http://www.pjbs.org

PJBS

ISSN 1028-8880

# Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 11 (19): 2331-2335, 2008
ISSN 1028-8880
© 2008 Asian Network for Scientific Information

# Correlation of Manganese Contents of Soils and Wheat Plants (*Triticum spelta*) in the Cukurova Region of Turkey

[1]S. Irmak and [2]H. Vapur
[1]Cukurova Agricultural Research Institute, Yuregir, Adana, Turkey
[2]Mining Engineering Department, Cukurova University, 01330 Balcali, Adana, Turkey

**Abstract:** In this study, the statistical analysis of manganese contents for soil, leaf and grain samples of the wheat plants, *Triticum spelta*, in the Cukurova Region of Adana in Turkey was performed to determine the relationship among the variables and correlation coefficients of manganese (Mn) contents. The soil samples were taken from the plant rhizosphere. Leaf samples at the stem elongation time and grain samples at the physiological maturity stage were analysed for Mn contents. The Mn contents of soil (MnS) were between 1.47 and 3.80 mg $kg^{-1}$, but the MnS of some samples were measured below the critical level of soil (1.00 mg $kg^{-1}$). Whereas Mn contents of leaves (MnL) were obtained between 47.55 and 126.40 mg $kg^{-1}$. The Mn contents of grain (MnG) were obtained between 20.16 and 49.08 mg $kg^{-1}$. Direct correlation was found between MnL and MnG. But indirect correlations between was found MnS and MnG. Correlation between MnL and MnG was significant at the 0.01 level according to statistical analysis.

**Key words:** Soil characteristic, manganese, micronutrient elements, mineral deficiency

## INTRODUCTION

Many elements of the periodic table are trace elements. Although some trace elements are essential for life, some of them have toxic effects in high concentrations. The chemical composition, behaviour of plant nutrients and heavy metals in soil depend on chemical properties and composition of the soil matrix, so the variation of composition in the soil matrix may lead to significant variation of composition and behaviour of soil nutrients and heavy metals. The distribution of a specific element or a micro element in the solid phase is important for controlling its initial rate of leaching. Elements adsorbed on particle surfaces will be more readily accessible to the soil solution (Zhang *et al*., 2003).

As staple crops contribute substantially to daily caloric intake among people in developing countries, there has been a resurgence of interest in addressing human malnutrition through breeding of staple crops, specifically to address micronutrient malnutrition (Gregorio *et al*., 2000; Long *et al*., 2004).

The recent studies showed the important role of micro elements in human and plant nourishment. The studies made especially on zinc point out that the problem of zinc deficiency is in serious condition in Turkey. Insufficient content of micronutrient elements in soil has a negative impact on the development of crops, which, in turn, affects human health. Micro element deficiencies like zinc and iron resulted in some serious health problems especially in children at developmental age. In this respect, micronutrient elements exhibit a profound significance for the condition of human health as much as they do for a successful production of crops.

Manganese, an essential trace element, is often applied to agricultural and horticultural crops. There are very little studies about Mn in the Turkey. The objectives of this study was to determine the soil Mn content of wheat production field in Cukurova region was to assess effects of MnS, on MnL, MnG and 1000 kernel.

## MATERIALS AND METHODS

**Description of the area:** Cukurova Region is one of the most important agricultural areas of Turkey (Fig. 1). The

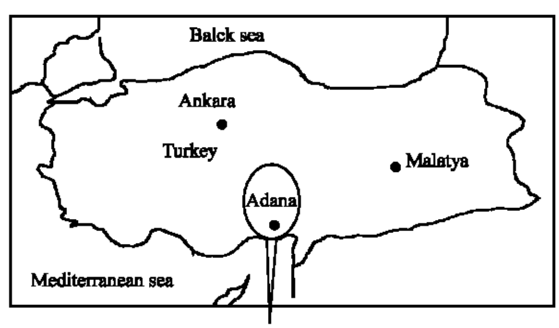


Fig. 1: The study area in Cukurova Region

**Corresponding Author:** S. Irmak, Cukurova Agricultural Research Institute, Yuregir, Adana, Turkey
Tel: +90 322 3340030 Fax: 90 322 3340357

area is characterized by xeric climate. The average amount of annual rainfall is 67.08 cm and potential total evaporation is 153.60 cm. The mean annual air temperature is 19.1°C. The mean annual soil temperature at 50 cm depth is 20.8°C. All the soils are xeric moist regime. The vegetations in the study area are grasses, cereal and leguminous crops. The vegetation was dominated by cereal and leguminous grasses. Wheat, cotton, maize, grape and soybean have been commonly growing in Cukurova Plain as industrial crops in Turkey.

**Laboratory experiments and data analysis:** In this study, 30 leaves samples, 30 grain samples and 30 soil samples in 2006 were collected to research from wheat (*Triticum* sp.) fields in Cukurova Region of Turkey. Plants were sampled during growing (heading) to determine MnL (Manganese in leaf). Grain samples were taken in the harvest season to determine MnG. Soil samples collected from 0-30 cm from roots region for laboratory analysis and dried with air to pass under screen (-2 mm). The particle size distribution of soil samples was determined by the pipette method (Xu *et al*., 2001). The pH was measured on saturation extracts (Radiometer PHM 82 standard pH meter). Organic C was measured by using a modified Walkley-Black procedure (Chan *et al*., 1995). Carbonate content was determined by the Scheibler calcimeter method (McKeague, 1978). Cation-exchange capacity was measured with Mg saturation followed by $NH_4$ substitution (Nelson and Sommers, 1996). Available $P_2O_5$ analysis was carried out by Olsen (Olsen and Sommers, 1982). Extractable Mn by the citrate dithionite-bicarbonate method was carried out by Olsen *et al*. (1954). The results were evaluated using correlation matrix and correlation graphics. For the purpose of data analysis, the SPSS 11.0 statistical software which offer a choice of correlation were used statistical analysis.

## RESULTS AND DISCUSSION

**Some chemical properties of soils:** $CaCO_3$ and organic matter content of soil samples were between 16 and 21% and 1.46 and 2.33%, respectively (Table 1). The CEC values changed between 21.24 and 38.02 cmol kg$^{-1}$. Soil pH of samples changed between 7.50 and 7.99 for all measurements. The lowest utilizable $P_2O_5$ content was observed as 16 kg ha$^{-1}$ in all samples. The highest amount of utilizable $P_2O_5$ was measured in sample 6 as 179 kg ha$^{-1}$ while the amount of utilizable $P_2O_5$ changed between 16 and 179 kg ha$^{-1}$. It is believed that the excess amount of utilizable $P_2O_5$ in soil was caused by overdose application

Table 1: Physico-chemical properties of soil samples (Irmak *et al*., 2008)

| | | | | | | Particle-size<2 mm (%) | | |
|---|---|---|---|---|---|---|---|---|
| Sample | $CaCO_3$ (%) | Org. M. (%) | CEC (cmol kg$^{-1}$) | pH (1/1) | $P_2O_5$ (kg ha$^{-1}$) | Clay | Silt | Sand |
| 1 | 16.0 | 2.33 | 26.04 | 7.50 | 125 | 31.9 | 43.0 | 25.1 |
| 2 | 17.0 | 2.05 | 28.66 | 7.64 | 49 | 31.1 | 46.1 | 22.8 |
| 3 | 16.0 | 2.02 | 29.77 | 7.71 | 51 | 30.6 | 44.8 | 24.6 |
| 4 | 16.0 | 1.83 | 25.04 | 7.58 | 130 | 32.2 | 41.9 | 25.9 |
| 5 | 16.0 | 1.71 | 29.63 | 7.62 | 70 | 33.2 | 43.7 | 23.1 |
| 6 | 16.0 | 1.49 | 21.24 | 7.57 | 179 | 23.1 | 25.3 | 51.6 |
| 7 | 19.0 | 1.90 | 38.02 | 7.69 | 64 | 34.4 | 49.2 | 16.4 |
| 8 | 21.0 | 1.83 | 30.62 | 7.75 | 68 | 32.2 | 45.9 | 21.9 |
| 9 | 18.0 | 1.73 | 32.22 | 7.76 | 47 | 40.8 | 48.7 | 10.5 |
| 10 | 21.0 | 1.90 | 30.83 | 7.73 | 65 | 38.7 | 49.7 | 11.6 |
| 11 | 19.0 | 2.08 | 30.87 | 7.68 | 25 | 37.1 | 51.7 | 11.2 |
| 12 | 18.0 | 2.08 | 29.94 | 7.71 | 66 | 37.1 | 52.3 | 10.6 |
| 13 | 18.0 | 2.14 | 30.91 | 7.74 | 38 | 39.5 | 47.9 | 12.6 |
| 14 | 17.0 | 2.24 | 35.50 | 7.64 | 122 | 40.2 | 48.6 | 11.2 |
| 15 | 18.0 | 2.21 | 33.08 | 7.71 | 122 | 39.1 | 49.7 | 11.2 |
| 16 | 18.0 | 1.96 | 34.75 | 7.66 | 74 | 39.1 | 49.2 | 11.7 |
| 17 | 18.0 | 2.17 | 36.33 | 7.65 | 69 | 40.8 | 48.2 | 11.0 |
| 18 | 18.0 | 1.74 | 34.72 | 7.76 | 66 | 41.4 | 48.9 | 9.7 |
| 19 | 18.0 | 1.99 | 33.08 | 7.68 | 81 | 39.6 | 49.3 | 11.1 |
| 20 | 17.0 | 1.99 | 33.55 | 7.72 | 105 | 37.2 | 50.5 | 12.3 |
| 21 | 18.0 | 1.90 | 33.80 | 7.71 | 49 | 41.7 | 48.3 | 10.0 |
| 22 | 18.0 | 1.86 | 33.66 | 7.77 | 56 | 41.8 | 47.5 | 10.7 |
| 23 | 19.0 | 1.99 | 30.88 | 7.74 | 16 | 39.0 | 48.2 | 12.8 |
| 24 | 21.0 | 2.05 | 30.80 | 7.72 | 72 | 34.7 | 50.6 | 14.7 |
| 25 | 20.0 | 1.71 | 33.30 | 7.67 | 60 | 37.3 | 48.9 | 13.8 |
| 26 | 21.0 | 1.46 | 31.72 | 7.63 | 29 | 38.4 | 53.7 | 7.9 |
| 27 | 21.0 | 1.65 | 31.63 | 7.50 | 46 | 35.1 | 50.5 | 14.4 |
| 28 | 21.0 | 1.27 | 31.51 | 7.59 | 60 | 36.4 | 52.0 | 11.6 |
| 29 | 18.0 | 1.65 | 32.60 | 7.99 | 51 | 36.1 | 47.2 | 16.7 |
| 30 | 17.0 | 1.68 | 31.60 | 7.72 | 31 | 36.1 | 44.0 | 19.9 |

of fertiliser (Irmak *et al*., 2007). The optimum amount of soil $P_2O_5$ content to provide favourable growing condition for plants is about 80 kg $ha^{-1}$. The excess amount of utilizable $P_2O_5$ content seems to have a negative effect on other microelements uptake from soil such as Fe, Mn, Mo, Cu, B, Zn, Cl, Na, Co, V and Si (Cakmak *et al*., 1997; Long *et al*., 2004).

**Manganese contents of soils:** Manganese contents of soils (Table 2) showed that Mn contents of soil were low ranging from 1.47 to 3.80 mg $kg^{-1}$. Mn contents of all soil samples were appeared to be lower than Mn critical level being 4.00 mg $kg^{-1}$. The sample 5 have had the lowest amount of Mn content being 1.47 mg $kg^{-1}$ and the sample 20 have had the highest amount of Mn content being 3.80 mg $kg^{-1}$. The high Mn content may be associated with chemical composition of parent material. The fields of the region were crossed with irrigation channels and connected with Seyhan River which was originated from Toros Mountains in Turkey. Therefore, the high Mn content of plants may be associated with irrigation waters. Ozturk (1997) mentioned considerable manganese sources located in Toros Mountains (Northern of Cukurova Plain, Turkey). Also, it is known that soil parent material and irrigation waters have an effect on chemical properties of soil such as pH, salinity (EC), Cation Exchange Capacity (CEC), Organic matter, Carbon to Nitrogen ratio (C/N) (Sahin and Nakiboglu, 2006; Irmak *et al*., 2007).

**Manganese contents of leaves:** Mn contents of leaf samples (Table 2) showed that Mn contents were varied between 47.55 and 126.40 mg $kg^{-1}$. Mn contents of leaves were appeared to be higher than critical level being 40 mg $kg^{-1}$. MnL content of sample 30 was determined as the lowest value (47.55 mg $kg^{-1}$). On the other hand, MnL content of sample 4 was determined as the highest value (126.40 mg $kg^{-1}$). There was a very applicable correlation between MnL and MgG when statistically data reduction applied on the measured values (Fig. 3). The best correlation coefficient was $R^2$= 0.81 (R= 0.90). Also, correlation coefficient was increased from 0.61 to 0.90, statistically when sample size was 22 (Fig. 2, 3).

**Manganese contents of grains:** MnG of the samples (Table 2) showed that the amount of MnG samples varied between 20.16 and 49.08 mg $kg^{-1}$. The sample 30 contained the lowest amount of Mn content with the maximum kernel weight (54.80 g). But, the sample 4 contained the highest amount of Manganese (49.08 mg $kg^{-1}$). While there was an inverse relation

Table 2: Manganese content of soils (MnS), leaves (MnL) and grains (MnG)

| Samples | Mn in soil | Mn in leaf (mg $kg^{-1}$) | Mn in grain | 1000 kernel (g) |
|---|---|---|---|---|
| 1 | 2.25 | 65.30 | 31.82 | 43.59 |
| 2 | 1.64 | 73.28 | 36.62 | 43.74 |
| 3 | 1.97 | 100.40 | 41.60 | 40.14 |
| 4 | 2.00 | 126.40 | 49.08 | 46.15 |
| 5 | 1.47 | 94.26 | 40.15 | 41.91 |
| 6 | 2.30 | 88.28 | 40.38 | 40.86 |
| 7 | 1.83 | 68.51 | 35.53 | 44.48 |
| 8 | 2.30 | 68.66* | 36.52* | 41.60 |
| 9 | 2.25 | 60.52* | 33.45* | 49.74 |
| 10 | 2.40 | 66.82 | 26.96 | 40.93 |
| 11 | 2.15 | 70.99 | 26.02 | 40.07 |
| 12 | 2.00 | 51.91 | 27.84 | 52.26 |
| 13 | 2.25 | 62.92 | 27.77 | 51.08 |
| 14 | 2.20 | 64.67 | 29.81 | 40.87 |
| 15 | 2.25 | 83.59 | 37.21 | 39.83 |
| 16 | 1.50 | 95.86 | 42.41 | 40.86 |
| 17 | 2.40 | 91.46 | 35.94 | 42.12 |
| 18 | 2.10 | 59.03* | 39.10* | 48.31 |
| 19 | 1.95 | 56.90 | 25.12 | 46.49 |
| 20 | 3.80 | 109.20* | 29.88* | 41.44 |
| 21 | 2.50 | 111.70* | 32.71* | 45.07 |
| 22 | 2.65 | 86.89 | 34.94 | 44.30 |
| 23 | 2.55 | 80.85 | 32.52 | 37.30 |
| 24 | 2.10 | 75.23* | 25.49* | 34.83 |
| 25 | 2.45 | 60.13* | 34.90* | 39.55 |
| 26 | 2.20 | 88.92 | 31.83 | 39.34 |
| 27 | 2.45 | 69.00 | 29.26 | 43.09 |
| 28 | 2.30 | 64.73 | 30.94 | 45.06 |
| 29 | 2.05 | 49.00* | 32.17* | 54.43 |
| 30 | 2.75 | 47.55 | 20.16 | 54.80 |

*Because of data reduction, the pointed values were not used (Fig. 3)

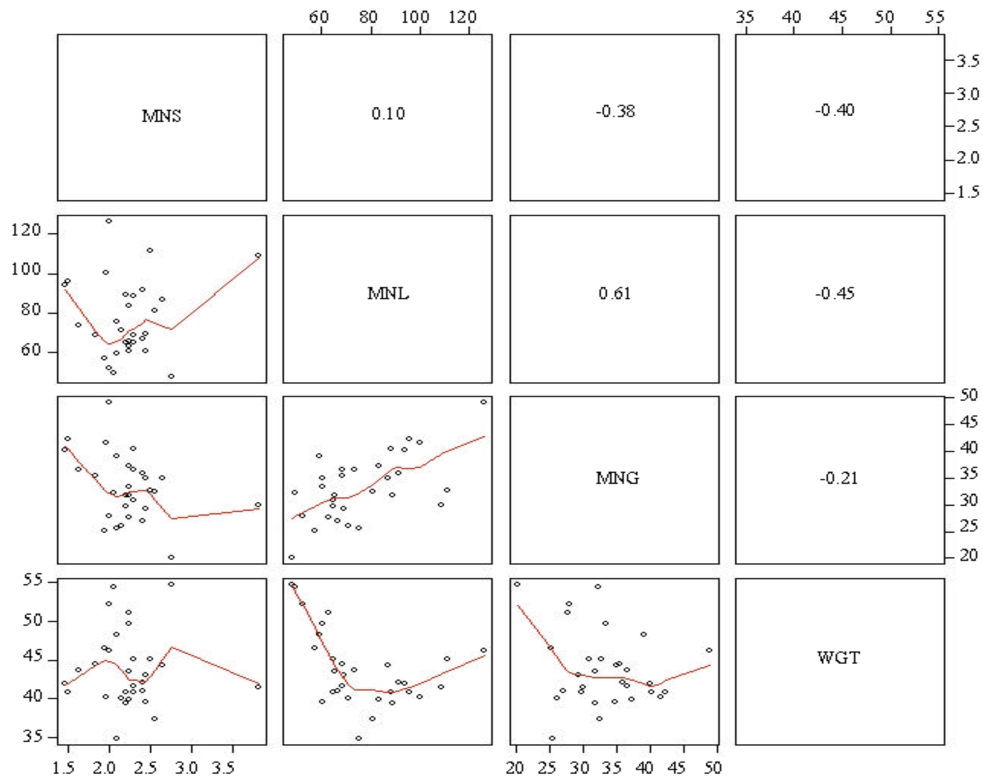


Fig. 2: General variations or correlations between MnS, MnL and MnG

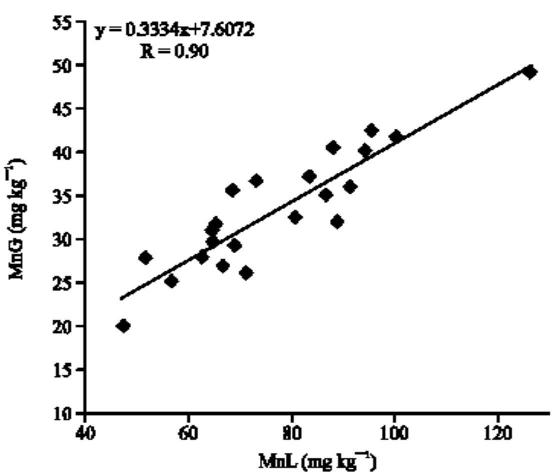


Fig. 3: The variation between MnL and MnG after statistical data reduction

between MnL and soil samples, there was a direct relation between MnG and MnL, respectively (Fig. 2, 3). Also, correlation between MnG and MnL is significant at the 0.01 level according to statistical analysis (Table 3). It means that there are very suitable distributions between

Table 3: The correlation matrix for MnS, MnL and MnG

| | Mn soil | Mn leaf | Mn grain | 1000 kernel |
|---|---|---|---|---|
| Mn soil | 1.00 | 0.10 | -0.38* | -0.20 |
| Mn leaf | 0.10 | 1.00 | 0.61** | -0.45* |
| Mn grain | -0.38* | 0.61** | 1.00 | -0.21 |
| 1000 kernel | 0.20 | 0.45* | -0.21 | 1.00 |

*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed)

MnG and MnL. Also, it shows that the plant can took the manganese as a microelement from another source. It should be concluded that the irrigation water of Seyhan River in Cukurova plain may consist of some micro elements or trace minerals. Table 2 showed that MnL contents were very high with maximum variation limits, but Mn contents of soils were very low values with minimum variation limits. The biggest standard deviation was observed for MnL data.

## REFERENCES

Cakmak, I., H. Ekiz, A. Yilmaz, B. Torun and N. Koleli *et al*., 1997. Differential response of rye, triticale, bread and durum wheats to zinc deficiency in calcareous soils. Plant Soil, 188: 1-10.

Chan, Y.C., P.D. Vowles, G.H. McTainsh, R.W. Simpson, D.D. Cohen and G.M. Bailey, 1995. Use of a modified Walkley-black method to determine the organic and elemental carbon content of urban aerosols collected on glass fibre filters. Chemosphere, 31: 4403-4411.

Gregorio, G.B., D. Senadhira, H. Htut and R.D. Graham, 2000. Breeding for trace mineral density in rice. Food Nutr. Bull., 21: 382-386.

Irmak, S., Y. Kasap and A. Surucu, 2007. Effects of town waste on the heavy metal contents and plant nutrient element contents of soils in Harran plain. Turk. Fresenius Environ. Bull., 16-3: 285-289.

Irmak, S., A.K. Surucu and S. Aydýn, 2008. Zinc contents of soils and plants in the cukurova region of Turkey. Asian J. Chem., 20: 3525-3536.

Long, J.K., M. Banziger and M.E. Smith, 2004. Diallel analysis of grain iron and zinc density in southern African-adapted maize inbreds. Crop Sci., 44: 2019-2026.

McKeague, J.A., 1978. Manual of Soil Sampling and Methods of Analysis. 2nd Edn., Canada Society Soil Science, Ottawa, Canada.

Nelson, D.W. and L.E. Sommers, 1996. Total Carbon, Orgamic Carbon and Organic Matter. In: Methods of Soil Analysis, Sparks, D.L. (Ed.). American Society Agronomy, Madison, pp: 961-1010.

Olsen, S.R., V. Cole, F.S. Watanabe and L.A. Dean, 1954. Estimation of Available Phosphorus in Soils. 1st Edn., US Department of Agriculture Cir., Washington.

Olsen, S.R. and E.L. Sommers, 1982. Phosphorus Availability Indices, Phosphorus Soluble in Sodium Bicarbonate, Methods of Soil Analysis, Part 2. In: Chemical and Microbiological Properties, Page, A.L., R.H. Miller and D.R. Keeney (Eds.). American Soc. of Agronomy, Madison, Wisconsin, USA., pp: 404-430.

Ozturk, H., 1997. Manganese deposits in Turkey: Distributions, types and tectonic setting. Ore Geol. Rev., 12: 187-203.

Sahin, I. and N. Nakiboglu, 2006. In direct determination of B in water by cathodic stripping voltammetry. Fresenius Environ. Bull., 15: 457-461.

Xu, J.M., K. Wang, R.W. Bell, Y.A. Yang and L.B. Huang, 2001. Soil B fractions and their relationship to Soil Properties. Soil Sci. Soc. Am. J., 65: 133-138.

Zhang, M.K., Z.L. He, D.V. Calvert, P.J. Stoffella and X.E. Yang, 2003. Phosphorus and heavy metal attachment and release in sandy soil aggregate fractions. Soil Sci. Soc. Am. J., 67: 1158-1167.