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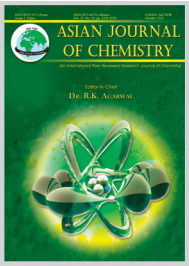

Comparative Study of Micronutrients in Soil and Plant Using Microwave Extraction in Wheat Fields of Lahore Suburbs, Pakistan

SHAFAQ MUBARAK*, MUHAMMAD ZIA-UR-REHMAN and ATTIKA HAQUE

Applied Chemistry Research Centre, PCSIR Laboratories Complex, Lahore-54600, Pakistan

*Corresponding author: Tel: +92 3074013632; E-mail: shafaq.mubarak@gmail.com

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In the present study, microwave digestion methodology is utilized to evaluate the micronutrient contents in soil and wheat leaves samples taken from different fields of Chuck 62 of Lahore city, Pakistan. There is considerable variation among wheat fields in terms of soil characteristics such as pH, EC, moisture, texture and micronutrients. The texture of soil differs from silty clay to silty clay loam. The value of pH, EC and moisture ranged from 5.6-6.9, 0.12-0.21(dS/m) and 0.9-2.3 %, respectively. As far as micronutrient contents are concerned, the values of Zn, Cu, Mn and Fe of bottom soil (15-30 cm) are in range of 71.7-96.4, 8.7-13.3, 208.6-288.7 and 218.2-247.3 mg/kg of soil, respectively. Top soil (0-15 cm) have the values 76.3-88.5, 6.5-15.2, 261.3-296.5, 172.6-241.2 mg/kg. Wheat leaves showed the level of Zn, Cu, Mn and Fe in the range of 40.2-67.3, 4.9-7.4, 112.4-134.7 and 64.2-79.6 mg/kg of soil respectively. The study shows that soil of each field is rich in micronutrients which are available to plants as depicted by the analysis of leaves. There is no need to apply any additional micronutrients to enhance the soil fertility and crop production.

Key Words: Soil micronutrient, Microwave digestion, Lahore wheat fields.

INTRODUCTION

In Pakistan wheat is grown in different patterns of crop rotation, such as; cotton-wheat, rice-wheat, sugarcane-wheat, maize-wheat, fallow-wheat. As presented by Mujahid[1] cotton-wheat and rice-wheat systems together account about 60 % of the total wheat area whereas rain-fed wheat covers more than 1.50 m ha area. Rotations with maize-sugarcane, pulses and fallow are also important.

Nutritional values of wheat in terms of micronutrients is known and work has been done in different countries by Curtin *et al.*[2], Irmak *et al.*[3], Kutman *et al.*[4] to check micronutrients level in soils and plants. Agricultural fields due to increased cultivation are losing their fertility as it is taken up by the plants. Moreover, the introduction of new high yielding hybrids or cultivators has further resulted in micronutrients deficiency. The deficiencies of zinc, boron and iron in Quetta, Pakistan has been reported by Zia *et al.*[5]. World level studies as carried by Amir Hossein *et al.*[6] revealed that soils are deficient for sustainable agriculture. Zinc and iron deficiency has been observed by Cakmak[7] in about 50 and 30 %, respectively. Soil and plant analysis done by Khattak[8] in Pakistan showed that more than 50 % of cultivated soils of the country are unable to supply sufficient micronutrients to many crops.

Fertilizers are being used to fulfill the deficiency of nutrients but their appropriate application is crucial, the need of fertilizers and the effect of soil type on zinc uptake by plant has been studied by Li *et al.*[9] and Jose *et al.*[10]. Wheat response to added micronutrient in Punjab has been observed by Chaudry *et al.*[11] and a Hal-tonic fertilizer effect is analyzed by Khan *et al.*[12]. Many analytical methods have been reported to analyze the soil and plant based on DTPA extraction by Cakmak *et al.*[13], DTPA-TEA extraction has been studied by Fonseca *et al.*[14]. Spectrophotometeric method with tetra-ethylthiuram disulfide and AAS method has been reported by Turek *et al.*[15]. High technology methods consists study of resin membrane technology[16] and method of ultrasonic slurry sampling electrothermal vaporization inductively coupled plasma mass spectrometry (USS-ETV-ICP-MS)[17]. From these, the best and quick technique is to apply microwave digestion to extract the micronutrients. The same study has been carried on tea samples[18]. Turkish legumes, kidney bean (*Phaseolus vulgaris* L.), lentil (*Lens esculenta*) and chickpea (*Cicer arietinum*) has also been studied on same basis by Erdoan *et al.*[19]. Work on wet digestion method for soil samples to analyze the total concentration (acid extraction) of elements by inductively coupled plasma emission spectro-metry (ICP-AES) has been done by Kovacs *et al.*[20].

These micronutrients has been analyzed on ICP-AES followed by microwave acid digestion with $HNO_3/HCl/H_2O_2$ by Achilli *et al.*[21]. Microwave extraction methodology with nitric and hydrofluoric acids for multi-elemental determination by inductively coupled plasma mass spectrometry has been reported[22].

The present work was carried out to assess the variability in Zn, Cu,Mn and Fe contents in wheat fields soil and plant (leaves) and their relationship with the level of these nutrients in soil depth. As nutrients absorption from soil by root depends upon the concentration of micronutrients in soil,it may help to assess the appropriate fertilizer quantity to be applied to soils for better yield.

EXPERIMENTAL

Collection of soil samples: For this research work, five wheat fields were selected from Manga Mandi Chack 62, Lahore Pakistan. All fields were irrigated with tube well water having area of about one acre. Soil samples were collected as top soil (0-15 cm) and bottom soil (15-30 cm). The sampling from fields done individually, six soil samples were taken from different sites of the same field and were mixed to get a homogenized representative sample. Each soil sample was labeled according to fields numbers. Similarly the wheat plants samples were also taken randomly. Soil samples were air dried and grounded to pass through 2 mm sieve to be used for analysis.

General procedure: Physical parameters of soil *i.e.*, soil type and soil texture was determined using textural triangle following the procedures mentioned by Lyon *et al.*[23]. Soil moisture, electrical conductivity and pH were determined by method described by Bashour *et al.*[24]. The concentration of the micronutrients (zinc, copper, iron, manganese) in each of the soil and plant samples were analyzed by microwave digestion technique as described by Chen *et al.*[25].

To extract the micronutrients from soil and plant leaves microwave digestion was performed in a household MW (Orient-N-N-7815F) equipped with invert technology (generally fixed at the required time) for realistic control of the microwave.

Soil sample (0.5 g) was taken in 120 mL Teflon-PFA microwave digestion vessel. Conc. HF (4 mL) was added to it and allowed to react overnight. Aqua regia (12 mL) was added and sample was digested at 0.83×10^6 Pa for 20 min. After digestion boric acid (2.0 g) was added to neutralize excess HF before analysis. Sample was filtered properly using a Watmann No. 42 filter paper and diluted upto 100 mL using distilled water. The same procedure was applied to the wheat plant samples including the additional step of crushing the leaves, before digestion. The solution was then used to analyze the micronutrient concentration through Atomic Absorption Spectrophotometer (Perklin, Elmer Model 8800).

RESULTS AND DISCUSSION

Fields were selected randomly at Chak 62 Manga Mandi Lahore. Physical parameters of soil like pH, moisture contents and electrical conductivity are summarized in Table-1. All fields show acidic soil. Values of moisture content differ with a range of 0.9-2.3 % with the highest moisture level in Field 1. Electrical conductivity is ranged from 0.12-0.16 dS/m which indicated that the soils are non- saline as reported in fact sheet[26], which are due to lower pH. The maintenance of soil micronutrients and the optimum level of nutrients are essential for the better productivity in agricultural systems. The electrical conductivity reflects the extent to which the soil is suitable for crops production. After repeated cultivation a stage is, however, reached when the soil becomes less productive if supply of certain nutrients is not provided. Thus, in order to makeup this deficiency; these nutrients in the form of their compounds have to be added to the soil to make it productive. The deficient and sufficient values of these nutrient has been recommended by National Fertilizer Development Centre, Islamabad (2003)[27], given in Table-2. The results of present study and the status of these nutrients *i.e.*, Zn, Cu, Mn and Fe with respect to soil depth and wheat leaves has shown in Table-3.

TABLE-1
PHYSICAL PARAMETERS OF SOIL SAMPLES

Field No	pH	Moisture (%)	EC (dS/m)
1	6.2	2.3	0.211
2	6.8	1.2	0.163
3	6.9	1.3	0.141
4	5.8	0.9	0.138
5	5.6	1.1	0.126

TABLE-2
STANDARDS FOR MICRONUTRIENTS IN SOIL

Micronutrients	Deficient Level (mg/kg)	Sufficient Level (mg/kg)
Zinc	<15-20	20-100
Copper	< 3-5	5-20
Manganese	< 10-20	20-300
Iron	<50	50-250

TABLE-3
MICRONUTRIENT CONTENTS IN SOIL AND PLANT LEAVES

Field No.	Sample	Zn (mg/kg)	Cu (mg/kg)	Mn (mg/kg)	Fe (mg/kg)
1	Bottom Soil	71.7	8.7	260.3	218.2
	Top Soil	76.6	6.5	290.2	184.5
	Wheat Leaves	41.9	5.2	120.1	78.4
2	Bottom Soil	94.2	9.6	288.7	225.3
	Top Soil	88.5	7.1	296.5	172.6
	Wheat Leaves	40.2	6.2	125.8	66.8
3	Bottom Soil	96.4	11.3	279.4	234.1
	Top Soil	82.2	6.7	286.3	241.2
	Wheat Leaves	67.3	5.6	112.4	67.1
4	Bottom Soil	92.4	12.4	242.2	247.3
	Top Soil	79.7	15.2	261.3	228.4
	Wheat Leaves	58.5	4.9	134.7	79.6
5	Bottom Soil	80.9	13.3	208.6	244.7
	Top Soil	76.3	9.1	277.4	232.8
	Wheat Leaves	50.1	7.4	129.8	64.2

Zinc status of soil and wheat crop: The research fields showed that the zinc concentration from 71.7-96.4, 76.6-88.5 and 40.2-67.3 mg/kg of soil in bottom soil, top soil and wheat leaves. As per standards the concentration of zinc in all fields, fall in sufficient category as per standards[27]. Comparison of zinc concentration in the fields is given in Fig. 1. It shows that

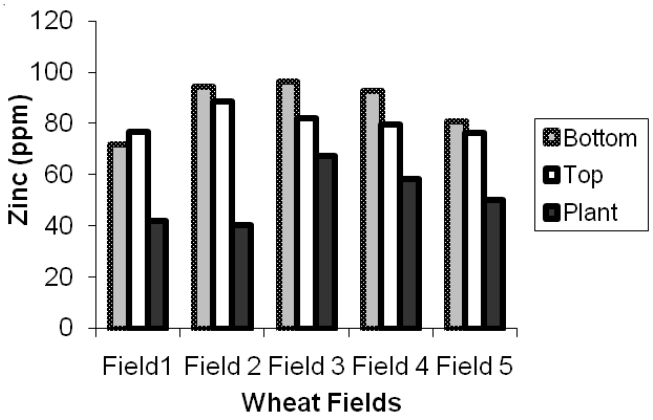

Fig. 1. Comparison of zinc micronutrient

the highest zinc level is observed in bottom soil of field 3. Wheat leaves with highest concentration of zinc is also observed in field 3. Zinc availability of plant increase as the soil pH increase. Field 3 has the maximum value of pH in the present studies and zinc concentration as well. These findings are in accordance to the studies done by Sheeja *et al.*[28], Sadashiva *et al.*[29] and Patiram *et al.*[30].

Copper status of soil and wheat crop: Copper concentration ranged from 8.7-13.3,6.5-15.2 and 4.9-7.4 mg/kg with respect to bottom, top soil and wheat leaves. The relationship of Cu level among soil layers and wheat leaves is shown in Fig. 2. Highest value is observed in topsoil of field 4 *i.e.*, 15.2 mg/kg. As per wheat leaves are concerned field 5 showed the maximum uptake from soil with value 13.3 mg/kg.

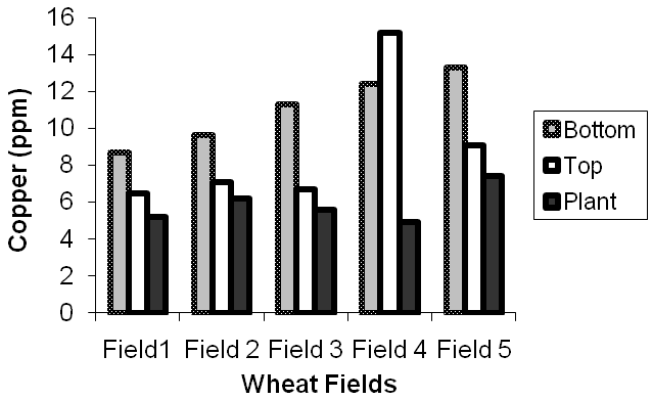

Fig. 2. Comparison of copper micronutrient

Manganese status of soil and wheat crop: As far Mn concentration, the values of bottom, top soil and wheat leaves ranged from, 208.6-288.7, 261.3-296.5, 112.4-129.8 mg/kg, respectively. Fig. 3 clearly indicate the trends in Mn level in all fields. The level of Mn is approximately same in top soils. Less variation is observed in bottom soil and wheat leaves. This shows that Mn as a whole has same level in all the fields and intake of this micronutrient by the plant is easy.

Iron status of soil and wheat crop: The results of Fe contents also falls in sufficient level. It is rather abundant in all the fields. The values ranged from 218.2-247.3, 172.6-241.2 and 64.2-79.6 mg/kg in bottom, top soil and plant samples. Comparison among top, bottom soil and leaves Fe contents is given in Fig. 4. It is observed that the iron like other micronutrients

Fig. 3. Comparison of manganese micronutrient

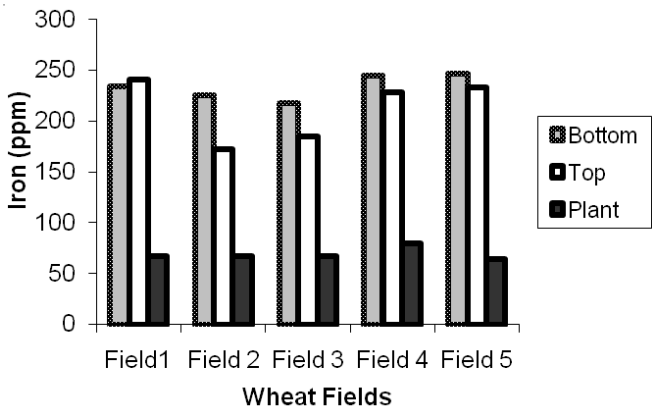

Fig. 4. Comparison of iron micronutrient

decreases with the increase in soil pH. These findings are supported by Rajakumar *et al.*[31] and Chinchmalatpure *et al.*[32] who reported the negative correlation between soil pH and iron concentration.

Conclusion

The wheat response to micronutrients in the selected fields was found to be in following order: Fe > Mn > Zn > Cu. Wheat grain and straw yield could be increased non-significantly with the increasing application of proper amount of micronutrients. Micronutrients deficiency in wheat crops may lead to yield reduction even upto 50 %. The majority of Pakistani soils are also facing wide spread deficiencies of these micronutrients. So, there is a sheer need of applying adequate amount of micronutrients to the wheat crops for their better production. As the nutrient levels vary from year to year and for this purpose we must know about the availability of micronutrients, pH, texture, moisture and electrical conductivity of the soils first. This data supports the fact that these essential micronutrients are in sufficient level for the proper growth of the plant. Further application of fertilizers should be adjusted by considering these analysis.

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