EFFECT OF SOIL APPLICATION OF PHOSPHORUS AND METHOD OF APPLICATION OF SOME MICRONUTRIENTS ON GROWTH AND MINERAL COMPOSITION OF MAIZE PLANT

M. S. M. BAZA , M. M. A. BADR AND M. A. A. AMIN

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

(Manuscript received 16 March 1991)

Abstract

Pot experiments were conducted during the summer season of 1990 to study the effect of phosphorus and some micronutrients applied by two different methods on growth and chemical constituents of maize variety Giza 2.

Treatments comprised all possible combinations of 3 rates of soil applied phosphorus ; 0, 30 and 60 kg P_2O_5 / fed; zinc and manganese were applied using two methods: foliar at the rate of 90 ppm, and to the soil at the rate of 5 ppm.

Phosphorus significantly increased dry matter yield of maize plants , and the rate 30 kg P_2O_5/fed showed the highest dry matter yield.

Zinc applied to the soil showed the highest dry matter yield followed by Mn applied to foliage.

A significant positive correlation coefficient between dry weights of the 4th and 5th leaves and dry weights of young leaves, stems and whole plants were evident .

A significant positive correlation was obtained between Zn concentration and dry weight.A significant negative correlation was obtained between P percentage/ Mn concentration in young leaves.

INTRODUCTION

Maize is one of the most important cereals grown in Egypt. It is used as human food and animal feed especially during summer where the shortage in green forage exists in Egypt.

Recently, efforts have been devoted to increase the productivity of maize per unit area by the addition of macro-and micronutrients.

Baloach *et al.* (1986) reported that maize grain yield increased significantly with the addition of 60 kg P_2O_5 + 300 kg F.Y.M. / ha. Zhang *et al.* (1986) found that production of 100 kg maize grain needed 1.79 kg N, 1.02 kg P_2O_5 and 1.86 kg K_2O. Salem *et al.* (1983) found that Zn fertilization favourably affected growth characters of maize. Soil application of $ZnSO_3$ up to 20 kg/fed or spraying with 0.6 % $ZnSO_4$ significantly increased dry weight of different parts of maize, plant height, stem diameter and leaf area of the topmost ear. Baker *et al.* (1985), in pot experiment and field trials, found that increasing Zn rates resulted in greater Zn uptake and greater dry matter yield . Lu *et al.* (1986) showed that soil application of Zn as 3 mg Zn/kg soil , increased Zn uptake by 32.7 - 176 % at the 8-leaf stage as compared with that of the control. Also, Kuldeep *et al.* (1987) reported that critical Zn level in the upper 3rd leaf was 16 , 15 and 15 ppm in 6, 8 and 10 - week old maize plant, respectively, and varied in other leaves and whole shoots at different growth stages. El-Gala *et al.* (1986) showed that critical levels of Mn and Zn in different Egyptian soils were positively correlated with their concentration in leaves of maize plants grown on soils with and without Mn and Zn applied as EDTA salts. Correlations were significant for Zn only.

The present study was undertaken to investigate the effects of soil application of various levels of P and the method of application of some micronutrients on maize plants.

MATERIALS AND METHODS

Pot experiments were conducted in the green house of the Plant Nutrition Research Section at Giza during the summer season of 1990 . The soil used was collected from the surface layer (0-30 cm) of the Agricultural Research Centre Farm at Giza (Alluvial soil). Some chemical characteristics of the soil sample are given in Table 1.

Table 1. Some properties of the soil used.

Soil Characteristics :		
$CaCo_3$ %	3.30	(Jackson 1958).
pH (1 : 25)	7.90	(Richards 1954).
Available N, ppm	25.00	(A. O. A. C. 1970)
Available P, ppm	14.40	(extracted by NaHCO3, Olsen *et al.*1954)
Available Fe, ppm	9.50	(Lindsay and Norvell 1978).
Available Mn, ppm	5.30	(Lindsay and Norvell 1978).
Available Zn, ppm	1.90	(Lindsay and Norvell 1978).

The pots , 9 kg capacity, were planted with corn seeds variety Giza 2 on the 17th of July and thinned into four plants per pot after complete emergence. Basal application of nitrogen at the rate of 90 kg/fed was applied after 15 days from planting to each pot as concentrated solution of urea. Zn and Mn were added as soil and foliar application. The soil addition of both micronutrients was performed at the rate of 5 ppm after 25 days from planting, while spraying was performed at 30 and 45 days from planting at the rate of 90 ppm with both Zn and Mn sulphate. Foliar solution was equal to about 280 L/fed. Each treatment was replicated 5 times and the pots were arranged randomly in sub-plot design, where P treatments were the main plots and micronutrients treatmetns were the sub-plots.

Three samples were taken during the growth period of corn plants . The first two samples were taken from two replicates after one and two weeks from the first spraying , respectively. The first sample consisted of the fourth and fifth leaves , while the second one was the sixth and seventh leaves. The late sample; three replicates; was collected at the age of 55 days, and separated to young leaves, mature leaves and stems. Plant samples were rinsed with 0.01 N HCl solution , washed several times with distilled water, oven dried at 70°C, ground in a stainless steel mill and wet digested using H_2SO_4 – $HClO_4$ acids mixture according to Jackson (1958). Phosphorus was estimated colorimeterically according to the method of A. O. A. C. (1970). Concentrations of Zn and Mn were determined according to Chapman and Pratt (1961) using the Perkin - Elmer 380 Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

1- Dry Matter Yield:

1-1 Dry matter yield as affected by phosphorus levels:

A significant incerase in dry matter content of the lower 4th, 5th, 6th and 7th leaves was observed as P_2O_5 rate increased up to 60 kg P_2O_5 /fed (Table 2). Results also indicate that the dry matter of different organs namely , young leaves, mature leaves , stems as well as whole plant significantly increased as P_2O_5 increased up to 60 kg P_2O_5 / fed (Table 3). However, the first rate of P (30 kg P_2O_5/fed) was more effective in this respect. these results could be attributed to the fact that P is involved in the supply and transfer of energy for all the biochemical processes such as photosynthesis , glycolysis, respiration and fatty acid synthesis . These results are in agreement with those of Estrella and Chulin (1985).

1-2 Dry matter yield as affected by Zn fertilization:

Zn fertilization increased the dry weight of the lower 4th, 5th, 6th and 7th leaves and different parts of maize plants (young leaves, mature leaves, stems and whole plant) significantly in the two methods of application (Table 2&3).

Results obtained show that Zn applied to soil was more effective in increasing dry matter yield than folliar application. Such results indicate clearly that Zn is vital for building up vegetative and reproductive organs in maize and because of its role in the activation of many enzymatic reactions, probable conncection with the production of auxin and its close involvement in nitrogen metabolism. The present results are in harmony with those obtained by Salem *et al.* (1983) and Baker *et al.* (1986).

1-3 Dry matter yield as affected by Mn fertilization:

Mn fertilization as soil or foliar application increased the dry matter content of the lower 4th, 5th , 6th and 7th leaves, and different parts of maize plants as well as the whole plant (Table 2 & 3). The highest dry matter yield was obtained with foliar application method. These results are expected since Mn is known to play a role in photosynthesis, oxidation - reduction processes and an activator of several enzymes , such as peroxidase, dehydrogenase, decarboxylase and kinase.

Table 2. Effect of Phosphorus and Methods of application of some Micronutrients on Dry Weight of the Lower 4th, 5th, 6th and 7th leaves.

Micrountrients Treatments	The 4th and 5th leaves				The 6th and 7th leaves			
	g/pot P_2O_5 Levels in kg/fed.							
	0	30	60	Mean	0	30	60	Mean
Control.	15.4	16.6	18.4	16.8	23.1	23.5	24.6	23.7
Zn soil application .	17.0	17.6	20.1	18.2	25.2	25.4	27.1	25.9
Zn foliar application .	16.3	16.7	19.1	17.4	23.4	23.6	26.4	24.5
Mn soil application .	15.7	17.6	18.9	17.4	23.6	23.7	27.2	25.6
Mn foliar application .	15.8	18.6	18.1	17.5	22.8	28.1	25.9	25.6
Mean	16.0	17.4	18.9	17.5	23.6	24.9	26.2	24.9
L. S.D.		0.05		0.01		0.05		0.01
P_2O_5 treatments		0.44		1.03		0.44		1.03
Zn & Mn treatemts		0.41		0.69		0.38		0.63
P_2O_5 X Zn & Mn		N.S.		N. S.		0.55		0.79

Table 3. Effect of Phosphorus and Methods of application of some Micronutrient on Dry Weight of the different Oragans of Corn Plant.

Micrountrients Treatments	Young Leaves				Mature Leaves				Stems				Whole Plant			
	g/ pot, P_2O_5 Levels in kg / fed.															
	0	30	60	Mean	0	30	60	Mean	0	30	60	Mean	0	30	60	Mean
Control.	23.0	40.4	45.9	36.4	30.8	40.4	39.0	36.7	28.1	43.5	46.0	39.2	81.9	124.3	130.9	112.4
Zn soil application	33.3	44.5	50.0	42.6	39.4	43.4	46.7	43.2	42.8	51.7	55.9	50.1	115.5	139.6	152.6	135.9
Zn foliar application	33.7	40.1	38.2	37.3	46.8	38.4	42.7	42.6	40.1	47.2	49.6	45.6	120.6	125.7	130.5	125.6
Mn soil application	24.4	45.7	36.1	35.4	39.5	39.9	32.8	37.4	40.9	49.0	39.8	43.2	104.8	134.6	108.7	116.0
Mn foliar application	35.3	42.1	42.2	39.9	43.1	43.1	40.3	42.2	44.6	42.9	41.3	42.9	123.0	128.1	123.8	125.0
Mean	29.9	42.6	42.5	38.3	39.9	41.0	40.3	40.4	39.3	46.9	46.5	44.2	109.2	130.5	129.3	123.0
L. S.D.		0.05	0.01	0.05		0.01		0.01		0.05		0.01		0.05		0.01
P_2O_5 treatments		2.54	5.87	0.83		1.92		1.92		1.46		3.36		4.33		9.99
Zn & Mn treatments		1.37	2.24	1.90		3.15		3.15		1.61		2.68		3.77		5.99
P_2O_5 X Zn & Mn treatments		1.94	2.82	2.73		3.98		3.98		2.32		3.38		5.43		7.90

Table 4. Effect of phosphorus and method of application of some micronutrients on P, Mn and Zn concentrations of Corn plants.

Treatments		4th & 5th Leaves			6th & 7th Leaves		
		P %	Mn (ppm)	Zn (ppm)	P %	Mn (ppm)	Zn (ppm)
P_0	Control.	0.196	90	50	0.147	80	40
	Zn soil application.	0.189	120	120	0.154	80	50
	Zn foliar application.	0.132	170	210	0.167	120	170
	Mn soil application.	0.134	120	30	0.222	80	30
	Mn foliar application.	0.152	660	30	0.161	360	40
P_{30}	Control.	0.121	90	30	0.119	60	40
	Zn soil application.	0.136	80	40	0.156	70	30
	Zn foliar application.	0.119	70	240	0.143	60	170
	Mn soil application.	0.119	70	20	0.154	80	20
	Mn foliar application.	0.130	750	20	0.147	440	30
P_{60}	Control.	0.123	70	20	0.147	60	20
	Zn soil application.	0.174	60	30	0.147	60	10
	Zn foliar application.	0.136	80	230	0.154	70	200
	Mn soil application.	0.125	70	90	0.150	60	30
	Mn foliar application.	0.123	670	40	0.180	550	40

Treatments		Young leaves			Mature leaves			Stems		
		P %	Mn	Zn	P %	Mn	Zn	P %	Mn	Zn
P_0	Control.	0.185	90	80	0.128	340	180	0.154	40	70
	Zn soil application.	0.167	30	70	0.130	350	110	0.152	40	60
	Zn Foliar application.	0.205	150	60	0.108	510	80	0.150	30	70
	Mn soil application.	0.122	410	100	0.108	380	80	0.145	30	60
	Mn Foliar application.	0.114	310	70	0.103	400	80	0.154	40	60
P_{30}	Control.	0.132	120	210	0.114	210	100	0.154	50	50
	Zn soil application.	0.136	80	180	0.123	70	60	0.136	40	50
	Zn foliar application.	0.119	460	70	0.123	140	230	0.191	30	60
	Mn soil application.	0.130	150	130	0.117	100	180	0.350	30	40
	Mn foliar application.	0.158	90	60	0.117	370	140	0.213	40	60
P_{60}	Control.	0.117	100	180	0.163	220	40	0.196	30	40
	Zn soil application.	0.097	150	230	0.163	200	80	0.189	30	60
	Zn foliar application.	0.114	370	150	0.138	320	190	0.132	40	60
	Mn soil application.	0.117	240	50	0.163	370	110	0.134	30	50
	Mn foliar application.	0.121	190	60	0.180	540	70	0.152	40	50

Results on the effect of P, Mn and Zn fertilization of maize plant indicate clearly that although the available content of these nutrients in the soil sample exceeded the critical levels reported by several workers, maize plants responded to soil and foliar trearments. In this connection , Sillanpaa (1982) gave an explanation for the contradiction that existed between the results obtained by soil versus plant analysis. Nutrients absorption by a plant is a process which takes place under laws of biochemistry and plant physiology while chemical soil extraction follows the laws of chemistry. Consequently the same nutrient fractions do not appear in the analysis. Therefore , it is understandable that many soil factors react differently during these two processes.

2 - NUTRIENT CONCENTRATIONS :

From the results in Table 4 it is clear that the soil application of phosphorus decreased P concentration of the 4th, 5th , 6th and 7th leaves as well as the young leaves of maize plants. These results might be attributed mainly to the dilution effect where the highest dry matter yield was recorded due to these treatments . On the contrary, such treatments increased P concentrations of mature leaves and stems of maize plants. Such increase in P concentration leads to the importance of proper balance when a nutritive programme is to be established.. These results are in agreement with those of Estrella and Chulin (1985).

Zn and Mn concentrations reached a very high levels when Zn and Mn were sprayed. These high concentrations did not affect dry weight of the plants and did not cause any symptoms of toxicity.

Significant positive correlation coefficients were observed between dry wieghts of the 4th and 5th leaves and dry weights of young leaves, stems and the whole plants dry weights (Table 5). However, a significant positive correlation was recorded for young leaves dry weight and Zn concentration. Also, a significant negative correlation was obtained for P concentration and Mn concentration in young leaves (Table 5).

Table 5. Correlation coefficients between the different variables in maize plants as affected by phosphorus and some micronutrients.

Characters	Correlation Coefficient (r)
4th & 5th D. wt. X Young leaves D.wt.	+ 0.727 **
4th & 5th D. wt. X Stems D.wt.	+ .0600 *
4th & 5th D. wt. X W. plant D.wt.	+0.647 **
D.wt. x Zn conc. in young leaves	+0.542 *
P conc. x concentration in young leaves	-0.502 *

** significant at 0.01 level . * significant at 0.05 level

REFERENCES

1. A.O.A.C., Association of Official Agricultural Chemists. 1970. Official Methods of Anal ., 11th ed., A. O.A.C., Washington , 5 D. C.
2. Baloach, S. V., A. Bhatti and A. H. Gurmani. 1986. To increase the efficiency of various phosphate fertilizers by mixing with farmyard manure using maize as a test crop . Tehqiqe1986 4 (1) 35- 40. (C. F. Field Crop Abst . 40 : 1987).
3. BaKer , M. N. , A. E. M. Ibrahim , E. A. Abdel - Latif and N. A. El - Ezz. 1985. Zinc availability in the permanent field experiment at Bahtim, A. R. Egypt. Annals of Agricultural Science, Moshtohor 23 : 1013 - 1022.
4. Chapaman, H. D. and P. F. Pratt.1961. Methods of analysis for soils, plants and water . Univ. of California, Division of Agric. Sci.
5. Chiriac, A. D., Dornescu, L. Tiganas and E. Tatarusanu. 1986. The effect of fertilizer applications on the evolution of brown luvic soils on the Suceava Plateau and on maize mineral nutrition. Analele Institutului de cercetaripentru Cereale siplante Tehnice, (C. F. Field Crop Abst ., 41 : 455-456). Fundulea, 53 : 455 - 456.
6. El -Gala , A. M., A. S. Ismail and M. A. Osman. 1986. Critical levels of iron, manganese and zinc in Egyptian soil . Journal of Plant Nutrition , 9: 267-280.
7. Estralla , and N. Chulin. 1985. Effect of residual and annually applied P on a corn-soybean sequence on a Nicollet Webstern soil complex. Dissertation Abstracts International. B (Science and Engneering), 45 (7) : 1964. (C. F. Field Crop Abst . 40 : 1987).

8. Jackson , M. L. 1958 . Soil chemical analysis . Prentice Hall, Inc. Englewood Cliffs, N. J.

9. Kuldeep Singh and K. Baverjee. 1987. Critical levels of Zn in corn (*Zea mays L.*) at different stages of growth. Indian Journal of Plant Physiology 30 : 7 -12.

10. Lindsay, W. L. and W. A. Norvell. 1978. Development of a DTPA test for Zn, Fe, Mn and Cu . Soil Sci. Soc. Am. J. , 42 : 421-428.

11. Lu, M. J. ; Qi, G. Y. M. B. and Lu. 1986. The response of maize to zinc fertilizer in cultivated Fluviogenic soil in an Oasis. J. Soil. Sci. China , 17 (1) 34-36- (C.F. Field Crop Abst ., 41 : 180).

12. Olsen, S. R., O. V. Cole, F. S. Watanabe and L. A. Dean. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U. S. D. A. Circ. 939.

13. Richards, L. A.*et al.* 1954. Diagnosis and imporovement of saline and alkali soils. U.S. Salinity Lab. USDA., Agric . Hand Book 60.

14.Salem , M. D. A. Roshdy and M. S. Baza. 1983. Effect of zinc fertilization on some characters of maize. Annal. of Agric. Sci., Moshtohor, 20 .

15.Sillanpaa, M. 1982. Micronutrients and the nutrient status of soils : a global study. Food and Agriculture Organization of the United Nations, Rome.

16.Zhang, S. C., S. Z. Zhang, G. R. Deng and K. D. Yuan. 1986. Economical application of fertilizers to maize. J. Soil . Sci. , China , 17 , 22 - 26. (C. F. Field Crop Abst., 41 : 176).

تأثير الإضافة الأرضية للفسفور وطرق اضافة بعض العناصر الصغرى على النمو والمكونات المعدنية لنبات الذرة

محمد صالح محمود باظة ، مصطفى أبو العنين بدر
محمد عزمى عبد الحكيم أمين

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

أقيمت تجربة أصص عام ١٩٩٠ لدراسة تأثير الفوسفور ، وطرق اضافة العناصر الصغرى على نبات الذرة الشامية ، صنف جيزة ٢.

أجريت التجربة بصوبة قسم بحوث تغذية النبات بالجيزة لدراسة تأثير الفسفور بمعدل صفر ، ٣٠ ، ٦٠ كجم فو٢ أ٥ / فدان وكذلك دراسة تأثير جميع التباديل والتوافيق بين الفوسفور والإضافة الأرضية والرش بعنصرى الزنك والمنجنيز بمعدل ٩٠ جزء فى المليون لكل منها على الترتيب.

أظهرت النتائج أن للفسفور تأثيراً معنوياً أدى الى زيادة محصول المادة الجافة وأن المعدل ٣٠ كجم فو٢ أ٥ / فدان أعطى أفضل النتائج.

أوضحت النتائج ايضاً ان الإضافة الأرضية للزنك بمعدل ٥ جزء فى المليون سجلت أفضل النتائج فى محصول المادة الجافة فى حين جاء الرش بعنصر المنجنيز بمعدل ٩٠ جزء فى المليون فى المرتبة الثانية .

بينت التجربة ايضاً ان هناك معامل ارتباط موجب قوى بين زيادة المادة الجافة للورقة الرابعة والخامسة وزيادة محتوى النبات من المادة الجافة للأوراق الحديثة والناضجة وكذلك لكل النبات عند عمر ٥٥ يوما .

أوضحت النتائج ايضاً أن هناك علاقة جوهريه موجبه بين اضافة الزنك وتكون المادة الجافة وأخرى سالبة بين النسبة المئوية للفوسفور وتركيز المنجنيز وذلك فى الأوراق الحديثة للنباتات.