Pak. j. sci. ind. res., vol.38, nos.11-12, November-December 1995

DETERMINATION OF TRACE ELEMENTS IN BARLEY, BEET AND PURSLANE OF KALABSHA AREA OF ASWAN IN EGYPT

M. H. Abou-El-Wafa, R. M. Awadallah,* A. E. Mohammed* and M. N. Rashed**

Chemistry Department, Faculty of Science, Qena, Egypt

(Received November 21, 1992; revised August 27, 1995)

Trace elements Ag, Au, Ca, Cl (Ca and Cl were estimated titrimetrically by EDTA and Cl by ion selective electrode), Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sr and Zn in barley, beet and purslane (leaves, stems, tubers and grains) as well as in the soil samples taken from the immediate vicinity of plant roots (10, 30 and 60 cm depths) in Klabsha area, an experimental farm of the High Dam Lake Development Authority, were estimated. The results show that purslane accumulates Ca, Cl, Fe, K, and Na, beet accumulates Au, Ca, Co, Cl, Mg, Mn and Na while Co, Cr, Cu and Zn are more concentrated in grains of barley than in its leaves (Ca, Cl, Fe, Mg, Mn, Na Sr and Ni are more concentrated in leaves than in grains).

Key words: Trace elements, Barley, Beet, purslane.

Introduction

Trace elements play an important role in chemical, biological, biochemical, metabolic, catabolic and enzymatic reactions in the living cells of plants, animals and human beings. Trace elements present in crops are, to a great extent, dependent on the available trace elements in the soil and in the irrigation water. Trace elements had been assayed by atomic absorption spectrophotometer in plants, vegetables and in soil samples [1-3]. Also, ion selective electroe was utilizd for the determination of chloride in plant, soil [4,5], canned vegetables [6] as well as fluoride in plant tissues [7]. The present work aims to assess the productivity of these crops and to determine and study the trace element level in leaves, stems, tubers and grains of barley, beet and in purslane planted in Kalabsha farm and to find a relationship between trae elements present in these crops and in the soil samples taken at 10, 30 and 60 cm depths.

Experimental

All chemical used were of Analar grades (BDH/Merck).

Plant crops. Barley, purslane and beet were planted in 16-10, 22-10and 12-11-1986 respectively. The total amount of fertilizers needed for feddan was 150-200 Kg of superphosphate and 200 Kg of nitro Kima (NH_4NO_3 + $CaCO_3$). The rate of irrigation water applied was $180m^3$ for faddan every two weeks (barley every three weeks).

Crop samples collection. The collected crops were subsampled to leaves, stems, tubers and grains, washed with running tap water followd by doubledistilled and deionized water, dried at 105°C, crushed, powdered and stored in bottles.

Soil samples collection. Soil samples were collected at 10, 30 and 60 cm depths, dried at 105°C, powdered and stored.

Preparation of crop and soil sample solutions for AAS

Crop samples. Four grams of each crop samples were wet ashed using 40 ml HNO_3-$HClO_4$ (1:1) acids mixture followed by drops of HF acid[8] to destroy the celluloses. The mixture was heated on a sand bath then the clear solution was made up to 100 ml using double distilled water.

Soil samples. One gram of soil sample was dissolved in 10 ml conc. HNO_3 and 10 ml conc. HCl and heated to dryness followed by addition conc. HNO_3 and HCl and reheated. The residue was extracted by 10 ml 2N HCl and completed to 100 ml with double distilled water.

Standard solution for AAS. Stock (500 ml solution), 1000 ppm/ml of different metals were used after dilution to the desired volume.

Determination of elements by AAS. The concentration of trace elements in crop and soil samples were measured by Pye Unicaum S.P 1900 Atomic Absorption Spectrophotometer with hollow cathode lamps of elements at characteristic wavelengths. Atomic absorption data were acquired by aspirating aqueous single element standard solutions, blank and samples with two deionized water rinses between each two readings.

Preparation of crop and soil sample solutions for ISE

Crop samples. One gram of dried finely ground crop sample was added to 50 ml of 1M $NaNO_3$ and stirred well, then filtered off.

Soil samples. 10 grams of each soil sample was shaken well with 100 ml chloride free deionized water and then filtered off.

Determination of chloride by ISE. For soil sample, the double junction electrode filled with 10% KNO_3, and one ml

*Chemistry Department, Faculty of Science, Aswan, Egypt.
**High Dam Lake Development Authority, Aswan,Egypt.

of low level ionic strength adjustor (ISA, 1M $NaNO_3$) was added to the sample and standard solutions. The chloride and reference electrodes were immersed in the sample solutions and concentration were read out . For crop sample, a known volume of sample was used then 0.5 ml of ISA was added followed by a known volume of expected standard concentration (single known addition technique) [4,9].

Results and Discussion

The lower Nubia area of Kalabsha [10] is divided into the Nubia plain, the scrap face and the limestone plateau. The soil is composed of fine to coarse materials belonging to the quaternary era, silty clay to clay, shale intercalated with anhydrite, sand dunes and Nubia sand composed of consolidated sand cemented iron-clay minerals, calcite and dolomite. The soil [11] belongs to order Entisols, suborder psamments and orthents.

Planting of barley, beet and purslane in Kalabsha as experimental farm were succeeded and gave promising yields (1and 5 tons/feddan grains and straw for barley), beet (2 tons/feddan) and purslane (9 tons/feddan). However, planting of these crops in their usual season (winter) which is the same as the planting time of the present crops, give 1.5 tons grains and 6 tons straw for barley, 2 tons beet and and 9 tons purslane which is not so far from the yield obtained from Kalabsha.

Results of trace elements are represented graphically in figures (1,2 and 3). From graphs, it is shown that, Ag, Au, Ca, Cl, Fe, K, Mg, Mn, Na, Ni, Pb, and Sr concentrate in stems and leaves of barley and Co, Cr, Cu and Zn accumulate in grains of barley. In the case of soil wherein barley planted, Ag, Au, and Co appear in samples taken from 10, 30 and 60 cm depth and Cr, Cur, K, Mn, Ni and Pb accumulate in samples taken from 30 cm depth, while Fe, Mg, Na, Sr, and Zn concentrate in samples of 10 cm depth.

Clacium and chloride exists in high concentration in samples of 60 cm depth. In case of beet, Ag, Au, Ca, Cl, Co, Cr, Fe, K, Mn, Pb, Sr and Zn, concentrate in the leaves, and Cu, Mg, Na and Ni accumulate in tuber, while in the soil, all the elements determined are concentrated in sample taken from 10 cm depth, but chloride is rich in 30 cm depth samples.

In the case of purslane, Ag, Au, Ca, Cl, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sr and Zn appear in higher concentrations. In the soil most of these elements such as Co, Cr, Cu, Fe, K, Mn and Na are concentrated in 10 cm depth samples, indicating the absorptivity of these elements by plants at 30 cm depth, Cl and Co are very low, however, absroption of the elements from 30 cm depth is high. This may be ascribed to their absorption by plant roots.

Comparing trace element concentrations in the three crops under study, it is noticed that, Ag, Au, Ca, Co, Cr, K, Mn, Na and Ni exist in high concentration in beet than in barley and in purslane, while Cl, Cu, Fe, Mg, Pb, Sr, and Zn, are present in high concentration in purslane than in beet and in barley.

Variations of the results of trace elements in the crops may be related to different botanic textures and molecular structures of plants, changes in chemical composition and to a variable rate of preferential selective uptake of trace elements from external soil solution, while variations of trace elements concentrations in the soil sample may be attributed to different chemical and minerological composition, and geochemical and biogeochemical fractionation of the soil.

Potassium and chloride present in high concentration in all the crops, particularly, leaves. K is an essential element, it regulates the osmotic pressure and activates the enzymatic reactions involving carbohydrate metabolism. Its deficiency decreases the rate of amino acids synthesis and reults in a low level of protein. Chloride is an essential element for plant growth, root formation. Deficiency of K and Cl results in weakening the internodes, chlorosis and rolling of leaves [12].

Sodium has a catalytic effect on enzyme activity, it has some definite function in the growth roots of some seedlings plants [12].

Mn serves as a cofactor and activator metal for enzymes, fatty acids, glycoprotein, DNA synthesis and chloestrol from acetate [12,13]. Mn deficiency causes a loss and disintegration of chlorophyll.

Ca and Mg are essential elements for binding the cell walls of plants. Ca activates a number of enzymes including α-amylase [12]. Its deficiency causes the accumualtion of starch in leaves which leads to destruction of meristematic regions, chlorosis, hookening of young leaves [12]. Mg plays a significant role in photosynthesis, nucleic acids synthesis and acts as a binding agent in the ribosomal particles [14], its deficiency results in the appearance of a purple colouration in the foliage [12].

Co and Fe are essential nutrient activators involving vitamin B_{12} synthesis and nitrogen fixation. Deficiency of Co causes poor growth, and chlorosis. Fe is important in chlorophyll synthesis and ferredoxin nitrate reductase [15]. Fe and Cu form a number of copper and iron proteins[16]. Cu is a constituent of ascorbic acid oxidase, lactase and tyrosinase[14].

Zinc stabilises the liposoluble membrane and resembles as a cofactor in a number of enzyme systems. It plays a specific part in protein metabolism and synthesis of RNA, DNA and auxin[12]. Its deficiency causes rolling, cholorosis and finally death of crop leaves.

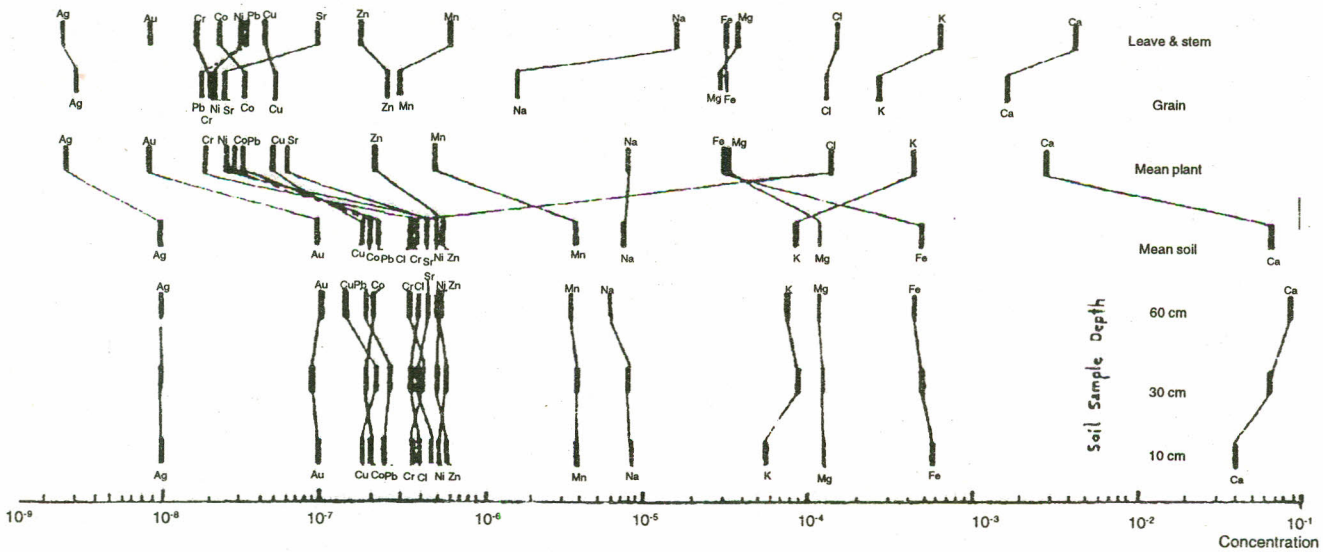

Fig. 1. Relationship between trace elements concentration in barley (leaves, stems and grains) planted in Kalabsha and in Kalabsha soil samples.

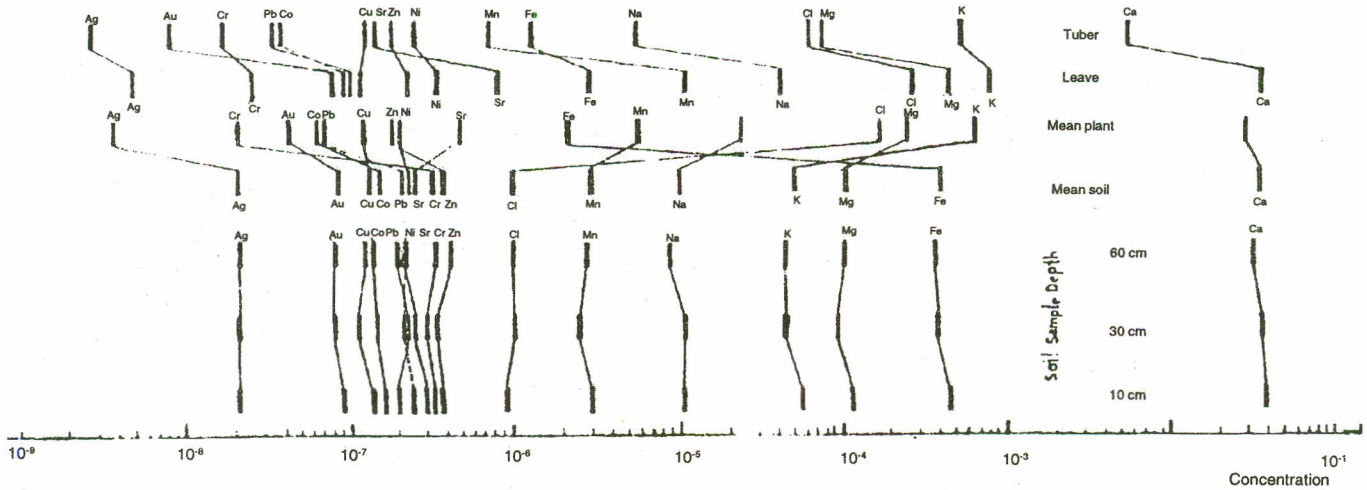

Fig. 2. Relationship between trace elements concentration in beet (leaves and tuber) planted in Kalabsha and in Kalabsha soil samples.

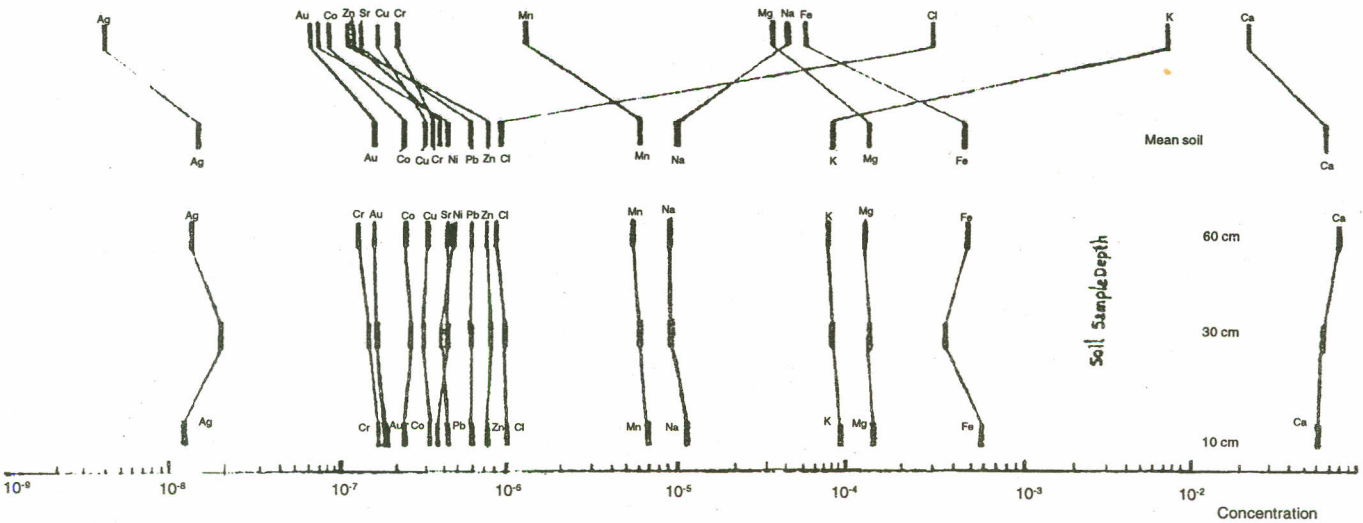

Fig. 3. Relationship between trace elements concentration in purslane (planted in Kalabsha) and in soil samples.

Ni activates a number of metal enzymes and plays an important role in pigmentation and colouration of plants [14]. Cr increases glucose tolerance and has a vital function for lipid and activates several enzymes[12]. Silver is known to be essential for plant in which it has unique metabolism, probably it binds to S-H group in proteins. So, barley can be utilized, with safety, as food for animals and can be utilized for making bread for peoples of developinmg countries. Purslane and beet can be used for animal feeding.

Purslane is cooked and used as food for peoples of developing countries, and beet is eaten fresh as salad and sugar is extracted from it.

The information gained on trace elements of valuable nutritional interest will help in establishing baseline levels. A continuation of these analyses (crops[17], food, fish[18], water[19], sugar cane[20] and molasses etc. [21] will give an indication of any intake variations over several years in the future.

Conclusion

Productivity of barley, beet and purslane given in Kalabsha farm is not so far from the standard rates. So Kalabsha soil is suitable for cultivation and can produce high yields of crops in future on improving the soil by treating it with fertilizers. Trace element concentrations of these plants planted in other areas[22], give lower values than those present in the crops under study which reflect its useful nutritional value.

References

1. S. Allen, Anal. Biochem., **138** (2), 346 (1984).
2. C. A. Rown, O. T. Zajicek and E. J. Calabrese, Anal. Chem., **54,** 149 (1982).
3. R. Emmerman and W. Luecke, Anal. Chem., **248,** 325 (1969).
4. R. L. Lacroik, D. R. Kenney and L. M. Walsh, Soil Sci. and Plant Anal, **1** (1), 1(1970).
5. R. Smart, A. D. Thomas and D. P. Drover, Comm. Soil Sci. Plant Anal., **5** (1), 1(1974).
6. *Orion Application Procedure,* No.205, (Orion Research Inc., (1980).
7. N. R. Mc Quaker and M. Gurney, Anal. Chem., **49,** 53 (1977).
8. P. Parks, Anal. Chem., **15,** 527 (1943).
9. *Hand Book of Electrode Technology,* (Orion Reseach Inc., 1982).
10. B. Issawi, *The Geology of Kurkur - Dungul Area,* General Egyption Organization, Geological Research and Mining, Geologial Survey, Report No. 49 (1982).
11. A. Shata, Geology and Geomorphology of the Lower Nubia Area, Report Desert Institute, Egypt (1962).
12. C.P. Malik and A.K. Srivastava, Plant Physiology, New Delhi (1982).
13. M. Gibbs, *Structure and Function of Chloroplasts* (Springerverlage, New York, 1978).
14. B. L. Oser, *Hawk's Physiological Chemistry* (McGraw-Hill, New Delhi, 1979) 4th ed.
15. B. L. Valle, J. F. Riovan, D. S. Auld and S. A. Latt, Phil, H. Trans. R.Soc., **257B,** 215 (1971).
16. I. Fridovich, Acta Chem. Res., **5,** 321 (1972).
17. M. K. Sherif, R. M. Awadallah and A. E. Mohamed, J. Radioanal. Chem., **53,** (1-2), 145 (1979).
18. R. M. Awadalla, J. Radioanal. Nucl. Chem., Letters, **103** 333 (1986).
19. M. K. Sherif, R. M. Awadallah and F. Grass, Chem. Erde, **40,** 178 (1981).
20. R. M. Awadallah, M. K. Sherif, A. E. Mohamed and F.J. Grass, Radioanal, Nucl. Chem., **98** (1), 49 (1986).
21. A. E. Mohamed, R. M. Awadallah and A. A. Hassan, J. Radioanal, Nucl. Chem., Articles, **129** (2), 453 (1989).
22. M. K. Sherif, R. M. Awadallah and A. E. Mohamed, Bull. Fac. Sci., Assiut Univ., Egypt, **7**(2), 341 (1978).