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SOIL FERTILITY STATUS IN SOME SOILS OF EL-BAHARIYA OASIS, EGYPT

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ABSTRACT

Identifying the situation of some micronutrients and study the effect of some physical and chemical properties of soils on nutrients status is reveal their importance on agricultural productivity. Clay content, soil pH, salinity, soil organic matter and calcium carbonate content are the main factors which influence nutrients availability in the soil.

Some extractable micronutrients contents i.e., Fe, Mn, Zn, Cu as well as B and their relation to some factors are studied in the soils of El-seala area at El-Bahareya region, Egypt. To achieve this target, thirty two representative soil profiles in the study area were investigated. The obtained results are summarized as follows:

DTPA extractable amount of Fe, Mn, Zn, Cu and B ranged between1.3–22.9, 2.1-17.9, 0.1-7, 0.1-20.3 and 0.15-7.15 mg kg-1, respectively. Some values of micronutrients are much greater than the marginal levels reported in the literature i.e. about 30.6 % for Fe, 100 % for Mn, 50 % for Zn, 38 % for Cu and 11.2 % for B. In general the soil profiles which have light texture contain low amounts of micronutrients, while on the other hand high amounts of these elements are shown in the heavy texture. About 7.5 % of soil samples have toxic limits of extractable B for soils under investigation. About 20.05 % of soil samples have sufficient limits of available Fe. About 21.85 % of soil samples contain sufficient amounts of available Mn. About 18.45 % of soil samples have adequate of extractable Zn. The critical values of the studied soil profiles reached to 43.75 % for Cu.

The statistical analysis i.e., the simple correlation coefficients between DTPA-extractable micronutrients and some soil variables are determined.

Keywords: Soil fertility-micronutrients- soil profile- EL-Baharya Oasis

INTRODUCTION

The phisiografic features of El Bahareya Oasis studied by Shehata (1992), using photo-interpretation techniques, and revealed that it consists of six geomorphic units, i.e., plains, man-made terraces, marshes, pediplains, sand dunes and mountains or hills.

The soil fertility is an important factor that affects the crop yield. Soil related limitations affecting crop productivity include nutritional disorders, and can be detected by evaluating the fertility status of the soil. Micronutrient cycling is quite different among various terrestrial ecosystems (Han et al., 2007). The application of mineral fertilizers is the most advantageous and fastest way to increase crop yields and their deficiency leads to various types of disorders in many crops (Duarah et al., 2011).

Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have a high degree of spatial variability. However, major constraints impede wide scale adoption of soil testing in most developing countries. Soil properties that can be changed in a short time by land use are dynamic soil quality indicators (Chan; et al., 2001).

Low soil fertility is recognized as an important constraint to increasing food production and farm incomes in many parts of Africa (Shepherd and Soule 1998). (Adesanwo et al., 2009) reported that management of soil fertility is the first condition for sustainable crop production and can reduce food importation in Nigeria and African countries.

Khalil et al., 2004 and Garis, 2006 studying the Egyptian soils mentioned that the levels of micronutrient elements could be used as a guide for substantiating the nature of parent material together with the pedogenic aspects, which lead to the prediction of soil genesis and formation**.**

The current study reveal the distribution mode of some micronutrients which are essential for plant (Fe, Mn, Zn, Cu and B) as related to some soil characteristics in El-Bahariya oasis region besides their status which affect soil fertility.

MATERIALS AND METHODS

The investigation was conducted at El-Seala area at El-Bahareya oasis region, is located between latitudes 28° 08' 25” N - 28° 13'21” N and longitude 28° 52'18” E - 28° 57'45” E. Thirty-two profiles were allocated chosen and dug at different locations representing the different soil texture. Soil samples are air-dried, crushed and passed through a 2 mm sieve for the subsequent analyses.

Some physical and chemical analyses were carried out namely; particle size distribution, organic matter, CaCO3 and CaSO4 contents as described by Page et al. (1982). Soil pH is determined in the soil paste but the soil electrical conductivity (ECe) is measured in the soil paste extract according to the methods outlined by U.S. Salinity Laboratory Staff (Richards, 1954).

Some physical an chemical properties of the studied soils are shown in Table 1.

The available contents of the studied micronutrients were extracted using diethylene triamine penta acetic acid (DTPA) according the method described by Lindsay and Norvell (1978), while B is extracted with hot water according to Mahler et.al.(1984).

The obtained data were exposed to proper statistical analysis of simple correlation coefficient by using model at 95 and 99% confidence levels (0.05 and 0.01) respectively, according to Pankhurtst and Appelo (1999).

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RESULTS AND DISCUSSION

Micronutrient status in the studied soils

Soil fertility is one of the important factors controlling the crop yield. Soil related limitations affecting the crop productivity and the nutritional disorders can be determined through evaluating the fertility status of the soils.

Boron (B):

Boron is required for proper development and differentiation of tissues. Its absence induces abnormalities and development of tissues.

As shown in (Table 2), available B content in the studied soil profiles range from 0.1 to 7.15 µg g^{-1} with an average 1.61 µg g^{-1}. The lowest value was found in the subsurface layer of profile No. 4, which is coarse textured i.e., sandy soil. Whereas, the highest values are associated with the subsurface layers of profiles Nos. 27 and 30 which are fine textured, namely clay loam and clay soils respectively. Coarse textured soils are inherently low in available B, (Katyal et. al. 1983).

Reisenauer et. al., (1973), reported that the index values for boron extracted from soils are < 1.0, 1.0-5.0 and > 5.0 µg g-1 representing nonsufficient, sufficient and toxic B concentrations. Accordingly, about 49 % of the soil samples under investigation contain nonsufficient concentration of available boron, while 43 % are sufficient and 7.5 % have toxic limits of extractable B for soils. The obtained results are in harmony with Katyal et. al. (1983), who stated that content of B lies between 1: 3 ppm, and mentioned that arid soils however show exceptionally high B values.

Focusing on the high amounts of boron found in medium and fine textured soils (clay loam) and having high soil pH, (Katyal *et. al.* 1983) mentioned that arid soils show exceptionally high B values but their availability decreases with the soil coarse texture and low organic matter.

Positive and significant correlations in Table (3) are showed with organic matter (r = 0.5578*), salinity (r=0.7396**), clay content (r=0.7613**).

Iron (Fe):

Data of the studied soil profiles (Table 2) reveal that Fe content ranges between 1.1 and 22.9 µg g-1 with an average 3.71 µg g^{-1}, and an irregular distribution pattern with depth. The lowest value is recorded in the deepest layer of profile No. 29, which has fine texture. Whereas, the highest value is detected in the light textured surface layer of soil profile No. 13.

The average of available iron content Table (2) is higher in light textuered soils, i.e., sandy and loamy sand soils (4.67 µg g^{-1} Fe) than that (2.43 µg g^{-1} Fe) in soils having medium to heavy texture i.e., sandy loam, clay loam and clayey soils. This finding may be attributed to the formation of Bahariya Oasis soils, known as Farafra – Bahariya Facien, (Gheith 1955). (Awadalla 1993) found that available Fe in the soils of El Fayoum Governorate, is in the range of 3.02 to 23.43 mg/kg.

According to (Lindsay and Norvell 1978), values of Fe extracted from soils are classified as: Low (< 2.5 µg g^{-1}), marginal (2.5-4.5 µg g^{-1}) and adequate (> 4.5 µg g^{-1}) Fe soil. Regarding the data in Table 2 About 40 % of soil samples under investigation contain critical levels of available iron, 40 % contain marginal levels and 20 % have sufficient available iron.

These results are in harmony with (Abdel Razik 1999) who stated that available Fe extracted by DTPA ranged from 0.3 to 24 µg g^{-1} in some Egyptian soils.

In the obtained results, some values of available Fe associated with high amounts of available Mn, Zn, B and Cu. So that high of these elements interfere with Fe uptake and utilization, those may promote Fe deficiency, (Katyal et. al. 1983) and (Murphy et. al. 1972).

Manganese (Mn)

The available Manganese Table (2) of the investigated soil profiles varied from 1.4 to 17.9 µg g-1 with an average 2.52 µg g-1. The lowest values (1.4 and 1.5 µg g-1) are recorded in soil profiles Nos. 14 and 29, which are associated with both high of pH (8.4 and 9.4) and calcium carbonate percent (9 and 9.2 %) respectively. These results are in agreement with the reported by (Katyal *et. al.* 1983) and (Murphy et. al. 1972), which mentioned that calcareous soils have high amounts of total Mn but available Mn is low due to the high pH.

The highest values of available Mn are shown in soil profiles No. 13, 18 and 30, while have low pH values and lower calcium carbonate percentage. The obtained data are in agreement with those reported by Katyal et. al. (1983) and Murphy et. al. (1972), who reported that manganese availability is higher in acid soils and added that high Fe availability in soils may induce Mn deficiency.

Considering 1.0 and 2.0 µg g-1 as critical limit and marginal range for Mn deficiency, according to Lindsay and Norvell, (1978), all the studied soils have sufficient amounts of available Mn, meanwhile about 22 % and 78 % of soil samples contain marginal and sufficient amounts of available Mn respectively.

Similar results are reported by Abdel Razik (1999) who stated that available Mn extracted by DTPA method varied from 0.8 to 30 µg g-1.

Available Mn has positive significant correlations with soil Zn (r=0.5980) and soil pH (r =- 0.7975**).

Zinc (Zn):

Available Zn content in the studied soil samples (Table 2) ranged from 0.09 to 20.3 µg g-1 with an average 1.02 µg g-1. The lowest value of Zn is found in the deepest layer of profile No. 25 representing the sandy soil which has coarse texture, while the highest value is detected in the subsurface layer of profile No.30, representing the soil which has clayey texture.

Depthwise distribution of Zn content, in general the values of available Zinc tended to decrease of amount Zn with depth.

According to Soltanpour and Schwab (1977), the index values for Zn extracted from soils by DTPA method are as follows: Low (0-0.9 µg g-1), marginal (1-1.5µg g-1) and adequate (> 1.5 µg g-1). The layers in the studied soil profiles contain 61.8 % low Zn, 19.85 % marginal amount and 18.45 % adequate of extractable Zn.

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Focusing on some layers of soil profiles No. 18 and 30, they contain high amounts of Zn (20.3 and 9.4 µg g-1) respectively, the reason of this manure, the layers of soil profiles lies in the acid side; they have low pH values i.e., 5.4 and 4.5 respectively. In contrast, very low of Zn content are shown in profile no. 14, which has highly soil pH (9.4). These results are agreement with suggested by Katyal *et. al.* (1983) and Murphy et. al. (1972).

The obtained results reveal that statistical relationship as a simple correlation coefficient between DTPA-extractable Zn and soil pH is highly negatively significant correlation (r = -0.7469**).

Copper (Cu)

The obtained values of DTPA-extractable Cu (Table 2) reveal that available Cu content varied from 0.08 to 7.0 µg g-1 , with an average 0.5 µg g-1. The lowest values mostly are found in the surface layers of soil samples which have coarse texture for both Entisols and Aridisols , whereas the highest values are detected incoarse and fine textured classesof soil families of Aridisols and Entisols respectively.

According to Lindsay and Norvell, (1978), the index value used for Cu extracted from soils by DTPA method are as follows: critical (<0.2 µg g-1), marginal (0.2-0.42 µg g-1) and high (> 0.5 µg g-1). The critical values of the studied soil profiles reached to 43.75 % Cu.

Regarding the values of profile No. 18, it was noticed that high amount of available Cu (7.0 ppm) associated to the highest value of Mn (20.3 ppm). In this respect, excess of Zn in the soil can accentuate Cu deficiency, Katyal *et. al.* (1983) and Robson *et. al.* (1981).

The obtained values of simple coefficients indicate highly positive significant correlation between available Cu and each of Zn (r=0.8341) and Mn (r=0.6211), while it has negatively significant correlated with pH value (r= - 0.7637).

Conclusion and recommendation

Continuous use of organic matter and physiologically acid fertilizers increase availability of elements under study.

Soil analysis which has less than 0.5 ppm soluble B are considered incapable of supplying sufficient B to support normal plant growth. Soils have available B values more than 5 ppm are considered toxic.

High Fe availability in soils may induce Mn deficiency. With other words high amounts of some nutrients interfere with Fe uptake and utilization, those may promote Fe deficiency.

Soils have values less than 0.6 ppm Zn extracted with DTPA, it is classified low in Zn availability and response of at least sensitive crops to Zn fertilizers

REFERENCES

Abdel Razik, S.A. (1999). Trace nutrients status and its relation to some soil variables in sandy and calcareous soils of Egypt. J. Agric. Sci. Mansoura Univ., 24 (3): 1441-1451.

Abdel Razik, S.A. (1999). Micronutrients status and its relation to some soil variable in the soils of El-Fayoum Governorate, Egypt. J. Appl. Sci., 17 (11): 291.

Adesanwo, O.O., Adetunji, M.T., Adesanwo, J.K., OSiname, O.A., Diatta, S., and Torimiro, D.O. (2009). Evaluation of Traditional Soil Fertility Management Practises for Rice Cultivation in Southwestern Nigeria.Am. Eurasian J. Agron., pp.45-49.

Awadalla A. A. (1993): mineralogical and physical properties of some soils at El Fayoum governorate and their relation to soil fertility. M. Sc. Thesis, Fac of Agric. At El Fayoum cairo Univ. , Egypt.

Bassirani N, Abolhassani, M., and Galavi, M. (2011). Distribution of available Micro-nutrients as related to the soil characteristics of Hissar; Haryana (India). Afr. J. Agric. Res. 6:4239-4242.

Chan, K.Y., Bowman, A., and Oates, A., 2001. Oxidizible organic carbon fractions and soil quality changes in an oxic paleustalf under different pasture leys. Soil Science 166, 61–67.

Duarah I., Deka M., Saikia N., and Deka Boruah H.P. (2011). Phosphate olubilizers enhance NPK fertilizer use efficiency in rice and legume cultivation. 3 Biotech. 1(4):227-238.

Garis, Y.L. (2006). Trace elements distribution relation to geomorphology of some soils along the North Western Coastal of Egypt. Egypt. J. of Appl. Sci., 21 (4A): 315-331.

Gheith, M.A., (1955). Classification and review of Egyptian iron deposits" symposium Appl. Geol. In the Near East, UNESCO Ankara, 1955, P 106 – 113.

Han, F.X., Kingery, W.L., Hargreavese, J.E., and Walkard, T.W. (2007). Effect of land uses on solid-phase distribution of micro-nutrients in selected vertisols of the Mississippi River Delta.Geoderma142:96-103.

Katyal J. K. and Randhawa N. S. (1983). " Micronutrients " fertilizer and plant nutration. FAO Bulliten 7

Khalil, M.N.; Mohamed I.R.; Metwally M.A. and Abdel Khali M.A. (2004). Distribution of some nutrients in certain soils of the new valley governorat. Zagazig J. Agric. Res., 31(5): 2287.

Lindsay, W.L. and Norvell, W.A. (1978). Development of a DTPA soil test for zinc, iron, manganese and copper. Soil Sci. Soc. Am. J., 42: 421-428.

Murphy L.S. and Walsh L.M. (1972). Correction of micronutrient deficiencies with fertilizers. In: Micronutrients in Agriculture. Soil Sci. Sos. Amer. Inc., Madison. Wisc., USA.

Mahler, R. L., D. V. Naylor, and M. K. Fredrickson. 1984. Hot water extraction of boron from soils using sealed plastic pouches. Comm. Soil Sci. Plant Anaysis 15:479- 492.

Page, A.L.; Milner, R.M. and Kenney, D.R. (1982). "Methods of Soil Analysis". Part 2-Chemical and Microbiological Properties, 2nd Ed., Amer. Soc. of Agronomy Series 9, SSA, Madison, Wisconsin, USA, 53711.

Pankhurtst, D.L. and Appelo, C.A.J. (1999). User's guide to PHREEQC (Version 2.0): A Computer program for secation batch-reaction, one dimensional transport, and inverse geochemical calculations. Water Resources Investigations Rep. 99-4259,U.S.Geol. Survey Denver, Co.

Reisenauer, H. M., Walsh, I. M. and Hoeft, R. C. (1973). Testing soils for Sulfur, Boron, Molybdenum and Chlorine " chapter 12 in soil testing and plant analysis " Walsh et al (eds), Soil Sci. Soc, Am, Inc. Madison, wisc.

Richard's, L.A. (1954)." Diagnosis and Improvement of Saline and Alkali Soils". U.S.D.A. Handbook No. 60, Washington D.C., U.S.A.

Robson, A.D. and Labanauskas C.K. Diagnostic of copper deficiency and toxicity. In: J.S. Loneragan et. al. (eds). Copper in soil and plants. Academic press. Sydney , Australia. Pp 287-312.

Shehata, R.B. (1992). Pedological studies land evaluation of El-Bahareya oasis soils. Ph.D. Thesis, Fac. of Agric, Menofiya Univ., Egypt.

Shepherd, K.D., and Soule, M.J. (1998). Soil Fertility Management in West Kenya: Dynamic simulation of Productivity and Sustainability at Different Resources Endowment Levels.Agric.Ecosystems,Environ., 133.

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

دراسة حالة خصوبة التربة في بعض أراضي منطقة الواحات البحرية – مصر

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يهدف البحث إلى دراسة حالة بعض العناصر المغذية الصغرى مثل الحديد والمنجنيز والزنك والنحاس والبورون فى بعض أراضى منطقة الواحات البحرية ، ومدى تأثر هذه العناصر بخواص الأرض الطبيعية والكيميائية للأرض موضع الدراسة.
ولتحقيق ذلك تم اختبار 32 قطاع أرضى تمثل أراضي منطقة الدراسة ، وكانت النتائج المتحصل عليها كالتالى :-

تراوحت قيم العناصر الصغرى المستخلصة بمحلول DTPA من 1,3 – 22,9 ، 2,1 – 17,9 ، 0,1 – 7 ، 0,1 – 20,3 ، 0,15 – 7,15 مليجرام عنصر / كيلو جرام تربة لكل من عناصر الحديد والمنجنيز والذنك والنحاس والبورون على التوالى.

كانت قيم العناصر المغذية الصغرى أعلى من الكميات الموصى بها (Marginal limit) ، حيث وجد تركيز كل من الحديد والمنجنيز والزنك والنحاس والبورون بزيادة قدرها 30% ، 100% ، 50% ، 38% ، 11% على التوالى.

بصفة عامة كان محتوى التربة من قيم عناصر الحديد والمنجنيز والزنك منخفضة فى الأراضى الرملية ذات القوام الخفيف ، بينما كان محتواها مرتفعاً فى الأراضى ذات القوام المتوسط إلى الثقيل .

حوالي 7.5 % من العينات المدروسة احتوت على قيم مرتفعة من عنصر البورون وتسبب سمية للنبات القائم.
حوالي 20.05 % من العينات المدروسة احتوت على كميات كافية من عنصر الحديد .
حوالي 21.85 % من العينات المدروسة احتوت على قيم مرتفعة من عنصر المنجنيز .
حوالي 43.75 % من العينات المدروسة احتوت على قيم حرجة من عنصر النحاس.
حوالي 18,45 % من العينات المدروسة احتوت على كميات محدودة من الزنك . تم اجراء تحليل الارتباط بين بعض العناصر المستخلصة بال DTPA وبعض عوامل الدراسة.