# Estimation of Essential Macro-nutrients in Sixteen Barley Cultivars (*Hordeum Vulgare* L.) and its Soil, Grown at Wheat Research Station Tandojam, Sindh

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(Received 31st January, 2004, revised 3rd July, 2004)

**Summary:** A study was conducted to evaluate the concentration of macronutrients accumulation in soil and barley cultivars grown at Wheat Research Station Tandojam, using flame atomic absorption spectrophotometer. The samples of different varieties of barley as well as soil samples of agricultural plot where all these varieties of barley were grown , They all are treated with nitric acid and hydrogen peroxide followed by dissolution in deionized water. The great range of each elements were observed in (mg/kg) . The sodium, potassium, calcium and magnesium determined in barley cultivars were found to be in the range of 892.86 – 2312.45 (Na), 4718.89 – 9514.51 (K), 6.42 – 122.45 (Ca), and 1157.42 – 2570.97 (Mg), in B-1 to B-16 respectively. The concentration in (mg/kg) of the soil of that specific plot was observed 4424.1 ± 291.12 (Na), 14181.0 ±556.5 (K), 3404.4 ± 327.0 (Ca), and 3975.2 ± 3847.8 (Mg). The validity of acid digestion method was checked by employing certified reference sample of Spinach NBS-1570. The measured values of elements are in closed agreement with certified values.

## Introduction

Barley is one of the world's oldest domesticated crops, and competes with wheat for the honor of a being the first form brought under cultivation [1]. Barley grains have a hull of adherent paleas, which are removable only with difficulty in hulled forms. In naked forms, the hull is readily lost during threshing. The hull amounts to about 13% of the grain (by weight) on the average, the proportion ranging from 7 to 25% according to type, variety, grain size, and latitude where the barley is grown.

The blue colour in some barley varieties, may be due to anthocyandin pigmentation. The three varieties of wheat were tested in artificially salinized soil for four different electrical conductivity levels (1.25, 4, 8 and 12dsm$^{-1}$) to assess the contents of various ions (Na, Ca, Mg) in plants and grains [2]. These results indicates that the accumulation of all the elements increases with the increases in salinity. A study by many scientists observed that the lengths of ear head and grain yield of barely were reduced due to combined treatment of cadmium and lead [3-5]. 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 [6-8] depends upon plant species, soil and climate. The plant species vary widely in tolerance to toxic metals and it depends on the soil characteristics such as pH, CEC, organic content and the amount of toxic metals present in soil. Variation in mineral content of different plant species grown on the same soil have also been reported [9].

Yang *et al.* [10] determined seven metals (Al, Ca, Cu, K, Fe, Mg and Zn) in thirteen different types of Belgian bread and bread products in order to distinguish between white and whole meal bread. 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 depend upon plants species, soil and climate [11,12]. The determination of essential, trace and toxic elements in soil and different grain food crops were performed by many researchers[13-15].

Variations in Ca, P, Fe, Cu, Zn and Mn contents of six wheat and six rice varieties under salt stress were investigated [16]. Uptake of various trace elements during germination of wheat, buckwheat and quinoa were studied [17]. The plant grown in Zn deficient soils have the tendency to accumulate heavy metals in wheat grain, it was studied the characterization of Zn uptake, binding and translocation in durum wheat.

Table 1 Determination of the Concentration (in mg/kg) of Na, K, Ca, and Mg in 16 Cultivars of Barley, Collected from Wheat Research Station Tandojam

| Barley Cultivars | *Name of Elements* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Na | | K | | Ca | | Mg | |
| | Minimum | Maxium | Minimum | Maxium | Minimum | Maxium | Minimum | Maxium |
| B1 | 2234.50 | 2409.30 | 5712.89 | 7282.37 | 113.80 | 130.23 | 2063.54 | 2408.73 |
| B2 | 958.99 | 1284.96 | 6480.19 | 8328.68 | 87.85 | 126.77 | 2436.35 | 2622.75 |
| B3 | 1384.16 | 1842.40 | 6863.84 | 7631.14 | 94.77 | 115.10 | 2063.54 | 2277.56 |
| B4 | 1308.58 | 1842.40 | 5015.35 | 5782.65 | 87.85 | 100.82 | 1966.89 | 2457.06 |
| B5 | 1497.54 | 1738.47 | 6061.66 | 7456.75 | 45.89 | 47.19 | 1897.85 | 2277.56 |
| B6 | 1218.82 | 1360.56 | 6794.08 | 7107.98 | 9.56 | 12.59 | 2070.45 | 2705.59 |
| B7 | 1058.20 | 1360.54 | 6410.44 | 8328.68 | 7.83 | 9.99 | 1870.24 | 2415.64 |
| B8 | 1039.30 | 1251.89 | 6619.70 | 7421.88 | 11.72 | 15.61 | 1953.08 | 2477.77 |
| B9 | 1308.58 | 1360.54 | 7979.91 | 9758.65 | 6.96 | 8.26 | 2388.02 | 2740.11 |
| B10 | 1431.41 | 1525.89 | 8572.82 | 9305.25 | 7.83 | 10.42 | 2243.04 | 2463.96 |
| B11 | 1124.34 | 1525.89 | 9235.49 | 9828.40 | 6.53 | 7.83 | 2201.62 | 2484.67 |
| B12 | 1195.20 | 1355.82 | 6270.93 | 7979.91 | 8.69 | 9.99 | 1773.58 | 2063.54 |
| B13 | 1218.82 | 1445.58 | 6236.05 | 7352.12 | 5.67 | 7.40 | 1939.27 | 2146.39 |
| B14 | 826.72 | 982.62 | 4352.68 | 5015.35 | 7.40 | 9.56 | 1034.88 | 1290.32 |
| B15 | 1313.30 | 1525.89 | 7491.63 | 9723.77 | 7.83 | 8.69 | 1808.10 | 2270.66 |
| B16 | 1289.68 | 1686.51 | 8154.30 | 10351.6 | 45.03 | 47.19 | 2015.22 | 2084.25 |
| Soil | 4424.10 | | 14181.00 | | 3404.4 | | 39751.2 | |

The purpose of this research was to examine the concentration of macro-nutrients in barley cultivars and their source i.e., soil, in order to improve their nutritional role as a source of bioavailable metals. This study would be highly significant for the nutritive purpose for the human being as well as for animals.

## Results and Discussion

It would be worthy of investigating the concentration levels of four elements among all the samples of the barley cultivars to gain some idea for the degree of variability in the uptake of different elements by different cultivars of barley grown on same agricultural plot in same season. Different symbols are used for different cultivars as indicated in the table 1. The elemental concentrations were determined on dry weight basis. The data in table 1 indicate the concentration of essential macro elements in different 16 cultivars of barley.

The value of sodium determined in sixteen cultivars of barley shows that B1 contains highest concentration in the range of 2234.50-2409.30 mg/kg, whereas lowest concentration 826.72– 982.62 mg/kg was detected in B14 as compared to the rest cultivars of the same location. The average content of Na was detected in B4, B9, B15 and B16 very close to one another. The soil of the agricultural plot possesses 4424.1 mg/kg of the sodium. Potassium is one of the important macronutrient that is found in higher concentration as compared with other micro-nutrients such as sodium, calcium and magnesium in barley cultivars. Highest concentration of potassium was observed in B11, which is in the range of 9235.49 – 9828.40 mg/kg, where as its lowest value was found in B14 in the range 4352.68 mg/kg. There is no any considerable variation in concentration of potassium as was observed in remaining varieties of barley. Accumulation of potassium in the soil of same plot where these cultivars grown was found to be 14181.0 mg/kg. Exept B4 and B14, all the cultivar contain higher amount of potassium than the recommended value [18].

The data of calcium in table 1 indicates that highest level was found in B1 in the range of 113.80 – 130.23 mg/kg and lowest level was observed in B13 in the range of 5.67 – 7.40 mg/kg, whereas there was no significant difference in the concentration of B7, B10, B14 and B15 cultivars. Similarly the concentration of B2, B3 and B4 is almost same. Rest of cultivars have significant difference in uptake of calcium. It was analyzed that soil of this area contain 3404.4 mg/kg.

In case of magnesium, maximum content was found in B2 (2436.35 – 2622.72 mg/kg), whereas the lowest concentration was observed in B14 (1034.88 – 1290.32 mg/kg). However the value of Mg in B3, and B6 are almost same in the range of 2063.54 – 2705.59 mg/kg. In soil 39751.2 mg/kg of the magnesiumwas observed.

Table 2. Barley cultivars/Pedigree and their soil collected from the Wheat Research Station Tandojam, Sindh (Pakistan)

| Codes | cultivars/Pedigree | Codes | cultivars/Pedigree | Codes | cultivars/Pedigree |
|---|---|---|---|---|---|
| B1 | Arar | B6 | Giza 120/5 | B11 | Bella Union |
| B2 | Rihane-03 | B7 | Albert | B12 | Cabuya |
| B3 | Beca's' | B8 | Arizona | B13 | Petuniaz |
| B4 | Beecher | B9 | Harma-03 | B14 | Egypt 4 |
| B5 | Orge | B10 | Tadmor/3 | B15 | Lignee 527 |
| | | | | B16 | Emir/Nackta |

## Experimental

*Material*

The experiment was conducted at Wheat Research Station (WRS) Tandojam, province Sindh of Pakistan during normal barley growing season (November 1999 to April, 2000) for two years. Sixteen cultivars/Pedigree were grown at wheat research station Tandojam. The entire cultivars as (table-2) were harvested at maturity stage and randomly collected to make a representative sample of each cultivar.

Soil samples were collected from the above agricultural research station where All these cultivars were grown by the usual procedure, i.e., from 0 to 15-cm depth. Soil samples were collected in the sunny days of the month of November 1999 to April 2000, with the help of a wooden tool to avoid contamina-tion of the soils with any of the element being studied.

The soil samples were air dried, ground and sieved (<0.5mm). The all soil samples were stoppered tightly in plastic bottles and labeled, for further investigation.

All 16 barley cultivars and soil samples were dried at 105°C in oven till constant weight. Replicate 1g samples of dried soil and 2g of each barley cultivar were weighed in to 100ml conical flasks and treated with 5ml of nitric acid. 5ml of nitric acid were also added to empty conical flask serving as a blank [19,20]. The flasks were covered with watch glasses, and their contents were heated at 100°C on an electric plate. After heating for one hour the contents of flasks were treated with 5ml more of nitric acid , 2ml of 35% hydrogen peroxide was added, and the heating 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 flasks 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, and magnesium levels. The results of these measurements are presented in table 1.

*Instrumentation*

A Hitachi Model 180-50 atomic absorption spectrophotometer was used for the determination of elements such as, sodium, potassium, calcium, and magnesium. The hollow-cathode lamps (made by Mitorika company) of each elements were used. 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 peaks. All instrumental parameters are given in table 3.

*Reagents and Calibration*

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

Calibration was obtained with external standards. The standards solutions were prepared by diluting a 1000mg/l multi element solution (ICP Multi element standard, 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.

Standards and sample solutions were aspirated into atomic absorption spectrophotometer and absorbance measurements were made for each element using optimum instrumental conditions for flame atomization mode.

Table 3. Instrumental Conditions for the FAAS Measurement of Na, K, Ca, and Mg.

| Elements | Wave length (nm) | Slit width (nm) | Lamp current (mA) | Fuel flow (acetylene) (l/min) | Flow rate (Air) (l/min) | Burner height (mm) | Signal out put |
|---|---|---|---|---|---|---|---|
| Na | 590 | 0.4 | 9.5 | 2.21 | 9.4 | 7.5 | 100% |
| K | 766.8 | 2.6 | 9.5 | 2.3 | 9.4 | 7.5 | |
| Ca | 422.2 | 2.6 | 7.3 | 2.6 | 9.4 | 12.5 | 100% |
| Mg | 285.5 | 2.6 | 7.0 | 2.0 | 9.4 | 7.5 | 100% |

Table 4. Statistical Data for Standards of Elements

| Elements | Concentration range ppm (x) | Absorbance (y) | Statistical calculation y = m x + c Slope ( m) | Intercept (c ) | Coefficient of determination ( $r^2$) |
|---|---|---|---|---|---|
| Na | 0 - 1 | 0 – 0.395 | 0.3952 | 0.0013 | 0.9990 |
| K | 0 - 1 | 0 - 2680 | 0.2678 | 0.0016 | 0.9997 |
| Ca | 0 - 1 | 0 - 0.1850 | 0.1852 | 0.0001 | 0.9998 |
| Mg | 0 –1 | 0 – 0.885 | 1.743 | 0.0036 | 0.9993 |

Elemental concentration were computed on an IBM compatible PC using a excel computer program. The statistical calculations for standards are given in table 4.

## Conclusions

It can be concluded that there were remarkable differences in up taking the 4 metals in different cultivars of barley even though, they can grow in the same soil and same climatic conditions. It may be due to some physiological, biochemical, anatomical and morphological, and genetic characters.

## AcknowledgementS

Ghulam Qadir Shar is thankful to Syed Iqrar Hussain Shah, Muhammed Aslam Nushad (Seed Certification Officers), Seed Certification & Registration Department and Malik Azhar Ali for their co-operation in sampling of the barley cultivars from Cereal Crop Research Institute Pirsabak, Nowshera (NWFP). Thanks are also due to my parent institute Shah Abdul Latif University, Khairpur, Sindh, Pakistan for financial support and grant of study leave.

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