > Olsen & Carlson (mean of extracted-Zn 2.10 mg/kg soil) (Table 4).

TABLE 4. Available Zn (mg/kg soil) extracted by different methods and their contents (mg/kg DM) in shoot of barley plants.

No	Olsen	Lankenen	Soltanpour	Lindsay	Kundsen	Shoot Content
1	0.96	2.93	3.76	2.33	1.96	240
2	0.41	14.33	3.43	3.86	5.56	507
3	2.80	10.66	2.00	4.26	3.66	733
4	2.73	5.33	3.66	5.33	3.76	613
5	2.50	8.33	3.00	2.63	3.76	640
6	2.20	5.00	3.90	4.76	5.96	540
7	1.26	2.83	2.33	2.20	1.36	177
8	3.73	10.30	3.46	4.30	7.50	987
9	1.63	5.40	1.36	1.20	2.33	260
10	3.66	12.03	2.26	5.00	1.53	173
11	1.16	11.80	2.46	2.10	4.46	206
12	1.13	2.70	2.73	1.43	3.30	264
13	1.80	7.33	3.76	1.40	2.00	807
14	2.03	18.00	3.73	2.36	2.00	341
15	3.26	6.00	1.43	3.23	3.93	607
16	3.46	14.33	4.33	4.16	5.40	1053
17	0.90	11.00	2.43	2.50	4.16	801
18	1.96	9.16	2.46	3.33	5.33	340
19	3.02	15.53	4.53	5.00	7.13	613
20	1.26	7.66	4.76	3.66	7.16	627
Mean	2.10	9.70	9.70	3.08	3.25	526

The correlations between the previous methods revealed significant correlation between the values of available Zn - extracted by Soltanpour & Schwab method and the values of Zn extracted by Knudsen et al., Lindsay & Norvell and Lakenen & Ervio methods with r values = 0.475**, 0.356** and 0.310** respectively. Also, the data revealed high significant correlation between Lindsay & Norvell method and the methods of Olsen & Carlson, Lakenen & Ervio and Knudsen with r values = 0.578**, 0.507** and 0.504** respectively. The results showed also that the correlation between the two extraction methods of Lakenen and Olsen was highly significant with r =0.319**.

Hegazy *et al.* (1991) reported that Lakenen & Ervio method was the best extraction method for available-Zn. They added that the high efficiency of this method could be due to the low initial pH of this solution (pH= 4.65).

These results coincided with the researches of Sippola (1994) and with Schnug *et al.* (1999).

Effects of indigenous soil parameters:

The values of the different indigenous soil parameters were exposed to stepwise regression analysis against soil extractable micronutrients for naming the most effective soil parameters on the powerful of the different used extractions. The stepwise regression equations were presented in Table 5. In addition, the contribution factors of these most effective parameters were mathematically calculated.

Extractable-Fe

Stepwise regression in Table 5 showed that, in the method of Soltanpour & Schwab, clay fraction was the strongest factor on extractable-Fe and contributed with 7%. On the other hand, OM content in soil contributed with 9.0 %, when Fe was extracted by Lindsay & Norvell method. With respect to Lakenen & Ervio method, sand fraction was the most effective factor followed by $CaCO_3$ % in soil. They contributed on Fe-extracted with 40.0 and 8.0 % respectively. In the method of Olsen & Carlson, sand % of soil was the effective factor on extracted-Fe and contributed with 8.0%,. Concerning the Knudsen *et al.,* method the most effective soil parameters on extractable –Fe were $CaCO_3$, clay and OM contents in of soil. Their contribution factors on the extracted iron were 33.0 %, 8.0% and 6.0 %, respectively.

Extractable-Mn

Data in Table 5 revealed that, O.M % is the greatest effective factor followed by clay %, sand % and EC of soil when Mn was extracted by Soltanpour & Schwab method. They contributed with 30.3 %, 24.9 %, 9.1% and 3.9 % respectively. With respect of Lindsay & Norvell, method silt % is the most effective factor followed by EC, O.M% and clay % of soil. Their contribution factors were 36.0%, 18.7 %, 4.7 %, and 7.0 % respectively. When Mn was extracted by Lakenen & Ervio method CaCo3 % in soil contributed with 17.2 %.

Concerning the Olsen & Carlson method, the most effective soil parameter on its efficiency were CaCO3 and EC of soil. Their contribution factors were 9.0 % and 15.0 % respectively. As for, Knudsen *et al.,* method the most effective soil parameter on extractable- Mn were pH and $CaCo_3$ %, of soil. Their contribution factors were 22.8 and 6.1%, respectively.

Extractable-Zn

As shown in Table 5, the stepwise regression indicated significant correlations among some soil parameter and Zn- extracted by three extractant only. Date showed that pH was the best effective soil parameter on extractable-Zn by Soltanpour & Schwab method and contributed with 16.0%. While in Lindsay & Norvell, the best effective soil parameter on extractable-Zn was $CaCO_3$ (contributed with 8.0%). With respect to Lakenen & Ervio method, OM % was the most effective soil factor on extractable-Zn and contributed with11.0 %.

The previous findings agree to some extent, with the researches of many scientists on the effects of different soil characteristics on the efficiency of some micronutrients chemical extractants (El-Hussieny, 1995; Tadross, 1997; Abdel-El-Kader, 2000 and Sadik *et al.,* 2002).

TABLE 5. Stepwise regression equations between the indigenous soil parameters and soil extracted micronutrients (mg/ Kg DM).

Extractable micronutrients	Methods of extraction	Stepwise regression equations	R^2
Iron (Fe)	Olsen	Y = 8.53 – 0.03 Sand	0.08
	Lakenen	Y = 138.9 – 1.04 Sand Y = 142.8 – 0.84 Sand – 1.17 $CaCo_3$	0.40 0.48
	Soltanpour	Y = 8.37 + 0.102 clay	0.07
	Lindsay	Y = 3.24 + 1.46 OM	0.09
	Knudsen	Y= 34.45 + 1.10 $CaCo_3$ Y = 51.22 + 0.93 $CaCo_3$ – 0.37 Clay Y= 39.82+ 0.84 $CaCo_3$- 0.53 Clay + 10.2 OM	0.33 0.41 0.47
Manganese (Mn)	Olsen	Y = 35.56 – 0.41 $CaCo_3$ Y = 29.77 – 0.65 $CaCo_3$ + 1.28 EC	0.09 0.240
	Lakenen	Y = 129.4 – 2.34 $CaCo_3$	0.172
	Soltanpour	Y =5.36+ 5.46 OM Y = 8.59+ 7.74 OM – 0.181 clay Y = 19.0+ 6.55 OM–0.291 Clay – 0.109 Sand Y = 17.99+ 5.62 OM – 0.269 Clay – 0.106 sand + 0.275 EC	0.303 0.552 0.643 0.682
	Lindsay	Y = 7.06 + 0.157 Silt Y = 5.14 + 0.134 Silt + 0.393EC Y = 2.53 + 0.118 Silt + 0.340EC + 1.81 OM Y = 3.61+ 0.122 Silt + 0.294 EC + 2.63OM – 0.059 Clay	0.360 0.547 0.594 0.664
	Knudsen	Y = 32.10 – 3.52 pH Y = 27.06 – 2.82 pH – 0.052 $CaCo_3$	0.228 0.289
Zinc (Zn)	Olsen		n s
	Lakenen	Y = 4.42+2.9 OM	0.11
	Soltanpour	Y = - 7.81 +1.39 pH	0.16
	Lindsay	Y= 2.93 + 0.03 $CaCO_3$	0.08
	Knudsen		n.s.

Y = Soil extractable-micronutrient

Biological evaluation of the different extraction methods:

A biological test was carried out, thought a greenhouse experiment, in order to study the correlations between the extracted amounts of available Fe, Mn & Zn and their contents in barley plants (Tables 2-4). These correlations were represented in Table 6.

TABLE 6. The correlations coefficients (r) and regression equations between soil micronutrients extracted with different methods and their concentration in barley plants.

Extractable Micronutrients	Methods of extraction	*Regression equations*	Correlation coefficients(r)
Iron (Fe)	Olsen	Y = 1135 + 58.7 X	0.285*
	Lakenen	Y = 1214 + 3.51 X	0.262*
	Soltanpour	Y = 1272 + 23.8 X	0.272*
	Lindsay	Y = 1244 + 55.3 X	0.270*
	Knudsen	Y = 1150 + 9.42 X	0.350**
Manganese (Mn)	Olsen	Y = 46.1 + 1.09 X	0.602**
	Lakenen	Y = 59.0 + 0.201 X	0.460**
	Soltanpour	Y= 11.5 + 0.054 X	0.262*
	Lindsay	Y = 63.5 + 1.59 X	0.256*
	Knudsen	Y = 66 4 + 3 20 X	0.256*
Zinc (Zn)	Olsen	Y = 296+ 109 X	0.420*
	Lakenen	Y = 373+ 15.6 X	0.289**
	Soltanpour	Y= 216.7 + 100 X	0.384**
	Lindsay	Y = 303.8 + 68 X	0.336**
	Knudsen	Y = 224 + 73 X	0.527**

* Significant correlation at 0.05 and ** at 0.01

Y= Micronutrient concentration in plant X=Soil extractable micronutrient

Data presented in Table 2 showed that Fe-content (mg/kg DM) in barley shoot plants ranged from 110 to 2449.3 (mg/kg DM) with mean value of 1567.86 (mg/kg DM). There was a significant correlations with positive trend, between

Fe- content in barley plants and Fe-extracted by the used extraction methods (Table 6) .The highest significant correlation was found with Knudsen et al., (r=0.350**), while the lowest correlation was found with the extraction agent of Lakenen & Ervio (r= 0.262*). These findings are in good agreement with the studies of Aboulroos *et al.* (1968) and Salem (2001).

Data presented in Tables 3 & 4 indicated that Mn-content (mg/kg DM)in barley shoot plants ranged from 39.33 to 149.3 mg/kg DM (mean value of 80.74). Significant Correlation was found between Mn-content in barely plants and Mn-extracted with all the studied methods. These correlations could be arranged in the order of: Olsen & Carlson (r=0.602**)>, Lakenen&Ervio (r=0.46**)>Soltanpour& Schwab (r=0.262*) >Lindsay & Norvell = Knudsen et al., (r =0.256*). Many investigators supported these findings such as Sillanpaa (1982) who found highly significant positive correlation (r=0.552**) between DTPA extractable- Mn and Mn-ppm in plant material. In addition, Hegazy *et al.* (1991) found that the amounts of Mn- extracted by Soltanpour & Schwab significantly correlated with Mn- content by sorghum plants (r =0.829**).

The data presented in Table 4 showed that Zn content (mg/kg DM)in barley plants ranged from 206 to 1053.3 (mg/kg DM) with mean value of 526.36 mg/kg DM.

The correlation coefficients and regression equations between Zn contents in plants and Zn-extracted under this study were positive and highly significant with all the extraction methods (Table 4). The highest significant correlation was found with Knudsen et al., r =0.527**, followed with the methods of Olsen & Carlson (r=0.420**), Soltanpour & Schwab(r=0.384**) and Lindsay & Norvell (r =0.336**). While the lowest one was found with the extraction method of Lakenen & Ervio, r = 0.289*.

Many investigators such as Hegazy *et al.* (1991) and Salem (2001) who found a positive significant correlation between Zn-content in barley plant and soil available–Zn extracted with Lakenen & Ervio or with Soltanpour & Schwab methods.

Correlations between the experimental extraction agents :

The correlations coefficients between the previous extraction methods were shown in Table 7. Generally, these data showed high significant correlations between the values of Fe, Mn and Zn extracted by the methods of Soltanpour and Lindsay. In addition, high significant correlations were noticed between the values of these nutrients extracted by Olsen & Lankenen.

On the other hand, non-significant correlations were found between the amounts of Fe-extracted by the solution of Kundsen *et al.* (1982) and those extracted by the other extracting agents under investigation. The findings of Salem (2001) supported these results.

TABLE 7 . Correlation coefficients between different extraction methods.

Extractable Micro-nutrients	Methods	Olsen	Lankenen	Soltanpour	Lindsay
Iron (Fe)	Lankenen	0.339**			
	Soltanpour	0.132	0.357**		
	Lindsay	- 0.121	0.378**	0.787**	
	Kundsen	- 0.029	- 0.087	0.119	0.220
Manganese (Mn)	Lankenen	0.461**			
	Soltanpour	0.012	- 0.196		
	Lindsay	0.178	- 0.084	0.794**	
	Kundsen	0.213	0.387**	0.280*	0.248
Zinc (Zn)	Lankenen & Ervio	0.319**			
	Soltanpour	0.040	0.310*		
	Lindsay	0.578**	0.507**	0.356**	
	Kundsen	0.198	0.224	0.475**	0.504**

* Significant correlation at 0.05 and ** at 0.01

References

Abdel-kader, G.A. (2000) Status of some micronutrients in soils of Kaluobia Governorate . *M.Sc. Thesis,* Fac. of Agric., Zagazig Univ., (Banha Branch) .

Abd El-Rasoul, S. M. (1995) Evaluation of critical levels of iron, zinc, copper and manganese in certain calcareous soils of Egypt. *Ph.D. Thesis,* Fac. of Agric., Al-Azhar Univ.

Abdel Razik, S. A. (1999) Trace element status and its relation to some soil variable in sandy and calcareous soils of Egypt. *J. Agric. Sci., Mansoura Univ.* **24**: 1141- 1451.

Aboulroos, S.A. (1968) Effect of leaching the soil on the status of some nutrient elements. *M.Sc. Thesis*, Fac. of Agric., Cairo Univ.

Barbara, F.R. and L.J. Brain (1994) Minitab Handbook. Duxbury press. An Imprint of Wad Sworth Publish. Comp., Belonont, California, U.S.A.

Black, C.A. (1965) *"Methods of Soil Analysis"*, Parts II, Amer. Soc. Agron., Inc. Publ. and II Madison, Wisc., U.S.A.

Brown, A.L.; Quick, J. and Eddings, J.L. (1971) A comparison of analytical methods for soil Zinc *Soil Sci Soc. Am. Proc.* **35**: 105 -107 .

Chapman, H.D. and Pratt, P.E. (1961) Methods for Analysis of Soils, Plants and Waters. Univ. of Calif, Div. of Agric. Sci.

El-Damaty, A.H.; Hamdi, H. and Orabi, A.A. (1971) Manganese status in the soils of Egypt. *U A.R J. Soil Sci.* **11**: 7 – 26 .

El-Hussieny, O.M. (1995) Petrochemical studies on some soils of Egypt with special reference to some to heavy meatless. *Ph.D. Thesis,* Fac. of Agric., Zagazig Univ., Egypt.

Hegazy, M.N.A.; El-Sayad, E.A. and Sorour, A.M. (1991) Evaluation of some extractants for determining available Fe, Mn, Zn and Cu in some Egyptian soils Zagazig. *J. Agric. Res.* **18**: 897 – 910 .

Knudsen, D.; Peterson, G.A. and Pratt, P.F. (1982) Lithium, Sodium and potassium. In: *"Methods of Soil Analysis"*, A.L. Page *et al.* (Ed.), Part 2, pp. 225 – 246. Agronomy Monogr, 9. ASA and SSSA, Madison, WI.

Lakenen, E. and Ervio, R. (1971) A comparison of eight extractants for the determination of plant available micronutrients in soils. *Acta Agric. Fenn.* **123**: 223 – 232 .

Lindsay, W.L. and Norvell, W.A. (1978) Development of a DTPA soil test for zinc, Iron, manganese and Copper. *Soil. Sci. Soc. Amer. J.* **42**: 421 – 428 .

Mohamed, N.A. (1990) Nutrient status in some soils as related to mineralogical composition *M.Sc. Thesis,* Fac. of Agric., Ain Shams Univ., Egypt.

Olsen, R.V. and Carlson, C.W. (1950) Iron chlorsis of Sorghum and trees as related to extractable soil iron and manganese. *Soil Sci. Soc. Amer. Proc.* **14**: 109 – 112 .

Raja, S. A.; Jehangir, K.K.; Sajida, P. and Izharul, H. (1989) To study DTPA extractable micronutrients status and their relationship with soil Properties of dir district. *Sarbadj .of Agric.* **5**.

Sadik, M.K.; Abd El-Hameed, A.H. and Alla, M.A. (2002) Evaluation of some micronutrient chemical extratents. *Egypt. J. Soil Sci.* **42** (2): 277 297 .

Sadana U.S., Takkar; P.N. Nayyar; V.K Kumarand, R. Brar, J.S. (1990) Zinc, iron, Manganese and copper status of soils and wheat crop of Hoshiarpur district Punjab India. *J. of Research Punjab Agric. Univ.* **27**: 32 - 40 .

Salem, H.M.S.S. (2001) Nutrients availability in soils in relation to the different methods of extraction Fe, Mn, Zn and Cu, *Ph.D. Thesis,* Fac. of Agric., Zagazig Univ., Egypt.

Schnug, E. and Fleckenstein, J. (1999) Coca-cola (cc) Extraction for the Evaluation of Available. Micronutrients in soils for oil seed Rap-Shohaeden, H.; L R Hossner; F.T. Turner and J. Abadia (1995): A comparison of extraction methods for evaluating Fe and P in rice soils. Iron nutrition in soils and plants. Proceedings of the seventh International symposium Zaragoza. Spain, 27 June- 2 July pp 175- 181

Sillanpaa, M. (1982) Micronutrients and the nutrient status of soils: A global study. FAO Soils Bulletin 48.

Sippola, J. (1994) Acid Ammonium Acetate- EDTA universal extractant in soil testing and environmental monitoring. *Commun. Soil Sci Plant Anal.* 25: 1755 - 1761 .

Soltanpour, P.N. and Schwab, A.P. (1977) A new soil test for simultaneous extraction of macro-and micronutrients in alkaline soils. Commune. *Soil. Sci. Plant Anal.* **8**: 195 -207 .

Tadross, S.Y. (1977) Studies on the status of some micronutrients in soils of Kalubia Governorate. *M.Sc. Thesis.*, Fac. of Agric. Moshtohour, Zagazig Univ. , (Banha Branch).

(*Received* 6/2007;
accepted 8/2007)

تقييم بعض الطرق المستخدمة لإستخلاص بعض المغذيات الصغرى الميسرة من التربة

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تهدف هذه الدراسة إلى تحديد أفضل الطرق التى يمكن إستخدامها لإستخلاص الصورة الميسرة من عناصر الحديد والمنجنيز والزنك تحت ظروف الأراضى المصرية ، ولإجراء هذه الدراسة تم تجميع عديد من عينات التربة السطحية والتى تمثل عددا من محافظات الجمهورية. والطرق المختارة للمقارنة فى هذه الدراسة هى طرق : أولسن و لاكنن و سلتانبور ولندساى وكندسن. كما اجريت دراسة بيولوجية لمعرفة العلاقة بين الكميات المستخلصة من العناصر تحت الدراسة وبين محتوى نباتات الشعير من تلك العناصر.

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي :-

يمكن ترتيب قوة إستخلاص الحديد الميسر لكل الطرق المستخدمة فى هذا الترتيب: لاكنن كندسن سلتانبور اولسن لندساى و كذلك يمكن ترتيب الطرق بحسب إستخلاصها للمنجنيز الميسر فى الترتيب التالى: لاكنن اولسن سلتانبور لندساى كندسن وبالنسبة للزنك فإن قوة إستخلاص الطرق له تأخذ هذا الترتيب: لاكنن كندسن لندساى سلتانبور اولسن

بالنسبه لعلاقة الارتباط بين محتوى العناصر الصغرى(تحت الدراسة) فى نباتات الشعير وبين الميسرالمستخلص من نفس العناصر، فقد أظهرت الدراسة وجود علاقات إرتباط قوية وموجبة الإتجاه بينهما فى كل الطرق المستخدمة فى البحث ، مع ملاحظة أن الأولوية فى علاقات الإرتباط هذه تختلف بحسب نوع العنصر ونوع محلول الإستخلاص.

أوضحت الدراسة أن تأثير عوامل التربة المختلفة (مثل: كربونات الكالسيوم ٪ والمادة العضوية ٪ و درجة ملوحة التربة والـ pH و نسب المكونات المختلفة المحددة لقوام التربة) يتوقف على قوة إستخلاص محاليل الإستخلاص المختلفة كما يتوقف على نوع المحلول نفسه وكذلك على نوع العنصر تحت الدراسة.

بحساب معاملات الارتباط بين الطرق محل الدراسة بعضها البعض لكل عنصر وجد ان معظم المعاملات الموجبة معنوية بينما لم تكن هناك معنوية للمعاملات السالبة .