Egypt. J. Agric. Res., 71 (3), 1993.

EFFECT OF ZN, MN AND FE ON YIELD AND QUALITY OF CORN GROWN ON SOME SOILS OF EGPYT

A. O. OSMAN , AZZA B. MOHAMMAD

SOHEIR A. AZER AND S. G. AWAD

Soil and Water Research Institute, Agricultural Research Centre , Giza, Egypt.

(Manuscript received 3 April 1991)

Abstract

Two field experiments of corn were conducted at Nubaria Agric. Res. Station representing highly calcareous soil (30 % $CaCo_3$), and at Gemmiza Agric. Res. Station representing alluvial soil dealing with corn. Each kilogram seed was mixed with two rates of Zn, Mn and Fe nutrients by the coating method. Data of yield characters and quality were compared with those resulting from foliar treatment and the control.

Application of 0.30 g Zn + 0.15 g Mn + 0.30 g Fe-chelate/Kg seed by the coating method, in both calcareous and alluvial soils , increased crop production. Such percentage incerases were 48.6, 7.05, 4.22, 49.95 and 48, 57% for the grain yield, shelling percentage, weight 1000 grains, starch and protein content, respectively, over the control for calcareous soil. Corresponding increases were 34.25, 3.80, 12.23, 36.23 and 93.32 % for the alluvial soil.

Foliar treatment with Zn + Mn + Fe showed an increase in the grain weight, weight of 1000 grains, starch and protein contents where the precentage increases were 19.66, 1.92, 22.14 and 14.54 respectively over the control for calcareous soil. Corresponding increases were 14.55, 1.93, 14.98 and 50, 58 % for the alluvial soil. In this connection, shelling percentage decreased in both soils.

INTRODUCTION

Available zinc is not sufficient under most Egyptian soils especially in calcareous soils. The same conclusion is also noticed with regard to other micronutrients i.e. Mn and Fe. In recent years, some evidence had been developed that application of micronutrients to plants had resulted in better growth and more yield under the Egyptian conditions.

Approaching optimum nutritional status within plant tisues is very difficult as the balance between different nutrients is changed during various periods of growth. Almost any change in the addition or the uptake of one nutrient is likely to alter the growth pattern through complicated vital processes which might change the balance between different nutrients in plant tissues.

Micronutrients affect directly or indirectly photosynthesis, respiration, protein synthesis..etc. The presence or absence of any nutrient during a specific stage of plant growth might affect the growth pattern through alteration in metabolic processes .

The present investigation was carried out to study the effect of Zn, Mn and Fe-nutrients on yield and quality of corn grown in calcareous and alluvial soils of Egypt.

MATERIALS AND METHODS

Two field experiments were conducted at the Agricultural Research Station of Nubaria at northern Tahrir representing the highly calcareous soils (30% $CaCO_3$) and at Gemmiza (representing alluvial aoils). The aim of this investigation was to study the effect of some micronutrients applied at different rates and methods of application on the yield and quality of corn.

The soil samples were analysed for their content of available nutrients according to Jackson (1958) and Lindsay and Norvell (1969). The levels of available Zn, Mn and Fe as detemined by DTPA extraction were found to be 1.0, 6.0 and 5.4

ppm respectively, for the calcareous soil. Corresponding values for the alluvial soil were 1.6, 8.0 and 7.6 ppm . The pH of the soil water suspension was 8.4 and the E.C. was 1.8 mho/cm for the calcareous soil. Corresponding values for the alluvial soil were 8.1 and 1.5.

Coating elements were used at the rate of 0.15 and 0.30 g/Kg grains. Zn and Mn were used in the form of EDTA, and Fe element was used in the form of EDDHA. These rates were used at several combinations.

The EDTA compound of the above mentioned elements was used at the concentration of 0.3 g/L at the volume of 400 L/feddan for the spraying treatment. Tritnon B material was used in all treatments as a wetting agent.

The basal fertilizer treatments were applied at the rate of 90, 30 and 48 Kg/feddan as N, P_2O_5 and K_2O, respectively. The nitrogenous fertilizer was applied at two doses; after 21 and 35 days from sowing, whereas other fertilizers were applied before planting.

Harvest was carried out when the moisture percentage in grain reached 30%. Kernels were thoroughly scraped off the cobs to obtain grain yield. Grain yield detemination was calculated on 15.5 % moisture basis. Shelling percentage and weight of 1000 grains were also determined.

Leaf ear samples were taken from the plants at the tasseling stage and prepared for the determination of Zn, Mn and Fe according to Jackson (1958). Starch amount of grain was determined according to Said and Nada (1947). Nitrogen was determined by the semi-micro Kjeldahl method.

RESULTS AND DISCUSSION

1- Yield of Corn grains :

The yield of corn grain is governed by the moisture content, shelling percentage and the weight of grains.

At the harvesting stage, ears weight as Kg/feddan were singnificantly affect-

ed by different manurial treatments (Table 1). The highest ears weight was given by the coating of seeds with 0.30 Zn + 0.15 Mn + 0.30 Fe/ Kg grains grown in the calcareous soil. The percentage increase of ears weight was 40.6% over the control. Corresponding increase was 23.4 % for the spraying trearment. Soil analysis indicated that available Zn, Mn and Fe-nutrients were not adequate. Hence, application of such nutrients to the plants had resulted in the best growth and the highest yield under both soils, especially the calcareous one. This was true with regard to the mean yield with both soils (Table 1) , where the mean yield in the calcareous soil was 3944.8 Kg ears/feddan. Corresponding value for the alluvial soil was 4927.0 Kg ears/feddan. This difference in the yield might be due to the divergence in soil fertility status. Accordingly,, coated grains with 0.30 Zn + 0.15 Mn + 0.30 Fe as well as spraying treatments increased ear weight by 24.4% and 10.8% over the control, respectively (Table I B).

Grain yield on 15.5% moisture basis, significanty increased by either coating or spraying (Table 1). The percentages of increase in grain weight were 48.6 % and 19.7% over the control, respectively with calcareous soil. The corresponding increases for the alluvial soil were 34.3% and 14.6%.

It is clear therefore that the changes in percent increases of ear weight at harvest , and in grain weight on 15.5% moisture basis, had indicated an earliness in grain's yield . This was apparent when the control and spraying treatment were taken in comparison.

2- Weight of 1000 corn grains :

As shown in Table 1 the 1000 grain weight of corn was generally heavier with the coated grain treatment than in the control and the spraying treatment. For the calcareous soil, significant differences in 1000 grain weights were obtained for coating grains with 0.30 Zn + 0.15 Mn + 0.30 Fe over the control and spraying method where the values were 402.5, 419.5 and 410.37g for the control, coating and spraying methods, respectively. Corresponding values for the alluvial soil were 417.10, 468.10 and 425.15g . This increase in grain weight could be attributed to the effect of micronutrients on the accumulation of carbohydrates through their catalytic role in the photosynthetic or respiratory pathways. It was reported that the ratio between the micronutrients in plant tissues was very important for the accumulation of many nutrients in plant (Osawa, 1973). In addition, many workers had

Table 1. Effect of Zn, Mn and Fe-nutrients on the yield component of corn grown in the calcareous and alluvial soils.

Treatment g/Kg grains Zn Mn Fe	Field Wt. ears Kg/fed.	Weight at 15.5 basis		Shelling %	Weight of 1000 grains
		Grain Kg/fed.	Cobs Kg/fed.		
A - Calcareous					
Control	321.00	2335.2	527.3	81.58	402.50
.15 .15 .15	3700.4	2651.6	609.1	81.32	380.00
.15 .15 .30	3951.2	2840.6	624.4	81.98	415.45
.15 .30 .15	3751.0	2700.6	642.6	80.78	415.35
.30 .30 .30	4039.2	2877.0	689.4	80.67	402.85
.30 .15 .15	3999.6	2982.0	540.3	84.66	412.40
.30 .15 .30	4501.2	3469.2	503.3	87.33	419.50
.30 .30 .15	4252.6	2976.4	762.8	79.60	397.95
.30 .30 .30	4100.8	2863.0	741.8	79.40	414.90
Spraying	3951.2	2794.4	750.4	78.83	410.37
L.S.D. 5%	660.0	448.0	83.4	4.20	7.07
B- Alluvial					
Control	4305.4	2800.0	758.7	78.68	417.10
.15 .15 .15	5024.8	3379.6	962.1	77.84	241.00
.15 .15 .30	5154.6	3619.0	922.3	79.69	426.40
.15 .30 .15	5093.0	3369.8	864.1	79.59	421.45
.15 .30 .30	4965.4	3302.6	932.6	77.98	458.75
.30 .15 .15	4494.6	3042.2	752.5	80.17	438.20
.30 .15 .30	5354.8	3759.0	843.1	81.68	468.10
.30 .30 .15	5115.0	3449.6	959.4	78.24	475.35
.30 .30 .30	4989.6	3194.8	932.8	77.57	425.15
Spraying	4769.6	3207.4	916.3	77.78	425.15
L.S.D. 5%	783.2	533.4	159.6	2.41	32.17

showed that application of many micronutrients regulates the content of nutrients in plant tissues (Badre 1980; Fuaad 1982; Orabi *et al*., 1982).

3- Shelling Percentage :

The effect of applying Zn, Mn and Fe-nutrients through the coating method on the shelling percentage of corn yield is shown in Table 1. Results show that coating grain corn with 0.30 Zn + 0.15 Mn + 0.30 Fe/Kg had significantly increased the Shelling percentage over the control in the calcareous and alluvial soils. The same trends were obtained in case of coating over the spraying treatment for the calcareous soil, but the difference was not significant with the alluvial soil.

With regard to the cobs, as weights of as Kg/feddan, 0.30 Zn + 0.15 Mn + 0.30 Fe treatment as well as spraying treatment gave lower values of cobs weight than in the control where the cobs weights were 503.3 and 750.4 Kg/feddan for both treatments, respectively in case of calcareous soil. The control recorded 527.3 Kg/feddan. Corresponding values were 843.1, 916.3 and 758,7 Kg/feddan for the alluvial soil. Such data indicate that spraying treatment with Zn, Mn and Fe had resulted in a high weight of cobs rather than grains, and had led to a lower shelling percentage.

4 - Starch yield :

Starch is the first abundant constituent of corn followed by protein. Considerable variation in starch content is caused by genetic or environmental factors. Corn grain starch content as affected by Zn, Mn and Fe- nutrients with different methods is shown in Table 2. In case of calcareous soil, all treatments that received 0.30g Zn in combination with Mn and Fe had significantly increased starch yield either by coating or by spraying over the control. As for the alluvial soil, the highest starch content was produced with 0.30 Zn + 0.15 Mn + 0.30 Fe treatment over the control as well as the spraying treatment. This might be due to the fact that many micronutrients affect the accumulation of carbohydrates through their effect on photosynthesis pathway, or through respiratory, anabolism and catabolism,prcesses (Hewitt 1963; Clarkson; Hanson 1980).

5- Protein Yield :

As indicated in Table 2 the highest protein yield of corn was indicated with the

Table 2. Effect of Zn, Mn and Fe-nutrients on starch and protein contents of corn grain grown in the calcareous and alluvial soils.

Treatment g/Kg grain Zn	Mn	Fe	Calcareous soil Starch Kg/fed.	Calcareous soil Protein Kg/fed.	Alluvial soil Starch Kg/fed.	Alluvial soil Protein Kg/fed.
Control			1466.5	248.9	1788.0	258.6
.15	.15	.15	1622.8	231.2	2092.0	377.6
.15	.15	.30	1760.5	235.3	2084.9	369.2
.15	.30	.15	1642.0	314.0	2096.0	343.8
.15	.30	.30	1766.5	321.4	2077.3	416.0
.30	.15	.15	1959.2	340.6	1910.5	362.4
.30	.15	.30	2199.0	369.8	2435.8	499.9
.30	.30	.15	1940.0	288.4	2290.5	401.1
.30	.30	.30	1869.0	305.2	2031.9	356.9
Spraying			1791.2	285.1	2055.9	389.4
$\bar{X}$			1811.8	294.0	2325.9	377.5
L.S.D.		5%	308.6	75.7	374.6	83.5

application of 0.30g Zn + 0.15g Mn + 0.30g Fe by coating over the control in calcareous and alluvial soils. While the spraying treatment produced high protien yield with the alluvial soil, it failed to reach 5% significance over the control in case of the calcareous soil. These results may be discussed on the basis that Zn, Mn and Fe affect nitrogen metabolism and play an important role in protein synthesis (Delvin and Withman, 1983).

During the early period of growth (leaf formation stage) the need for micronutrients is very essential for building up different plant organs especially the leaves. Seed treatment by the coating method is needed for root poliferation and absorption in order to cover the requirements of plant organs through the early stage of growth, while late application of micronutrients by the spraying method had a slight effect especially with the calcareous soil.

6- Leaf ear analysis :

Results in Table 3 clearly show the effect of different manurial treatments of Zn, Mn and Fe concentrations on leaf ear samples taken at the tasseling stage for the two experiments. Obtained data indicated that Zn, Mn and Fe concentrations were relatively low in calcareous soil. This may explain the higher response to such nutrients by the coating method compared to the other methods. It seems that micronutrients application throug coating passes through the surface of corn grain by diffusion and translocation to the developing plant parts (El- Gowhari et al., 1970). It was reported that the ratio between micronutrients in plant tissues was very important for the accumulation of many nutrients in plants (Badre 1980, Fuaad 1982).

Table 3. Effect of Zn, Mn and Fe nutrients on the leaf ear analysis at the tasseling stage of corn plant grown in calcareous and alluvial soils.

Treatment g/Kg grains Zn Mn Fe	Calcareous soil			Alluvial soil		
	Zn (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)
Control	15	20	80	25	30	100
.15 .15 .15	30	20	100	35	35	120
.15 .15 .30	35	20	120	35	40	130
.15 .30 .15	40	30	100	45	45	90
.15 .30 .30	35	40	100	30	50	120
.30 .15 .15	45	60	100	50	45	100
.30 .15 .30	55	40	120	60	45	140
.30 .30 .15	45	25	100	45	50	95
.30 .30 .30	45	40	140	50	60	120
Spraying	65	60	100	70	50	120
$\bar{X}$	41	36	106	45	45	114

REFERENCES

1. Badre, F.I.M. 1980. Effect of foliar application with some micronutrients on growth, yield and quality of onion. M.Sc. Thesis, Faculty Agric., Alex. University.
2. Clarkson, D. T., and J.B. Hanson. 1980. The mineral nutrition of higher plants. Ann. Rev Plant Physiology, 31:239-298.
3. Delvin, R.M., and F.H. Withman. 1983. Plant Physiology 4th ed. PWS publishers, Willara Grant Press. Boston.
4. El-Gowhary, S.M., W.L. Lindsay, and W.D. Kember. 1970. Effect of complexing agent and acids on the diffusion of Zn to stimulated roots. Soil Sci. Soc. Amer Proc., 34:211.
5. Fuaad, H.A. 1982. Micronutrients effect on quality and quantity of onion. M.Sc. Thesis, Faculty Agric., Cairo Univ.
6. Hewitt, E.J. 1963. The essential nutrient elements: Requirement and interaction in plants. Plant Physiology. Stweard, F.C. vol. III. Inorgainic nutrition of plants. Academic Press, New York.
7. Jackson, M.L., 1958. "Soil Chemical Analysis" Constable & Co. Ltd. London.
8. Lindsay, W.L. and W.A. Norvell. 1969. Development of DTPA soil test for zinc, iron manganese and cupper. Sol Sci. Amer J. 42:421-428.
9. Orabi, A.A., and M. Abdel-Aziz. 1982. Zinc-phosphorus relationship and effect of some biocomponents of corn grown on calcareous soil. Plant and Soil, 69:(3):437-444.
10. Osawa, T. 1973. Heavy metal toxicities in vegetable crops. The effect of iron concentration in the nutient solution on Zn toxicities in vegetable crops. J. Jap. Soc. Hort. Sci., 42:259-263. (c.f. Hort. Abst., 44: 8480).
11. Said, H., and I.A.M. Nada. 1947. Carbohydrate changes in crude potato. Cairo University, Fac. Sci., Bull. 26:249.

تأثير الزنك والمنجنيز والحديد على محصول الذرة كماً ونوعاً فى بعض الأراضى المصرية

محمد عثمان محمد عثمان ، عزه بركات محمد
سهير عزيز عازر ، صلاح غالى عـــوض

معهد بحوث الأراضى والمياه – مركز البحوث الزراعية – الدقى – الجيزة

أقيمت تجربتان على محصول الذرة فى محطة البحوث الزراعية بالنوبارية ممثله للأراضى الجيرية (٣٠٪ كربونات كالسيوم) ومحطة البحوث الزراعية بالجيزة ممثلة للأراضى الطينية . استخدمت عناصر الزنك والمنجنيز والحديد فى معاملات مختلفه بتركيزين لكل منها فى معاملة تغليف البذور ومقارنتين إحداهما بدون معاملة والأخرى رشت فيها العناصر الثلاثة .

ازداد محصول الذرة بالمعاملة ٣٠ ر جم زنك + ١٥ر جم منجنيز + ٣٠ جم حديد بطريقة تغليف البذور فى كلا النوعين من التربة. وبلغت نسبة الزيادة ٦ر٤٨ ، ٥ر٧ ، ٢٢ر٤ ، ٩٥ر٤٩ لمحصول الحبوب وصافى التفريط ووزن ١٠٠٠ حبه ومحتوى النشا والبروتين الكلى فوق المقارنه على الترتيب بالنسبة للأراضى الجيرية . وعلى نفس المنوال كانت نسبة الزيادة هى ٢٥ر٣٤ ، ٨٠ر٣ ، ٢٣ر٣٦ ، ٣٠ر٩٣ فى الأراضى الطينية .

حققت معاملة الرش بعناصر الزنك والمنجنيز والحديد زيادة فى وزن الحبوب ، ١٠٠٠ حبه ومحتوى النشا والبروتين وكانت النسب المئوية ٦٦ر١٩ ، ٩٢ر١ ، ١٤ر٢٢ ، ٥٤ر١٤ فوق المقارنة على الترتيب بالنسبة للأراضى الجيرية . وعلى نفس المنوال كانت نسبة الزيادة المئوية هى ٥٥ر١٤ ، ٩٣ر١ ، ٩٨ر١٤ ، ٥٨ر٥٠ بالنسبة للأراضى الطينية . وفى هذا المجال ، انخفضت النسبة المئويه لصافى التفريط فى كلا النوعين من التربة.