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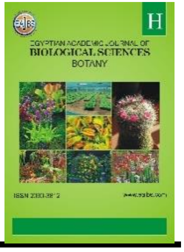

Evaluation of Some Soil Tests to Extract Many of The Available Micronutrients in The Egyptian Soils

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ABSTRACT

Three extractions were used to assess the availability of micronutrients in different soil collections. The suitability of some extractions under the conditions of Egyptian soils will be discussed. Three extraction methods (Mehlic 3, Soltanpour and Kelowna) were used for the determination of available Fe, Zn, Mn, Cu and B content of the soil samples (sand, calcareous and clay) during 2020 season. Surface soil samples (0-30 cm) were collected from three sites of Al Boston area in the new Nobaria, Governorate, Egypt, during 2020 season. From each selected plot, ten points were selected in a zig-zag path. The results revealed that the highest values of available Fe, Zn and Cu were given with the extraction solution of Soltanpour, while the highest values of available Mn and B were given with the extraction solution of Mehlic 3. On the other hand, the results showed that clay soil recorded the maximum available Fe, Zn, Mn and Cu, while calcareous soil recorded the maximum available boron content. The interaction between different extraction methods and soil samples was highly significant during 2020 season.

INTRODUCTION

Egypt has an arid land with almost 96% of uninhabited parts of its territory. More than ninety million inhabitants are concentrated mainly in the Nile delta and valley as well as in the northern coastal zone along with the Mediterranean Sea and in small areas of Western desert where lands are suitable for agricultural production (Bakeer 2008 and Sayed 2013). The main challenge facing Egypt today is the need for better development and management of natural resources to meet the growing needs of the nation. The ratio between land and human resources is the most important problem in Egypt (Abdel-Hamid *et al.*, 2010). The horizontal agricultural expansion in the Western desert is one of the most important objectives of Egyptian agricultural policy to meet the food security needs of the growing population (Ismail *et al.*, 2010). The agricultural expansion in new desert areas is also a priority to compensate for the successive loss of agricultural land in Egypt (Aldabaa *et al*., 2010). The Southwest Tushka area which lies southwest of Egypt is considered as one of the promising areas for agricultural expansion and development (Abd El-Aziz 2004). Land assessment allows lands to be evaluated for agricultural use in accordance with their physical and chemical capacities as well as limitations to protect soil resources from

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degradation during potentialities achieving farmers' demands for optimal crop production (Sharififar 2012).

Essentially it is a desertic plateau with a vast flat expansion of rocky ground or numerous closed depressions. The greatest altitude is attained in the extreme southwestern corner where the general plateau character is disturbed by the great mountain of Gebel Uweinat. North of this mountain, a broad high terrain plateau, known as Gilf El-Kebir, extends for more than 200 km. This sandstone plateau is bordered in the south by a prominent escarpment, that descends gradually to the north and east directions forming a very extensive pediment sandy plain. This sandy plain is dotted in several parts by many rock exposures of Tertiary volcanic origin and basement complex rocks of granitites. Cretaceous rocks formed of what is called the Nubian formation, which is essentially sandstone, occupy the sand plain. In general, soil characteristics, classification and evaluation of some parts in Egypt using different programs (ASLE, MicroLEIS and Modified Storie Index) which were studied at regional stages were investigated by many researchers (Khalifa, 2001 and Ahmed 2016).

Soil testing in the Czech Republic is based on the use of the Mehlich 3 method for the determination of macronutrients and diethylen triamine penta acetic acid (DTPA) and hot-water extraction for the determination of micronutrients. Since inductively coupled plasma optical emission spectrometers have become commonly used in soil testing laboratories, Mehlich 3 extractant could be used very effectively also for a simultaneous micronutrient determination. To take full advantage of the universal Mehlich 3 extractant, new criteria for evaluation of the content of micronutrients in this extractant are needed. The criteria presented in this study were obtained by a simple calculation of criteria from the relationships between the Mehlich 3 extractant and the extraction methods for which the criteria were available (DTPA for copper, zinc, manganese, iron and hot-water extraction for boron). The first calculated estimates of the criteria were pre-validated and slightly adjusted to minimize the difference between the frequency of the samples in each category after determination and evaluation by the compared methods. Further adjustment of the presented critical values with respect to the field and pot experiments will be necessary for the future Zbíral (2016).

Soil testing is an important practice for nutrient management in agricultural production systems. In the United States, soil-test methods and interpretations vary across state lines, making institutional collaborations challenging and crop fertilization guidelines inconsistent. Uniformity and transparency in P and K soil fertility testing and fertilizer recommendations are needed to enhance end-user adoption. The Fertilizer Recommendation Support Tool (FRST) project is developing a comprehensive database of P and K correlation–calibration results that can be accessed through an online tool for use in research and fertilizer recommendation development. This collaborative project, which includes over 30 land-grant universities, the USDA-ARS, the USDA-NRCS, and several not-for-profit organizations, contains a national survey describing the current status of soil testing, minimum requirements for correlation–calibration data inclusion, and database population and creating FRST as a user-friendly online decision support tool. The FRST project will provide more consistent, transparent, and science-based information for crop nutrient recommendations across the United States (Lyons *et al.,* 2020).

The objective of this work was to study the Evaluation of some soil tests to extract many of the available nutrients in the Egyptian soils.

MATERIALS AND METHODS

Surface soil samples (0-30 cm) were collected from three sites of Al Boston area in the new Nobaria, Governorate, Egypt, during 2020 season. From each selected plot, ten points were selected in a zig-zag path. Using soil auger, the samples were collected separately in polythene bags as per the standard procedures recommended by (Srinivasamurthy *et al.*, 2010) and laboratory manual prepared by (Walkley and Black 1934). The quartering technique was used for the preparation of final soil samples. The collected soil samples were air-dried, crushed and sieved through a 2mm sieve and stored in polythene bags for physic-chemical analysis.

Particles-size distribution and the electrical conductivity of the soil samples were performed using the method of (Jackson 1973). Soil organic matter content was determined using the dichromate oxidation method (Jackson 1973). Soil calcium carbonate was estimated using the calcimeter method according to (Nelson and Sommers 1982). Soil reaction pH was determined in saturated soil paste suspension by a gears electrode (Mclean, 1982). Soil salinity (EC) was measured in 1:1 of soil and water extract using a conductivity meter (Jackson 1973). Soluble ions were determined in the saturated soil paste extract according to (Hesse, 1998).

Soil pH in 1:1 solution (1Soil: 1Water) was determined using a digital pH meter, EC was determined by a digital conductivity meter. Organic carbon was determined by using the modified Walkely-Black method (Page *et al.*, 1982), available phosphorous by (Jackson 1973) and available potassium by (Jackson 1973), nitrogen by micro Kjeldahl digestion and distillation method (Varma *et al.*, 1982) was used during analysis.

Calcium and magnesium: determined in soil-water extract (1:1) by titration with versenate (EDTA) solution using Muroxide as an indicator for calcium and Erichrome black T (E.B.T) for calcium plus magnesium, according to (Jackson 1973).

Sodium and potassium: soluble sodium and potassium in soil: water 1:1 w/v extract were determined using flame photometry method according to (Jackson 1973).

Carbonate and bicarbonate: soluble Carbonate and bicarbonate were determined volumetrically in soil: water 1:1 w/v extract by titration against (0.05N) hydrochloric acid solution using methyl orange as an indicator according to (Jackson 1973).

Chlorides: soluble chloride was determined volumetrically in soil: water 1:1 w/v extract by titration against (0.05N) silver nitrate solution with potassium chromate as indicator according to (Jackson 1973).

Sulphate: soluble sulphate in soil: water 1:1 w/v extract by were determined using spectrophotometer according to (Jackson 1973).

Cu, Fe, Mn and Zn were extracted on duplicate samples byDTPA (Lindsay and Norvell, 1978) and with acid solution of Mehlich-3 (Mehlich3 1984).

The extracting solutions were prepared as follows:

DTPA: 0.005 mol L21 DTPA (diethylenetriaminepentaacetic acid), 0.1 mol L21 TEA (triethanolamine) and 0.01 mol L21 $CaCl_2$ at pH 7.3. Soil volumes of 10 cm^3 and 20mL of DTPA solution were used for the extraction. The suspensions were placed in polyethylene flasks covered with a plastic stopper and shaken by horizontal–circular movements at 240 oscillations per minute for two hours. Then, the suspensions were filtered and nutrient concentrations were measured (Abreu *et al.*, 1997).

Table 1: Some physicochemical properties of collected Albostan soil during the 2020 season.

Parameter	Sandy soil		Silty soil		Clay soil	
	Value	**Unit**	**Value**	**Unit**	**Value**	**Unit**
Mechanical Analysis						
Sand	96	%	5	%	17	%
Silt	1	%	88	%	11	%
Clay	3	%	7	%	72	%
Textural class	**Sandy**		**Silt**		**Clay loam**	
pH (1:1)	7.47	-	7.17	-	7.02	-
$CaCO_3$	4.17	%	39.68	%	3.58	%
EC (1:1)water extract)	10.44	dS/m	3.34	dS/m	1.53	dS/m
O.M	0.67	%	2.68	%	3.15	%
Soluble cations						
Ca^{2+}	5.00	meq/l	11.00	meq/l	29.00	meq/l
Mg^{2+}	4.00	meq/l	10.00	meq/l	26.00	meq/l
Na^{+}	8.39	meq/l	18.40	meq/l	48.12	meq/l
K^{+}	1. 82	meq/l	0.97	meq/l	1.28	meq/l
Soluble anions						
HCO_3^-	2.00	meq/l	3.00	meq/l	2.00	meq/l
Cl^-	6.00	meq/l	1350	meq/l	95.50	meq/l
SO_4^{2-}	7.30	meq/l	16.90	meq/l	6.90	meq/l
Available nutrients						
Nitrogen (N)	43.28	mg/kg	34.12	mg/kg	359.90	mg/kg
Phosphorus (P)	16.00	mg/kg	8.00	mg/kg	215.00	mg/kg
Potassium (K)	12.52	mg/kg	84.4	mg/kg	379.32	mg/kg
Copper (Cu)	1.22	mg/kg	0.331	mg/kg	1.50	mg/kg
Zinc (Zn)	0.374	mg/kg	1.37	mg/kg	0.366	mg/kg
Iron (Fe)	5.15	mg/kg	4.31	mg/kg	5.21	mg/kg
Manganese (Mn)	2.61	mg/kg	3.33	mg/kg	22.20	mg/kg

a) Mehlich-3: 0.2mol L21 CH_3COOH, 0.25mol L21 NH4NO3, 0.015 mol L21 NH_4F, 0.013 mol L21 HNO_3, 0.001 mol L21 EDTA adjusted to pH 2.5. Soil volumes of 5cm^3 with 50mL of Mehlich-3 extractant were taken. The suspensions were placed in polyethylene flasks covered with plastic stoppers and shaken by horizontal– circular movements at 240 oscillations per minute, for 5 minutes. After filtration nutrient contents were determined.

In addition, the total contents of the studied elements (Cu, Fe, Mn and Zn) were digested with nitric acid, USEPA 3051 method described in (Abreu *et al.*, 1996).

Both available and total forms of Fe, Mn, Cu and Zn were analyzed by inductively coupled plasma emission spectrometry (ICP-AES), Jobin Yvon JY 50-P model.

b) Soltanpour method : ten grams (g) of air-dried soil was extracted with 20 ml of the (1:2 soil weight: solution volume) for 15 minutes extracting times. The prepared solution was (1 F NH_4HCO_3 + 0.005 F DTPA) adjusted to pH 7.6., according to Soltanpour and Schwab (1977).

c) Kelowna-95 0.015 M ammonium fluoride (NH_4F) + 0.5 M acetic acid (CH3COOH) + 1.0 M ammonium acetate (CH_3COONH_4) • ammonium acetate 1.0 M ammonium acetate (CH_3COONH_4) at pH 7.0 • bicarbonate (Olsen) 0.5 M sodium bicarbonate ($NaHCO_3$) at pH 8.5 according to Ashworth and Mrazek (1995).

Four grams (g) of air-dried soil was extracted with 40 mL of the above solutions (1:10 soil weight:solution-volume), except bicarbonate, for 5 minutes before filtering. In the case of bicarbonate, 2 g was extracted with 40 mL (1:20 soil-weight:solution-volume) for 30 minutes. In all cases, several drops of toluene were added before shaking and again to the solution after filtering to discourage potential microbial activity. The bicarbonate extracts were acidified with concentrated nitric acid prior to ICP analyses to eliminate problems of carbon dioxide gas during the analyses. Appropriate adjustments were made to calculations if volumes were changed. Elements were measured in the filtered solution by ICP with appropriate matrix matching of the standards. A reference soil and occasional duplicate analyses of study samples were included to monitor and evaluate the quality of analyses. The concentrations of the elements in the soil samples were calculated to a gram oven-dry weight using water contents determined on separate air-dry samples.

Statistical Analysis:

The obtained data were subjected to the proper method of statistical analysis of variance as described by Gomez and Gomez (1984). The treatment means were compared using the revised least significant differences (L.S.D.) test at 0.05 level of probability.

RESULTS AND DISCUSSION

A-Effect of Different Extraction Methods on Available Micronutrients:

- **Iron:**

Three extraction methods (Mehlic 3, Soltanpour and Kelowna) were used for the determination of available iron content of the soil samples (sand, calcareous and clay) as shown in Table (2) and Fig. (1 and 2). The results revealed that the highest values of available Fe were given with the extraction solution of Soltanpour (5.28 µg g^{-1}), followed by Mehlic 3 (4.58 µg g^{-1}), as compared with Kelowna which recorded the lowest values of available Fe (0.04 µg g^{-1}).

On the other hand, the results in the same table showed that clay soil recorded the maximum available Fe content (5.70 µg g^{-1}), followed by Calcareous soil (2.17 µg g^{-1}), while sandy soil recorded the lowest mean values of available Fe content (1.58 µg g^{-1}), during 2020 season.

The interaction between different extraction methods and soil samples was highly significantly on iron content, where interaction between Mehlic 3 and clay soil recorded the highest values of iron content (9.04 µg g^{-1}), followed by Soltanpour (8.00 µg g^{-1}) and Kelowna (0.05 µg g^{-1}) during 2020 season.

There were substantial variations in the amount of extractable Fe in the soils. Available Fe varied widely depending on the extraction method used, reasons for which could be due to type, concentration, pH, shaking time and solution ratio of the extraction solution (Sorensen *et al.*, 1971; Whitney, 1988) and variability observed in the physical and chemical properties of the soils used (Loeppert and Iskeep, 1996 and Elinc, 1997).

The usefulness of any soil extractant to predict the availability of micronutrient elements is dependent on the ability to predict (from the extractant) the extent to which plants will accumulate a given nutrient element. Although comparisons between various treatments can be problematic due to variations in soil types, properties and treatment duration (Menzies *et al.,* 2007), an effective extracting will be able to assess the availability of these trace elements under a variety of soil conditions (McBridge *et al.,* 2004 and Menzies *et al.,* 2007).

- **Zinc:**

The available zinc content of the soil samples (sand, calcareous and clay) underused three extraction methods (Mehlic 3, Soltanpour and Kelowna) are shown in Table (2) and Fig (1 and 2).

The results showed that the highest values of available Zn were recorded by the extraction solution of Soltanpour (1.68 µg g^{-1}), followed by Mehlic 3 (1.27 µg g^{-1}), as compared with Kelowna which recorded the lowest values of available Zn (0.16 µg g^{-1}).

In addition, the results in the same table and Fig. (1 and 2) showed that clay soil recorded the maximum available Zn content (5.70 µg g^{-1}), followed by Calcareous soil (2.17 µg g^{-1}), while sandy soil recorded the lowest mean values of available Zn content (1.58 µg g^{-1}).

The interaction between different extraction methods and soil samples was highly significantly on zinc content, where interaction between Soltanpour and calcareous soil recorded the highest values of zinc content (1.98 µg g^{-1}) followed by Mehlic 3 with clay soil (1.74 µg g^{-1}), and Kelowna with clay soil (0.17 µg g^{-1}) during 2020 season.

The extractability of Mehlich 3 for soil Zn was also higher than that of the conventional DTPA extracting because Zn in soils could be dissolved and complexes by ammonium nitrate and EDTA, respectively (Seth *et al*., 2017).

Relationship of extractable Zn with important Physico-chemical properties of soil, reactions of Zn in soil involves pH, organic matter, clay content, Fe oxides, cation exchange capacity (Haddad and Evans 1993, Borkert *et al.*, 1998). The amount of Zn extracted by the three extractants showed a significant positive correlation with organic C, but negative correlations with pH and $CaCO_3$ content of the soils.

- **Manganese (Mn):**

The results obtained for manganese content of the soil samples (sand, calcareous and clay) underused three extraction methods (Mehlic 3, Soltanpour and Kelowna) are shown in Table (2) and Fig (1 and 2).

The results revealed that the highest values of available Mn were recorded by the extraction solution of Mehlic 3 (6.91 µg g^{-1}), followed by Soltanpour (5.74 µg g^{-1}), as compared with Kelowna which recorded the lowest values of available Mn (1.56 µg g^{-1}) during season 2020.

On the other side, the results in Table (2) and Fig (1 and 2) showed that clay soil recorded the maximum available manganese content (9.22 µg g^{-1}), followed by Calcareous soil (3.12 µg g^{-1}), while sandy soil recorded the lowest mean values of available manganese content (1.86 µg g^{-1}), during season 2020.

The interaction between different extraction methods and soil samples was highly significantly on manganese content, where interaction between Mehlic 3 and clay soil recorded the highest values of manganese content (12.93 µg g^{-1}), followed by Soltanpour (12.04 µg g^{-1}) and Kelowna (2.69 µg g^{-1}) during 2020 season.

Mehlich (1984) found that the addition of EDTA to the M-3 solution increased the Cu, Mn, and Zn by 170%, 50%, and 25% compared to the extracting solution without EDTA addition. The amount of extractable Mn varied remarkably depending on and extractants used and the parent material from which the soils are derived (Yusuf *et al.*, 2005).

- **Copper (Cu):**

The results tabulated in Table (2) and Fig (1 and 2) indicated that the copper content of the soil samples (sand, calcareous and clay) underused three extraction methods (Mehlic 3, Soltanpour and Kelowna). However, the highest values of available copper were recorded by the extraction solution of Soltanpour (2.66 µg g^{-1}), followed by Mehlic 3 (0.519 µg g^{-1}), as compared with Kelowna which recorded the lowest values of available Cu (0.105 µg g^{-1}) during season 2020.

In this respect, the results in Table (1) and Fig (1 and 2) revealed that clay soil recorded the maximum available copper content (1.79 µg g^{-1}), followed by sandy soil (0.83 µg g^{-1}), while Calcareous soil recorded the lowest mean values of available copper content (0.68 µg g^{-1}), during season 2020.

The interaction between different extraction methods and soil samples was highly significant on copper content, where interaction between Soltanpour and clay soil recorded the highest values of copper content (4.43 µg g^{-1}), followed by Mehlic 3 (0.86 µg g^{-1}), and Kelowna (0.21 µg g^{-1}) during 2020 season.

Amounts of Cu extracted by Mehlich 3 are closely related to those obtained using DTPA ($R^2 = 0.864$), with M3 extracting 2.45 more Cu than DTPA (Tran and Simard 1993). Mehlich 3 extracted higher amounts of Cu than DTPA, which is in agreement with reported results (De Abreu *et al.*, 1996; Garcia *et al.*, 1997). A number of authors have reported that the vast bulk of soil Cu, up to 60%, is in the organically complexes fraction (Sims 1986; De Abreu *et al.* 1996). Therefore extractants that show a preference for organic matter bound fractions (chelating agents), present a greater capacity to extract soil Cu. Mehlich (1984) reported that Cu extraction increased by 170% when EDTA was added to the solution.

- **Boron (B):**

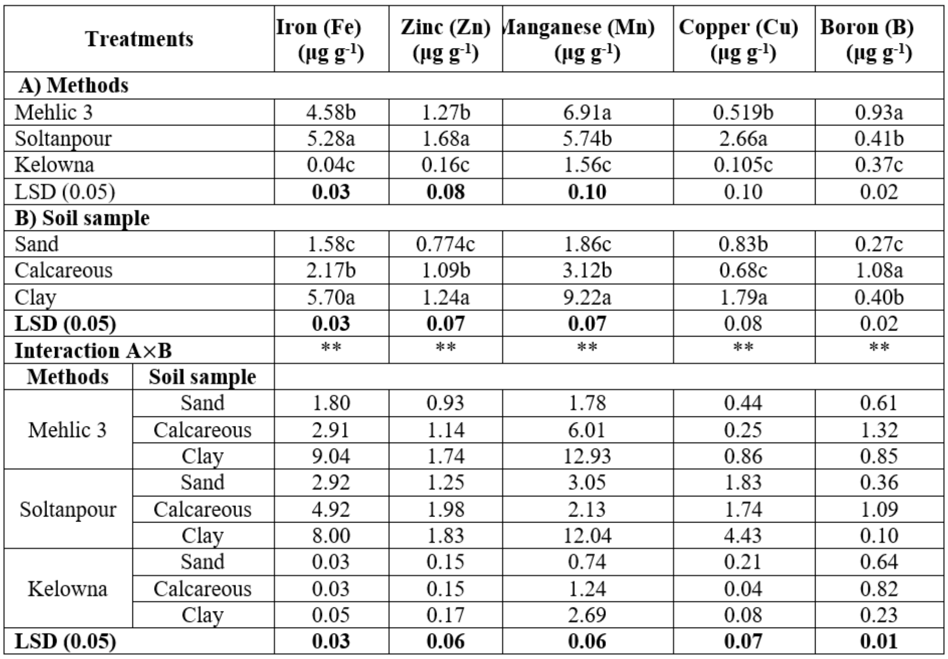
Three extraction methods (Mehlic 3, Soltanpour and Kelowna) were used for the determination of available boron content of the soil the highest values of available boron were given with the extraction solution of Mehlic 3 samples (sand, calcareous and clay) as shown in Table (2) and Fig (1 and 2). The results revealed that (0.93 µg g^{-1}), followed by Soltanpour (0.41 µg g^{-1}), as compared with Kelowna which recorded the lowest values of available boron (0.37 µg g^{-1}) during 2020 season.

Furthermore, the results in Table (2) and Fig (1 and 2) revealed that calcareous soil recorded the maximum available boron content (1.08 mg/g), followed by clay soil (0.40 µg g^{-1}), while sandy soil recorded the lowest mean values of available boron content (0.24 mg/g), during season 2020.

The interaction between different extraction methods and soil samples was highly significantly on boron content, where interaction between Mehlic 3 and calcareous soil recorded the highest values of boron (1.32 µg g^{-1}), followed by Soltanpour and calcareous soil (1.09 µg g^{-1}), and Kelowna and calcareous soil (0.82 mg/g) during 2020 season.

Zbiral (2016) observed a higher amount of extractable B with Mehlich 3 than that with hot water since acetate and fluoride anions in Mehlich 3 could effectively displace B from specific sorption sites.

Table 2: Effect of different extraction methods on available Fe, Zn, Mn, Cu and B during 2020 season.



Treatments		**Iron (Fe) (µg g^{-1})**	**Zinc (Zn) (µg g^{-1})**	**anganese (Mn) (µg g^{-1})**	**Copper (Cu) (µg g^{-1})**	**Boron (B) (µg g^{-1})**
A) Methods						
Mehlic 3		4.58b	1.27b	6.91a	0.519b	0.93a
Soltanpour		5.28a	1.68a	5.74b	2.66a	0.41b
Kelowna		0.04c	0.16c	1.56c	0.105c	0.37c
LSD (0.05)		**0.03**	**0.08**	**0.10**	0.10	0.02
B) Soil sample						
Sand		1.58c	0.774c	1.86c	0.83b	0.27c
Calcareous		2.17b	1.09b	3.12b	0.68c	1.08a
Clay		5.70a	1.24a	9.22a	1.79a	0.40b
LSD (0.05)		**0.03**	**0.07**	**0.07**	0.08	0.02
Interaction A×B		**	**	**	**	**
Methods	**Soil sample**					
Mehlic 3	Sand	1.80	0.93	1.78	0.44	0.61
	Calcareous	2.91	1.14	6.01	0.25	1.32
	Clay	9.04	1.74	12.93	0.86	0.85
Soltanpour	Sand	2.92	1.25	3.05	1.83	0.36
	Calcareous	4.92	1.98	2.13	1.74	1.09
	Clay	8.00	1.83	12.04	4.43	0.10
Kelowna	Sand	0.03	0.15	0.74	0.21	0.64
	Calcareous	0.03	0.15	1.24	0.04	0.82
	Clay	0.05	0.17	2.69	0.08	0.23
LSD (0.05)		**0.03**	**0.06**	**0.06**	**0.07**	**0.01**

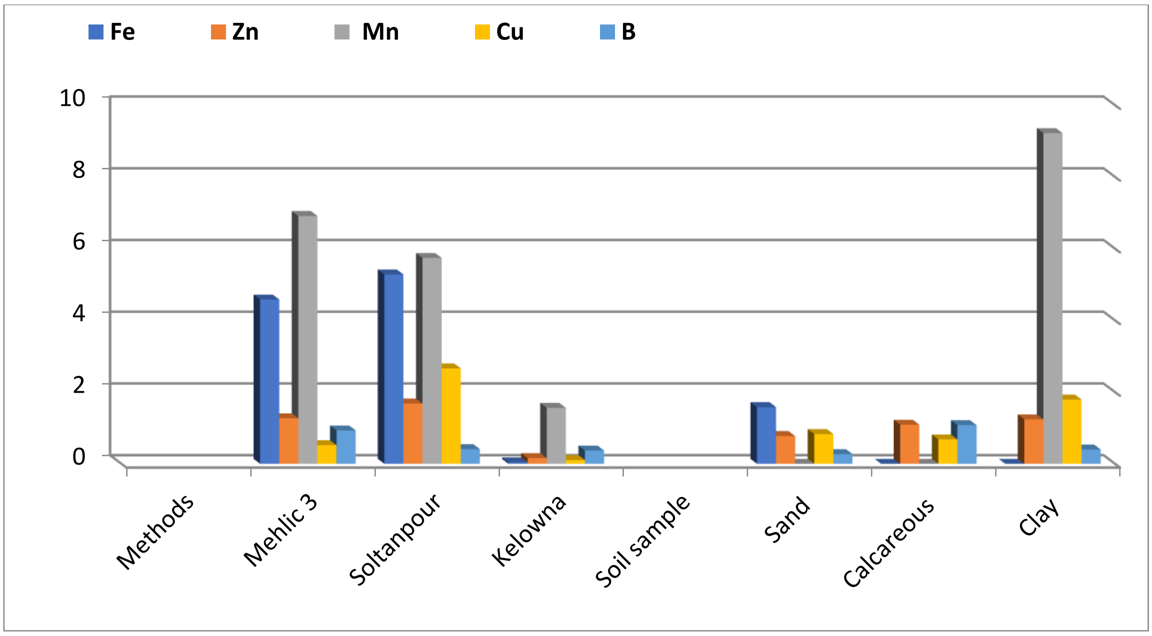


Fig. 1: Effect of different extraction methods on available Fe, Zn, Mn, Cu and B during 2020 season.

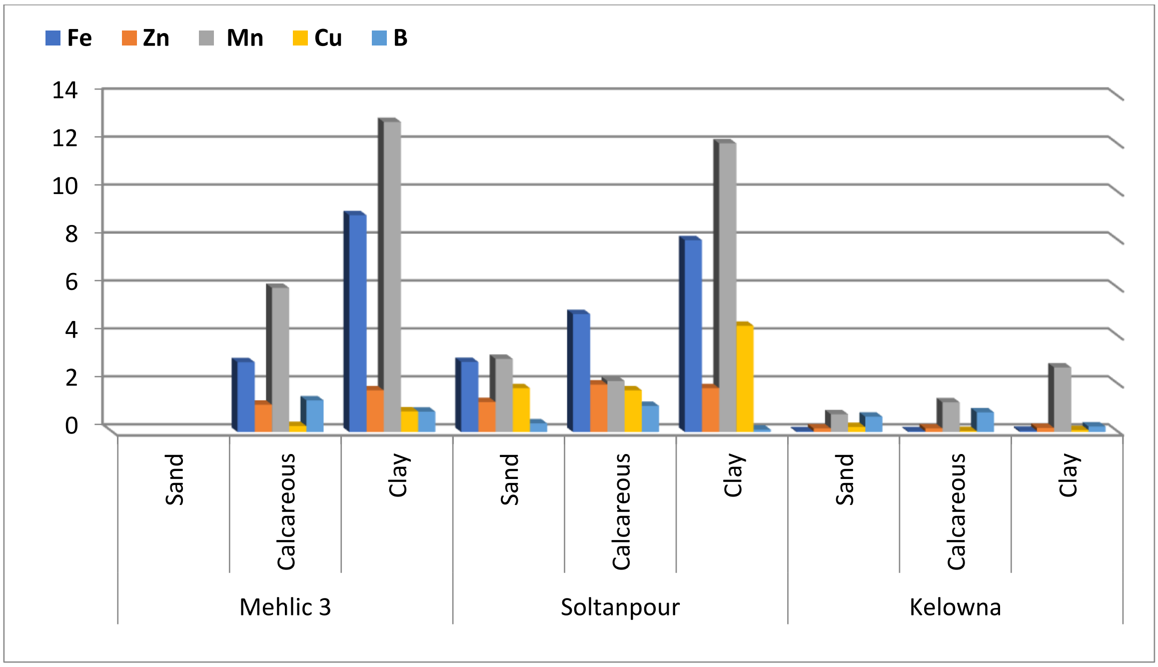


Fig. 2: Interaction between different extraction methods and soil samples on available Fe, Zn, Mn, Cu and B during 2020 season.

Conclusion

Results showed that the highest mean values of Mn and B were recorded by Mehlic 3 method, while the Soltanpour method recoded the maximum values of Fe, Cu and Zn compared with Kelowna method which recorded the lowest mean values of these elements. In addition, clay soil gave the maximum values of Fe, Cu, Mn and Zn, while calcareous soil recorded the highest mean values of B, compared to sandy soil which recorded the lowest mean values of all micronutrients studied during 2020 season.

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ARABIC SUMMARY

تقييم بعض اختبارات التربة لاستخلاص العديد من المغذيات المتاحه فى الأراضى المصرية

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تستخدم ثلاث عمليات استخلاص لتقييم مدى توافر المغذيات الدقيقة والصغرى في مجموعات التربة المختلفة. وتم مناقشة مدى ملاءمة بعض عمليات الاستخلاص تحت ظروف التربة المصرية. تم استخدام ثلاث طرق استخلاص (مهليك 3 ، سلطانبور ، كيلونا) لتقدير المحتوى المتاح من الحديد والزنك والمنجنيز والنحاس والبورون لعينات التربة (الرمل والكلس والطين) خلال موسم 2020. جمعت عينات التربة السطحية (0-30 سم) من ثلاثة مواقع مختلفة بمنطقة البستان في النوبارية الجديدة بمحافظة البحيرة، مصر خلال موسم 2020، من كل مخطط تم تحديده ، تم تحديد عشر نقاط في مسار متعرج. أوضحت النتائج أن أعلى قيم متاحة من الحديد والزنك والنحاس أعطيت مع محلول الاستخلاص من سلطانبور (Soltanpour) ، بينما أعطيت أعلى قيم متاحة من المنجنيز و البورون مع محلول الاستخلاص مهليك 3 (Mehlic 3). من ناحية أخرى، أظهرت النتائج أن التربة الطينية سجلت الحد الأقصى المتاح من الحديد والزنك والمنجنيز والنحاس ، بينما سجلت التربة الجيرية أقصى محتوى متاح من البورون. كان التفاعل بين طرق الاستخلاص المختلفة وعينات التربة معنوياً بشكل كبير خلال موسم 2020.