Al-Azhar J. Agric. Res., Vol. 38
PP. 117-128, (December), 2003

FOLIAR FEEDING OF NPK AS PARTIAL SUBSTITUTION OF SOIL APPLIED FERTILIZERS FOR IMPROVING CORN GROWTH AND DECREASE POLLUTION

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ABSTRACT: Two experiments were carried out during the summer season of 2002 on corn. One of them was carried out at the green house of "Micronutrients Project" National Research Centre and the other at the Agricultural Research Station of National Research Centre, Kalubia Governorate. The objective was to through some light on foliar feeding of NPK as a partial substitution of conventional NPK practices. Treatments were the recommended rate of soil NPK (control) in addition to four treatments: 3/4; 1/2, 1/4 soil NPK recommended combined with three foliar sprays with NPK compound (19: 19: 19) at rate of 2.5 g/liter and three foliar sprays with the aforementioned compound without any NPK soil addition.

Results can be summarized as follows:

1- Both fresh and dry weight of corn plants showed slight increase due to substitution of quarter NPK recommended by foliar feeding, while reducing soil application than that resulted in decreasing the biomass accumulation.

2- Decreasing NPK applied to soil than recommended resulted generally, in reducing macro- and micronutrient concentrations.

3- Applying 3/4 recommended soil NPK in combination with foliar feeding increased macro- and micronutrients uptake.

4- Applying 3/4 recommended soil NPK in combination with foliar feeding could achieve maximum yield without any losses as obtained from control treatment.

INTRODUCTION

Corn (Zea mays L.) is one of the most important cereal crops in Egypt for both human consumption and animal feeding.

Soil application of NPK fertilizers may lead to some losses of these fertilizers. However, application of such nutrients as foliar spray may decrease such losses. El-Fouly and El-Sayed, (1995) reported that N-losses from the recommended N-dose for corn as a summer crop were 50% through leaching and/or denitrification. These losses can pollute water and/or air. In this connection, El-Fouly and Fawzi, (1996) mentioned that N-losses in summer crops are very high and efficiency of N-fertilizers used is very low. Consequently, both drainage water and ground shallow water (that used for village drinking water) are heavily polluted with nitrate in summer.

Foliar feeding is often the most effective and economical way to correct plant nutrient deficiencies. In case of low P availability from fertilizers applied to soil, particularly in crops which need P in late growth stages, where P becomes unavailable in short periods, after it is added (El-Fouly and Abou El-Nour ,1998). Moreover, Oosterhuis, (1998) reported that foliar feeding of K may offer the opportunity of correcting K deficiency more quickly and efficiently, especially in the late season when soil application of K may not be effective.

During the last decades, foliar feeding of nutrients has become an established procedure in crop production to increase yield and improve the quality of crop products (Roemheld and El-Fouly, 1999). This procedure can also improve nutrient utilization and lower environmental pollution through reducing the amounts of fertilizers added to soil (Abou El-Nour, 2002). On the other hand, foliar feeding of a nutrient may actually promote root absorption of the same nutrient (Oosterhuis, 1998 and Soepardi, 1998) or other nutrients through improving root growth and increasing nutrients uptake (El-Fouly and El-Sayed 1997; Abdalla and Moubark, 1992). The concept of foliar feeding implies that nutrient applied to leaves and other above ground plant parts are absorbed and taken up by plants. Accordingly, nutrients needed by plants can theoretically be fed through plant leaves. Moreover, several research works revealed that foliar feeding is more efficient than soil fertilization. This fact is totally true in case of micronutrients under arid and semi-arid conditions (Alexander, 1986: Amberger, 1991: El-Fouly and Rezk, 1986 and Salama et al., 1996). However, in case of macronutrients, it must be born in mind that crops require very high amounts of such nutrients, and plant leaves are only able to take up a very limited amount of nutrients as compared with the plant's high demand (Mengel and Kirkby, 1987 and Miller et al., 1998). Consequently, foliar feeding as a partial substitution to soil fertilization needs further investigations

The objective of this investigation was to throw some light on the use of foliar feeding of NPK as a partial substitution of their conventional fertilizer practices.

MATERIAL AND METHODS

Two experiments were carried out during the summer season of 2002. The first was conducted at the green house of " Micronutrients Project", National Research Centre, Cairo, Egypt to study the possibility of reducing the recommended rate of NPK soil application through foliar feeding and its effect on biomass accumulation and nutritional status of corn seedlings. The second experiment was conducted at the Agricultural Research Station of, National Research Centre, Shalkan, Kalubia Governorate for testing the same treatments on corn grain yield under field conditions.

1. Pot experiment

Corn grains cv. H-10 was sown on 28th April 2002 in Mitschelisch pots of 20 cm internal diameter and 17.5 cm depth. Each pot was filled with 7-kg soil translocated from the Agricultural Research Station of National Research Centre, Shalkan, Kalubia Governorate, where the field experiment was conducted. A soil

sample was taken before the addition of any fertilizers and analyzed for physico-chemical characteristics (Table 1).

The experiment included five treatments as follows:

1- Recommended rate of soil NPK (120 kg N +30 kg P_2O_5 + 50 kg K_2O/ feddan).

2- 3/4 treatment No.1 (i.e. 90 kg N +22.5 kg P_2O_5 + 37.5 kg K_2O/ feddan) + F.F

3- 1/2 treatment No.1 (i.e. 60 kg N +15 kg P_2O_5 + 25 kg K_2O/ feddan) + F.F

4- 1/4 treatment No.1 (i.e. 30 kg N +7.5 kg P_2O_5 + 12.5 kg K_2O/ feddan) + F.F

5- Foliar feeding only (F.F)

Table 1: Soil physico-chemical characteristics (0-30cm)

Parameter	Value
Sand %	15.2
Silt %	35.0
Clay %	49.8.
Texture	Clay loam
PH { Soil – water suspension}	8.81
E.C. dS/m { soil –water extract}	0.24
$CaCO_3$ %	1.86
Organic matter %	1.41
Macronutrients (mg/100 g soil)	
P	2.3
K	31.2
Mg	146.0
Micronutrients (mg/kg soil)	
Fe	8.4
Mn	4.2
Zn	0.8

Texture : ***Bouyoucos (1954)***
pH & E.C. (1 soil: 2.5 water) : ***Jackson (1973)***
CaCo3 : ***Black (1965)***
Organic Matter % : ***Walkely and Black (1934)***
K , Na & Mg : ***Jackson (1973)***
P : ***Olsen et al. (1954)***
Fe, Mn & Zn : ***Lindsay and Norvel (1978)***

Ten corn grains were sown in each pot, thinned to be 4 seedlings ten days later. Each pot received the aforementioned soil treatments. Treatments were distributed in a randomized complete block design (RCBD) with four replicates, according to Snedecor and Cochran, (1967). Plants were foliar sprayed three times with 14 days intervals. The first spray was preformed at 25 days from sowing with NPK compound (19: 19: 19) at a rate of 2.5 g/ liter. One week after the last spray, plants (62 day's age) were harvested to determine shoot fresh and dry weights.

Shoot samples were wet digested with a mixture of nitric, perchloric and sulphoric acids (8:1:1) according to Chapman and Pratt, (1978) to determine the plant total Zn, Mn, Fe, Mg, K, P and Ca. While, total nitrogen was determined in the dry plant material using Kjeldahl method according to Ma and Zauzaga (1942).

II. Field experiment

A field experiment was conducted during the summer season of 2002 at Agricultural Research Station of, National Research Centre, Shalkan, Kalubia Governorate. Treatments were the same as in the pot experiment. Corn grains of the same hybrid were sown on April 29th in randomized complete block design with four replicates. The experimental plot (25.2 m^2) consisted of 6 rows with 6 m long and 70 cm apart. Three grains were dropped in hills spaced 30 cm. After 35 days from sowing, seedlings were thinned to one plant per hill. The experimental plots received phosphorus treatments before sowing. Nitrogen and potassium treatments were applied after 35 and 50 days from sowing, respectively. Foliar feeding treatments were applied using the same compound as mentioned in experiment I. Plants were foliar sprayed three times with 10 days intervals, starting at 40 days from sowing in 200, 250 and 300 liter/feddan, respectively. Amounts of applied NPK through foliar feeding are shown in Table 2.

Table 2: Amounts of applied N, P and K (g) through foliar feeding.

No. of spray	Age (Day)	Volume (Liter/fed.)	N	P_2O_5	K_2O
			(gram/fed.)		
1st spray	40	200	95	95	95
2nd spray	50	250	119	119	119
3rd spray	60	300	143	143	143
Total		750	357	357	357

At harvest (15th September 2002), grains yield of the middle two rows were harvested and converted to ton/feddan.

RESULTS

I. Experimental soil presentation:

Table 1 indicates that the experimental soil was clay loam in texture, very high alkalinity in reaction, had satisfactory content of phosphorus and high contents of potassium and magnesium. The soil was poor in its organic matter and micronutrient contents, without any salinity problems. The evaluation was according to Ankerman and Large, (1974).

II. Pot Experiment

Growth:

Data presented in fig. 1 clearly showed that the combination between soil application of 3/4 recommended rate of soil fertilizers and foliar feeding increased both fresh and dry weights/plant by about 11 & 8%, respectively, as compared with applying the full-recommended rate of soil fertilizers. However, application of half and quarter recommended rate of soil fertilizers in combination with foliar feeding resulted in decreasing both fresh and dry weights by about 12 & 31 and 11 & 32%, respectively, as compared with soil application treatment. Moreover. 45% reduction in both fresh and dry weights was observed as a result of applying foliar feeding only.

Macronutrient concentrations:

Data recorded in table 3 showed that decreasing the amounts of fertilizers added to soil, nitrogen concentration decreased. As compared to control treatment, the reduction of nitrogen was in the ranged of 5- 34%. However, No marked effect was noticed in case of both phosphorus and potassium concentrations. Concerning magnesium, it was also, found that by decreasing the amount of soil applied fertilizers, magnesium concentration did not markedly affect with an exception, in case of foliar feeding treatment, where, the concentration markedly decreased. Calcium concentration showed no marked change except in case of using the half-recommended rate of NPK soil application in combination with foliar feeding, where a marked increase was noticed as compared to other treatments.

Table (3): Effect of reducing the recommended rate of fertilizers applied to soil on macronutrient concentrations (%) of corn plants.

Treatment	Nitrogen	Phosphorus	Potassium	Magnesium	Calcium
			(%)		
1) Recommended rate of Fertilizers (control)	2.32	0.191	2.25	0.46	1.20
2) 3/4 (1) + foliar spray of fertilizers	2.21	0.194	2.15	0.49	1.20
3) 1/2 (1) + foliar spray of fertilizers	2.14	0.184	2.28	0.47	1.28
4) 1/4 (1) + foliar spray of fertilizers	1.85	0.180	2.28	0.45	1.20
5) foliar spray of fertilizers	1.53	0.187	2.28	0.42	1.20
LSD 5%	0.17	N.S.	N.S.	0.04	0.04

Micronutrient concentrations:

It is clear from the data presented in Table 4 that application of 3/4 rate from recommended soil fertilizers in combination with foliar feeding gave nearly the same manganese and zinc concentrations as compared with control treatment. However, the lowest micronutrients concentration was observed with foliar feeding when applied as a single treatment.

Table (4) Effect of reducing the recommended rate of fertilizers applied to soil on micronutrient concentrations (%) of corn plants

Treatment	Iron	Manganese	Zinc
	(mg/kg)		
1) Recommended rate of Fertilizers (control)	138	70	102
2) 3/4 (1) + foliar spray of fertilizers	203	69	102
3) spray of 1/2 (1) + foliar fertilizers	173	75	84
4) spray of 1/4 (1) + foliar fertilizers	122	63	88
5) foliar spray of fertilizers	113	63	81
LSD 5%	26	8	13

Uptake of macronutrients:

As shown in Table 5 that all macronutrient uptakes were increased by applying 3/4 recommended soil fertilizers in combination with foliar feeding. By decreasing the amount of fertilizers added to soil than 3/4 of recommended dose, generally resulted in marked decrement in their uptake. The lowest reduction was noticed with the foliar feeding when applied as a single treatment.

Table (5): Effect of reducing the recommended rate of fertilizers applied to soil on macronutrients uptake (mg/plant) of corn plants

Treatment	Nitrogen	Phosphorus	Potassium	Magnesium	Calcium
	mg/plant				
1) Recommended rate of Fertilizers (control)	173.8	14.4	169.0	33.7	90.1
2) 3/4 (1) + foliar spray of fertilizers	178.5	15.7	174.5	39.4	99.1
3) 1/2 (1) + foliar spray of fertilizers	141.2	12.1	150.5	31.1	84.0
4) 1/4 (1) + foliar spray of fertilizers	94.3	9.2	116.0	23.1	61.3
5) foliar spray of fertilizers	63.3	7.8	93.3	17.5	80.8
LSD 5%	16.3	2.1	20.2	4.2	8.1

Uptake of micronutrients uptake:

Data presented in table 6 showed that micronutrients uptake followed the same trend of macronutrients uptake where, applying 3/4 of recommended rate of NPK soil fertilizers combined with foliar feeding gave the highest micronutrients uptake as compared with the other treatments.

Table (6): **Effect of reducing the recommended rate of fertilizers applied to soil on micronutrients uptake (ug/plant) of corn plants.**

Treatment	Iron	Manganese	Zinc
	(ug/plant)		
1) Recommended rate of Fertilizers (control)	1041	524	766
2) 3/4 (1) + foliar spray of fertilizers	1647	559	821
3) spray of 1/2 (1) + foliar fertilizers	1412	505	556
4) spray of 1/4 (1) + foliar fertilizers	624	322	449
5) foliar spray of fertilizers	467	262	334
LSD 5%	361	68	123

III Field Experiment

Fig. 2 shows that there was no marked effect on 100 grain weight; grain yield per plant and grain yield per feddan between control treatment and applying 3/4 recommended rate of soil fertilizers combined with foliar feeding. However, reducing the amounts of applied soil fertilizers than 3/4 recommended rate led to marked depression in these parameters. The lowest values were obtained by foliar feeding as single treatment. The percentage reduction under this treatment in 100 grain weight; grain yield per plant and grain yield per feddan reached to 42, 53 and 64%, respectively as compared with the control treatment.

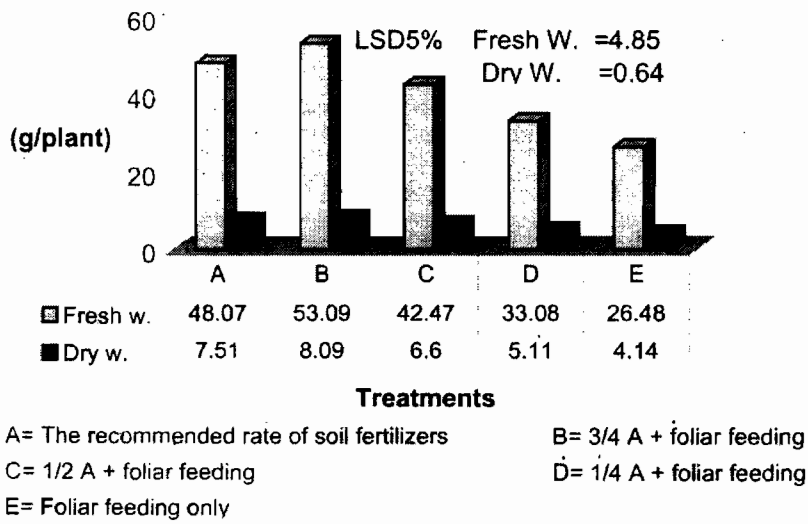

Fig. (1): Effect of reducing the ratw of recommended soil fertilizers through out foliar feeding on fresh and dry weights of corn (g/plant).

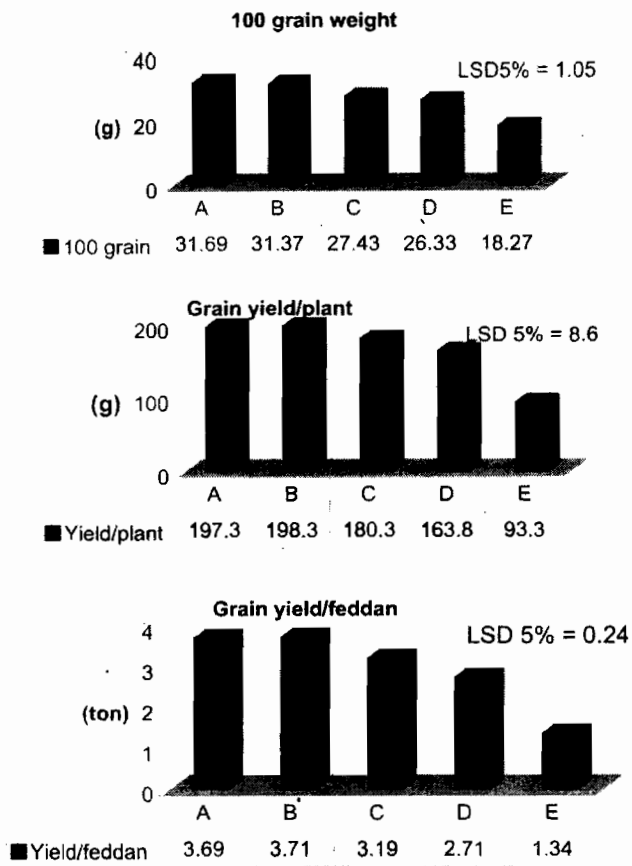

Fig. (2): Effect of reducing the ratw of recommended soil fertilizers on 100 grain weight; grain yield / feddan.

DISCUSSION

It is well known that to achieve the maximum quantity and quality of crop yield, the crop requires optimal nutrients supply. The hypothesis of this study supposes that the control treatment (i.e. application of soil fertilizers according to recommended rate) could result the maximum yield (quantity and quality). Consequently, as compared with control treatment, foliar feeding treatment resulted in 45% depression in either fresh or dry matter weights. This means that the nutrients applied through foliar feeding are not fairly enough to face the requirements of corn plants. These results are in agreement with those obtained by Mingel and Kirkby 1987; Miller el al., 1998 and Ahmed, 1998 who stated that crops required a very high amount from macronutrients, and plant leaves are only able to take it by very small amounts. However, foliar feeding in combination with 3/4 fertilizer

amounts of control treatment increased these parameters. This indicates that substitution of 1/4 applied recommended rate of soil fertilizers by foliar feeding did not affect plant growth. Concerning the nutrients status of corn, both macro- and micronutrients concentration were generally showed small reductions by reducing the amounts of soil fertilizer application. In spite of that the uptake of these nutrients showed more or less increment by applying 3/4 amounts of control treatment combined with foliar feeding. This may be due to the positive effect of foliar feeding on plant root growth and hence, promoting nutrient up take. In turn, this may be due to stimulating and enhancement of limiting nutrient. Baier and Baierova. 1999; El-Fouly and El-Sayed 1997; Abdalla and Moubark, 1992 observed similar results .However, reducing the rate of applied soil fertilizers to 1/2 and /or 1/4 of control treatment combined with foliar feeding showed negative effect on the most uptake of nutrients. It is concluded that substitution of more than 1/4 amounts of control treatment by foliar feeding failed to improve the nutritive status of corn plants. With regard to grain yield and 100-grain weight, it is clear that applying 3/4 recommended rate of soil fertilizers combined with foliar feeding showed positive effect on these parameters. This positive effect on grain yield would find an interpretation through that substitution of 1/4 recommended rate of applied soil fertilizers by foliar feeding could cover the plants nutritive needs. Consequently, improving the physiological performance of sprayed plants.

From the overall data, it could be concluded that it is better to substitute 1/4 of fertilizers added to soil by foliar feeding to achieve the maximum quantity and quality of corn grain production with minimum environmental pollution.

ACKNOWLEDGMENT

This paper represent part of the activities of the Egypto-German Project "Micronutrient and Plant Nutrition Problems in Egypt" conducted by the National Research Center, Cairo (co-ordinator Prof. Dr. M.M. El-Fouly) and the Institute of Plant Nutrition, Technical University Munich (Prof. Dr. A. Amberger). It was supported by the German Agency for Technical Co-opration (GTZ) and the Egyptian Academy for Scientific Research and Technology (ASRT).

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الإحلال الجزئى للتسميد بالنتروجين والفوسفور والبوتاسيوم عن طريق الرش الورقى لتحسين نمو الذرة وتقليل التلوث

الزناتى عبد المطلب على أبو النور عبد الوهاب عبد المقصود عبد المجيد

المركز القومى للبحوث- قسم تغذية النبات

أجريت تجربتان فى الموسم الصيفى ٢٠٠٢ على نبات الذرة أحدهما بصوبة مشروع العناصر الصغرى بالمركز القومى للبحوث والأخرى بمحطة البحوث الزراعية الخاصة بالمركز القومى للبحوث بمحافظة القليوبية. وقد كان الهدف من الدراسة هو إلقاء الضوء على إمكانية استخدام التسميد الورقى بالنتروجين والفوسفور والبوتاسيوم كعوض عن جزء من التسميد الأرضي لهذ العناصر.

وكانت المعاملات كالأتي:

١- المقارنة (إضافة الوحدات الموصى بها من النتروجين والفوسفور والبوتاسيوم للتربة)
٢- إضافة ٣/٤ الوحدات الموصى بها من النتروجين والفوسفور والبوتاسيوم أرضا + الرش الورقى
٣- إضافة ١/٢ الوحدات الموصى بها من النتروجين والفوسفور والبوتاسيوم أرضا + الرش الورقى
٤- إضافة ١/٤ الوحدات الموصى بها من النتروجين والفوسفور والبوتاسيوم أرضا + الرش الورقى
٥- التغذية الورقية

وتتلخص النتائج المتحصل عليها فى الاتى:-

١- زاد كلا من الوزن الطازج والوزن الجاف لنبات الذرة زيادة طفيفة نتيجة لاحلال٤/١الكميات الموصى بها من الأسمدة المضافة أرضا بالرش الورقى.كما أظهرت النتائج أن تخفيض كميات الأسمدة المضافة أرضا لأكثر من الـ ١/٤ أدى إلي نقص فى أوزان النبات.
٢- انخفضت تركيزات العناصر الصغرى والكبرى فى النبات نتيجة خفض معدلات الأسمدة الموصى بها والمضافة أرضا.
٣- زاد محتوى النباتات من العناصر الصغرى والكبرى نتيجة المعاملة بـ ٣/٤ الوحدات الموصى بها من الوحدات الموصى بها من النتروجين والفوسفور والبوتاسيوم أرضا + الرش الورقى
٤- حققت المعاملة ٣/٤ الوحدات الموصى بها من النتروجين والفوسفور والبوتاسيوم أرضا + الرش الورقى أعلى محصول من ناحية الكم والجودة بالمقارنة بمحصول معاملة المقارنة.