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# Growth and Nutrient Contents Response of Maize to Foliar Nutrition with Micronutrients Under Irrigation with Saline Water

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**Abstract:** A pot experiment was conducted to investigate the influence of spraying salinity-stressed maize plants grown on two soils ( sandy and clay) with micronutrients on growth, expressed as root and shoot dry matter production and macro- and micronutrient contents. Treatments were: 1- irrigation with tap water; 2- irrigation with a mixture of NaCl and $CaCl_2$ (each of 2g/L) and 3- treatment 2 + 4 foliar sprays with EDTA- micronutrient compound containing 2.8% Fe + 2.8% Mn + 2.8% Zn + 14% N. at rate 1g/L. Root growing media had significant effect on growth and nutrient contents. Clay soil showed better growth as well as more nutrient contents as compared with sandy soil medium. Salinity treatment had a negative effect on growth and nutrient contents measured in root and shoot except in case of root Ca and shoot Na. Spraying salinity-stressed plants with micronutrient compound showed a significant positive effect on root dry weight, while this treatment could decrease the depression in shoot dry weight caused by salinity treatment. Spraying salinity-stressed plants with micronutrient compound showed a significant positive effect on both root and shoot nutrient contents with some exceptions, where shoot N and P contents showed slight reduction as compared with control treatment. The interaction effect between soil type and micronutrients foliar spray was significant.

**Key words:** Maiz, saline water, micronutrients

## Introduction

Consequent upon the fact that the rainless desert occupies about 95% of the total area of Egypt. Revegetation of such desert has been carried out in large scale in the recent years. Almost, all crops planted there have been continuously irrigated with the ground water. The main problems of revegetation in Egypt are harsh climate conditions and high salinity of most ground water resources.

Potential exploitation of salt affected soils and /or available poor quality irrigation water may contribute a good deal to the national income. This may be reached if special care is paid to proper utilization by choosing tolerant crop/cultivar and modifying the supplemental nutritional application to counter-balance the nutritional status of the plant (Ahmed, 1987). Mangal (1999) stated that salt tolerance can be appraised according to three criteria: (1) ability of crop to survive on saline soil; (2) yield of the crop on saline soil and (3) the relative yield of crop when grown on saline and non-saline soil under similar growing conditions.

Foliar application of nutrients is partially overcoming the negative effect of stress conditions influencing root growth and absorption capacity (Abdalla and Mobarak, 1992 ; Salama *et al.*, 1996 ; El-Fouly and Abou El-Nour, 1998). In this respect, El-Fouly and El-Sayed (1997) stated that foliar fertilization of both macro and micronutrients is practiced whenever, nutrients uptake through the root system is restricted due to stress conditions.

Increasing in desert cultivation where, saline water irrigation is the almost source available, emphasizes the need for more information on crop performance and tolerance under salinity stress condition. Thus, it is economical to identify salt tolerant crop varieties that can be grown normally by studying their capacity to take up the needed nutrients under salinity stress condition.

In this direction the present study was undertaken to compare the reaction of maize hybrid-310 (T.W.C.) to micronutrients foliar spray under salinity of irrigation water in both sandy and clay soils.

## Materials and Methods

A pot experiment was carried out in the vegetative house of Micronutrient project, Botany Department, National Research Centre, Dokki, Cairo, Egypt during the summer season of 2001 to investigate the influence of spraying micronutrients on growth, macro- and micronutrients content of maize hybrid –310 (T.W.C.) grown on both sandy and clay soils under salinity stress conditions induced by irrigation with saline water.

Mitscherlisch pots of 20 cm internal diameter and 17.5 cm depth filled with 7 kg of sandy and clay soils were used. Each pot was fertilized with 1.4g calcium super phosphate (15.5% $P_2O_5$); 0.7g potassium sulphate (48% $K_2O$) and 2.1g ammonium nitrate (33.5% N).

Soil samples were taken before the addition of the basic fertilizers and analyzed for physico – chemical characteristics (Table 1).

Table 1: Soil physico-chemical characteristics

| Character | Case | |
|---|---|---|
| | Sand | Clay |
| Sand % | 88.8 | 23 |
| Silt % | 4.0 | 36 |
| Clay % | 7.2 | 41 |
| Texture | Sandy | clay |
| pH | 8.543 | 8.24 |
| E.C. dS/m | 1.18 | 0.7 |
| $CaCO_3$ | 4.00 | 3.2 |
| Organic matter % | 0.52 | 1.36 |
| Available macronutrients (mg/100 g soil) | | |
| P | 1.17 | 1.56 |
| K | 2.64 | 15.88 |
| Mg | 6.0 | 162.0 |
| Na | 29.4 | 14.0 |
| Available micronutrients (mg/kg soil) | | |
| Fe | 3.1 | 2.6 |
| Mn | 0.70 | 3.2 |
| Zn | 0.60 | 0.98 |

Texture : Bauyoucos (1954)
pH & E.C. (1 soil: 2.5 water) : Jackson (1973)
CaCO3 : Walkely and Black (1934)
K , Na & Mg : Jackson (1973)
P : Olsen *et al.* (1954)
Fe, Mn & Zn : Lendsay and Norvel (1978)

Treatments were arranged in a split plot design with four replicates. Soil type replaced as main plots and salinity as sub plots.

Following treatment have been applied during experiment:

1- Control: irrigation with tap water.
2- Irrigation with tap water salinized with a mixture of NaCl and $CaCl_2$, each of 2g/L, to reach electrical conductivity of 5.6 dS/m.
3- Treatment 2 + micronutrients foliar spray with an EDTA-micronutrient compound contains 2.8% Fe + 2.8% Mn +2.8% Zn + 14% N at rate of 1.5g/ liter.

Six grains of maize were sown in each pot, seven days later seedlings were thinned to be four per pot. Seedlings were irrigated with tap water for 20 days. Thereafter, the aforementioned treatments were carried out for another 20 days. The seedlings were sprayed four times, five days intervals with the chelated micronutrient compound. The total amount of water applied through irrigation was 8.1 liter/pot.

**Plant analysis:** Seedlings of 52 day's age were harvested .The dry matters of roots and shoots were calculated. Root and shoot samples were prepared for macro- and micronutrients analysis according to Chapman and Pratt (1978), where the ground plant organs were dry ashed in Muffle furnace at 550°C, then extracted by 2N HCl.

**Total N:** It was determined in the dry plant organ using Bushi digestion and $N_2$-distillation unit.

**Total P:** It was photometrically determined using the molybdate-vananate method according to Jackson (1973).

**Total K, Na and Ca:** They were determined using Dr. Lang-M8D flamephotometer.

**Micronutrients and Mg:** They were determined using atomic absorption spectro-photometer.

Uptake of nutrients of both root and shoot was calculated by multiplying the dry weight by nutrient concentration.

The data were statistically analyzed as split-plot design according to Snedecor and Cochran (1967). Comparisons among means of treatments were tested for significance against LSD values at 5% level of probabilities.

## Results and Discussion

**Growth:** Fig. 1 and 2 showed highly marked significant effect on plant growth due to the tested soil types. Root and shoot dry weights decreased by 52.5 and 60.6%, respectively for plants grown on sandy soil as compared with those grown on clay soil. On the other hand, dry weight of root and shoot decreased by about 24 and 21%, respectively due to salinity treatment as compared with control treatment. However, plants irrigated with saline water and sprayed with micronutrient compound showed significant increment in root dry weight as compared with control, where the increment reached to 19%. Moreover, the previous treatment could decrease the depression in shoot growth from 21 to only 6% (on dry weight basis). The interaction effect was significant. Spraying plants grown on clay soil with micronutrient compound showed the highest root dry weight, while, plants of control treatment grown on clay soil showed the highest shoot dry weight. From the results obtained, it could be concluded that plants irrigated with saline water showed great depression in dry weight. Such reduction may be due to the inadequency of nutrients presented in the growing media (Sliman and Ghandoor, 1988) or to the decrease in water entry rate into plant (Meiri and Poljakoff-Mayber, 1970; Shreif, 2000) since under saline condition root pressure is reduced causing a decrease in water flow. That means less water is taken up by the roots and transported into shoot. Consequently, less water is available for normal growth and development (Lopez and Satti, 1996). Hussein *et al.* (1990); El-Fouly and Salama (1999) and El-Fouly *et al.* (2001) came to the same conclusion. It is interesting to note that spraying micronutrient can improve plant tolerance to salinity by increasing root growth which leads to promote nutrient uptake. In this respect, Gray (1977) and El-Fouly *et al.* (2001) found that spraying of micronutrient compounds has been used to prevent nutritional disorders of crops under saline conditions. Also, Abdalla and Mobarak (1992) on faba bean and Salama *et al.* (1996) on maize found that spraying micronutrients showed a positive effect on dry matter production of both root and shoot.

**Macronutrient contents:** Significant effect of soil type on root and shoot macronutrient contents was found (Fig. 3 and 4), where, plant grown on clay soil showed more macronutrient contents as compared with those grown on sandy soil, except in case of Ca. It is probable that the less macronutrient contents recorded in sandy soil were mainly due to nutrient deficiencies mediated by the roots. El-Fouly and Salama (1999) reported that under saline conditions nutrient absorption is restricted by lack of nutrients or by the small water potential in the rooting medium. Concerning salinity treatment, it is clear (Fig. 5 and 6) that macronutrient contents generally, decreased comparing to control treatment with some exception, where root Ca content increased by 6% and shoot Na increased by 11%. Moreover, root Na content showed insignificant decrement. The reduction of nutrients uptake under saline conditions could be attributed to the decrease in dry matter accumulation (Hussein *et al.*, 1990). On the other hand, Grattan and Grieve (1999) stated that salinity can directly affect nutrient uptake, such as $Na^+$ reducing $K^+$ uptake or by $Cl^-$ reducing $NO_3^-$uptake. They added that salinity reduces phosphate uptake and accumulation in crops grown in soils primarily by reducing phosphate availability. However, foliar spray treatment markedly increased all macronutrient content, except root P and shoot Na contents, as compared with control treatment. The recorded increase in macronutrient contents could be interpret through improving root growth and consequently leads to increase nutrients uptake and translocation as well ( Abdalla and Mobarak, 1992). Significant interaction effect was found (Fig. 7 and 8). However, spraying plants grown on clay soil with micronutrient compound gave the highest macronutrient contents in both root and shoot with an exception for shoot P and Na contents. Where plants grown on clay soil and irrigated with salinized water gave the highest Na content. On the other hand, the lowest macronutrient contents were obtained from salinity treatment by sandy soil.

**Micronutrient contents:** Data (Table 2) showed that growing media significantly affected root and shoot micronutrient contents. Plants grown on sandy soil showed dramatic depression in both shoot and root micronutrient contents as compared with those grown on clay soil. Concerning salinity as well as salinity plus micronutrients foliar spray as compared with control treatment, it is quite clear that salinity treatment caused marked depressions in root Fe, Mn, Zn and Cu contents by 60, 45, 20 and 20%, respectively. While this treatment decreased the aforementioned nutrients by 36, 39, 49 and 20% in plant shoot contents. However, spraying plants grown under the same salinity condition with micronutrients caused marked increments in root Fe, Mn and Zn contents but, caused significant reduction in their Cu content (13%). Salinity treatment caused less depression in shoot micronutrient contents as compared with those of root. The decrement caused by this treatment reached to 36, 39, 49 and 20% for Fe, Mn, Zn and Cu, respectively. Spraying such plants with micronutrients could improve the depression in both Mn and Zn contents. However, in case of Fe and Cu spraying

Table 2: Effect of foliar spray of micronutrient compound on micronutrient contents mg/ pot (4 plants) of maize grown under salinity stress condition

| Treatments | Iron(mg/pot) | | | Manganese(mg/pot) | | | Zinc(mg/pot) | | | Copper(mg/pot) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sand | Clay | Mean | Sand | Clay | Mean | Sand | Clay | Mean | Sand | Clay | Mean |
| **Root** | | | | | | | | | | | | |
| Control | 8.50 | 23.70 | 16.1 | 0.370 | 1.28 | 0.83 | 0.538 | 1.24 | 0.89 | 0.102 | 0.82 | 0.461 |
| Salinity | 4.10 | 5.65 | 6.38 | 0.328 | 0.60 | 0.46 | 0.513 | 0.90 | 0.71 | 0.077 | 0.66 | 0.369 |
| Salinity + MN | 7.35 | 34.33 | 20.84 | 0.569 | 1.17 | 0.87 | 0.595 | 1.65 | 1.12 | 0.092 | 0.71 | 0.401 |
| Mean | 6.64 | 22.23 | | 0.42 | 1.01 | | 0.550 | 1.26 | | 0.090 | 0.73 | |
| LSD 5% | | | | | | | | | | | | |
| Soil | | | 0.41 | | | 0.02 | | | 0.03 | | | 0.012 |
| MN | | | 0.51 | | | 0.03 | | | 0.03 | | | 0.014 |
| Soil X MN | | | 0.72 | | | 0.04 | | | 0.05 | | | 0.020 |
| **Shoot** | | | | | | | | | | | | |
| Control | 1.66 | 4.32 | 2.99 | 0.342 | 1.15 | 0.75 | 0.385 | 1.15 | 0.77 | 0.0509 | 0.0983 | 0.075 |
| Salinity | 0.80 | 3.02 | 1.99 | 0.212 | 0.70 | 0.46 | 0.243 | 0.53 | 0.39 | 0.0312 | 0.0887 | 0.060 |
| Salinity + MN | 1.63 | 4.58 | 3.11 | 0.354 | 0.92 | 0.64 | 0.517 | 0.87 | 0.69 | 0.0566 | 0.1082 | 0.082 |
| Mean | 1.36 | 3.98 | | 0.30 | 0.92 | | 0.38 | 0.84 | | 0.0462 | 0.0983 | |
| LSD 5% | | | | | | | | | | | | |
| Soil | | | 0.05 | | | 0.01 | | | 0.01 | | | 0.001 |
| MN | | | 0.06 | | | 0.02 | | | 0.02 | | | 0.002 |
| Soil X MN | | | 0.09 | | | 0.02 | | | 0.02 | | | 0.002 |

MN = Micronutrients foliar spray

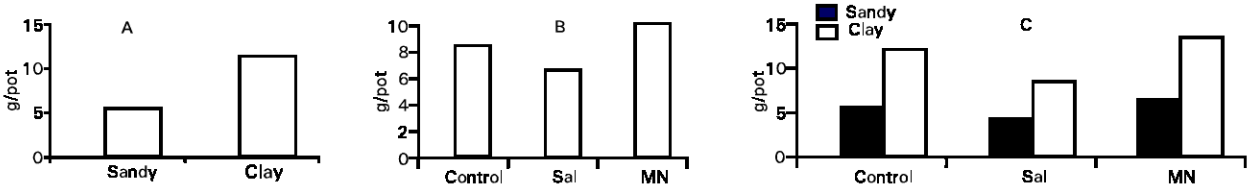
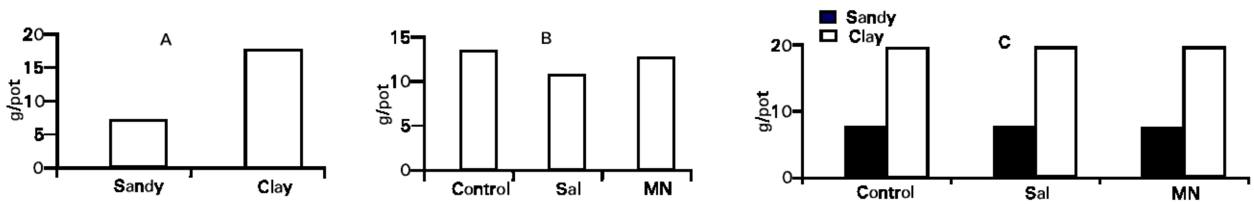



Fig. 1: Effect of foliar spray of micronutrient compound on root dry matter production of maize grown under salinity, salinity stress conditions




A = Effect of soil type B = Effect of micronutrient foliar spray C = Effect of the interaction

Fig. 2: Effect of foliar spray of micronutrient compound on shoot dry matter production of maize grown under salinity, salinity stress conditions

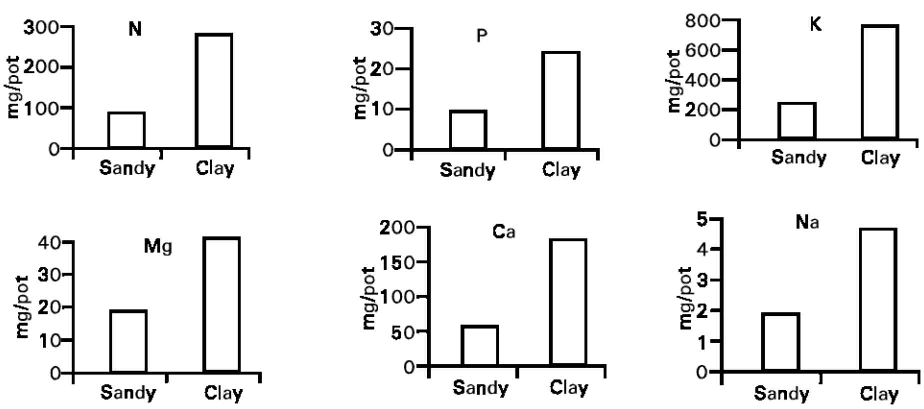



Fig. 3: Effect of soil type on shoot macronutrient contents mg/ pot (4 plants)

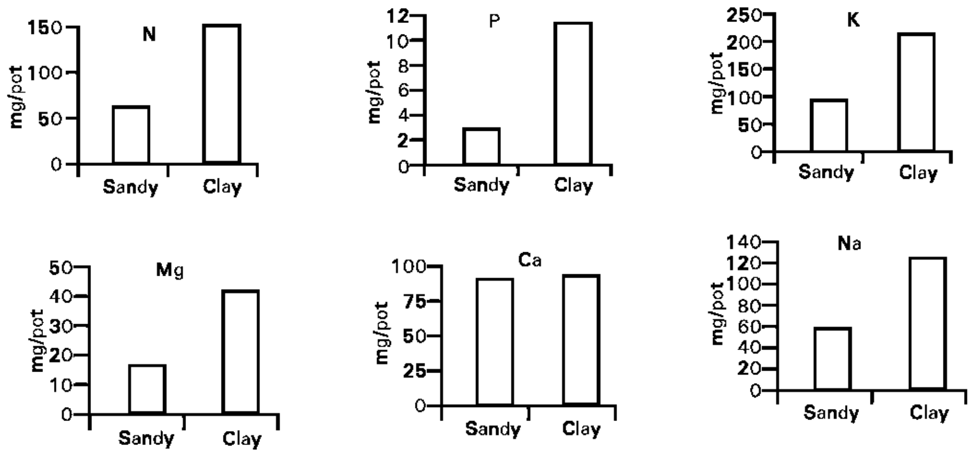



Fig. 4: Effect of soil type on root macronutrient contents mg/ pot (4 plants)

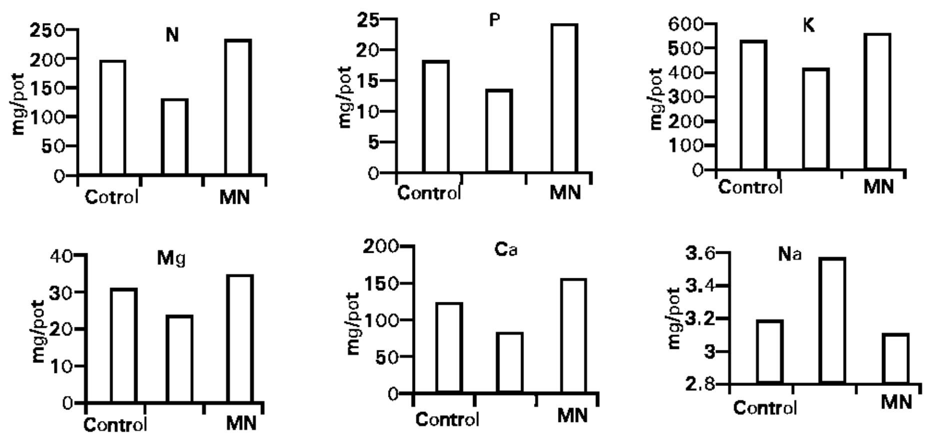



Fig. 5: Effect of micronutrient foliar spray on shoot macrountrient contents mg/ pot (4 plants)

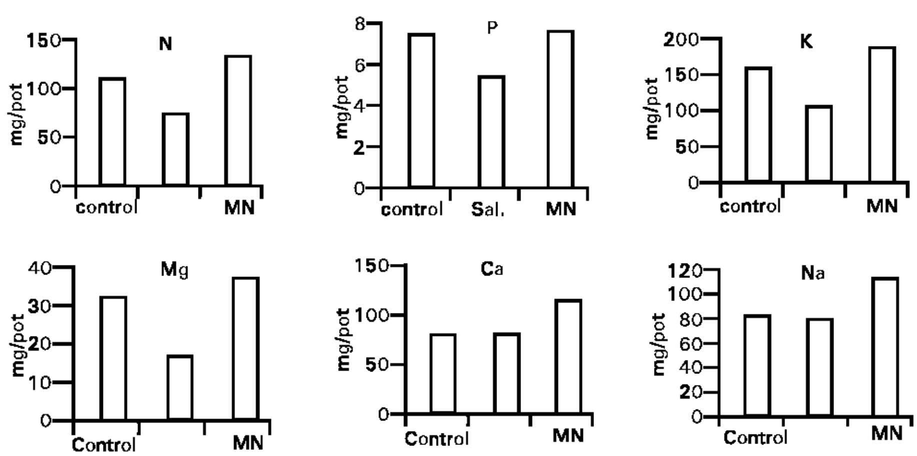



Fig. 6: Effect of micronutrient foliar spray on root macrountrient contents mg/ pot (4 plants)

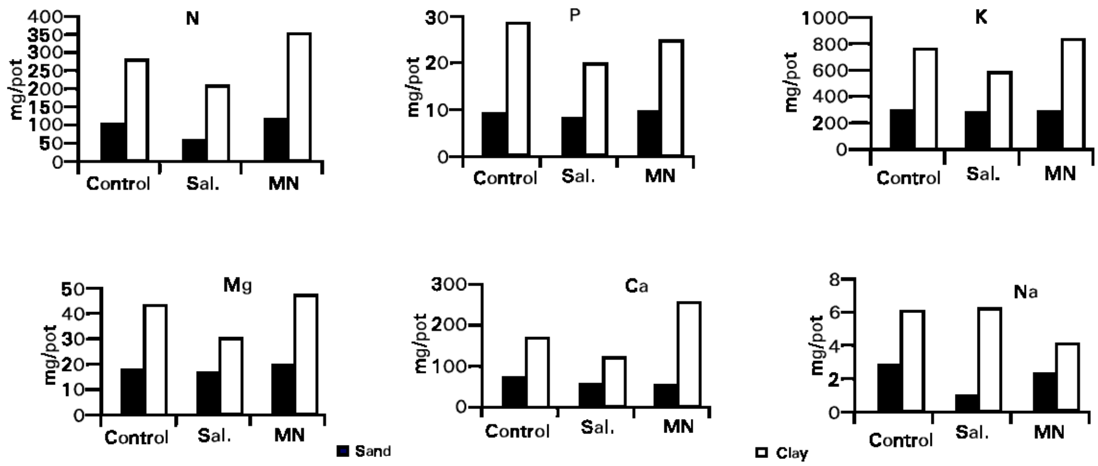



Fig. 7: Interaction effect between micronutrients foliar spray and soil type on shoot macronutrient contents mg/ pot (4 plants) of maize under salinity stress conditions

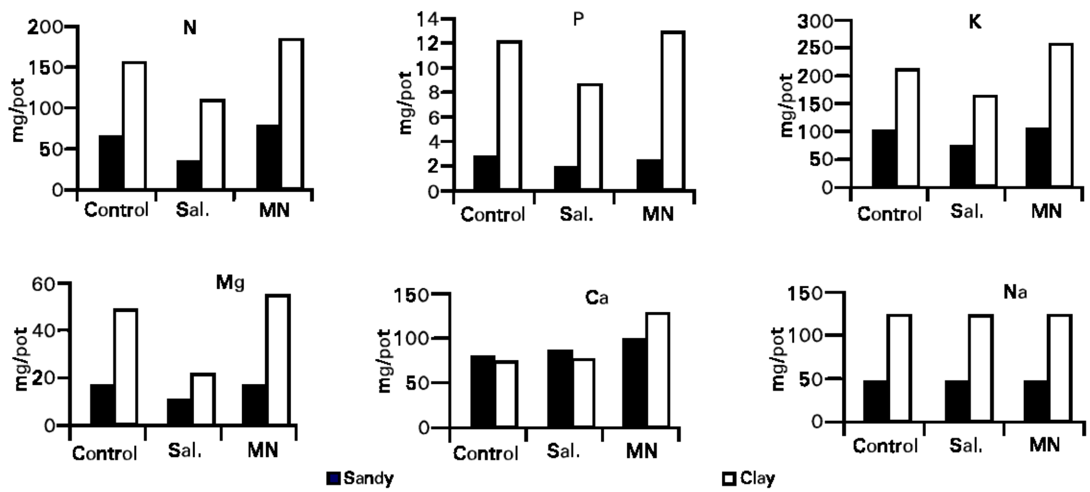



Fig. 8: Interaction effect between micronutrients foliar spray and soil type on root macronutrient contents mg/ pot (4 plants) of maize under salinity stress conditions

micronutrients could cover the depression caused by salinity and gave increment in their contents. These results were confirmed by El-Fouly *et al.* (2001). Significant interaction effect between soil type and treatments was found. Spraying salinity-stressed plants grown on clay soil with micronutrient compound gave generally, the highest micronutrient contents in both root and shoot. On contrary to those salinity stressed plants grown on sandy soil showed the lowest content values.

It could be concluded that salinity adversely affected the growth of maize hybride-310 expressed as root and shoot dry matter production. This depression in dry matter may be due to the inadequency of osmotic regulation induced by imbalance uptake of nutrients presented in the soil. In addition, spraying salinity-stressed plants with micronutrients can reduce the undesirable effect of salinity through improving growth and nutrient status of plants as well.

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