Variation in Uptake of Essential and Toxic Elements of Different Varieties of Wheat Grown in Same Agricultural Plot of Baluchistan, Pakistan

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Summary: The comparative study was done of different wheat varieties in their capacity to accumulate different thirteen essentials and trace elements grown on same agricultural plot. Six samples for each (Zardana, Azri-96 and Daman-98) as representative samples, grown on same plot of agricultural research institute sariab, Quetta. The soil samples of same agricultural plot was also analysed for same elements.

Standard reference samples of same varieties was collected from FSC&RD (Federal Seed Certification and Registration Department) . Atomic absorption spectrophotometer was used for the determination of all 13 elements. The characteristics mean of each element for three varieties of representative samples were found to be in the ranges of 586.87-974.69, 3606.81-3697.44, 189.71-269.69, 1511.22-1606.5, 19.19-35.13, 31.72-46.59, 32.74-44.28, 4.28-5.32, 1.235-1.551, 0.609-0.907, N.D, 0.470-0.528 and 0.271-0.296 mg/kg for Na, K, Ca, Mg, Fe, Zn, Mn, Cu, Ni, Pb, Co, Cd and Cr respectively which were compared with certified samples at 95% confidence limit.

Introduction

The factors which regulate the growth of plants are depend on a number of a biochemical processes involving various inorganic elements present in the soil. Large variation in mineral content of different crops [1,2,3] depend upon plants species, soil and climate. The plant species vary widely in tolerance to toxic metals and varieties with a species can also vary three to ten fold. variation in mineral content of different plant species grown on the same soil have also been reported [4].

Soil status and response of micronutrient fertilizers became very much essential to know [5]. Intensive and specialized cropping systems are also conducive to micronutrient deficiency in soils [4]. The contents of micro and macronutrients in soil and uptake of these in wheat and other food commodities as well in vegetables were studied by various researchers [6,7,8,9]. Micronutrients i.e. Zn, Cu and Mn play an important role in plant growth, so that it is necessary that the availability of these should be determined in the soil. Various workers tested and devised many methods under variable soil conditions for the determination of available content of any single micronutrient element [10]. It has been found that micronutrients requirements of various crops are increasing due to use of high rates of NPK and high yield varieties [13]. The effect of soil nutrients on different vegetables and fruits were studied [14]. Information of the metals on their biocycling from soil to crop to consumer as well as information on their level for the human health is, therefore, necessary in making decision on the best course to the rejection/utilization of the specific wheat varieties.

Results and Discussion

Uptake of essential and trace elements depends on the amount of these elements present in

the soil, irrigation water and species of the plants. It was observed that the soil contains (5336.3±282.6)mg/kg of the Na and the maximum uptake of the sodium was (974.69±46.73) found to be in the representative samples of the *Azri-96* while the lower concentration (586.87±24.13) was detected in the representative samples of the *Daman-98*. Potassium is another important and essential element for both (i.e. animal and plants) and is present in huge quantity (5150.9±412.7) mg/kg in the soil. It was observed that the greater quantity of the potassium (3697.4±55.15) was analysed in the representative sample of the *Azri-96* and minimum (3606.81±55.15) in the representative sample of the *Daman-98* variety. A considerable amount of the Ca (15219.5±517.1) mg/kg was found in the soil, from which the absorbed concentration was maximum (269.69±5.32) in representative sample of the *Azri-96* and the minimum concentration (189.71±7.65) mg/kg in the representative sample of the *Daman-98*. The high concentration of Mg (1606.5±34.77) was analysed in the representative sample of the *Azri-96* and lower concentration (1511.22±26.56) was found in the representative sample of the *Zardana* while as the soil of the same plot contains (30766.2±1329.9) mg/kg.

The considerable amount of essential trace elements such as Fe, Zn, Mn and Cu was found in soil as well as in wheat varieties. Iron is one of the important element for the biochemical reaction which is present in soil (5472.5±454.2) and its maximum uptake (35.13±1.89) was found in *Zardana* representative sample and minimum concentration (19.19±1.04) mg/kg was found in the representative sample of the *Azri-96*. In the representative sample of the *Zardana*, Zn was found to be (46.59±1.37) as a maximum concentration and lower concentration was (31.72±1.17) found in the representative sample of the *Azri-96* as compare to the soil concentration (90.78±7.72) mg/kg. The high concentration (44.28±1.79) of the Mn was found in the representative sample of the *Daman-98* and lowest concentration (32.74±0.53) in representative sample of the *Azri-96* which were absorbed from (413.52±40.79) mg/kg of the soil. The higher value (5.32±0.17) of the copper was determined in representative sample of *Zardana* and lower value (4.28±0.16) was detected in representative sample of the *Azri-96* and its growing soil contain (40.43±3.62) mg/kg.

Nickel, lead, cobalt, cadmium and chromium are the trace and toxic elements which are present in less quantity in the soil. Representative sample of the *Azri-96* contains maximum concentration (1.551±0.00) of the Nickel while the minimum concentration (1.235±0.00) was found in the representative sample of the *Daman-98* and the soil of that plot contains (18.18±0.65) mg/kg nickel. The higher uptake of the lead was found in the representative sample of the *Azri-96* and *Daman-98* (i.e. 0.907±0.08 and 0.907±0.00) respectively while low uptake (0.609±0.17) was found in the representative sample of the *Zardana* and its soil contains (5.25±0.51) mg/kg lead. The soil of the Agriculture Research Institute Sariab, Quetta contain (12.33±1.99) mg/kg of the cobalt, but non of cobalt was detected in any of the wheat variety . Cadmium is one of the trace and toxic element which have lowest concentration (1.47±0.10) in soil as compared to all other elements, and its highest concentration (0.528±0.082) was found in the representative sample of the *Zardana* and lowest value (0.470±0.00)mg/kg in *Azri-96*. Chromium was detected (12.11±1.49) in the soil while its maximum (0.296±0.031) uptake was found in representative sample of the *Zardana*, lower (0.271±0.022) in *Azri-96* representative sample as shown in table 3

Experimental

Procedure

The clay loam soil was collected from experimental fields of Agriculture Research Institute, Sariab, Quetta. Air-dried and seived (<0.5mm) soil. The experiment was conducted at the above place during normal wheat growing season (November, 1999 to May, 2000). Three commercial wheat varieties 'Zardana, 'Azri-96 and 'Daman-98' belonged to *Triticum aestivum* were sown and harvested at maturity stage. The grains were separated from their spikes by single heads thresher model No. AAM-8 which were randomly collected and make the representative samples while as reference samples were obtained from the "Federal Seed Certification and Registration Department"

All three wheat varieties and soil samples were dried at 105C° in oven. Replicate 1g samples of dried soil and 2g of each wheat variety were weighed in to 100ml conical flasks and treated with 5ml of nitric acid. 5ml of nitric acid was also added to empty conical flask serving as a blank. The flasks were covered with watch glasses, and their contents were heated to reflux gently on an electric plate. After refluxing for one hour the contents of flasks were treated with 5ml more of nitric, 2ml of 35% hydrogen

Table 1 Instrumental conditions for the AAS measurement of Na, K, Ca, Mg, Fe, Zn, Mn, Cu, Ni, Pb, Co, Cd and Cr.

Elements	Wave length (nm)	Slit width (nm)	Lamp Current (mA)	Fuel flow (acetylene) (l/min)	Flow rate (Air) (l/min)	Burner Height (mm)	Oxidant (Air) kg/cm^2	Fuel (Acetylene) kg/cm^2	Signal out put
Na	590	0.4	9.5	2.21	9.4	7.5	1.60	0.25	100%
K	766.8	2.6	9.5	2.3	=	=	=	0.3	=
Ca	422.2	2.6	7.3	2.6	=	12.5	=	0.4	=
Mg	285.5	2.6	7.0	2.0	=	7.5	=	0.2	=
Fe	248.3	0.2	9.5	2.30	=	=	=	0.3	=
Zn	214.0	1.3	9.5	2.0	=	=	=	0.2	=
Mn	279.8	0.4	=	=	=	=	=	=	=
Cu	325.0	1.3	=	=	=	=	=	=	=
Ni	232.3	0.2	9.5	=	=	=	=	=	=
Pb	232.3	1.3	7.0	=	=	=	=	=	=
Co	250.0	0.2	9.5	=	=	10.0	=	0.35	=
Cd	229.0	1.3	7.0	2.30	=	7.5	=	0.30	=
Cr	358.2	1.3	6.0	=	=	7.0	=	0.30	=

Table 2 Statistical data for standards of elements

Elements	Concentration range ppm (x)	Absorbance/ Division (y)	Statistical calculation y = m x + c		
			m	c	r^2
Na	0 - 0.25	0 - 0.084*	0.3344	0.0001	0.9996
K	0 - 1	0 - 0.207*	0.2069	0.0006	0.9999
Ca	0 - 5	0 - 0.256*	0.0508	0.0024	0.9993
Mg	0 - 1	0 - 0.885*	0.8856	0.0017	0.9999
Fe	0-1	0 - 0.096*	0.0976	-0.0016	0.9989
Zn	0 - 0.5	0 - 0.138*	0.2761	-0.0004	0.9999
Mn	0 – 1	0 – 0.196*	0.1962	0.0005	0.999
Cu	0 – 1	0 –0.086*	0.0862	0.0004	0.9989
Ni	0 – 0.25	0 – 14 div.	55.31	0.20	0.9984
Pb	0 – 0.25	0 – 15 div.	60.80	-0.4	0.9968
Co	0 – 0.50	0 – 29 div.	58.4	-0.35	0.9994
Cd	0 – 0.25	0 – 28 div.	110.39	0.052	0.9977
Cr	0 – 0.125	0 – 15 div.	121.59	-0.3977	0.9969

Absorbance*
div. =Divisions

peroxide was added, and the heating at gentle reflux was continued for another hour. The watch glasses were removed from the flasks, and the heating was continued until the volumes of their contents were reduced to 2-3ml. The contents of flask were cooled, diluted with high purity water, and filtered through whatman # 42 paper in to 25ml volumetric flasks. The contents of the flasks were brought to volume with high purity water and examined by atomic absorption spectrometry for their sodium, potassium, calcium, magnesium, iron, zinc, manganese, copper, nickel, lead, cobalt, cadmium and chromium levels. The results of these measurements are presented in table-3.

Instrumentation

A Hitachi Model 180-50 atomic absorption spectrophotometer was used for the determination of elements such as, sodium, potassium, calcium, magnesium, iron, zinc, manganese, copper, nickel, lead, cobalt, cadmium and chromium. The hollow-cathode lamps (made by Mtiorika company) of all above elements were operated at lamps current 9.5, 9.5, 7.3, 7.0, 9.5, 9.5, 7.0, 7.0, 9.5, 7.0, 9.5, 7.0, and 6.0mA respectively. The flow-rate for fuel 2.30 $1min^{-1}$ and air 9.40 $1min^{-1}$ was used respectively to obtain a clear yellow flame (reducing condition). The spectrophotometer out put was connected to a Hitachi recorder 056 with a range of 5mV. The signals measured were the heights of the absorbance/division peaks. All instrumental parameters are given in table 2.

Reagents and Calibration

The supra pure nitric acid (65% w/v) and hydrogen peroxide (35% w/v) reagents (Merck), high-purity water (electrical resistivity $\rangle$ 10mΩ cm) was produced with a Milli-Q system Millipore, MA, USA).

Calibration was obtained with external standards. The standards solutions were prepared by

Table-3: Variation in uptake of different trace and toxic metals in three varieties of *Triticum aestivum* grown on same agricultural plot using Atomic Absorption Spectrophotometer Hitachi Model 180-50

Elements	Soil		*Zardana*		*Azri-96*		*Daman-98*	
	Mean	Stdv.	Rep*. sample	Ref#. sample	Rep. sample	Ref. sample	Rep. sample	Ref. sample
Na	5336.3	±282.6	703.69±38.53	695.37±30.52	974.69±46.73	969.42±55.02	586.87±24.13	589.66±26.43
K	5150.9	±412.7	3614.37±45.31	3628.29±71.38	3697.4±55.15	3711.82±55.15	3606.81±55.15	3580.3±100.2
Ca	15219.5	±517.1	246.92±12.28	239.11±12.28	269.69±5.32	276.52±7.10	189.71±7.65	193.25±12.79
Mg	30766.2	±1329.9	1511.22±26.56	1521.46±23.37	1606.5±34.77	1613.32±28.93	1561.79±23.19	1533.52±15.1
Fe	5472.5	±454.2	35.13±1.89	37.21±1.62	19.19±1.04	21.49±1.45	30.44±1.89	27.98±2.38
Zn	90.78	±7.72	46.59±1.37	49.31±1.37	31.72±1.17	29.21±1.42	46.36±0.40	47.56±0.74
Mn	413.52	±40.79	39.57±0.84	41.31±0.62	32.74±0.53	33.18±0.53	44.28±1.79	46.12±1.79
Cu	40.43	±3.62	5.32±0.17	5.57±0.018	4.28±0.16	4.81±0.15	4.40±0.21	4.08±0.33
Ni	18.18	±0.65	1.393±0.223	1.091±0.056	1.551±0.00	1.824±0.112	1.235±0.00	1.526±0.00
Pb	5.25	±0.51	0.609±0.17	0.713±0.06	0.907±0.08	0.826±0.07	0.907±0.00	0.971±0.02
Co	12.33	±1.99	N.D	N.D	N.D	N.D	N.D	N.D
Cd	1.47	±0.10	0.528±0.082	0.431±0.041	0.470±0.00	0.392±0.082	0.499±0.041	0.542±0.082
Cr	12.11	±1.49	0.296±0.031	0.00±0.004	0.271±0.022	0.252±0.013	0.287±0.044	0.354±0.031

* = Representative sample collected from agricultural plot. # = Reference sample collected from FSC & RD

diluting a 1000mg/l multi element solution (ICP Multi element standard iv, Merck, Darmstadt, FRG) with the same acid mixture used for sample dissolution. Glassware were cleaned by soaking with the contact over night in a 10% (w/v) nitric acid solution and then rinsed with deionized water.

Solutions were aspirated into atomic absorption spectrophotometer and absorbance/ divisions measurements were made for each element using optimum instrumental conditions for flame atomization mode.

Reference standards were also run in parallel for inter calibration of our own standards. Elemental concentration were computed on an IBM compatible PC using a excel computer program.

The statistical calculation for standards are given in table 3.

Conclusions

So, it has been observed that, the botanical factor play an important role in uptake of essential and trace elements. The high amount of toxic metals was noted in agricultural area where the wheat samples were collected. Hence care should be taken in selection of particular variety of food grains. Because, wheat is a staple food and 90% of the Pakistani population consumed this food.

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