

application methods on N recovery % was significant. This is true in both seasons as well as in the combined average. Results showed that in the combined average of two studied seasons the highest N recovery % (53.46 %) could be produced by combining 100 kg N /fed + 70 mg Mn /l + foliar application method. Differences between 50 or 100 kg N /fed levels under 70 mg Mn /l and the same Mn application method were not significant.

Results reported by **El-Sheikh, (1998)** who found that application of 36 to 72 g Mn /fed gave significant increases in N recovery only where 120 or 160 kg N was applied.

### **General conclusion**

The highest grain yield and its quality were generally recorded by foliar application or soaking grains with 70 mg Mn /l plus 150 kg N /fed in Kalubia Governorate .In all cases , consideration should be given to the actual available contents of the nutrient in the soil itself.

## *SUMMARY*

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Two field experiments were conducted at the Agriculture Research and Experimental Station of the Faculty of Agriculture at Moshtohor, Zagazig University in the two successive growing seasons of 1997 and 1998. The aim was to study the effects of four nitrogen levels (0, 50, 100 and 150 kg N /fed), three manganese nutrient rates (tap water, 70 and 140 mg Mn / l) and three methods of Mn application (grain soaking, foliar spraying and soaking + spraying) on the growth, grain yield and its components as well as grain quality of maize cv. T.W.C.310.

The soil of the experimental plots was clay texture, with a pH value of 7.91, 3.89 %  $\text{CaCO}_3$ , 1.98 % organic matter content, 17.3 mg /kg available N and 8.5 mg /kg available Mn.

A split-plot in a randomized complete block design with four replications was used, the main plots were devoted for nitrogen levels, the sub-plot for Mn levels and their methods of application. Sub-plot area was 16.8 m<sup>2</sup> (1/250 fed). Planting was done on 22 June in 1997 and 1998. The preceding crop was wheat in both seasons.

The results of the experiments could be summarized as follows:

### **I-Effect of nitrogen application:**

- 1- The increases in nitrogen rates significantly decreased number of days to 50 % tasseling and silking in both seasons. The earliest flowering was reached at the highest nitrogen level.
- 2- Application of 50, 100 and 150 kg N / fed significantly increased plant height, ear height, stem diameter, number of

active green leaves / plant and area of the topmost ear leaf at 75 days from planting. The highest value of these traits were generally recorded at the highest N rate.

- 3- Application of nitrogen fertilizer levels caused significant increases in leaf area index (LAI), dry weight / plant, crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR).
- 4- Grain yield components, namely, number of ears / plant, ear length, number of kernels / row, number of rows / ear, ear diameter, 100- kernels weight, ear weight, grain yield / ear, shelling % and grain yield /plant significantly increased with increasing N rates up to 150 kg /fed. However, the difference between 100 and 150 kg N /fed in some studied characters were not significant.
- 5- Grain, straw and biological yields /fed as well as crop index and harvest index significantly increased with increasing nitrogen rates up to 150 kg N fed. Application of 50, 100 and 150 kg N /fed significantly increased grain yield over the control treatment by 178.7, 374.5 and 432.4 % in the 1997 season and 171.2, 310.1 and 364.3 % in the 1998 season, being 174.4, 337.3 and 393.1 % in the combined average.
- 6- Application of nitrogen fertilizer levels caused a significant increase in P, K, CP, Mn and oil percentage in maize grain. While, it decreased total carbohydrate content in both seasons.
- 7- N uptake significantly increased markedly with the increase in N level. On the combined average of both seasons, N uptake was 11.73, 35.03, 60.54 and 72.77 kg /fed at the N

rate of zero, 50, 100 and 150 kg N /fed, respectively. The same trend were obtained in Mn uptake.

- 8- N economic efficiency (NEE) has been reduced with the increase in N level. On the average of to studied seasons, N economic efficiency valued 29.18, 28.23 and 21.94 kg grain /kg N at the N level of 50, 100 and 150 kg N /fed.
- 9- Applying 50, 100 and 150 kg N /fed recorded apparent N recovery (ANR) of 46.60, 48.82 and 40.69 % in the combined average, respectively.

## **II-Effect of manganese application:**

1. The time of 50 % tasseling and silking significantly decreased as the Mn treatment increased up to 70mg Mn /l. On the other hand, significantly increases the time of 50 % tasseling and silking were observed when Mn concentration was raised up to 140 mg Mn /l.
2. The plant height (in 2<sup>nd</sup> season and combined average), ear height , number of active green leaves /plant and ear leaf area (in 1<sup>st</sup> season and combined average) , were significantly increased as the Mn level increased up to 70 mg Mn /l. Whereas, a further increases in the concentration of Mn up to 140 mg Mn /l. decreased them. The difference between the control and 140 mg Mn /l levels concerning their effects on plant height, ear height and number of green leaves plant<sup>-1</sup> were not significant.
3. Leaf area index (LAI), dry weight /plant, CGR were significantly increased by applying manganese nutrient at the rate of 70 mg Mn/l. While, RGR and NAR were not affected

by Mn application.

4. Grain yield components, namely, number of ears / plant (in 1998 & combined average), ear length (in 1998), ear weight, 100-kernel weight, grain yield /ear and grain yield /plant were significantly increased by applying 70 mg Mn /l., but them decreased by using higher concentration (140mg Mn /l.). However, the difference between zero and 140 mg Mn /l. in most characters were not significant.
5. Grain, straw and biological yields /fed as well as crop index and harvest index significantly increased as a result of adding 70 mg Mn /l. Whereas, a further increase in the rate of Mn up to 140 mg Mn /l. decreased them. Applying 70 mg Mn /l. increased the grain yield over the control treatment by 6.97, 10.79 and 9.07 % in the 1997, 1998 seasons as well as in the combined average, respectively.
6. Application of Mn nutrient caused a significant increase in CP , P, Mn contents in maize grain, but no significant difference in K , oil and carbohydrate contents due to adding Mn levels.
7. Applying 70 mg Mn /l caused significant increased in N uptake and Mn uptake in maize grain.
8. N economic efficiency (NEE) increased as a result of Mn application. On the combined average of two growing seasons , Mn at 70 mg /l gave the highest mean value of NEE which was 21.23 kg grain / kg N applied.
9. Apparent N recovery (ANR) was significantly increased by Mn application. The highest average (36.75%) produced by applying 70 mg Mn /l in the combined average.

### III-Effect of Mn application methods:

1. Mn application methods showed a significant effect on the average number of days to 50 % tasseling and silking of maize plant only in the first season, the latest tasseling and silking dates behavior were produced by using grain soaking and foliar spraying as methods on Mn application.
2. Adding Mn as a foliar application resulted a significant increase in ear height (in 1997) and ear leaf area.
3. Leaf area index (LAI) (in 1997 & combined average), dry weight /plant and CGR were significantly affected by the methods of Mn application. The highest values were obtained when using foliar spraying as Mn application method.
4. Grain yield components, namely, number of ears / plant (in combined average), ear weight, grain yield/ear (in 1998 & combined average), 100- kernel weight, grain yield/plant (in 1997 & combined average), and shelling % (in 1998) significantly increased by Mn foliar application .
5. Methods of Mn application did not show any significant effect on the average grain yield / fed . However, the data revealed that foliar application with Mn gave the highest values of grain yield / fed. Also, Crop index and harvest index did not affected by methods of Mn application. On the other side, straw and biological yields were significantly effected by using foliar spraying as Mn application method.
6. Methods of Mn application did not affect on the chemical contents of maize grains in both seasons.
7. Adding Mn nutrient as a foliar spraying significantly increased N uptake and Mn uptake in maize grains.

8. Methods of Mn application did not show any significant difference on N economic efficiency (NEE).
9. Apparent N recovery % increased by Mn grain soaking or foliar spraying with Mn on maize plants.

#### **IV-Interaction effects:**

##### **a-Effect of the first order interaction:**

##### **1-The results showed that N x Mn had a significant effect on:**

- Leaf area index (in 1997)
- Dry weight /plant (in 1997, 1998 & combined average)
- Ear weight (in 1997 & combined average)
- Grain yield /ear (in 1997)
- 100-kernel weight (in 1997)
- Shelling % (in 1997 & 1998)
- Grain yield /plant (in 1998)
- N uptake in grain (in 1997, 1998 & combined average)
- Mn uptake in grain (in 1997, 1998 & combined average)
- N recovery % (in 1997, 1998 & combined average)

Most the highest values were generally recorded by combining 150 kg N /fed + 70 mg Mn /l.

##### **2-Significant effect of N x Mn application methods were recorded on the following characters:**

- Dry weight /plant (in 1998 & combined average)
- Ear weight (in 1998)
- Grain yield /ear (in 1998 & combined average)
- N uptake in grain (in 1997, 1998 & combined average)
- Mn uptake in grain (in 1997, 1998 & combined average)
- N recovery % (in 1997, 1998 & combined average)



The highest values of these traits were recorded by combining 150 kg N /fed + application Mn as grain soaking or foliar spraying.

**3-Significant interaction effect between Mn x Mn application methods were recorded on:**

- N uptake in grains ( in 1997 , 1998 & combined average)
- Mn uptake in grains ( in 1997 , 1998 & combined average)
- N recovery % ( in 1997 , 1998 & combined average)

The highest values were generally recorded by combining 70 mg Mn /l + application of Mn as a foliar spraying method.

**b-Effect of the second order interaction:**

**1-Significant interaction of N xMn x Mn application methods were recorded on:**

- Dry weight / plant ( in 1997 , 1998 & combined average)
- N uptake in grains ( in 1997 , 1998 & combined average)
- Mn uptake in grains ( in 1997 , 1998 & combined average)
- N recovery % ( in 1997 , 1998 & combined average)

**In general,** most the highest values were recorded by combining 150 kg N /fed + 70 mg Mn /l + application of Mn as a foliar spraying method.

The practical application indicate a necessity of N or Mn for maize production. Response to Mn may occur for the high N level (150 kg N /fed). Foliar application with 70 mg Mn /l 400 L water /fed or grain soaking in the same respective Mn concentration (12 hour) plus 150 kg N /fed produced the highest grain yield and its quality of maize.

In all cases, consideration should be given to the actual available contents of the nutrients in the soil itself.