RESULTS AND DISCUSSION

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The present study aimed to investigate the response of maize plants ***(Zea mays L.)*** to four levels of nitrogen fertilizer (0, 50, 100 and 150 kg N / fed.), three levels of manganese nutrient (0, 70 and 140 mg Mn / l.) and three methods of Mn application (grain soaking , foliar spraying and grain soaking + foliar spraying) .The interaction effect of the three experimental factors on the studied traits were considered.

The results included, tasseling and silking dates , some growth characters, some growth analyses, yield components, grain yield of maize and grain quality . Also, N economic efficiency and apparent N recovery as affected by N , Mn levels and methods of Mn application were studied .

I- Flowering date :

1- Tasseling dates :

The results in Table (3) showed the effect of nitrogen , manganese levels , Mn application methods and their interactions on tasseling dates of maize plants in 1997 and 1998 seasons as well as their combined average. Tasseling dates was recorded as the number of days from planting to 50 % tassling .

1-1- Effect of nitrogen application :

The results in Table (3) showed that nitrogen application significantly affected tasseling date in maize in both seasons as well as in the combined average. The results indicated that in 1997 season applying N at rates of 50, 100 and 150 kg N / fed induced an earlier tasseling by 1.4, 2.8 and 3.4 days compared with the check treatment, respectively. The corresponding values

Table 3. Effect of N ,Mn levels , methods of Mn application and their intractions on tasseling date in 1997 and 1998 seasons and their combined data .

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr	Mean
None	0	63.6	63.5	64.3	63.8	64.3	64.8	64.8	64.6	64.0	64.2	64.6	64.2
	70	63.5	62.8	63.3	63.2	64.0	63.8	62.8	63.5	63.8	63.3	63.1	63.4
	140	64.0	64.3	63.3	63.9	63.3	64.0	63.0	63.4	63.7	64.2	63.2	63.7
	Mean	**63.7**	**63.5**	**63.6**	**63.6**	**63.9**	**64.2**	**63.5**	**63.9**	**63.8**	**63.9**	**63.6**	**63.7**
50	0	62.8	62.5	63.8	63.0	63.8	63.3	64.0	63.7	63.3	62.9	63.9	63.4
	70	61.0	60.8	62.5	61.4	60.3	61.3	63.3	61.6	60.7	61.1	62.9	61.5
	140	63.0	61.5	62.0	62.2	62.5	62.3	62.0	62.3	62.8	61.9	62.0	62.2
	Mean	**62.3**	**61.6**	**62.8**	**62.2**	**62.2**	**62.3**	**63.1**	**62.5**	**62.2**	**62.0**	**62.9**	**62.4**
100	0	60.5	61.3	61.5	61.1	63.0	62.3	62.5	62.6	61.8	61.8	62.0	61.9
	70	60.3	59.0	60.8	60.0	61.0	60.8	60.3	60.7	60.7	59.9	60.6	60.4
	140	60.8	61.3	61.5	61.2	61.0	61.3	61.0	61.1	60.9	61.3	61.3	61.2
	Mean	**60.5**	**60.5**	**61.3**	**60.8**	**61.7**	**61.5**	**61.3**	**61.5**	**61.1**	**61.0**	**61.3**	**61.1**
150	0	59.8	60.5	60.8	60.4	61.5	61.0	61.3	61.3	60.7	60.8	61.1	60.8
	70	59.3	59.0	61.0	59.8	58.5	60.0	59.3	59.3	58.9	59.5	60.2	59.5
	140	60.8	60.3	60.3	60.5	60.0	60.3	59.3	59.9	60.4	60.3	59.8	60.2
	Mean	**60.0**	**59.9**	**60.7**	**60.2**	**60.0**	**60.4**	**60.0**	**60.1**	**60.0**	**60.2**	**60.3**	**60.2**
Mnxappl.	0	61.7	62.0	62.6	62.1	63.2	62.9	63.2	63.1	62.4	62.4	62.9	62.6
	70	61.0	60.4	61.9	61.1	61.0	61.5	61.4	61.3	61.0	60.9	61.7	61.2
	140	62.2	61.9	61.8	61.9	61.7	62.0	61.3	61.7	61.9	61.9	61.6	61.8
	Mean	**61.6**	**61.4**	**62.1**		**61.9**	**62.1**	**62.0**		**61.8**	**61.8**	**62.0**	

Comparisons:

LSD (0.05	N-level	(A)	0.7	0.9	0.8
	Mn-level	(B)	0.5	0.5	0.6
	Appli. Methods	(C)	0.5	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

in 1998 season were 1.4 , 2.4 and 3.8 days, respectively . Similarly, the combined average indicated that N fertilizer at 50 ,100 and 150 kg N / fed induced an earlier tasseling by 1.3 , 2.6 and 3.5 days , respectively compared with the control treatment .

It could be concluded that nitrogen fertilizer enhanced earlier tasseling in maize . The results showed the role of N in the formation of sexual organs and in enhancing an early flowering through an increase in the meristematic activity in plants.

The present results are in general agreement with those reported by **El-Sheikh (1993); Hassan (1995); El-Habbak (1996) and Badr at al.(1997)** who noticed that number of days to 50 % tassling was affected by the application of N fertilizer up to 135 kg / fed. Whereas, **Salwau (1985)** found that tasseling dates were not significantly affected by nitrogen levels.

1-2-Effect of manganese application :

It is clear from Table (3) that application of Mn nutrient significantly decreased the time of 50 % tasseling by adding 70 mg Mn / l. While, 140 mg Mn / l increased it in both seasons as well as combined average. The maximum number of days from sowing to 50 % tasseling 62.1, 63.2 and 62.6 days were obtained over the control in 1997, 1998 and combined average respectively. Whereas, the lowest one 61.1, 61.3 and 61.2 days was obtained from 70 mg Mn / l in 1997, 1998 seasons and combined average, respectively. Decreased the time of 50 % tasseling by adding Mn nutrient may be due to Mn application stimulation root growth and N uptake in maize plant (**Gardner et al. 1985**).

Similar results were also reported by **Abdel-Salam et al (1993a).** However, The present results did not agree with those reported by **El-Hattab et al (1986) and Allam and El-Naggar (1992).** They noticed that Mn application showed no significant effect on pollen shedding.

1-3-Effect of manganese application methods:

It is clear from data of the same Table that Mn application methods showed a significantly affected on average number of days to 50 % tasseling of maize plant only in the 1st season. The latest tasseling behavior was produced when Mn was applied as grain soaking and foliar spraying methods. The average number of days to 50% tasseling were 61.6 and 61.4 days by using two methods, respectively.

1-4- Interaction effects :

The results showed that all interactions between the experimental factors had no significant effect on tasseling date.

2- Silking date :

The results in Table (4) indicated the effect of nitrogen , manganese levels ,Mn application methods and their interactions on silking date of maize plants in 1997 and 1998 seasons as well as their combined average. Silking dates was recorded as the number of days from planting to 50 % silking .

2-1- Effect of nitrogen application :

The results presented in Table (4) show that application of nitrogen fertilizer significantly enhanced silking in both seasons as well as in the combined average.

In 1997 season, applying N at 50 , 100 and 150 kg / fed. significantly reduced silking date by 2.5 , 4.4 and 5.4 days,

Table 4. Effect of N,Mn levels , methods of Mn application and their intractions on silking date in 1997 and 1998 seasons and their combined data ▲

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Method of Mn-application				Method of Mn-application				Method of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	67.0	67.5	68.3	67.6	69.0	69.3	69.0	69.1	68.0	68.4	68.6	68.3
	70	67.8	67.8	68.3	67.9	67.8	67.3	66.8	67.3	67.8	67.5	67.5	67.6
	140	68.3	67.0	67.3	67.5	67.8	68.5	67.8	68.0	68.0	67.8	67.5	67.8
	Mean	**67.7**	**67.4**	**67.9**	**67.7**	**68.2**	**68.3**	**67.8**	**68.1**	**67.9**	**67.9**	**67.9**	**67.9**
50	0	66.3	66.0	67.0	66.4	67.5	67.5	67.8	67.6	66.9	66.8	67.4	67.0
	70	62.8	62.3	64.5	63.2	64.3	65.0	66.5	65.3	63.5	63.6	65.5	64.2
	140	65.8	65.5	66.5	65.9	67.5	66.5	65.0	66.3	66.6	66 0	65.8	66.1
	Mean	**64.9**	**64.6**	**66.0**	**65.2**	**66.4**	**66.3**	**66.4**	**66.4**	**65.7**	**65.5**	**66.2**	**65.8**
100	0	64.0	63.0	64.0	63.7	66.5	65.8	66.0	66.1	65.3	64.4	65.0	64.9
	70	62.8	61.5	62.8	62.3	64.5	63.5	63.8	63.9	63.6	62.5	63.3	63.1
	140	63.5	63.3	64.5	63.8	65.5	65.8	65.0	65.4	64.5	64.5	64.8	64.6
	Mean	**63.4**	**62.6**	**63.8**	**63.3**	**65.5**	**65.0**	**64.9**	**65.1**	**64.5**	**63.8**	**64.3**	**64.2**
150	0	62.3	63.0	63.3	62.8	65.0	64.5	65.0	64.8	63.6	63.8	64.1	63.8
	70	61.0	61.5	62.0	61.5	61.3.	63.0	62.3	62.2	61.1	62.3	62.1	61.8
	140	62.8	62.0	63.0	62.6	63.5	63.8	62.3	63.2	63.1	62.9	62.6	62.9
	Mean	**62.0**	**62.2**	**62.8**	**62.3**	**63.3**	**63.8**	**63.2**	**63.4**	62.6	63.0	63.0	62.8
Mnxappl.	0	64.9	64.9	65.7	65.1	67.0	66.8	67.0	66.9	66.0	65.8	66.3	66.0
	70	63.6	63.3	64.4	63.8	64.5	64.7	64.9	64.7	64.0	64.0	64.6	64.2
	140	65.1	64.5	65.3	65.0	66.1	66.2	65.0	65.8	65.6	65.3	65.2	65.4
	Mean	**64.5**	**64.2**	**65.1**		**65.9**	**65.9**	**65.6**		**65.2**	**65.0**	**65.4**	

Comparisons:

LSD (0.05	N-level	(A)	0.6	1.3	0.7
	Mn-level	(B)	0.5	0.6	0.5
	Appli. Methods	(C)	0.5	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

respectively compared with the check treatment. The corresponding reductions in silking date in 1998 season for the same N rates were 1.7, 3.0 and 4.7 days, respectively, being 2.1 , 3.7 and 5.1 days in the two seasons average.

It could be concluded that N enhanced silking in maize. This result is a clear illustration for the role of N in building sexual organs in maize plants. It is clear that N application encouraged the meristematic activity and increased the vegetative growth which pushed maize plants towards earlier silking.

Similar results were also obtained by **El-Habbak and Shams El-Din (1996); El-Moursy et al. (1998) and Nofal (1999)** she found that N fertilizer caused a significant decrease in number of days to 50 % silking. On the other hand, **Salwau (1985)** indicated that N application showed no effect on silking over the three years of study.

2-2- Effect of manganese application :

The results showed in Table (4) that Mn application had a significant effect on the time of 50 % silking as a result of applying 70 mg Mn / l. This is true in both seasons and combined average.

The same trend was observed by **Abdel-Salam et al. (1993a).**

2-3- Effect of manganese application methods:

It is evident from the same Table that foliar application and grain soaking of Mn significantly decreased the time of 50 % silking in the 1st season only.

2-4- Interaction effects :

The results reported in Table (4) indicated that all interaction between the experimental factors had no significant effect on silking date.

II- Growth characters :

1-Plant height (cm):

The results in Table (5) indicated the effect of nitrogen , manganese levels , Mn application methods and their interactions on plant height of maize plants at 75 days from planting in 1997 and 1998 seasons as well as their combined average.

1-1- Effect of nitrogen application :

The results showed that N application had a significant effect on plant height. Increasing N levels from 0 to 50, 100 and 150 kg N /fed significantly increased maize plant height by 15.5, 20.1 and 20.1 % in the 1997 season, respectively. However, the difference between 100 and 150 kg N fed^{-1} was insignificant. The corresponding increases in 1998 season were 20.2, 31.8 and 37.9 % for the same respective N levels. The increases in plant height over the two seasons average were 17.7, 25.8 and 28.6 % respectively.

It is quite evident from the present results that N has a prominent role on maize growth expressed in terms of plant height. The vital role of N and its necessity for protoplasm formation, cell division and merestimatic activity in plant organs in clearly illustrated.

The increase in plant height probably resulted from the increase in the internode length due to the increase in the activity

Table 5. Effect of N,Mn levels, methods of Mn application and their intractions on plant height (cm) at 75 days from plantingin 1997 and 1998 seasons and their combined data.

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Method of Mn-application				Method of Mn-application				Method of Mn-application			
		soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	242.3	249.0	249.5	246.9	209.3	213.8	204.9	209.3	225.8	231.4	227.2	228.1
	70	252.3	252.5	243.8	249.5	216.0	219.0	215.6	216.9	234.1	235.8	229.7	233.2
	140	242.8	253.5	255.8	250.7	211.9	207.4	217.5	212.3	227.3	230.4	236.6	231.5
	Mean	**245.8**	**251.7**	**249.7**	**249.0**	**212.4**	**213.4**	**212.7**	**212.8**	**229.1**	**232.5**	**231.2**	**230.9**
50	0	285.0	289.5	286.0	286.8	252.4	249.4	249.0	250.3	268.7	269.4	267.5	268.5
	70	280.5	289.0	289.3	286.3	260.6	259.8	262.5	261.0	270.6	274.4	275.9	273.6
	140	288.8	289.8	291.5	290.0	256.6	252.1	260.1	256.3	272.7	270.9	275.8	273.1
	Mean	**284.8**	**289.4**	**288.9**	**287.7**	**256.5**	**253.8**	**257.2**	**255.8**	**270.6**	**271.6**	**273.1**	**271.8**
100	0	305.5	304.5	296.3	302.1	277.4	277.8	278.0	277.7	291.4	291.1	287.1	289.9
	70	319.8	296.5	297.3	304.5	279.3	278.6	291.3	283.0	299.5	287.6	294.3	293.8
	140	302.3	292.8	291.5	295.5	280.8	287.9	272.8	280.5	291.5	290.3	282.1	288.0
	Mean	**309.2**	**297.9**	**295.0**	**300.7**	**279.1**	**281.4**	**280.7**	**280.4**	**294.1**	**289.7**	**287.8**	**290.5**
150	0	300.8	300.8	301.5	301.0	292.3	290.1	290.5	291.0	296.5	295.4	296.0	296.0
	70	310.3	308.0	294.3	304.2	296.7	299.0	304.2	300.0	303.5	303.5	299.2	302.1
	140	298.3	299.0	292.3	296.5	292.9	286.1	289.9	289.6	295.6	292.6	291.1	293.1
	Mean	**303.1**	**302.6**	**296.0**	**300.6**	**293.9**	**291.8**	**294.9**	**293.5**	**298.5**	**297.2**	**295.4**	**297.0**
Mnxappl.	0	283.4	286.0	283.3	284.2	257.9	257.8	255.6	257.1	270.6	271.9	269.5	270.7
	70	290.7	286.5	281.2	286.1	263.2	264.1	268.4	265.2	276.9	275.3	274.8	275.7
	140	283.1	283.8	282.8	283.2	260.6	258 4	260.1	259.7	271.8	271.1	271.4	271.4
	Mean	**285.7**	**285.4**	**282.4**		**260.5**	**260.1**	**261.4**		**273.1**	**272.7**	**271.9**	

Comparisons:

LSD (0.05	N-level	(A)	10.5	8.5	6.7
	Mn-level	(B)	N.S	2.9	2.6
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

of meristematic tissues .

The results reported by several investigators showed that plant height of maize respond to nitrogen application (**Younis et al. 1994 ; Abdullah 1995 ; Amer et al. 1995 ; Abdrabou 1996 ; Badr et al. 1997 ; El-Morsy et al. 1998 and Nofal 1999).** On the other hand, **El-Habbak (1996) and Aly et al. (1996)** they mentioned that N fertilizer levels of 90 , 105 and 120 kg /fed were not found to have any measurable effect on plant height.

1-2-Effect of manganese application:

From the same Table it was clear that Mn nutrient increased markedly and significantly the maize plant height up to the level of 70 mg Mn / l concentration. While, increasing Mn level up to 140 mg Mn / l resulted a decrease in plant height. This is true in the 2nd season as well as combined average . However, there was no significant difference among zero and 140 mg Mn / l concentrations. Higher concentration of Mn (140 mg Mn / l) may cause a poisonous effect on maize plants. The same trend was obtained in the 1st season without significant differences between all Mn concentrations. The highest average of plant height were 286.1, 265.2 and 275.7 cm in 1997, 1998 and combined average, respectively. It could be concluded that application of Mn resulted an increase in the length of stem due to manganese, it play important role in promoting maize growth. Mn is important in root extension, cell division, respiration, nitrogen metabolism and activation of enzymes in growth plant **(Marschner,1995).**

This result agrees with those reported by **Allam and El-Naggar (1992); Abdel-Salam et al. (1993a); Ashoub et al.**

(1996) and El-Sheikh (1998) who stated that significant response to Mn spraying for plant height. On the other hand, Allam (1983) reported that plant height was not affected by Mn application, this result may be due to the differences in genetically constitution of the studied varieties .

1-3- Effect of manganese application methods:

It is evident from the same Table that the differences among the average values of Mn application methods were not significant in both growing seasons as well as the combined average.

1-4- Interaction effects :

All the effect of the interactions between the experimental factors were not significant on plant height in both seasons as well as in the combined average.

2-Ear height (cm):

The results in Table (6) indicated the effect of nitrogen , manganese levels ,Mn application methods and their interactions on topmost ear height of maize plants at 75 days from planting in 1997 and 1998 seasons as well as their combined average.

2-1- Effect of nitrogen application :

The results in Table (6) showed that N levels significantly affected in ear height in both seasons as well as the combined average. The results cleared that applying N at 50, 100 and 150 kg / fed. increased ear height by 27.1, 33.6 and 36.1 % over the check treatment in 1997 season , respectively . However, the differences between 100 and 150 kg N / fed. was insignificant. The corresponding increases for the same N levels in 1998 season were 16.58, 36.6 and 48.2 % respectively, being 22.0,

Table 6. Effect of N,Mn levels , methods of Mn application and their intractions on ear height (cm) at 75 days from planting in 1997 and 1998 seasons and their combined data.

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	106.8	107.3	108.3	107.4	93.9	96.4	103.8	98.0	100.3	101.8	106.0	102.7
	70	108.8	113.0	110.5	110.8	103.5	99.4	102.1	101.7	106.1	106.2	106.3	106.2
	140	105.0	108.0	103.8	105.6	104.3	95.5	101.8	100.5	104.6	101.8	102.8	103.0
	Mean	**106.8**	**109.4**	**107.5**	**107.9**	**100.5**	**97.1**	**102.5**	**100.1**	**103.7**	**103.3**	**105.0**	**104.0**
50	0	134.5	132.8	133.8	133.7	114.4	112.0	112.6	113.0	124.4	122.4	123.2	123.3
	70	137.3	142.0	139.0	139.4	118.6	120.8	124.1	121.2	127.9	131.4	131.6	130.3
	140	137.0	139.5	137.8	138.1	112.3	116.3	119.6	116.0	124.6	127.9	128.7	127.1
	Mean	**136.3**	**138.1**	**136.8**	**137.1**	**115.1**	**116.3**	**118.8**	**116.7**	**125.7**	**127.2**	**127.8**	**126.9**
100	0	142.0	144.0	142.3	142.8	134.9	136.3	135.5	135.5	138.4	140.1	138.9	139.1
	70	147.5	145.0	142.0	144.8	135.8	142.9	145.1	141.3	141.7	143.9	143.6	143.1
	140	142.5	147.0	145.5	145.0	127.9	140.9	131.1	133.3	135.2	143.9	138.3	139.1
	Mean	**144.0**	**145.3**	**143.3**	**144.2**	**132.9**	**140.0**	**137.3**	**136.7**	**138.4**	**142.7**	**140.3**	**140.4**
150	0	145.8	148.3	143.5	145.8	148.1	149.4	140.8	146.1	146.9	148.8	142.1	146.0
	70	146.8	146.0	147.3	146.7	156.4	151.6	151.6	153.2	151.6	148.8	149.4	149.9
	140	146.0	152.0	145.8	147.9	144.3	146.5	145.6	145.5	145.1	149.3	145.7	146.7
	Mean	**146.2**	**148.8**	**145.5**	**146.8**	**149.6**	**149.2**	**146.0**	**148.3**	**147.9**	**149.0**	**145.8**	**147.5**
Mnxappl.	0	132.3	133.1	131.9	132.4	122.8	123.5	123.2	123.2	127.5	128.3	127.5	127.8
	70	135.1	136.5	134.7	135.4	128.6	128.7	130.8	129.3	131.8	132.6	132.7	132.4
	140	132.6	136.6	133.2	134.1	122.2	124.8	124.5	123.8	127.4	130.7	128.9	129.0
	Mean	**133.3**	**135.4**	**133.3**		**124.5**	**125.7**	**126.1**		**128.9**	**130.5**	**129.7**	

Comparisons:				
LSD (0.05	N-level	(A)	4.0	8.2	4.7
	Mn-level	(B)	1.8	2.9	2.0
	Appli. Methods	(C)	1.8	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

35.0 and 41.8 % in the combined average.

As a conclusion, this results is quite expected since nitrogen fertilizer resulted in an increase in the average length of the internode through encouraging meristematic activity. N is essential for building up protoplasem and proteins which induce cell division and increase meristematic activity.

Similar results were reported by **El-Ashmony et al. (1991); Salwau (1993); Shafshak et al. (1994a) and Badawi and El-Moursy (1997).**

2-2-Effect of manganese application :

It was clear from the data shown in Table (6) that application of 70 mg Mn / l increased markedly and significantly ear position . While, a further increase up to 140 mg Mn / l decreased ear position. However, there was no significant difference between zero and 140 mg Mn / l concentrations. This is true in both seasons as well as combined average.

Applying Mn at the rate of 70 mg Mn / l significantly increased ear height by 2.26, 4.95 and 3.60 % over the check treatment in 1997, 1998 and the two seasons average, respectively. It could be concluded that Mn showed in general a positive effect on the ear height. Such results show clearly the important role of Mn in promoting maize growth. Mn is important in cell division, N metabolism and activation of enzymes in plant growth. **(Gardner et al. 1985 and Marshner, 1995).**

The results reported by **Allam and El-Naggar (1992); Abdel-Salam et al. (1993a); Abdel-Salam and El-Shiekh (1994); Ashoub et al. (1996) and El-Sheikh (1998)** indicated

that Mn application considerably increased ear height. On the other hand, **Allam (1983) and El-Shiekh et al.(1999)** found that Mn application did not significantly increased ear height, the contradiction between this results could be due to the differences in genetically constitution of the studied varieties.

2-3- Effect of manganese application methods :

The data presented in the same Table indicated that the mean values of ear height significantly increased by using foliar spraying as application method in 1997 season only. Whereas, the effect of Mn application methods were not significant in 2nd season and combined average.

2-4- Interaction effects :

The results reported in Table (6) showed that all interactions between the experimental factors had no significant effects on ear height in both seasons as well as in the combined average.

3- Stem diameter (cm):

The results in Table (7) indicated the effect of nitrogen , manganese levels ,methods of Mn application and their interactions on stem diameter of maize plants at 75 days from planting in 1997 and 1998 seasons as well as their combined average.

3-1-Effect of nitrogen application :

Data in Table (7) revealed that stem diameter was significantly affected as a results of fertilizing maize plants by nitrogen rates in both growing seasons as well as combined average.

Table 7. Effect of N,Mn levels , methods of Mn application and their intractions on stem diameter (cm) at 75 days from planting in 1997 and 1998 seasons and their combined data.

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	1.90	1.98	1.86	1.91	1.48	1.50	1.40	1.46	1.69	1.74	1.63	1.69
	70	1.95	2.14	1.98	2.02	1.75	1.85	1.68	1.76	1.85	1.99	1.83	1.89
	140	2.00	1.86	2.04	1.97	1.63	1.65	1.40	1.56	1.81	1.75	1.72	1.76
	Mean	**1.95**	**1.99**	**1.96**	**1.97**	**1.62**	**1.67**	**1.49**	**1.59**	**1.78**	**1.83**	**1.73**	**1.78**
50	0	2.60	2.70	2.49	2.59	1.85	2.10	1.88	1.94	2.23	2.40	2.18	2.27
	70	2.59	2.86	2.49	2.65	1.98	2.68	1.98	2.21	2.28	2.77	2.23	2.43
	140	2.50	2.62	2.59	2.57	1.85	1.93	1.90	1.89	2.17	2.27	2.25	2.23
	Mean	**2.56**	**2.72**	**2.52**	**2.60**	**1.89**	**2.23**	**1.92**	**2.01**	**2.23**	**2.48**	**2.22**	**2.31**
100	0	2.67	3.06	2.61	2.78	2.25	2.30	2.20	2.25	2.46	2.68	2.40	2.51
	70	2.63	3.02	3.01	2.89	2.38	2.35	2.15	2.29	2.50	2.69	2.58	2.59
	140	2.98	2.89	2.77	2.88	2.38	2.35	2.38	2.37	2.68	2.62	2.57	2.62
	Mean	**2.76**	**2.99**	**2.79**	**2.85**	**2.33**	**2.33**	**2.24**	**2.30**	**2.55**	**2.66**	**2.52**	**2.57**
150	0	3.02	2.90	2.97	2.96	2.55	2.48	2.45	2.49	2.79	2.69	2.71	2.73
	70	3.10	3.34	3.29	3.24	2.58	2.58	2.55	2.57	2.84	2.96	2.92	2.90
	140	2.92	3.20	2.83	2.98	2.53	2.55	2.43	2.50	2.72	2.88	2.63	2.74
	Mean	**3.01**	**3.15**	**3.03**	**3.06**	**2.55**	**2.53**	**2.48**	**2.52**	**2.78**	**2.84**	**2.75**	**2.79**
Mean	0	2.55	2.66	2.48	2.56	2.03	2.09	1.98	2.04	2.29	2.38	2.23	2.30
	70	2.57	2.84	2.69	2.70	2.17	2.36	2.09	2.21	2.37	2.60	2.39	2.45
	140	2.60	2.64	2.56	2.60	2.09	2.12	2.03	2.08	2.35	2.38	2.29	2.34
	Mean	**2.57**	**2.71**	**2.58**		**2.10**	**2.19**	**2.03**		**2.33**	**2.45**	**2.30**	

Comparisons:					
LSD (0.05	N-level	(A)	0.26	0.28	0.38
	Mn-level	(B)	N.S	N.S	N.S
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

In 1997 season, increasing nitrogen levels from 0 to 50, 100 and 150 kg / fed. caused a significant increase in stem diameter over the control treatment by 0.63, 0.88 and 1.09 cm, respectively.

In 1998 season, the corresponding increases were 0.42, 0.71 and 0.93 cm. for the same respective nitrogen levels. The increase in stem diameter over the two seasons average were 0.53, 0.79 and 1.01 cm respectively.

Here it should be noted that the differences in stem diameter between 100 and 150 kg N / fed did not reach the 5 % level of significance in both seasons and combined average. The increase in maize stem diameter with the increase in N application may be attributed to the increase in meristemic activity.

Many investigators found similar results such as **Salwau and Shams El-Din (1992); Hammam (1995); Lamlom (1997) and El-Moursy et al. (1998).** Whereas, **Salwau (1985)** recorded that stem diameter was not significantly affected by N levels.

3-2-Effect of manganese application:

It is evident from the same Table (7) that the differences among the average values of stem diameter due to the different Mn treatments were not significant. However, the data revealed that 70 mg Mn / l concentration gave the highest values of stem diameter. While, increasing Mn concentration up to 140 mg Mn / l reduced it.

Similar results were also reported by **Allam (1983)** who showed that applied of 0.6 % $MnSO_4$ insignificant increased

stem diameter of maize plants than the control. On the other hand, **Osman (1997)** indicated that there was significant increment in stem diameter due to the using 0.15g Mn / l level.

3-3- Effect of manganese application methods :

It is clear from Table (7) that Mn application methods was not significantly affected on stem diameter in both growing seasons and combined average.

3-4-Interaction effects :

All the effect of the interactions between the experimental factors were not significant on stem diameter in both season as well as in the combined average.

4-Number of green leaves / plant:

The results in Table (8) indicated the effect of nitrogen , manganese levels ,Mn application methods and their interactions on number of green leaves / plant at 75 days from planting in 1997 and 1998 seasons as well as their combined average.

4-1-Effect of nitrogen application:

Nitrogen fertilizer levels significantly increased number of green leaves / plant in both growing seasons as well as combined average (Table 8). Application of 50, 100 and 150 kg N / fed increased number of active green leaves / plant over the control treatment by 16.5, 34.5 and 39.1 % in 1997 season, respectively, and by 20.4, 30.6 and 41.8 % in 1998 season , at the same N fertilizer levels, being 18.3, 32.7 and 40.4 % in the combined average.

The increase in number of green leaves maize / plant due to nitrogen application is mainly due to the role of nitrogen in

Table 8. Effect of N,Mn levels , methods of Mn application and their intractions on number of green leaves/plant at 75 days from planting in 1997 and 1998 seasons and their combined data .

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	10.95	10.65	11.60	11.07	9.70	9.15	9.75	9.53	10.33	9.90	10.68	10.30
	70	11.33	10.70	11.15	11.06	9.35	10.75	10.20	10.10	10.34	10.73	10.68	10.58
	140	10.95	10.78	10.93	10.88	9.95	9.50	9.75	9.73	10.45	10.14	10.34	10.31
	Mean	**11.08**	**10.71**	**11.23**	**11.00**	**9.67**	**9.80**	**9.90**	**9.79**	**10.37**	**10.25**	**10.56**	**10.40**
50	0	13.50	12.78	12.98	13.08	11.25	11.75	11.80	11.60	12.38	12.26	12.39	12.34
	70	12.70	13.00	13.18	12.96	11.75	12.08	12.05	11.96	12.23	12.54	12.61	12.46
	140	12.50	12.20	12.43	12.38	12.15	11.95	11.60	11.90	12.33	12.08	12.01	12.14
	Mean	**12.90**	**12.66**	**12.86**	**12.81**	**11.72**	**11.93**	**11.82**	**11.82**	**12.31**	**12.29**	**12.34**	**12.31**
100	0	15.00	14.28	14.78	14.68	12.55	12.70	12.40	12.55	13.78	13.49	13.59	13.62
	70	15.20	15.15	14.78	15.04	13.08	13.30	12.60	12.99	14.14	14.23	13.69	14.02
	140	14.35	14.50	14.85	14.57	12.60	12.70	12.80	12.70	13.48	13.60	13.83	13.63
	Mean	**14.85**	**14.64**	**14.80**	**14.76**	**12.74**	**12.90**	**12.60**	**12.75**	**13.80**	**13.77**	**13.70**	**13.76**
150	0	14.78	15.40	15.38	15.18	14.10	13.75	14.10	13.98	14.44	14.58	14.74	14.58
	70	15.70	16.43	15.83	15.98	14.40	14.33	14.00	14.24	15.05	15.38	14.91	15.11
	140	14.53	15.63	14.33	14.83	13.80	13.45	13.65	13.63	14.16	14.54	13.99	14.23
	Mean	**15.00**	**15.82**	**15.18**	**15.33**	**14.10**	**13.84**	**13.92**	**13.95**	**14.55**	**14.83**	**14.55**	**14.64**
Mnxappl.	0	13.56	13.28	13.68	13.50	11.90	11.84	12.01	11.92	12.73	12.56	12.85	12.71
	70	13.73	13.82	13.73	13.76	12.14	12.61	12.21	12.32	12.94	13.22	12.97	13.04
	140	13.08	13.28	13.13	13.16	12.13	11.90	11.95	11.99	12.60	12.59	12.54	12.58
	Mean	**13.46**	**13.46**	**13.51**		**12.06**	**12.12**	**12.06**		**12.76**	**12.79**	**12.79**	

Comparisons:				
LSD (0.05	N-level	(A)	0.59	0.55
	Mn-level	(B)	0.22	0.30
	Appli. Methods	(C)	N.S	N.S
		AXB	N.S	N.S
		AXC	N.S	N.S
		BXC	N.S	N.S
		AXBXC	N.S	N.S

0.52
0.28
N.S
N.S
N.S
N.S
N.S

encouraging chlorophyll formation and meristimatic tissue in maize plants. Number of green leaves could be considered an external expression of the meristimic activity in plants.

Increased number of green leaves / plant due to application of high nitrogen were reported by **Gouda et al. (1992) ; El-Sheikh (1993) ; Younis et al. (1994); Amer et al. (1995) and Badr et al. (1997).** Whereas, **El-Habbak (1996)** recorded that application of nitrogen fertilizer did not on number of green leaves / plant.

4-2- Effect of manganese application :

It is clear from data of Table (8) that application of Mn nutrient increased the number of green leaves / plant by adding 70 mg Mn / l. While, a further increase in Mn concentration up to 140 mg Mn / l decreased it. In fact there was no significant difference in the number of green leaves / plant between zero and 140 mg Mn / l concentration of Mn applied in 2nd season and combined average. The highest number of green leaves / plant 13.76, 12.32 and 13.04 in 1997, 1998 and combined average respectively were obtained by applying 70 mg Mn/ l.

These results coincide with those obtained by **Osman (1997)** who found that Mn nutrient rates of 0.15 g / l. level significantly increased number of green leaves / plant.

4-3- Effect of manganese application methods :

It is clear from Table (8) that Mn application methods did not affected in number of green leaves / plant in both growing seasons and combined average.

The present results did not agree with those reported by **Osman (1997)** who found that using 0.15g Mn / l as foliar

spraying caused a significant increase in number of green leaves / plant.

4-4- Interaction effects :

All the effect of the interactions between the experimental factors were not significant on number of green leaves / plant in both seasons as well as in the combined average.

5-Area of the topmost ear leaf (cm^2):

The results in Table (9) indicated the effect of nitrogen , manganese levels, Mn application methods and their interaction on area of the topmost ear leaf at 75 days from planting in 1997 and 1998 seasons as well as their combined average.

5-1-Effect of nitrogen application :

The results in Table (9) showed that the increase in nitrogen levels significantly increased the area of topmost ear leaf in both season as well as combined average.

In 1997 season, applying nitrogen equal to 50, 100 and 150 kg N / fed. significantly increased leaf area over the check treatment by 19.7, 49.1 and 73.7 % respectively, and by 23.4, 63.7 and 85.5 % in 1998 season . The corresponding increase being 21.7, 56.5 and 79.7 % in the combined average, respectively.

It is worthy to mention that increasing ear leaf area with increasing N application reflected the important role of N in building up the photosynthetic apparatus and regard to the net assimilation rate which may cause an increase in the meristematic activity and consequently in leaf growth .

Table 9. Effect of N, Mn levels , methods of Mn application and their intractions on area of topmost ear leaf (cm2) at 75 days from planting in 1997 and 1998 seasons and their combined data ·

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	315.3	310.7	306.5	310.8	328.5	328.7	322.3	326.5	321.9	319.7	314.4	318.7
	70	314.5	316.7	312.6	314.6	328.9	333.2	329.1	330.4	321.7	324.9	320.9	322.5
	140	312.7	315.1	310.6	312.8	331.5	326.5	324.8	327.6	322.1	320.8	317.7	320.2
	Mean	**314.1**	**314.2**	**309.9**	**312.7**	**329.6**	**329.5**	**325.4**	**328.2**	**321.9**	**321.8**	**317.7**	**320.5**
50	0	367.2	372.9	375.4	371.8	408.5	410.0	407.0	408.5	387.9	391.5	391.2	390.2
	70	372.3	379.0	377.5	376.3	405.7	411.7	398.7	405.4	389.0	395.4	388.1	390.8
	140	374.4	374.5	374.6	374.5	400.0	404.0	405.8	403.3	387.2	389.2	390.2	388.9
	Mean	**371.3**	**375.4**	**375.8**	**374.2**	**404.7**	**408.6**	**403.8**	**405.7**	**388.0**	**392.0**	**389.8**	**390.0**
100	0	462.3	462.8	464.9	463.4	536.0	535.3	534.9	535.4	499.2	499.1	499.9	499.4
	70	466.3	471.5	472.0	469.9	540.3	541.4	528.5	536.7	503.3	506.4	500.3	503.3
	140	465.2	466.1	464.2	465.2	537.8	539.9	540.1	539.3	501.5	503.0	502.1	502.2
	Mean	**464.6**	**466.8**	**467.0**	**466.2**	**538.0**	**538.8**	**534.5**	**537.1**	**501.3**	**502.8**	**500.8**	**501.6**
150	0	531.7	546.0	546.1	541.3	607.8	609.4	607.7	608.3	569.8	577.7	576.9	574.8
	70	544.1	548.5	540.7	544.4	607.5	612.5	609.4	609.8	575.8	580.5	575.1	577.1
	140	542.6	545.5	543.1	543.7	607.5	608.0	608.5	608.0	575.1	576.8	575.8	575.9
	Mean	**539.5**	**546.7**	**543.3**	**543.2**	**607.6**	**609.9**	**608.6**	**608.7**	**573.5**	**578.3**	**575.9**	**575.9**
Mnxappl.	0	419.1	423.1	423.2	421.8	470.2	470.9	468.0	469.7	444.7	447.0	445.6	445.7
	70	424.3	428.9	425.7	426.3	470.6	474.7	466.4	470.6	447.4	451.8	446.1	448.4
	140	423.7	425.3	423.1	424.0	469.2	469.6	469.8	469.5	446.5	447.5	446.5	446.8
	Mean	**422.4**	**425.8**	**424.0**		**470.0**	**471.7**	**468.1**		**446.2**	**448.7**	**446.0**	

Comparisons:

LSD (0.05	N-level	(A)	5.75	6.09	3.76
	Mn-level	(B)	2.67	N.S	1.88
	Appli. Methods	(C)	2.67	2.64	1.88
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

The present results are in agreement with those reported by **Gouda et al. (1992); Shafshak et al. (1994a); Amer et al. (1995) and Lamlom (1997).**

5-2-Effect of manganese application:

The results in Table (9) indicated that Mn application at the rate of 70 mg Mn / l significantly increased area of topmost ear leaf in 1997 season . Whereas, the effect of Mn in ear leaf area was not significant in 1998 season.

Applying 70 mg Mn / l increased area of topmost ear leaf by 4.5 cm^2 and 0.9 cm^2 in 1997 and 1998 seasons , respectively . Also, the combined analysis of both seasons showed a significant response of area of topmost ear leaf to Mn application where an increase of 2.7 cm^2 was recorded . While , a further increase up to 140 mg Mn / l. decreased it.

Such results indicated clearly that Mn essential for cereals. This important micronutrient is required for building up vegetative as well as reproductive plant organs.

Similar results were obtained by **Allam and El-Naggar (1992) and Abdel-Salam et al. (1993a)** who found that application of Mn in either form significant increased ear leaf area and the best rates were 0.4-0.6 % mineral Mn or 0.04-0.06 % organic Mn. On the other hand, **Allam (1983) and El-Hattab et al. (1986)** showed that ear leaf area was not affected by Mn nutrition.

5-3-Effect of manganese application methods:

It is clear from the data of Table (9) that foliar application method of Mn resulted a significant increase in the area of topmost ear leaf. The highest mean values of area of topmost ear

leaf were 425.8, 471.7 and 448.7 cm^2 in 1997, 1998 as well as in the combined average, respectively.

5-4- Interaction effects :

Area of topmost ear leaf was not affected significantly by the interactions between all experimental factors in both seasons as well as in the combined average.

III- Growth analysis :

1-Leaf area index (LAI):

Leaf area index (LAI) expresses the ratio of leaf surface (one side only) to the ground area occupied by the crop. **Watson 1952**

Data on LAI as effected by N , Mn levels , Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average at 75 days from planting are shown in Table (10)

1-Effect of nitrogen application:

It is clear from data in Table (10) that various N levels affected the leaf area index significantly in both seasons and in the combined analysis.

All the applied nitrogen rates (50 , 100 and 150 kg N / fed) increased the average LAI of maize plant significantly as compared to the control. The highest rate of N (150 kg N /fed) produced the largest LAI which were on the average of 4.44, 4.06 and 4.25 in the 1^{st},2^{nd} seasons and their combined average.

It was noticed that N application showed positive effect on LAI of maize plant because nitrogen plays an important role as one of the essential elements required for plant growth. The

Table 10. Effect of N,Mn levels , methods of Mn application and their intractions on leaf area index (LAI) at 75 days from planting in 1997 and 1998 seasons and their combined data .

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr	Mean
None	0	2.43	2.50	2.33	2.42	2.27	2.22	2.23	2.24	2.35	2.36	2.28	2.33
	70	2.60	2.58	2.58	2.58	2.51	2.31	2.24	2.35	2.56	2.44	2.41	2.47
	140	2.40	2.43	2.43	2.42	2.27	2.22	2.19	2.23	2.33	2.32	2.31	2.32
	Mean	**2.48**	**2.50**	**2.44**	**2.47**	**2.35**	**2.25**	**2.22**	**2.27**	**2.41**	**2.37**	**2.33**	**2.37**
50	0	2.88	3.03	2.88	2.93	2.28	2.41	2.32	2.34	2.58	2.72	2.60	2.63
	70	3.15	3.20	2.85	3.07	2.97	2.93	2.81	2.90	3.06	3.07	2.83	2.98
	140	2.85	2.98	2.95	2.93	2.35	2.54	2.83	2.57	2.60	2.76	2.89	2.75
	Mean	**2.96**	**3.07**	**2.89**	**2.97**	**2.53**	**2.63**	**2.65**	**2.60**	**2.74**	**2.85**	**2.77**	**2.79**
100	0	3.88	4.35	3.78	4.00	3.41	3.42	3.43	3.42	3.64	3.88	3.60	3.71
	70	3.38	4.05	3.38	3.60	3.77	4.09	3.69	3.85	3.57	4.07	3.53	3.73
	140	3.78	3.60	3.23	3.53	3.42	3.52	3.44	3.46	3.60	3.56	3.33	3.50
	Mean	**3.68**	**4.00**	**3.46**	**3.71**	**3.53**	**3.68**	**3.52**	**3.58**	**3.60**	**3.84**	**3.49**	**3.64**
150	0	4.43	4.55	4.25	4.41	3.91	3.87	4.07	3.95	4.17	4.21	4.16	4.18
	70	4.75	4.83	4.38	4.65	4.17	4.19	3.90	4.09	4.46	4.51	4.14	4.37
	140	3.98	4.48	4.35	4.27	4.11	4.16	4.15	4.14	4.04	4.32	4.25	4.20
	Mean	**4.38**	**4.62**	**4.33**	**4.44**	**4.06**	**4.07**	**4.04**	**4.06**	**4.22**	**4.35**	**4.18**	**4.25**
Mnxappl.	0	3.40	3.61	3.31	3.44	2.97	2.98	3.01	2.99	3.18	3.29	3.16	3.21
	70	3.47	3.66	3.29	3.48	3.35	3.38	3.16	3.30	3.41	3.52	3.23	3.39
	140	3.25	3.37	3.24	3.29	3.04	3.11	3.15	3.10	3.14	3.24	3.20	3.19
	Mean	**3.37**	**3.55**	**3.28**		**3.12**	**3.16**	**3.11**		**3.25**	**3.35**	**3.19**	

Comparisons:					
LSD (0.05	N-level	(A)	0.14	0.11	0.13
	Mn-level	(B)	0.12	0.10	0.12
	Application	(C)	0.12	N.S	0.12
		AXB	0.23	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

increase in LAI may be due to the increase in number of green leaves / plant as well as the area of leaves / plant of maize.

Among the workers who found that N application increased LAI were **El-Amin (1994) and Zaghloul (1999)** recorded that increasing N rates to maize plant up to 150 kg / fed induced a significant increase in the leaf area index. On the other hand, **Shafshak et al. (1995)** showed that the increase of N level from 30 to 150 kg /fed had no significant effect on LAI.

1-2-Effect of manganese application:

It is clear from the same Table that Mn concentrations showed a significant effect on the LAI as was revealed from both seasons and combined average. Adding 70 mg Mn / l increased LAI. While, the highest level of 140 mg Mn / l decreased it as compared with 70 mg / l level. The average LAI for 70 mg Mn / l were 3.48 , 3.30 and 3.39 in both studied seasons and combined average, respectively.

This results is in accordance with those obtained by **El-Sheikh et al. (1999)** noticed that foliar application of Mn at the rate of 90 mg / l enhanced LAI to reach the level of significant.

1-3-Effect of manganese application methods:

Mn application methods affected the average LAI significantly in the first season and combined average. It is clear from Table (10) that maximum LAI were produced by foliar application of Mn. by using this application method, the obtained average LAI of maize plant were 3.55 and 3.35 in the 1st season and combined average, respectively. Similar results were also obtained by **El-Sheikh et al.(1999)**

1-4-Interaction effects:

Data reported in the same Table indicated that LAI was affected significantly by the interaction between N and Mn levels in the first season. The highest value of LAI (4.65) was obtained by combining 150 kg N/fed + 70 mg Mn / l.

2-Dry weight / plant (g).

The results in Table (11) and Fig.1 (a, b and c) indicated the effects of nitrogen , manganese levels and Mn application methods and their interaction on total dry weight of maize plants at 75 days from planting in 1997 and 1998 seasons as well as their combined average.

2-1-Effect of nitrogen application:

The effect of N fertilizer level on total dry weight / plant are shown in Table (11) and Fig. 1(a, b and c.) Adding 150 kg N /fed significantly increased dry weight / plant compared with the other N levels. This is true in both seasons and combined average. Application of 50 , 100 and 150 kg N / fed significantly increased total dry weight over the check treatment by 50.3 , 95.0 and 120.4 g / plant in 1997 season and by 63.7 , 116.0 and 145.7 g / plant in 1998 season, being 56.9 , 105.4 and 133.0 g / plant in the combined average at the same respective N levels, respectively. In this connection, the effect of N fertilizer on accumulating dry matter may be attributed to increasing photosynthetic area which resulted in increasing photosynthetic gains (**Thomposon and Troeh, 1980**).

These results are in agreement with those obtained by **El-Kholy, (1987); Badr, et al. (1997) and Zaghluol (1999)**. On the other hand, **Salwau (1985)** found that the fresh and dry weight of

Table 11. Effect of N, Mn levels , methods of Mn application and their intractions on dry weight / plant at 75 days from planting in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	127.6	128.9	125.3	127.3	128.0	130.1	128.0	128.7	127.8	129.5	126.7	128.0
	70	131.3	135.9	128.6	131.9	129.8	143.3	131.0	134.7	130.6	139.6	129.8	133.3
	140	127.7	128.7	126.4	127.6	129.5	128.4	127.1	128.3	128.6	128.6	126.7	128.0
	Mean	**128.9**	**131.2**	**126.8**	**128.9**	**129.1**	**133.9**	**128.7**	**130.6**	**129.0**	**132.5**	**127.7**	**129.8**
50	0	174.6	178.2	173.7	175.5	182.7	188.4	184.7	185.3	178.7	183.3	179.2	180.4
	70	178.0	183.9	176.2	179.4	191.7	195.0	194.0	193.6	184.8	189.5	185.1	186.5
	140	179.3	177.3	191.3	182.7	193.7	194.1	224.6	204.1	186.5	185.7	208.0	193.4
	Mean	**177.3**	**179.8**	**180.4**	**179.2**	**189.4**	**192.5**	**201.1**	**194.3**	**183.3**	**186.2**	**190.8**	**186.7**
100	0	218.1	222.5	217.6	219.4	243.1	241.4	246.9	243.8	230.6	231.9	232.3	231.6
	70	230.3	230.6	224.3	228.4	248.0	248.4	247.2	247.8	239.2	239.5	235.8	238.1
	140	224.1	226.2	221.3	223.9	246.5	245.5	252.1	248.0	235.3	235.8	236.7	236.0
	Mean	**224.2**	**226.4**	**221.1**	**223.9**	**245.9**	**245.1**	**248.7**	**246.6**	**235.0**	**235.8**	**234.9**	**235.2**
150	0	241.3	247.7	241.5	243.5	268.8	272.8	268.4	270.0	255.1	260.3	255.0	256.8
	70	253.2	256.9	252.4	254.1	282.0	285.0	280.5	282.5	267.6	271.0	266.5	268.3
	140	247.9	253.5	249.8	250.4	274.0	277.3	277.3	276.2	261.0	265.4	263.6	263.3
	Mean	**247.5**	**252.7**	**247.9**	**249.3**	**274.9**	**278.4**	**275.4**	**276.3**	**261.2**	**265.5**	**261.7**	**262.8**
Mnxappl.	0	190.4	194.3	189.5	191.4	205.7	208.2	207.0	206.9	198.0	201.2	198.3	199.2
	70	198.2	201.8	195.4	198.5	212.9	217.9	213.2	214.7	205.5	209.9	204.3	206.6
	140	194.8	196.4	197.2	196.1	210.9	211.3	220.3	214.2	202.8	203.9	208.7	205.2
	Mean	**194.5**	**197.5**	**194.0**		**209.8**	**212.5**	**213.5**		**202.1**	**205.0**	**203.8**	

Comparisons:

LSD (0.05	N-level	(A)	2.4	1.1	2.5
	Mn-level	(B)	2.1	2.9	1.9
	Appli. Methods	(C)	2.1	2.9	1.9
		AXB	4.2	5.8	4.5
		AXC	N.S	5.8	4.5
		BXC	N.S	N.S	N.S
		AXBXC	7.3	10.0	6.8

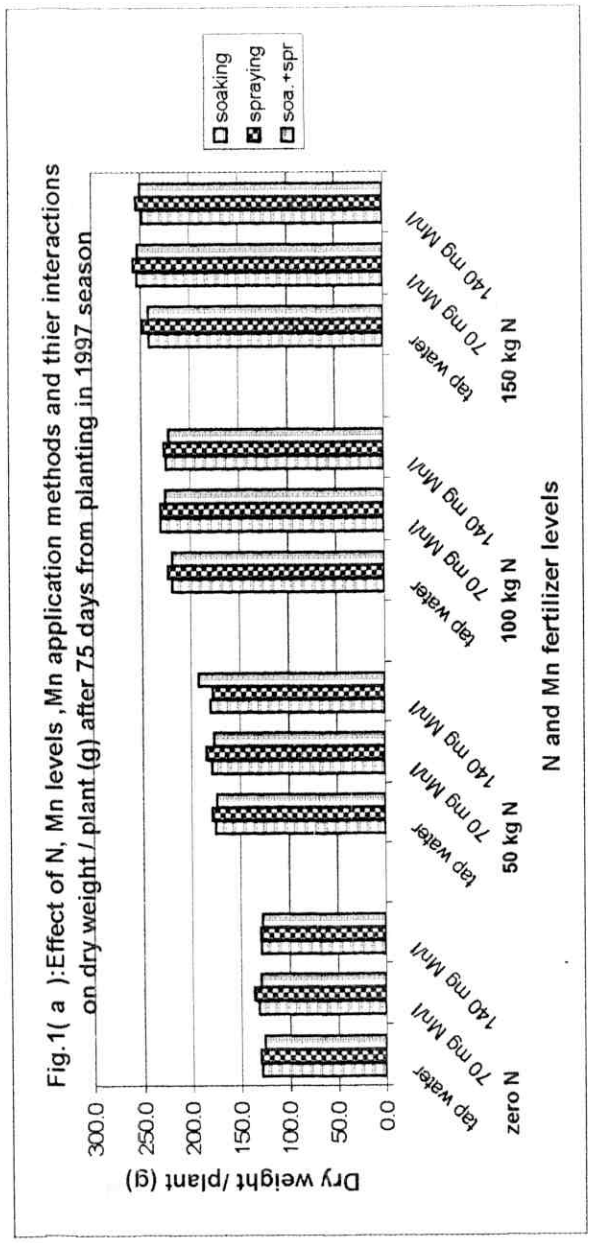
Fig.1(a):Effect of N, Mn levels ,Mn application methods and thier interactions on dry weight / plant (g) after 75 days from planting in 1997 season
Dry weight /plant (g)
300.0
250.0
200.0
150.0
100.0
50.0
0.0
soaking
spraying
soa.+spr
tap water
70 mg Mn/l
140 mg Mn/l
zero N
50 kg N
100 kg N
150 kg N
N and Mn fertilizer levels

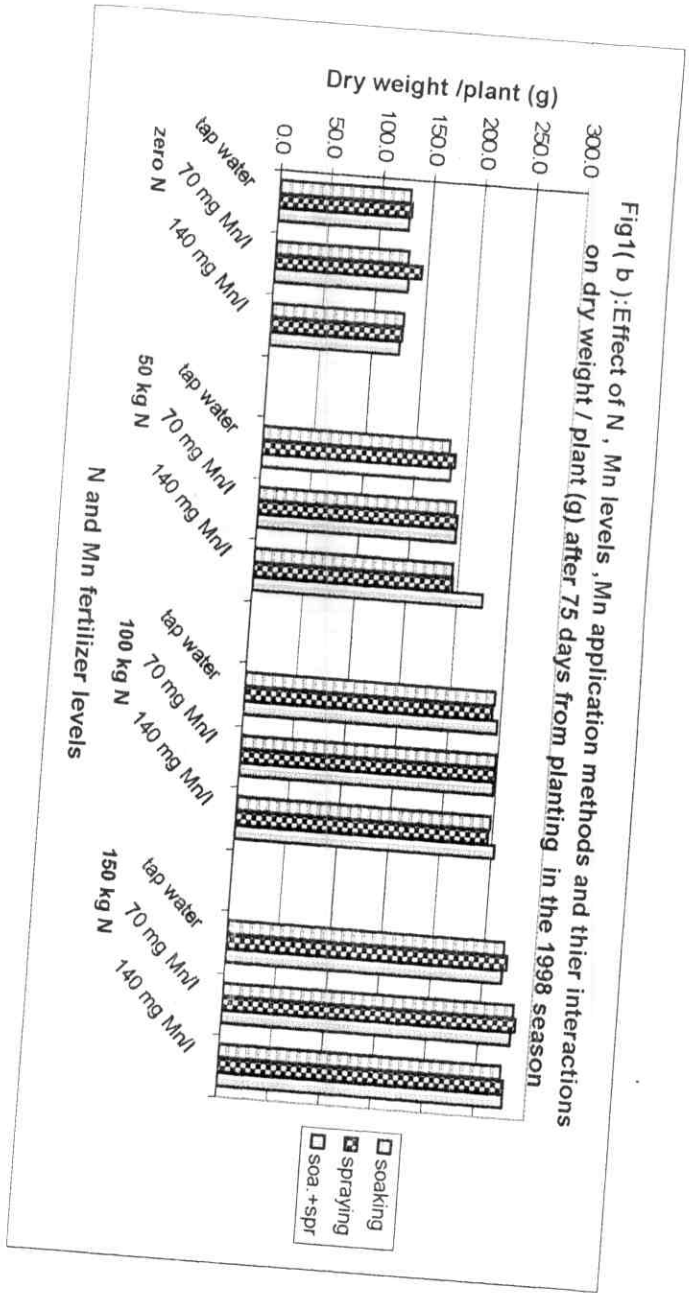

Fig1(b):Effect of N , Mn levels ,Mn application methods and thier interactions on dry weight / plant (g) after 75 days from planting in the 1998 season

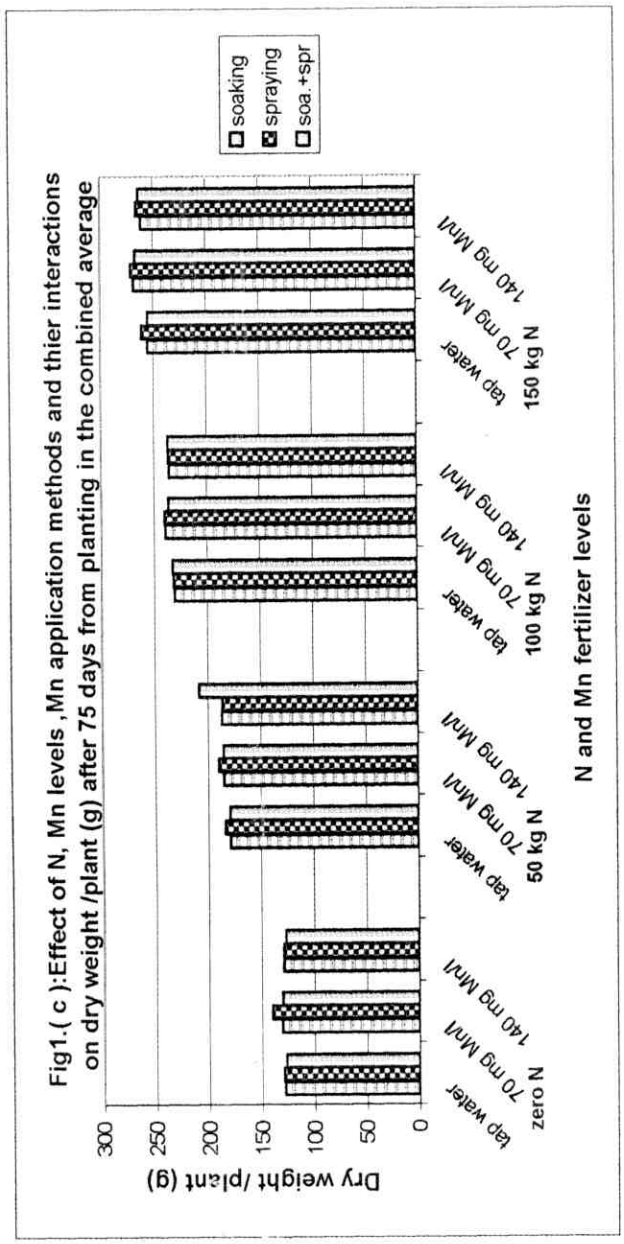
Fig1.(c):Effect of N, Mn levels ,Mn application methods and thier interactions on dry weight /plant (g) after 75 days from planting in the combined average
soaking
spraying
soa.+spr
Dry weight /plant (g)
300
250
200
150
100
50
0
tap water
70 mg Mn/l
140 mg Mn/l
zero N
50 kg N
100 kg N
150 kg N
N and Mn fertilizer levels

plant parts at 75 days after sowing date were not significantly affected by increasing N level up to 120 kg /fed, since the maize plants were grown in fertile soil after field bean.

2-2-Effect of manganese application:

It is clear from the data of Table (11) and Fig. 1(a , b and c) that application of Mn resulted a significant increase in the total dry weight / plant by increasing the level of Mn at the rate 70 mg Mn / l . A further increase in Mn levels up to 140 mg Mn / l resulted in a reduction in the dry weight / plant because this high concentration led to a poisonous effect on the plant (**Amberger and Yousry 1988 a&b**). The highest mean values of dry weight were 198.5, 214.7 and 206.6 g / plant in both seasons and combined average, respectively.

Such result indicates clearly that Mn is essential for cereals. This important micronutrient is required for building up vegetative as well as reproductive plant organs.

Similar results were also found by **Amin, et al. (1987)** working on maize **and Abdel-Salam and El-Sheikh (1994)** working on Sorghum and they found that applying Mn nutrient at the rate of 50 mg/l caused 15 , 9 and 9 % for dry weight of leaves, stems and total dry weight per sorghum plant, respectively. In the 1st and the 2nd cuts increased were 14.2 , 12.0 and 12.0 %.

The soil analysis showed that the soil contained only 5 - 8 available Mn which is considered as a low level (**Ankerman and Larg,1974**).

2-3-Effect of manganese application methods:

It is clear from the results reported in Table (11) and Fig 1

(a, b and c) that methods of Mn application showed a significant effect on total dry weight / plant in both seasons and combined average. The highest mean values of dry weight / plant were reported when adding Mn as a foliar spraying and soa. + spr.

Similar results were obtained **by Abdel-Salam and El-Sheikh (1994).**

2-4-Interaction effects:

The interaction between N and Mn rates in the both seasons and combined analysis of two seasons Table (11) indicated that the total dry weight / plant was significantly affected. The highest dry weight of maize plant was obtained by the combined treatment of 150 kg N /fed + 70 or 140 mg Mn / l. Whereas, the lowest one resulted from zero N + zero Mn levels.

The interaction between N and Mn application methods in the 1998 season and combined average showed that dry weight of maize plant was significantly affected. Results indicated that the highest dry weight / plant could be produced by applying the highest rate of N (150 kg / fed) using any methods of Mn application.

The interaction between various N , Mn rates and Mn application methods were also significant in the both seasons and combined average Table (11).

It could be concluded that the highest average of dry weight / plant could produced by applying the highest rate of N (150 kg / fed) , plus 70 or 140 mg Mn / l with any methods of Mn application.

3-Crop growth rate (CGR):

Crop growth rate (CGR),is defined as the increase of plant material per unit of time. **Radford (1967).**

Data obtained on CGR as affected by N , Mn levels , Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average are presented in Table (12).

3-1-Response to nitrogen application:

The data presented in Table (12) indicated that the mean values of CGR significantly increased by increasing the level of N up to 150 kg N / fed. This is true in both seasons and combined average. The highest average (42.1 , 52.5 and 47.3 gm/m^2/week) were obtained by 150 kg N / fed in both seasons and combined average, respectively. This result is expected since nitrogen increases the vegetative growth and dry weight of maize.

The previously mentioned result were in agreement with those of **Faisal (1983) and Abu-Grab et al. (1997)** they found that N rate up to 100 and 125 kg /fed increased the CGR.

3-2-Response to manganese application:

Data presented in Table (12) show that adding Mn at the rate of 70 mg Mn / l resulted a significant increase in CGR. Increasing the concentration up to 140 mg Mn / l caused a reduction it in first season and combined average due to the poisonous influence of the high concentration. The maximum average (33.0 , 38.9 and 35.9 gm/m^2/week) were obtained from 70 mg Mn / l. in both seasons and combined average, respectively. There was no any specific trend could be detected.

Table 12. Effect of N, Mn levels , methods of Mn application and their intractions on CGR gm / m2 / week at 60 - 75 days from planting in 1997 and 1998 seasons and their combined data .

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	19.9	22.0	20.6	20.8	19.2	19.3	19.6	19.4	19.6	20.7	20.1	20.1
	70	20.9	22.2	20.0	21.0	19.9	19.1	18.8	19.2	20.4	20.6	19.4	20.1
	140	19.3	20.6	18.6	19.5	20.0	19.6	20.5	20.0	19.6	20.1	19.5	19.8
	Mean	**20.0**	**21.6**	**19.7**	**20.4**	**19.7**	**19.3**	**19.6**	**19.5**	**19.8**	**20.5**	**19.7**	**20.0**
50	0	27.2	27.9	27.5	27.5	29.9	33.7	31.7	31.8	28.6	30.8	29.6	29.6
	70	29.9	30.3	28.9	29.7	33.5	32.9	33.6	33.3	31.7	31.6	31.2	31.5
	140	29.8	29.7	32.9	30.8	34.7	33.4	38.6	35.5	32.2	31.5	35.7	33.2
	Mean	**29.0**	**29.3**	**29.8**	**29.3**	**32.7**	**33.3**	**34.6**	**33.5**	**30.8**	**31.3**	**32.2**	**31.4**
100	0	34.8	38.5	34.8	36.0	43.6	46.2	48.7	46.1	39.2	42.4	41.7	41.1
	70	38.1	38.1	38.1	38.1	48.5	48.3	47.6	48.1	43.3	43.2	42.9	43.1
	140	36.6	36.1	35.8	36.2	47.1	49.4	49.4	48.6	41.8	42.8	42.6	42.4
	Mean	**36.5**	**37.6**	**36.2**	**36.8**	**46.4**	**48.0**	**48.5**	**47.6**	**41.4**	**42.8**	**42.4**	**42.2**
150	0	41.6	43.1	38.9	41.2	50.9	52.8	50.3	51.4	46.2	48.0	44.6	46.3
	70	43.2	43.4	42.6	43.1	54.3	54.9	55.2	54.8	48.7	49.2	48.9	48.9
	140	42.3	43.0	41.1	42.1	51.1	52.6	50.6	51.4	46.7	47.8	45.9	46.8
	Mean	**42.3**	**43.2**	**40.9**	**42.1**	**52.1**	**53.4**	**52.0**	**52.5**	**47.2**	**48.3**	**46.5**	**47.3**
Mnxappl.	0	30.9	32.9	30.4	31.4	35.9	38.0	37.6	37.2	33.4	35.4	34.0	34.3
	70	33.0	33.5	32.4	33.0	39.0	38.8	38.8	38.9	36.0	36.1	35.6	35.9
	140	32.0	32.4	32.1	32.1	38.2	38.7	39.8	38.9	35.1	35.5	35.9	35.5
	Mean	**32.0**	**32.9**	**31.6**		**37.7**	**38.5**	**38.7**		**34.8**	**35.7**	**35.2**	

Comparisons:					
LSD (0.05	N-level	(A)	0.82	1.08	1.00
	Mn-level	(B)	0.87	1.00	0.72
	Appli. Methods	(C)	0.87	1.00	0.72
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

3-3-Effect of manganese application methods:

Mn application methods data in Table (12) indicated that Mn as a foliar spraying or grain soaking + foliar spraying caused significant increase in CGR in the two growing seasons and combined average. This increment in CGR is mainly resulted from the increment detected in dry weight of plant and all studied growth characters.

3-4-Interaction effects:

The results presented in the same Table showed that none of the interactions between the experimental factors significantly affected CGR either in both growing seasons or their combined average.

4-Relative growth rate (RGR) :

Relative growth rate (RGR) is defined as the increase of plant material per unit of material per unit of time. **Radford (1967)**

Data on RGR as effected by N , Mn levels , Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average are shown in Table (13).

4-1-Effect of nitrogen application:

It is clear from Table (13) that the mean values of relative growth rate significantly increased by increasing N levels up to 100 kg N / fed , but no further significant increase was obtained from the higher levels u to 150 kg N / fed. The average values were 0.200 , 0.245 and 0.222 gm/gm/week for 100 kg N / fed level in the 1st ,2nd and combined average, respectively. The increases in relative growth rate is mainly resulted from the

Table 13. Effect of N, Mn levels , methods of Mn application and their intractions on RGR gm / gm / week at 60 - 75 days from planting in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997Season				1998 Season				Combined analysis			
		Methods of Mn-application			Mean	Methods of Mn-application			Mean	Methods of Mn-application			Mean
		soaking	spraying	soa.+spr.		soaking	spraying	soa.+spr.		soaking	spraying	soa.+spr.	
None	0	0.187	0.209	0.199	0.198	0.178	0.176	0.183	0.179	0.183	0.193	0.191	0.189
	70	0.191	0.197	0.186	0.191	0.183	0.155	0.169	0.169	0.187	0.176	0.178	0.180
	140	0.179	0.193	0.174	0.182	0.185	0.183	0.194	0.187	0.182	0.188	0.184	0.185
	Mean	**0.186**	**0.200**	**0.186**	**0.191**	**0.182**	**0.171**	**0.182**	**0.178**	**0.184**	**0.186**	**0.184**	**0.185**
50	0	0.186	0.187	0.189	0.187	0.199	0.221	0.210	0.210	0.193	0.204	0.200	0.199
	70	0.204	0.199	0.198	0.200	0.215	0.206	0.213	0.211	0.210	0.203	0.206	0.206
	140	0.202	0.203	0.210	0.205	0.222	0.211	0.211	0.215	0.212	0.207	0.211	0.210
	Mean	**0.197**	**0.196**	**0.199**	**0.198**	**0.212**	**0.213**	**0.211**	**0.212**	**0.205**	**0.205**	**0.205**	**0.205**
100	0	0.192	0.212	0.206	0.203	0.222	0.241	0.251	0.238	0.207	0.227	0.229	0.221
	70	0.201	0.200	0.207	0.203	0.248	0.246	0.243	0.246	0.225	0.223	0.225	0.224
	140	0.198	0.192	0.195	0.195	0.241	0.258	0.251	0.250	0.220	0.225	0.223	0.223
	Mean	**0.197**	**0.201**	**0.203**	**0.200**	**0.237**	**0.248**	**0.248**	**0.245**	**0.217**	**0.225**	**0.226**	**0.222**
150	0	0.211	0.213	0.194	0.206	0.238	0.245	0.235	0.239	0.225	0.229	0.215	0.223
	70	0.208	0.205	0.206	0.206	0.243	0.243	0.250	0.245	0.226	0.224	0.228	0.226
	140	0.208	0.207	0.199	0.205	0.233	0.238	0.227	0.233	0.221	0.223	0.213	0.219
	Mean	**0.209**	**0.208**	**0.200**	**0.206**	**0.238**	**0.242**	**0.237**	**0.239**	**0.224**	**0.225**	**0.219**	**0.222**
Mnxappl.	0	0.194	0.205	0.197	0.199	0.209	0.221	0.220	0.217	0.202	0.213	0.208	0.208
	70	0.201	0.200	0.199	0.200	0.222	0.213	0.219	0.218	0.212	0.206	0.209	0.209
	140	0.197	0.199	0.195	0.197	0.220	0.223	0.221	0.221	0.209	0.211	0.208	0.209
	Mean	**0.197**	**0.201**	**0.197**		**0.217**	**0.219**	**0.220**		**0.207**	**0.210**	**0.208**	
Comparisons:													
LSD (0.05	N-level	(A)		0.007			0.009				0.006		
	Mn-level	(B)		N.S			N.S				N.S		
	Appli. Methods	(C)		N.S			N.S				N.S		
		AXB		N.S			N.S				N.S		
		AXC		N.S			N.S				N.S		
		BXC		N.S			N.S				N.S		
		AXBXC		N.S			N.S						

increment detected in all studied growth traits and dry weight of plant.

These results are in accordance with those recorded by **Abu-Grab et al. (1997)** they found that RGR at 65-85 days from planting responded the applying of different levels of N in both growing seasons, but the difference failed to reach the significance level.

4-2-Effect of manganese application:

Regarding the Mn application at the same Table, it did not affected on the RGR in both seasons as well as in the combined average.

4-3-Effect of manganese application methods:

It is obviously clear that the methods of Mn application did not exhibit any difference in average RGR in 1^{st} ,2^{nd} and in the combined average.

4-4- Interaction effects:

All interactions between the experimental factors had no significant on RGR Table (13).

5-Net assimilation rate (NAR):

Net assimilation rate (NAR) of a plant an instant in time is defined as the increase of plant material per unit of assimilatory material per unit of time. **Radford (1967).**

Data in Table (14) demonstrate the results of 1997 , 1998 seasons and combined average for the values of NAR as affected by N , Mn levels , Mn application methods as well as the interaction between them.

Table 14. Effect of N, Mn levels , methods of Mn application and their intractions on NAR gm/gm/week at 60 - 75 days from planting in 1997 and 1998 seasons and their combined data .

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	0.632	0.688	0.642	0.654	0.640	0.627	0.618	0.628	0.636	0.658	0.630	0.641
	70	0.653	0.659	0.655	0.656	0.618	0.601	0.585	0.601	0.636	0.630	0.620	0.629
	140	0.605	0.645	0.615	0.622	0.639	0.625	0.661	0.642	0.622	0.635	0.638	0.632
	Mean	**0.630**	**0.664**	**0.637**	**0.644**	**0.632**	**0.618**	**0.621**	**0.624**	**0.631**	**0.641**	**0.629**	**0.634**
50	0	0.640	0.652	0.662	0.651	0.728	0.846	0.787	0.787	0.684	0.749	0.725	0.719
	70	0.675	0.671	0.672	0.673	0.835	0.781	0.830	0.815	0.755	0.726	0.751	0.744
	140	0.694	0.714	0.694	0.701	0.861	0.832	0.922	0.872	0.778	0.773	0.808	0.786
	Mean	**0.670**	**0.679**	**0.676**	**0.675**	**0.808**	**0.820**	**0.846**	**0.825**	**0.739**	**0.749**	**0.761**	**0.750**
100	0	0.689	0.779	0.705	0.724	1.000	1.015	1.040	1.018	0.845	0.897	0.873	0.871
	70	0.749	0.729	0.758	0.745	1.079	0.987	1.043	1.036	0.914	0.858	0.901	0.891
	140	0.738	0.722	0.728	0.729	0.979	1.048	1.051	1.026	0.859	0.885	0.890	0.878
	Mean	**0.725**	**0.743**	**0.730**	**0.733**	**1.019**	**1.017**	**1.045**	**1.027**	**0.872**	**0.880**	**0.888**	**0.880**
150	0	0.753	0.747	0.677	0.726	1.032	1.029	0.935	0.999	0.893	0.888	0.806	0.862
	70	0.739	0.724	0.753	0.739	1.037	1.025	1.062	1.041	0.888	0.875	0.908	0.890
	140	0.772	0.723	0.700	0.732	0.943	1.002	0.955	0.967	0.858	0.863	0.828	0.849
	Mean	**0.755**	**0.731**	**0.710**	**0.732**	**1.004**	**1.019**	**0.984**	**1.002**	**0.879**	**0.875**	**0.847**	**0.867**
Mnxappl.	0	0.679	0.717	0.672	0.689	0.850	0.879	0.845	0.858	0.764	0.798	0.758	0.773
	70	0.704	0.696	0.710	0.703	0.892	0.849	0.880	0.874	0.798	0.772	0.795	0.788
	140	0.702	0.701	0.684	0.696	0.856	0.877	0.897	0.877	0.779	0.789	0.791	0.786
	Mean	**0.695**	**0.704**	**0.688**		**0.866**	**0.868**	**0.874**		**0.780**	**0.786**	**0.781**	

Comparisons:				
LSD (0.05	N-level	(A)	0.021	0.037
	Mn-level	(B)	N.S	N.S
	Appli. Methods	(C)	N.S	N.S
		AXB	N.S	N.S
		AXC	N.S	N.S
		BXC	N.S	N.S
		AXBXC	N.S	N.S

0.023
N.S
N.S
N.S
N.S
N.S
N.S

5-1-Effect of nitrogen application:

Data presented in Table (14) show that NAR was significantly affected by the application of N fertilizer. Where, it was found that applying nitrogen fertilizer at different levels increased the average NAR as compared with the control treatment. The difference between the NAR due to the application of N fertilizer at rates of 100 and 150 kg N / fed was not significant. The highest NAR (0.733 , 1.027 and 0.880 gm/gm/week) were obtained from the 100 kg N /fed. While, the lowest one (0.644 , 0.624 and 0.634 gm/gm/week) were obtained from zero nitrogen level in both seasons and combined average, respectively. This result might be attributed to the effect of N on increasing vegetative growth and photosynthetic pigments of maize plant.

This result agrees with those obtained by **Faisal (1983)** who showed that NAR was significantly increased with increasing N rates up to 120 kg N / fed.

5-2-Effect of manganese application:

Mn application did not exert any significant effect on average of NAR in both growing seasons as well as in the combined average.

5-3-Effect of manganese application methods:

Net assimilation rate was not significantly affected by the methods of Mn application. This is true in both seasons and in the combined analysis.

5-4-Interaction effects:

Data reported in the same Table indicated that NAR was not affected significantly by all the interactions between the

experimental factors.

IV- Yield components :

1-Number of ears / plant:

The results in Table (15) indicated the effect of nitrogen , manganese levels ; methods of Mn application and their interactions on number of ears maize / plants in 1997 and 1998 seasons as well as their combined average.

1-1-Effect of nitrogen application :-

Data presented in Table (15) showed that N levels significantly affected number of ears plant^{-1} in both seasons as well as in the combined average. The results cleared that applying N at 50, 100 and 150 kg / fed. increased ears number / plant over the check treatment by 38.8, 116.3 and 132.6 % in 1997 season., respectively. The corresponding increases for the same N levels in 1998 season were 32.4, 63.2 and 75.0 % respectively, being 36.2, 86.2 and 101.7 % in the combined average.

The present results indicates clearly that N reduced barreness in maize, which is observed in the check treatment, and also, increased number of two-eared in maize plants.

These results are in harmony with those obtained by **Shafshak et al. (1994a); El-Habbak (1996) and El-Moursy and Badawi (1998).**

1-2- Effect of manganese application :-

The results in the same Table (15) indicated clearly that Mn application significantly increased ears number / plant in the 2nd season as well as in the combined average.

Table 15. Effect of N,Mn levels , methods of Mn application and their intractions on number of ear/plant in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	0.53	0.50	0.45	0.49	0.65	0.68	0.63	0.65	0.59	0.59	0.54	0.57
	70	0.45	0.53	0.40	0.46	0.60	0.80	0.75	0.72	0.53	0.66	0.58	0.59
	140	0.53	0.55	0.53	0.53	0.63	0.70	0.65	0.66	0.58	0.63	0.59	0.60
	Mean	**0.50**	**0.53**	**0.46**	**0.49**	**0.63**	**0.73**	**0.68**	**0.68**	**0.56**	**0.63**	**0.57**	**0.58**
50	0	0.50	0.65	0.78	0.64	0.85	0.85	0.85	0.85	0.68	0.75	0.81	0.75
	70	0.65	0.78	0.70	0.71	0.93	0.93	0.93	0.93	0.79	0.85	0.81	0.82
	140	0.70	0.73	0.63	0.68	0.88	0.90	0.98	0.92	0.79	0.81	0.80	0.80
	Mean	**0.62**	**0.72**	**0.70**	**0.68**	**0.88**	**0.89**	**0.92**	**0.90**	**0.75**	**0.80**	**0.81**	**0.79**
100	0	1.03	1.03	1.03	1.03	1.08	1.05	1.08	1.07	1.05	1.04	1.05	1.05
	70	1.05	1.13	1.08	1.08	1.13	1.15	1.15	1.14	1.09	1.14	1.11	1.11
	140	1.10	1.05	1.03	1.06	1.10	1.15	1.15	1.13	1.10	1.10	1.09	1.10
	Mean	**1.06**	**1.07**	**1.04**	**1.06**	**1.10**	**1.12**	**1.13**	**1.11**	**1.08**	**1.09**	**1.08**	**1.08**
150	0	1.18	1.10	1.10	1.13	1.10	1.18	1.18	1.15	1.14	1.14	1.14	1.14
	70	1.18	1.23	1.10	1.17	1.20	1.15	1.20	1.18	1.19	1.19	1.15	1.18
	140	1.13	1.15	1.13	1.13	1.10	1.10	1.50	1.23	1.11	1.13	1.31	1.18
	Mean	**1.16**	**1.16**	**1.11**	**1.14**	**1.13**	**1.14**	**1.29**	**1.19**	**1.15**	**1.15**	**1.20**	**1.17**
Mnxappl.	0	0.81	0.82	0.84	0.82	0.92	0.94	0.93	0.93	0.86	0.88	0.88	0.88
	70	0.83	0.91	0.82	0.85	0.96	1.01	1.01	0.99	0.90	0.96	0.91	0.92
	140	0.86	0.87	0.83	0.85	0.93	0.96	1.07	0.99	0.89	0.92	0.95	0.92
	Mean	**0.83**	**0.87**	**0.83**		**0.94**	**0.97**	**1.00**		**0.88**	**0.92**	**0.91**	

Comparisons:

LSD (0.05	N-level	(A)	0.06	0.04	0.05
	Mn-level	(B)	N.S	0.04	0.03
	Appli. Methods	(C)	N.S	N.S	0.03
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

Applying Mn at the rate of 70 mg Mn /l. significantly increased ears number /plant by 3.65, 6.45 and 4.54 % in 1997, 1998 and the two seasons average, respectively. In fact there was no significant difference in the number of ears / plant between 70 and 140 mg Mn / l. level.

This results is in accordance with those obtained by **El-Sheikh (1998)** recorded that Mn treatment significantly increased number of ears /plant in the 1st season only. On the other hand, **Allam (1983) ; Allam and El-Naggar (1992) and Abdel-Salam et al. (1993a)** found rather similar increases though insignificant.

1-3- Effect of manganese application methods :

It is clear from the results reported in Table (15) that methods of Mn application showed a significant effect on the ears number / plant in the combined analysis of the two experimental seasons only. The highest number of ears /plant (0.92) was produced by using foliar application method.

Similar results were also reported by **El-Sheikh (1998)** found that Mn nutrient as a foliar spraying significantly increased number of ears /plant in the first season only.

1-4- Interaction effects :

It is obviously clear that neither the first order interaction nor the second order interaction between the experimental factor exert any effect on the average ears number / plant.

2- Ear length (cm):

The results in Table (16) indicated the effect of nitrogen , manganese levels ,methods of Mn application and their interactions on ear length in 1997 and 1998 seasons as well as

Table 16. Effect of N,Mn levels , methods of Mn application and their intractions on ear length (cm) in 1997 and 1998 seasons and their combined data·

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	14.7	12.3	14.5	13.8	15.3	15.0	14.2	14.9	15.0	13.7	14.4	14.3
	70	14.0	14.1	13.9	14.0	15.6	15.5	15.9	15.7	14.8	14.8	14.9	14.8
	140	13.9	14.7	13.9	14.2	14.9	14.7	14.8	14.8	14.4	14.7	14.3	14.5
	Mean	**14.2**	**13.7**	**14.1**	**14.0**	**15.3**	**15.1**	**15.0**	**15.1**	**14.7**	**14.4**	**14.5**	**14.5**
50	0	18.1	17.9	17.5	17.8	19.0	19.0	18.5	18.8	18.6	18.4	18.0	18.3
	70	17.5	18.6	17.7	17.9	19.0	19.1	18.8	19.0	18.3	18.9	18.2	18.4
	140	17.8	17.6	18.0	17.8	18.6	18.9	19.2	18.9	18.2	18.2	18.6	18.3
	Mean	**17.8**	**18.0**	**17.7**	**17.9**	**18.9**	**19.0**	**18.8**	**18.9**	**18.3**	**18.5**	**18.3**	**18.4**
100	0	20.2	21.2	20.5	20.6	20.4	20.4	19.7	20.1	20.3	20.8	20.1	20.4
	70	19.6	21.4	20.4	20.4	20.5	20.4	20.3	20.4	20.1	20.9	20.3	20.4
	140	19.3	21.0	20.5	20.3	19.0	20.3	20.5	19.9	19.1	20.7	20.5	20.1
	Mean	**19.7**	**21.2**	**20.4**	**20.5**	**19.9**	**20.4**	**20.1**	**20.1**	**19.8**	**20.8**	**20.3**	**20.3**
150	0	20.9	21.2	21.0	21.0	21.3	22.2	20.5	21.4	21.1	21.7	20.7	21.2
	70	21.9	22.2	20.7	21.6	21.6	21.8	20.9	21.4	21.7	22.0	20.8	21.5
	140	21.0	20.4	20.0	20.4	20.9	21.3	20.9	21.0	20.9	20.9	20.4	20.7
	Mean	**21.2**	**21.3**	**20.5**	**21.0**	**21.2**	**21.8**	**20.8**	**21.3**	**21.2**	**21.5**	**20.7**	**21.1**
Mnxappl.	0	18.5	18.2	18.4	18.3	19.0	19.2	18.2	18.8	18.7	18.7	18.3	18.6
	70	18.3	19.0	18.2	18.5	19.2	19.2	19.0	19.1	18.7	19.1	18.6	18.8
	140	18.0	18.4	18.1	18.2	18.3	18.8	18.8	18.7	18.2	18.6	18.5	18.4
	Mean	**18.2**	**18.5**	**18.2**		**18.8**	**19.0**	**18.7**		**18.5**	**18.8**	**18.4**	

Comparisons:

LSD (0.05	N-level	(A)	0.7	0.8	0.7
	Mn-level	(B)	N.S	0.3	N.S
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

their combined average.

2-1-Effect of nitrogen application :

Results presented in Table (16) show that nitrogen resulted a significant increase in ear length in both seasons and their combined average.

In 1997 season, increasing nitrogen levels from 0 to 50, 100 and 150 kg / fed. caused a significant increase in ear length by 27.9, 46.4 and 50 % respectively, when compared with control treatment. However , the difference between 100 and 150 kg N / fed levels was insignificant.

In 1998 season, the corresponding increases were 25.2, 33.1 and 41.1 % for the same respective N levels. Such increases in ear length over the two seasons average were 26.9, 40.0 and 45.5 %, respectively. This results is a good manifestation for the role of N as an essential element in building maize ears. The increase in ear length is mainly due to the positive effect of N on plant growth of maize which in turn is reflected on the yield component.

The present results show the role of N on yield components of maize and are in general agreement with those obtained by **Dawood et al. .(1992) Gouda et al. (1992) El-Sheikh (1993); Salwau (1993) ; Hammam (1995) and Zaghloul (1999).** On the other hand, **El-Kholy (1987)** mentioned that increasing nitrogen levels from 75 to 100 kg / fed had no significant effect on ear length.

2-2-Effect of manganese application :

The results presented in the same Table showed that Mn application at the rate of 70 mg / l. significantly increased ear

length in the 2nd only.

Applying 70 mg Mn / l. increased ear length by 2.14 % compared with the check treatment. However, there was no significant difference between zero and 140 mg Mn / l. levels.

Similar results were also obtained by **Allam and El-Naggar (1992), Abdel-Salam et al. (1993a) and El-Sheikh (1998)** who found that foliar application with Mn at rate of 72 g / fed gave the highest value of ear length compared with unspraying treatment. The non significant effect of Mn application reported by others such as **Allam (1983); El-Hattab et al. (1986).**

2-3-Effect of manganese application methods :

Regarding the Mn application methods, it did not affect the ear length significantly in both seasons as well as in the combined average. (Table 16). However, the data revealed that foliar application method gave the highest average of ear length.

Foliar application of Mn significantly increased ear length of maize plant as found by **Allam and El-Naggar (1992), Abdel-Salam et al. (1993a) and El-Sheikh (1998).**

2-4-Interaction effects :

The data reported in Table (16) indicated that the effect of interactions among all experimental factor had no significant effects on ear length in both growing seasons as well as in the combined average.

3-Ear diameter (cm) :

The results for the effect of different nitrogen, manganese levels and various methods of Mn application and their interaction on ear diameter of maize plants in 1997 and 1998

seasons as well as their combined average are presented in Table (17).

3-1- Response to nitrogen application:

Data in Table (17) show that ear diameter was significantly increased by increasing N levels up to 100 kg N / fed. This is true in both seasons as well as combined average of 1997 and 1998 seasons. However, the difference between 100 and 150 kg N / fed. was insignificant. Application of N fertilizer increased ear diameter and this may be due to increased cell division and elongation **(Thomson and Troeh, 1980)** and increased number of rows / ear. Application of 50 and 100 kg N / fed. increased ear diameter over the control treatment by 10.7 and 23.0 % in 1997 season, respectively. The corresponding increases in 1998 season, were 28.2 and 34.8 % for the respective N levels. Increases in ear diameter over the two seasons average were 19.0 and 28.8 %, respectively.

Similar results were also reported by **Gouda et al. (1992); El-Sheikh (1993); Abdel-Samie (1994); Badr et al. (1997) ; El-Moursy et al .(1998) and Nofal (1999)** she found that the increases in N levels increased markedly ear diameter. On the other hand, **El-Kholy (1987) and Lamlom (1997)** showed that ear diameter was not significant affected by various N levels.

3-2- Effect of manganese application:

It is clear from the same Table that Mn application did not exert any significant effect on the average of ear diameter in both growing seasons as well as in the combined average.

Table 17. Effect of N,Mn levels , methods of Mn application and their intractions on ear diameter (cm) in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	3.65	3.52	3.45	3.54	3.05	3.32	3.28	3.22	3.35	3.42	3.36	3.38
	70	3.58	3.85	3.67	3.70	3.22	3.21	3.22	3.21	3.40	3.53	3.45	3.46
	140	3.96	3.82	3.34	3.70	3.55	3.27	3.59	3.47	3.75	3.54	3.47	3.59
	Mean	**3.73**	**3.73**	**3.49**	**3.65**	**3.27**	**3.26**	**3.36**	**3.30**	**3.50**	**3.50**	**3.43**	**3.47**
50	0	4.15	3.07	4.05	3.75	4.36	4.36	4.11	4.28	4.25	3.72	4.08	4.02
	70	4.13	4.37	4.29	4.26	4.22	4.50	3.94	4.22	4.17	4.43	4.12	4.24
	140	4.09	4.02	4.20	4.10	3.82	4.31	4.42	4.18	3.95	4.16	4.31	4.14
	Mean	**4.12**	**3.82**	**4.18**	**4.04**	**4.13**	**4.39**	**4.15**	**4.23**	**4.13**	**4.10**	**4.17**	**4.13**
100	0	4.50	4.61	4.48	4.53	4.57	4.61	4.25	4.47	4.53	4.61	4.37	4.50
	70	4.35	4.64	4.52	4.51	4.59	4.45	4.50	4.51	4.47	4.55	4.51	4.51
	140	4.27	4.55	4.50	4.44	4.43	4.46	4.21	4.37	4.35	4.51	4.36	4.41
	Mean	**4.37**	**4.60**	**4.50**	**4.49**	**4.53**	**4.51**	**4.32**	**4.45**	**4.45**	**4.55**	**4.41**	**4.47**
150	0	4.66	4.59	4.47	4.58	4.61	4.50	4.49	4.54	4.64	4.55	4.48	4.56
	70	4.88	4.76	4.74	4.79	4.53	4.51	4.52	4.52	4.71	4.63	4.63	4.66
	140	4.42	4.39	4.33	4.38	4.45	4.54	4.27	4.42	4.43	4.46	4.30	4.40
	Mean	**4.65**	**4.58**	**4.51**	**4.58**	**4.53**	**4.52**	**4.43**	**4.49**	**4.59**	**4.55**	**4.47**	**4.54**
Mnxappl	0	4.24	3.95	4.11	4.10	4.15	4.20	4.03	4.13	4.19	4.07	4.07	4.11
	70	4.23	4.40	4.31	4.31	4.14	4.17	4.05	4.12	4.19	4.28	4.18	4.22
	140	4.18	4.19	4.09	4.16	4.06	4.14	4.12	4.11	4.12	4.17	4.11	4.13
	Mean	**4.22**	**4.18**	**4.17**		**4.12**	**4.17**	**4.07**		**4.17**	**4.17**	**4.12**	

Comparisons:

LSD (0.05	N-level	(A)	0.17	0.24	0.23
	Mn-level	(B)	N.S	N.S	N.S
	Appli.methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

3-3- Effect of manganese application methods:

It is obviously clear that the methods of Mn application did not exhibit any difference in the average ear diameter in the 1^{st} ,2^{nd} seasons and combined analysis of two seasons.

3-4- Interaction effects:

All interactions between the experimental factors were not significant on ear diameter in both seasons as well as in the combined average.

4-Number of rows / ear:

The results in Table (18) showed the effect of nitrogen , manganese levels, Mn application methods and their interactions on number of rows /ear in 1997 and 1998 seasons as well as their combined average.

4-1-Effect of nitrogen application :

The results in Table (18) indicated that a significant effect of N application on number of rows / ear in both growing seasons as well as in the combined average.

In 1997season, applying N at 50 , 100 and 150 kg N / fed significantly increased number of rows / ear by 6.03 , 11.20 and 13.79 % compared with the control, respectively. The.increases in 1998 season for the same N levels were 18.75 , 25.89 and 33.04 % , being 12 28 , 18.42 and 23.68 % in the combined average, respectively.

It could be concluded that nitrogen application favorably affected number of rows /ear due to the role of N in grain formation and plant growth.

The results obtained by **Salwau (1993); Badawi and**

Table 18. Effect of N,Mn levels , methods of Mn application and their intractions on number of row/ear in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	11.4	11.4	11.7	11.5	10.9	11.0	11.2	11.0	11.1	11.2	11.4	11.2
	70	11.5	11.8	11.8	11.7	12.0	11.9	11.0	11.6	11.7	11.9	11.4	11.7
	140	11.6	11.5	11.8	11.6	11.0	10.7	10.9	10.9	11.3	11.1	11.4	11.2
	Mean	**11.5**	**11.6**	**11.8**	**11.6**	**11.3**	**11.2**	**11.0**	**11.2**	**11.4**	**11.4**	**11.4**	**11.4**
50	0	11.7	12.2	12.1	12.0	12.2	12.6	13.0	12.6	11.9	12.4	12.5	12.3
	70	12.2	12.8	12.7	12.6	14.2	14.7	14.3	14.4	13.2	13.7	13.5	13.5
	140	12.9	11.9	12.2	12.3	13.2	13.0	12.4	12.9	13.0	12.4	12.3	12.6
	Mean	**12.3**	**12.3**	**12.3**	**12.3**	**13.2**	**13.4**	**13.2**	**13.3**	**12.7**	**12.9**	**12.8**	**12.8**
100	0	12.8	12.8	12.8	12.8	13.5	14.1	13.7	13.8	13.1	13.5	13.2	13.3
	70	12.7	13.0	13.3	13.0	14.9	14.9	14.6	14.8	13.8	13.9	13.9	13.9
	140	12.6	13.5	12.7	12.9	14.5	13.7	13.5	13.9	13.5	13.6	13.1	13.4
	Mean	**12.7**	**13.1**	**12.9**	**12.9**	**14.3**	**14.2**	**13.9**	**14.1**	**13.5**	**13.6**	**13.4**	**13.5**
150	0	13.3	13.0	13.0	13.1	14.3	14.8	15.2	14.8	13.8	13.9	14.1	13.9
	70	13.7	13.5	13.4	13.5	16.0	16.1	15.2	15.8	14.9	14.8	14.3	14.6
	140	13.0	12.7	13.1	12.9	14.3	14.0	14.5	14.3	13.6	13.3	13.8	13.6
	Mean	**13.3**	**13.1**	**13.1**	**13.2**	**14.9**	**15.0**	**15.0**	**14.9**	**14.1**	**14.0**	**14.0**	**14.1**
Mnxappl.	0	12.3	12.3	12.4	12.3	12.7	13.1	13.3	13.0	12.5	12.7	12.8	12.7
	70	12.5	12.8	12.8	12.7	14.3	14.4	13.8	14.1	13.4	13.6	13.3	13.4
	140	12.5	12.4	12.4	12.4	13.2	12.8	12.8	13.0	12.9	12.6	12.6	12.7
	Mean	**12.4**	**12.5**	**12.5**		**13.4**	**13.4**	**13.3**		**12.9**	**13.0**	**12.9**	

Comparisons:

LSD (0.05	N-level	(A)	0.7	0.2	0.5
	Mn-level	(B)	N.S	0.2	0.2
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

Moursy (1997) and Badr et al. (1997) who found that adding 45 – 135 kg N / fed significantly increased number of rows / ear. On the other hand, **Abdrabou (1996) and El-Habbak (1996)** who noticed that N fertilizer levels had no significant effect on number of rows / ear.

4-2-Effect of manganese application:

Data presented in Table (18) show that increasing Mn concentration up to 70 mg Mn /l. resulted a significant increase in number of rows / ear. Increasing the concentration up to 140 mg / l. caused a reduction in number of rows / ear. This is true in the 2nd season and in the combined average. Increases in this trait in 1st season were also observed but were far below the level of significant. The maximum average (12.7 , 14.1 and 13.4) were obtained from 70 mg Mn / l.

Opposite results were obtained by **Allam and El-Naggar (1992)** they indicated that number of rows /ear was not affected by application of Mn.

4-3-Effect of manganese application methods:

It is clear from the same Table that there were no appreciable significant difference in the number of rows / ear by using the other different application methods of Mn nutrient in both growing seasons as well as in the combined average.

4-4-Interaction effects:

Number of rows /ear was not affected by the interactions between all experimental factors in both seasons as well as in the combined analysis.

5-Number of kernels / row :

The results in Table (19) indicated the effect of nitrogen ,

Table 19. Effect of N,Mn levels methods of Mn application and their intractions on number of kernels/row in 1997 and 1998 seasons and their combined data

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	31.2	29.2	31.6	30.7	31.0	31.0	30.6	30.8	31.1	30.1	31.1	30.8
	70	29.9	31.2	32.1	31.1	31.4	32.2	31.3	31.6	30.7	31.7	31.7	31.3
	140	32.7	32.5	28.9	31.4	30.6	32.0	30.7	31.1	31.7	32.2	29.8	31.2
	Mean	**31.3**	**31.0**	**30.9**	**31.0**	**31.0**	**31.7**	**30.9**	**31.2**	**31.1**	**31.3**	**30.9**	**31.1**
50	0	39.7	40.9	39.5	40.0	40.8	40.7	41.7	41.1	40.3	40.8	40.6	40.5
	70	37.1	42.4	36.8	38.8	41.1	43.6	40.4	41.7	39.1	43.0	38.6	40.2
	140	40.6	40.5	40.1	40.4	41.5	42.5	40.4	41.5	41.0	41.5	40.3	40.9
	Mean	**39.1**	**41.2**	**38.8**	**39.7**	**41.1**	**42.3**	**40.8**	**41.4**	**40.1**	**41.7**	**39.8**	**40.6**
100	0	40.9	35.7	45.0	40.5	44.9	43.7	44.4	44.3	42.9	39.7	44.7	42.4
	70	44.0	45.5	44.7	44.7	45.2	45.2	42.6	44.3	44.6	45.3	43.6	44.5
	140	42.3	44.9	44.2	43.8	42.1	42.0	43.9	42.6	42.2	43.4	44.0	43.2
	Mean	**42.4**	**42.0**	**44.6**	**43.0**	**44.1**	**43.6**	**43.6**	**43.7**	**43.2**	**42.8**	**44.1**	**43.4**
150	0	43.7	46.1	50.6	46.8	46.2	46.2	44.6	45.7	44.9	46.1	47.6	46.2
	70	47.1	49.8	47.9	48.3	44.9	46.3	44.3	45.2	46.0	48.0	46.1	46.7
	140	46.5	44.6	43.8	45.0	43.8	42.8	45.8	44.1	45.2	43.7	44.8	44.5
	Mean	**45.8**	**46.8**	**47.4**	**46.7**	**45.0**	**45.1**	**44.9**	**45.0**	**45.4**	**45.9**	**46.2**	**45.8**
Mnxappl.	0	38.9	38.0	41.7	39.5	40.7	40.4	40.2	40.5	39.8	39.2	41.0	40.0
	70	39.6	42.2	40.4	40.7	40.6	41.8	39.6	40.7	40.1	42.0	40.0	40.7
	140	40.5	40.6	39.3	40.1	39.5	39.8	40.2	39.8	40.0	40.2	39.7	40.0
	Mean	**39.6**	**40.3**	**40.4**		**40.3**	**40.7**	**40.0**		**40.0**	**40.5**	**40.2**	

Comparisons:

LSD (0.05	N-level	(A)	2.0	1.4	1.4
	Mn-level	(B)	N.S	N.S	N.S
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

manganese levels ,methods of Mn application and their interactions on number of kernels / row in 1997 and 1998 seasons as well as their combined average.

5-1-Effect of nitrogen application:

The results in Table (19) show clearly that N application significantly affected number of kernels / row in both seasons as well as in the combined average . The results indicated that in 1997 season, the highest average (46.7 kernels) was obtained at the highest N level (150 kg /fed.) whereas the lowest average (31.0 kernels) was obtained at the unfertilized treatment (zero level). In the 2nd season as well as the combined average , number of kernels row^{-1} responded to N fertilization in similar manner. Application of N fertilizer increased number of kernels row^{-1} and this may be due to N increased ear length, the pollination and fertilization of maize plants .

It could be concluded that N fertilization enhanced tasseling and silking dates and increased photosynthetic and dry matter content (Table 19).

These results agree with those obtained by **Gouda et al .(1992); Salwau (1993); Abdel-Samie (1994); and Badr et al.(1997)** who indicated that adding 90 – 135 kg N /fed significantly increased number of kernels / row. On the other hand, **El-Habbak (1996)** using the N rates of 90 , 110 and 130 kg N /fed and demonstrated that N addition had no significant effect on number of kernels / row.

5-2- Response to manganese application:

It is clear from the same Table that number of kernels / row was not significantly affected by the applied Mn nutrient in

the two successive seasons as well as in the combined average.

This result is agreement with those reported by **Allam (1983)** who found that number of kernels / row did not respond significantly to applied Mn nutrient. On the other hand, **El-Sheikh (1998)** found that increase in number of kernels / row due to spraying 72 g Mn / fed over the unsprayed treatment was 7.1 %.

5-3- Effect of manganese application methods :

It is obviously clear that there were no appreciable significant difference in number of kernels / row by using the other different Mn application methods in 1st,2nd and in the combined average.

5-4- Interaction effects :

The results presented in Table (19) indicated that all interactions between the experimental factors had no significant effects on number of kernels / row in 1997, 1998 seasons and in the combined average.

6-Ear weight (g):

The results in Table (20) showed the effect of nitrogen , manganese levels, methods of Mn application and their interactions on ear weight in 1997 and 1998 seasons as well as their combined average.

6-1-Effect of nitrogen application:

Application of N rates up to 150 kg / fed significantly increased ear weight in 1997, 1998 and the combined average (Table 20). Increases in ear weight over the control treatment in the 1st season reached 92.4, 103.0 and 109.4 g at 50, 100 and 150 kg N / fed., respectively. In the 2nd season the respective

Table 20. Effect of N,Mn levels , methods of Mn application and their intractions on ear weight (g) in 1997 and 1998 seasons and their combined data .

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr.	Mean
None	0	109.2	108.3	107.4	108.3	110.8	96.3	117.3	108.1	110.0	102.3	112.3	108.2
	70	116.8	115.8	110.3	114.3	107.3	103.5	111.5	107.4	112.0	109.7	110.9	110.8
	140	107.3	106.2	115.6	109.7	106.5	110.9	112.3	109.9	106.9	108.6	113.9	109.8
	Mean	**111.1**	**110.1**	**111.1**	**110.8**	**108.2**	**103.6**	**113.7**	**108.5**	**109.6**	**106.8**	**112.4**	**109.6**
50	0	201.7	206.3	199.9	202.6	219.1	207.0	191.3	205.8	210.4	206.6	195.6	204.2
	70	206.9	211.3	201.8	206.6	188.6	223.8	184.2	198.8	197.7	217.5	193.0	202.7
	140	198.7	197.2	205.2	200.4	209.2	198.2	184.0	197.1	204.0	197.7	194.6	198.8
	Mean	**202.4**	**204.9**	**202.3**	**203.2**	**205.6**	**209.7**	**186.5**	**200.6**	**204.0**	**207.3**	**194.4**	**201.9**
100	0	207.8	207.6	206.6	207.3	234.9	240.0	234.4	236.4	221.4	223.8	220.5	221.9
	70	223.3	223.9	215.9	221.0	232.9	243.0	241.1	239.0	228.1	233.5	228.5	230.0
	140	206.3	219.6	213.0	213.0	210.2	236.0	222.6	222.9	208.3	227.8	217.8	217.9
	Mean	**212.5**	**217.0**	**211.8**	**213.8**	**226.0**	**239.7**	**232.7**	**232.8**	**219.2**	**228.3**	**222.3**	**223.3**
150	0	229.9	228.0	217.1	225.0	248.0	246.4	242.9	245.8	239.0	237.2	230.0	235.4
	70	219.6	220.0	220.9	220.2	266.6	269.6	243.4	259.8	243.1	244.8	232.1	240.0
	140	214.3	222.9	209.0	215.4	252.0	231.8	231.2	238.3	233.2	227.3	220.1	226.8
	Mean	**221.3**	**223.6**	**215.6**	**220.2**	**255.5**	**249.2**	**239.1**	**248.0**	**238.4**	**236.4**	**227.4**	**234.1**
Mnxappl.	0	187.2	187.5	182.7	185.8	203.2	197.4	196.5	199.0	195.2	192.5	189.6	192.4
	70	191.6	192.7	187.2	190.5	198.8	210.0	195.0	201.3	195.2	201.4	191.1	195.9
	140	181.7	186.5	185.7	184.6	194.5	194.2	187.5	192.1	188.1	190.3	186.6	188.3
	Mean	**186.8**	**188.9**	**185.2**		**198.8**	**200.5**	**193.0**		**192.8**	**194.7**	**189.1**	

Comparisons:					
LSD (0.05	N-level	(A)	6.77	7.08	4.55
	Mn-level	(B)	2.76	6.09	3.41
	Appli. Methods	(C)	2.76	6.09	3.41
		AXB	5.52	N.S	6.83
		AXC	N.S	13.78	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

increases in this trait were 92.1 ,124.3 and 139.5 g . being 92.3 , 113.7 and 124.5 g in the average of two seasons. The accumulation of synthesized metebolites resulted in a high dry matter accumulation and finally high ear weight. This results may be due to increase in plant growth, dry matter content, ear length, ear diameter, number of row /ear, number of kernels / row and 100- grain weight.

The positive effect of nitrogen fertilizer on ear weight of maize was reported by many investigators such as **Shafshak et al. (1994a); Hammam (1995); Badr et al. (1997); Oikeh et al. (1998); Nofal (1999) and Zaghloul (1999)** who found that ear weight significantly increased with increasing N rates up to 150 kg / fed. On the other hand, **El-Habbak (1996)** indicated that nitrogen fertilizer had no significant effect on the ear weight.

6-2- Effect of manganese application:

Data presented in Table (20) show that increasing Mn nutrient rates up to 70 mg / l. resulted a significant increase in ear weight. Increasing the concentration up to 140 mg Mn / l. caused a reduction in ear weight due to the poisonous effect of the high concentration .The maximum average of ear weight 190.5, 201.3 and 195.9 g were obtained from 70 mg Mn / l. in 1997, 1998 and in the combined average, respectively. While, the minimum average were obtained from 140 mg Mn / l.

It could be concluded that Mn nutrient showed in general a positive effect on ear weight due to the important role of Mn in cell division , N metabolism and activation of enzymes in growth plant (**Marschner, 1995**).

Similar results were also reported by **Allam and El-**

Naggar (1992) and El-Sheikh (1998) who stated that increases in ear weight due to spraying 72 g Mn/fed were 10.7 %. On the other hand, **Allam (1983)** noticed that ear weight was not affected by Mn nutrient.

6-3- Effect of manganese application methods:

The average values shown in Table (20) indicated that methods of Mn application showed a significant effect on ear weight in both seasons as well as in combined average of two seasons.

Foliar application of Mn increased markedly and significant ear weight. The highest values of ear weight (188.9, 200.5 and 194.7 g) were obtained from foliar application method in 1st , 2nd seasons and combined average, respectively.

This result is in accordance with those obtained by **Allam and El-Naggar (1992) and El-Sheikh (1998)** who found that foliar application of Mn nutrient significantly increased ear weight. On the other hand, **Allam (1983)** noticed that ear weight was not affected by Mn nutrient as foliar application method.

6-4 Interaction effects:

The ear weight was affected significantly by the interaction between N and Mn levels in 1st season as well as in the combined average (Table 20). The highest value of ear weight (225.09 g) was obtained under the check Mn treatment (zero level) and 150 kg N/fed and the lowest one (108.39 g) was obtained from zero N + zero Mn level in 1997 season. But the highest value of ear weight was obtained by combined treatment of 150 kg N / fed + 70 mg Mn / l. Whereas, the lowest one resulted from the application of zero N + zero Mn in the

combined average. Also, the ear weight was significantly affected by the interaction between Mn rates and methods of Mn application in 2nd season. The highest average of ear weight was obtained from grain soaking method + 150 kg N/fed treatment.

Similar results were also reported by **El-Sheikh (1998)** who found that the interaction between N x Mn was significant and the highest values of ear weight produced by combining 120 or 160 kg N /fed where Mn was 36 or 72 g / fed.

7-Grain yield / ear (g) :

The results in Table (21) indicated the effects of nitrogen , manganese levels, methods of Mn application and their interactions on grain yield / ear of maize plants in 1997 and 1998 seasons as well as their combined average.

7-1- Effect of nitrogen application:

Application of 50, 100 and 150 kg N / fed. significantly increased grain yield / ear over the control treatment by 85.1,99.3 and 105.8 g in 1997 season , respectively. The corresponding increases for the same N levels in 1998 season were 83.1, 115.0 and 133.5 g respectively. Being 84.1, 107.2 and 119.6 g in the combined average (Table 21). Application of 150 kg N / fed. significantly increased grain yield / ear compared with the other N levels in both seasons. These results may be attributed to the increase in plant growth, number of rows / ear, number of kernels / row, ear weight and 100- kernel weight.

Results reported by **(Gouda et al 1992; El-Sheikh 1993;Salwau 1993; Abdel-Samie 1994; Shafshak et al. 1994a and Badr et al. 1997)** reported that grain yield / ear significantly increased by increasing nitrogen rates up to 120 – 150 kg / fed.

Table 21. Effect of N,Mn levels , methods of Mn application and their intractions on grain yield /ear (g) in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application			Mean	Methods of Mn-application			Mean	Methods of Mn-application			Mean
		soaking	spraying	soa.+spr		soaking	spraying	soa.+spr		soaking	spraying	soa.+spr	
None	0	76.8	71.6	71.2	73.2	81.6	69.8	83.0	78.2	79.2	70.7	77.1	75.7
	70	83.3	86.9	82.7	84.3	78.3	75.2	81.4	78.3	80.8	81.1	82.0	81.3
	140	76.7	81.6	84.9	81.1	77.1	81.4	80.9	79.8	76.9	81.5	82.9	80.4
	Mean	**78.9**	**80.0**	**79.6**	**79.5**	**79.0**	**75.5**	**81.8**	**78.7**	**78.9**	**77.8**	**80.7**	**79.1**
50	0	165.6	170.1	163.1	166.2	167.4	161.4	147.5	158.8	166.5	165.8	155.3	162.5
	70	165.5	168.5	160.0	164.6	149.2	186.5	152.3	162.7	157.3	177.5	156.1	163.6
	140	163.4	161.0	164.1	162.8	174.3	165.5	151.9	163.9	168.8	163.2	158.0	163.3
	Mean	**164.8**	**166.5**	**162.4**	**164.6**	**163.6**	**171.1**	**150.6**	**161.8**	**164.2**	**168.8**	**156.5**	**163.2**
100	0	174.8	174.7	178.4	176.0	191.9	198.6	192.9	194.5	183.4	186.6	185.6	185.2
	70	183.4	185.5	180.5	183.1	196.7	206.6	201.5	201.6	190.0	196.1	191.0	192.4
	140	175.1	179.2	177.4	177.2	174.8	196.8	183.9	185.2	174.9	188.0	180.6	181.2
	Mean	**177.8**	**179.8**	**178.7**	**178.8**	**187.8**	**200.7**	**192.8**	**193.7**	**182.8**	**190.2**	**185.7**	**186.3**
150	0	192.3	190.0	182.4	188.2	213.7	213.9	209.6	212.4	203.0	201.9	196.0	200.3
	70	184.0	185.1	189.9	186.3	230.9	231.6	203.6	222.0	207.4	208.3	196.7	204.2
	140	181.3	182.1	180.4	181.3	216.1	196.1	194.0	202.1	198.7	189.1	187.2	191.7
	Mean	**185.8**	**185.7**	**184.2**	**185.3**	**220.2**	**213.9**	**202.4**	**212.2**	**203.0**	**199.8**	**193.3**	**198.7**
Mnxappl.	0	152.4	151.6	148.7	150.9	163.7	160.9	158.2	160.9	158.0	156.3	153.5	155.9
	70	154.0	156.5	153.2	154.6	163.7	175.0	159.7	166.1	158.9	165.7	156.5	160.4
	140	149.1	151.0	151.7	150.6	160.6	159.9	152.7	157.7	154.8	155.5	152.2	154.1
	Mean	**151.8**	**153.0**	**151.2**		**162.7**	**165.3**	**156.9**		**157.2**	**159.1**	**154.0**	

Comparisons:					
LSD (0.05	N-level	(A)	5.7	6.8	4.1
	Mn-level	(B)	2.4	5.2	2.9
	Appli. Methods	(C)	N.S	5.2	2.9
		AXB	5.5	N.S	N.S
		AXC	N.S	10.5	5.9
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

7-2- Response to manganese application:

It is evident from the Table (21) that Mn application at the rate of 70 mg / l. significantly increased grain yield / ear. While, a further increase up to 140 mg / l. decreased it. However, there was no significant difference between zero and 140 mg Mn / l. levels.

Adding 70 mg Mn / l. increased grain yield / ear by 2.45, 3.23 and 2.88 % compared with tap water treatment in the 1st, 2nd seasons and in the combined analysis of two growing seasons, respectively. This result is expected since Mn increase the plant growth, number of rows / ear, 100- grain weight and ear weight.

Results reported by **Allam and El-Naggar (1992)** showed that foliar application of Mn significantly increased weight of grains / ear. Also, **El-Shiekh (1998)** demonstrated that increases in kernels weight /ear due to spraying 72 g /fed was 11.4 %.

7-3- Effect of manganese application methods:

Data in Table (21) show that in the second season and in the combined average grain yield /ear significantly increased due to using foliar application method with Mn. While, methods of Mn application did not exert any significant effect on the average of grain yield / ear in the 1st season and there was no significant difference between grain soaking and foliar application with Mn in the 1998 season as well as in the combined average. The highest average (153.0, 165.3 and 159.1 g) were obtained when used foliar application method in 1997, 1998 seasons and combined average.

Similar results were also found by , **El-Sheikh (1998).**

7-4- Interaction effects:

Results in Table (21) indicated that all interactions between the experimental factors had no significant effect on grain yield / ear, except the interaction between N and Mn in 1997 season . Also, between N and method of Mn application in 1998 season and in the combined average which excreted a significant effect on this trait. The results showed that highest grain yield /ear (188.2 g) was achieved by combining 150 kg N / fed + zero Mn levels and the lowest average were obtained from zero N + zero Mn levels in 1997 season. Also, the highest grain yield / ear was obtained by combining 150 kg N /fed + grain soaking in the 2nd season and combined average.

Results reported by **El-Sheikh (1998)** who found that the interaction between N x Mn was significant and the highest values of kernel weight / ear (g) produced by combining 120 or 160 kg N / fed where Mn was 36 or 72 g / fed.

8-100- kernel weight (g):

The results in Table (22) indicated the effect of nitrogen , manganese levels, methods of Mn application and their interaction on 100-kernel weight in 1997 and 1998 seasons as well as their combined average.

8-1- Effect of nitrogen application:

Data on the 100- kernel weight of maize as affected by N fertilizer levels in 1997, 1998 seasons as well as combined average are shown in Table (22). Nitrogen fertilizer treatments significantly increased 100- kernel weight in both seasons and their combined data. The higher N level (150 kg N / fed.) was

Table 22. Effect of N,Mn levels , methods of Mn application and their intractions on 100-kernel weight (g) in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	23.2	22.8	24.3	23.4	23.5	24.2	24.5	24.1	23.3	23.5	24.4	23.7
	70	24.1	25.3	23.2	24.2	24.1	25.5	25.1	24.9	24.1	25.4	24.1	24.5
	140	22.2	22.7	21.6	22.2	24.6	23.7	23.1	23.8	23.4	23.2	22.3	23.0
	Mean	**23.1**	**23.6**	**23.0**	**23.2**	**24.1**	**24.5**	**24.2**	**24.3**	**23.6**	**24.0**	**23.6**	**23.7**
50	0	24.7	25.7	25.8	25.4	26.3	29.8	26.0	27.4	25.5	27.7	25.9	26.4
	70	28.1	27.9	27.9	28.0	29.3	29.6	27.6	28.9	28.7	28.8	27.8	28.4
	140	27.1	27.4	27.1	27.2	28.6	28.2	27.2	28.0	27.9	27.8	27.2	27.6
	Mean	**26.6**	**27.0**	**26.9**	**26.8**	**28.1**	**29.2**	**27.0**	**28.1**	**27.3**	**28.1**	**26.9**	**27.5**
100	0	29.7	30.7	29.8	30.1	31.4	29.7	30.1	30.4	30.6	30.2	29.9	30.2
	70	31.7	32.4	30.6	31.6	32.2	33.0	31.2	32.1	32.0	32.7	30.9	31.8
	140	29.9	30.7	29.3	30.0	30.3	31.7	30.3	30.8	30.1	31.2	29.8	30.4
	Mean	**30.4**	**31.3**	**29.9**	**30.5**	**31.3**	**31.5**	**30.5**	**31.1**	**30.9**	**31.4**	**30.2**	**30.8**
150	0	33.5	34.0	32.6	33.4	32.6	34.8	33.1	33.5	33.0	34.4	32.8	33.4
	70	34.8	34.2	33.4	34.1	31.7	34.7	34.9	33.8	33.2	34.4	34.2	33.9
	140	33.2	32.9	31.3	32.5	33.7	32.8	33.7	33.4	33.5	32.9	32.5	32.9
	Mean	**33.8**	**33.7**	**32.4**	**33.3**	**32.7**	**34.1**	**33.9**	**33.6**	**33.2**	**33.9**	**33.2**	**33.4**
Mnxappl.	0	27.8	28.3	28.1	28.0	28.4	29.6	28.4	28.8	28.1	28.9	28.3	28.4
	70	29.7	29.9	28.7	29.4	29.3	30.7	29.7	29.9	29.5	30.3	29.2	29.7
	140	28.1	28.4	27.3	28.0	29.3	29.1	28.6	29.0	28.7	28.8	27.9	28.5
	Mean	**28.5**	**28.9**	**28.1**		**29.0**	**29.8**	**28.9**		**28.8**	**29.3**	**28.5**	

Comparisons:

LSD (0.05	N-level	(A)	1.1	1.4	1.3
	Mn-level	(B)	0.5	0.6	0.6
	Appli. Methods	(C)	0.5	0.6	0.6
		AXB	0.9	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

more effective increasing this character. Applying 50, 100 and 150 kg /fed. increased 100- kernel weight over the unfertilized treatment by 3.6 , 7.3 and 10.1 g in 1997 season and by 3.8 , 6.8 and 9.3 g in 1998 season, respectively. Similarly, the combined average increased that N at 50, 100 and 150 kg N / fed. increased 100- kernel weight by 3.8, 7.1 and 9.7 g, respectively. The present results indicate clear that N application induced an increase in grain plumbness of maize showing the major role of this vital nutritive element. The increase in N application encourages the metabolic efficiency which is consumed in grain filling.

Similar results were reported by **Lamlom (1997); El-Moursy et al. (1998) ; Nofal (1999) and Zaghluol (1999)** who found that 100- kernel weight significantly increased with increasing N fertilizer levels up to 150 kg / fed. On the other hand, **El-Habbak(1996)** reported that 100-kernel weight was not affected by varying N application rates.

8-2- Effect of manganese application:

Manganese nutrient increased significantly the 100-kernel weight at the rate of 70 mg Mn / l.Table (22). While, increasing Mn level up to 140 mg Mn / l. resulted a decrease in 100- kernel weight. This is true in the 1st, 2nd seasons as well as combined average . However, There was no significant difference between zero and 140mg Mn / l . Higher concentration of Mn (140 mg Mn / l.) may cause a poisonous effect on 100-kernel weight. The highest average of 100- kernel weight were 29.4, 29.9 and 29.7 g in 1997, 1998 seasons and combined average, respectively.

Similar results were also found by **Ghaly et al. (1991), Ashoub et al. (1998) and El-Sheikh (1998).** On the other hand, **Allam (1983) and El-Hattab et al. (1986)** they indicated that 100- grain weight was insignificantly affected by Mn nutrient.

8-3- Effect of Mn application methods:

Methods of Mn application showed a significant effect on the 100- kernel weight in both seasons as well as in the combined analysis (Table 22). The highest average (28.9,29.8 and 29.3 g) were obtained when used foliar application method in 1997, 1998 seasons and combined average.

8-4- Interaction effects:

Regarding the interactions between the experimental factors (Table 22), it did not affect on the 100- kernel weight significantly except the interaction between N x Mn levels in first season only. The highest values of 100- kernel weight (34.1g) produced by applying the highest rate of N fertilize (150 kg N / fed) + 70 mg Mn / l.

Similar results were reported by **El-Sheikh (1998)** who found that the interaction between N x Mn was significant and the highest values of 100- kernel weight produced by combining 120 or 160 kg N / fed where Mn was 36 or 72 g / fed.

9-Shelling percentage :

The results in Table (23) indicated the effect of nitrogen , manganese levels , Mn application methods and their interactions on shelling % in 1997 and 1998 seasons as well as their combined average.

9-1-Effect of nitrogen application:

The results in Table (23) indicated that increases in N

Table 23. Effect of N,Mn levels ,methods of Mn application and their intractions on shelling percentage in 1997 and 1998 seasons and their combined data .

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	70.3	66.4	66.3	67.7	73.7	72.5	70.8	72.3	72.0	69.4	68.5	70.0
	70	71.2	75.0	75.0	73.7	73.0	72.8	73.0	72.9	72.1	73.9	74.0	73.3
	140	71.3	77.0	73.4	73.9	72.4	73.4	72.0	72.6	71.9	75.2	72.7	73.2
	Mean	**71.0**	**72.8**	**71.6**	**71.8**	**73.0**	**72.9**	**71.9**	**72.6**	**72.0**	**72.8**	**71.8**	**72.2**
50	0	82.1	82.5	81.5	82.0	76.3	78.0	77.1	77.1	79.2	80.2	79.3	79.6
	70	79.9	79.7	79.4	79.7	79.0	83.3	82.7	81.7	79.5	81.5	81.0	80.7
	140	82.2	81.6	79.9	81.2	83.3	83.6	82.5	83.1	82.8	82.6	81.2	82.2
	Mean	**81.4**	**81.3**	**80.3**	**81.0**	**79.5**	**81.6**	**80.8**	**80.6**	**80.5**	**81.4**	**80.5**	**80.8**
100	0	84.1	84.1	86.4	84.9	81.7	82.8	82.3	82.3	82.9	83.4	84.4	83.6
	70	82.1	82.9	83.7	82.9	84.5	85.1	83.6	84.4	83.3	84.0	83.6	83.6
	140	84.8	81.6	83.3	83.2	83.2	83.5	82.6	83.1	84.0	82.5	83.0	83.2
	Mean	**83.7**	**82.8**	**84.5**	**83.7**	**83.1**	**83.8**	**82.8**	**83.2**	**83.4**	**83.3**	**83.6**	**83.4**
150	0	83.6	83.4	84.0	83.7	86.2	86.8	86.3	86.4	84.9	85.1	85.2	85.1
	70	83.8	84.2	86.0	84.7	86.6	85.9	83.7	85.4	85.2	85.0	84.8	85.0
	140	84.7	81.7	86.5	84.3	85.8	84.6	83.9	84.7	85.3	83.2	85.2	84.5
	Mean	**84.1**	**83.1**	**85.5**	**84.2**	**86.2**	**85.8**	**84.6**	**85.5**	**85.1**	**84.4**	**85.1**	**84.9**
Mnxappl.	0	80.0	79.1	79.6	79.6	79.5	80.0	79.1	79.5	79.7	79.5	79.3	79.5
	70	79.3	80.4	81.0	80.2	80.8	81.8	80.7	81.1	80.0	81.1	80.9	80.7
	140	80.8	80.5	80.8	80.7	81.2	81.2	80.3	80.9	81.0	80.8	80.5	80.8
	Mean	**80.0**	**80.0**	**80.5**		**80.5**	**81.0**	**80.0**		**80.2**	**80.5**	**80.2**	

Comparisons:					
LSD (0.05	N-level	(A)	2.8	1.2	1.4
	Mn-level	(B)	N.S	0.7	0.7
	Appli. Methods	(C)	N.S	0.7	N.S
		AXB	2.6	1.4	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

level significantly increased shelling % in both seasons and their combined average.

The results showed that all levels of nitrogen induced a significant increases in shelling %, but no significant difference could be detected among the 100 and 150 kg N / fed levels in the first season only. The highest shelling % was recorded at the highest N level, being 84.2 , 85.1 and 84.9 % in 1997 , 1998 and the combined average, respectively.

It could be concluded that N markedly increased shelling % and a good supply of nitrogen could increase this trait due to the effect of N on grain formation .

Similar results were also obtained by **Salwau (1993); Shafshak et al. (1994a) ; Hammam (1995) and Zaghluol (1999).**

9-2-Effect of manganese application:

The results in Table (23) indicated that applying Mn at 70 mg / l induced an increase in shelling percentage. This increase was significant in the 2nd season as well as in the combined average, but was far below the level of significant in the 1st season.

The results indicated that the application of 70 mg Mn / l. produced a shelling percentage of 80.2 , 81.1 and 80.7 % in the 1997 , 1998 and the combined average, respectively.

It could be concluded that Mn application positively affected shelling percentage.

Opposite results were reported by **Ghaly et al. (1991); Allam and El-Naggar (1992) and Abdel-Salam et al. (1993a)**

they found that Mn nutrient had no significant effect on shelling %. The contradiction between such results could be due to the differences in genetically constitution of the studied varieties.

9-3-Effect of manganese application methods:

Foliar application of Mn significantly increased shelling % in the second season only (Table 23). Foliar application produced a highest average (81.0 %) in 1998 season. However, the difference between other methods were not significant.

9-4-Interaction effects:

All interactions between the experimental factors were not significant on shelling % in both seasons and the combined average with one exception for the interaction between N and Mn levels which showed significant effect in first and second seasons.

The results showed that highest shelling percentage (84.7 %) was achieved by combining 150 kg N / fed + 70 mg Mn / l in 1997 season and (86.4 %) was achieved by combining 150 kg N / fed +zero level of Mn in 1998 season. While, the lowest average were obtained from zero N + zero Mn levels in both seasons.

10- Grain yield / plant (g):

The effect of nitrogen, manganese levels , methods of Mn application and their interactions on grain yield / plant in 1997 and 1998 seasons as well as their combined average are presented in (Table 24).

10-1- Effect of nitrogen application:

Data in Table (24) indicated that the mean values of grain yield /plant significantly increased by increasing the level of N

Table 24. Effect of N, Mn levels , methods of Mn application and their intractions on grain yield / plant (g) in 1997 and 1998 seasons and their combined data

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr	Mean
None	0	40.0	36.4	32.2	36.2	53.2	46.4	51.5	50.4	46.6	41.4	41.9	43.3
	70	37.5	45.7	33.0	38.7	46.8	59.9	61.0	55.9	42.1	52.8	47.0	47.3
	140	40.4	44.8	44.5	43.2	48.2	57.3	52.6	52.7	44.3	51.1	48.5	48.0
	Mean	**39.3**	**42.3**	**36.6**	**39.4**	**49.4**	**54.5**	**55.0**	**53.0**	**44.4**	**48.4**	**45.8**	**46.2**
50	0	82.6	110.6	125.7	106.3	142.6	137.4	125.3	135.1	112.6	124.0	125.5	120.7
	70	107.6	130.3	111.4	116.4	136.7	173.0	139.8	149.8	122.2	151.6	125.6	133.1
	140	114.7	117.5	102.7	111.6	151.8	148.4	147.9	149.4	133.2	133.0	125.3	130.5
	Mean	**101.6**	**119.5**	**113.2**	**111.4**	**143.7**	**152.9**	**137.7**	**144.8**	**122.7**	**136.2**	**125.5**	**128.1**
100	0	179.5	179.2	182.7	180.5	205.9	208.1	208.0	207.3	192.7	193.6	195.3	193.9
	70	192.7	208.9	194.2	198.6	221.0	237.6	231.9	230.1	206.8	223.2	213.0	214.4
	140	192.8	188.0	182.0	187.6	191.2	226.5	211.2	209.6	192.0	207.3	196.6	198.6
	Mean	**188.3**	**192.0**	**186.3**	**188.9**	**206.0**	**224.0**	**217.0**	**215.7**	**197.2**	**208.0**	**201.6**	**202.3**
150	0	226.8	209.1	200.9	212.3	235.3	251.6	246.1	244.3	231.0	230.3	223.5	228.3
	70	215.9	226.8	208.7	217.1	278.0	266.6	244.2	262.9	247.0	246.7	226.5	240.0
	140	203.7	209.6	203.1	205.5	237.5	215.3	223.5	225.4	220.6	212.5	213.3	215.4
	Mean	**215.5**	**215.2**	**204.2**	**211.6**	**250.2**	**244.5**	**237.9**	**244.2**	**232.9**	**229.8**	**221.1**	**227.9**
Mnxappl.	0	132.2	133.8	135.3	133.8	159.2	160.9	157.7	159.3	145.7	147.3	146.5	146.5
	70	138.4	152.9	136.8	142.7	170.6	184.2	169.2	174.7	154.5	168.6	153.0	158.7
	140	137.9	140.0	133.1	137.0	157.2	161.9	158.8	159.3	147.5	150.9	145.9	148.1
	Mean	**136.2**	**142.2**	**135.1**		**162.3**	**169.0**	**161.9**		**149.3**	**155.6**	**148.5**	

Comparisons:

LSD (0.05	N-level	(A)	13.3	9.5	7.6
	Mn-level	(B)	6.6	7.6	5.2
	Appli. Methods	(C)	6.6	N.S	5.2
		AXB	N.S	15.3	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

up to 150 kg N /fed. This is true in both seasons as well as in the combined average.

Increases in grain yield / plant due to application of 50 and 150 kg N / fed compared with control were 182.7 and 437.1 % in the 1st season ,respectively. In the second season, they were 173.7 and 361.6 % . comparable range of increase for grain yield / plant in the average of both seasons was 177.3 and 393.3 % . This result may be due to the increasing in number of ears / plant, ear weight and grain yield / ear, 100- grain weight and shelling percentage.

Increased grain yield / plant due to application of high N fertilizer were reported by **El-Sheikh,(1998) and Zaghluol, (1999).**

10-2- Effect of manganese application:

It is clear from the data of Table (24) Mn nutrient application caused a significant increase in grain yield / plant as Mn level adding 70 mg / l. While, a further increase up to 140 mg Mn / l. decreased it. Higher level of Mn (140 mg Mn / l.) may cause a poisonous effect on maize plant.

Applying 70 mg Mn / l. increased grain yield / plant by 6.65, 9.67 and 8.25 % compared with control treatment in 1997, 1998 seasons and combined average, respectively. However, the difference among zero and 140 mg Mn / l. levels was insignificant.

Similar results were obtained by **Allam and El-Naggar (1992) and Abdel-Salam et al. (1993a)** they found that spraying maize plant with Mn (mineral or organic) significantly increased grain yield / plant.

10-3- Effect of manganese application methods:

It is clear from the same Table that methods of Mn application showed a significant effect on the grain yield / plant in the first season and combined average. The highest grain yield / plant (142.2, 169.0 and 155.6 g) were obtained when using foliar application method in 1st ,2nd and combined average, respectively. However, the difference between other both different application method were insignificant.

This results are in line with those obtained by **Abdel-Salam et al. (1993a).**

10-4- Interaction effects :

All the effect of the interactions between the experimental factors were not significant on grain yield / plant in both seasons as well as in the combined average with one exception for the interaction between N and Mn rates which showed significant effect in the 2nd season only.

It is evident from Table (24) that N fertilizer on grain yield / plant was more clear where Mn nutrient was applied at the rate of 70 mg / l. the maximum grain yield / plant (262.9 g) which was recorded by combing 150 kg N + 70 mg Mn / l. in the 2nd season.

V- Grain , straw and biological yields / fed:

1-Grain yield (ardab / fed.):

Effect of nitrogen , manganese levels ,methods of Mn application and their interaction on grain yield / fed in 1997 and 1998 seasons as well as their combined average are given in Table (25) and Fig.2 (a, b and c)

Table 25. Effect of N, Mn levels , methods of Mn application and their intractions on grain yield (ardab/fed) in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	5.09	4.64	4.13	4.62	6.96	5.98	6.83	6.59	6.03	5.31	5.48	5.61
	70	4.83	6.06	4.31	5.07	5.77	7.89	7.92	7.19	5.30	6.97	6.12	6.13
	140	5.35	5.57	5.55	5.49	6.39	7.37	6.93	6.90	5.87	6.47	6.24	6.19
	Mean	**5.09**	**5.42**	**4.67**	**5.06**	**6.37**	**7.08**	**7.23**	**6.89**	**5.73**	**6.25**	**5.95**	**5.98**
50	0	10.96	14.64	14.77	13.45	19.09	17.72	16.61	17.80	15.02	16.18	15.69	15.63
	70	13.60	16.25	14.74	14.86	18.24	21.40	18.53	19.39	15.92	18.82	16.64	17.13
	140	14.60	14.68	12.72	14.00	19.37	18.27	19.01	18.88	16.98	16.48	15.87	16.44
	Mean	**13.05**	**15.19**	**14.08**	**14.11**	**18.90**	**19.13**	**18.05**	**18.69**	**15.97**	**17.16**	**16.06**	**16.40**
100	0	22.23	22.57	24.00	22.93	26.44	27.86	27.25	27.19	24.34	25.22	25.62	25.06
	70	26.01	27.22	23.10	25.44	28.46	31.65	32.03	30.71	27.24	29.43	27.57	28.08
	140	25.12	22.92	22.93	23.66	25.17	28.75	26.81	26.91	25.14	25.84	24.87	25.28
	Mean	**24.45**	**24.24**	**23.35**	**24.01**	**26.69**	**29.42**	**28.70**	**28.27**	**25.57**	**26.83**	**26.02**	**26.14**
150	0	28.80	25.78	26.99	27.19	29.86	33.76	31.17	31.60	29.33	29.77	29.08	29.39
	70	27.59	28.67	26.49	27.58	37.34	35.14	32.08	34.86	32.47	31.90	29.29	31.22
	140	25.84	26.08	26.25	26.06	31.71	28.00	29.00	29.57	28.78	27.04	27.62	27.81
	Mean	**27.41**	**26.84**	**26.58**	**26.94**	**32.97**	**32.30**	**30.75**	**32.01**	**30.19**	**29.57**	**28.66**	**29.47**
Mnxappl.	0	16.77	16.91	17.47	17.05	20.59	21.33	20.46	20.79	18.68	19.12	18.97	18.92
	70	18.01	19.55	17.16	18.24	22.45	24.02	22.64	23.04	20.23	21.78	19.90	20.64
	140	17.73	17.31	16.86	17.30	20.66	20.60	20.44	20.56	19.19	18.95	18.65	18.93
	Mean	**17.50**	**17.92**	**17.17**		**21.23**	**21.98**	**21.18**		**19.37**	**19.95**	**19.17**	

Comparisons:

LSD (0.05	N-level	(A)	2.49	1.30	1.30
	Mn-level	(B)	1.06	1.11	0.79
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

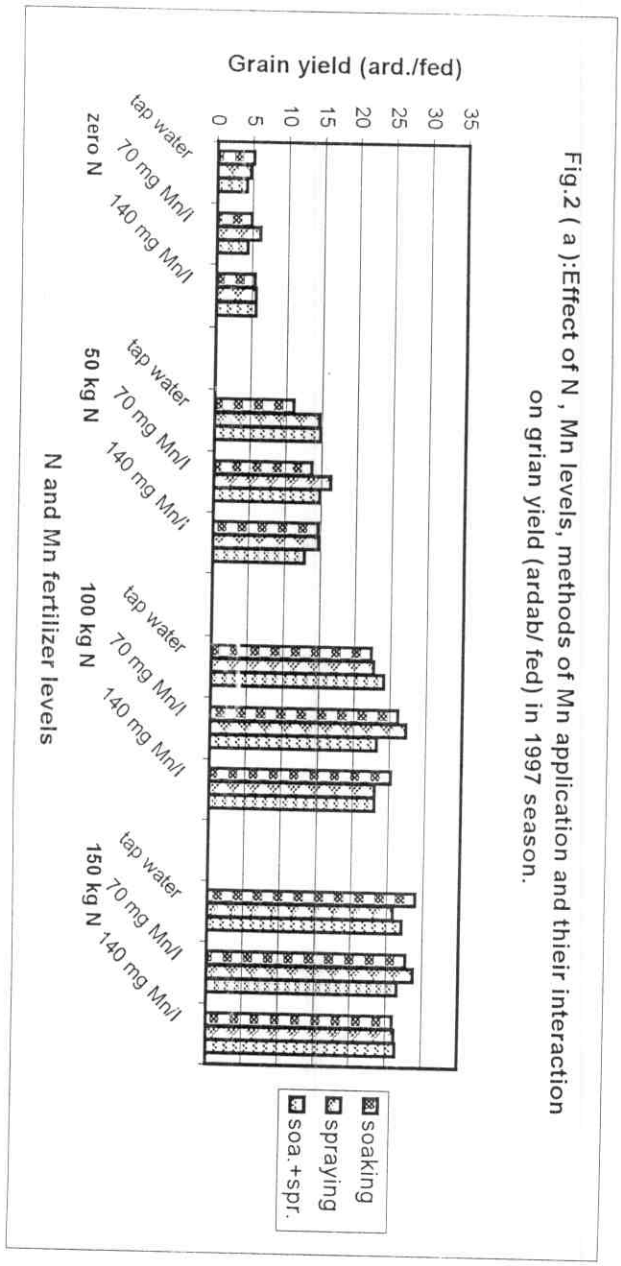

Fig.2 (a):Effect of N , Mn levels, methods of Mn application and thieir interaction on grian yield (ardab/ fed) in 1997 season.

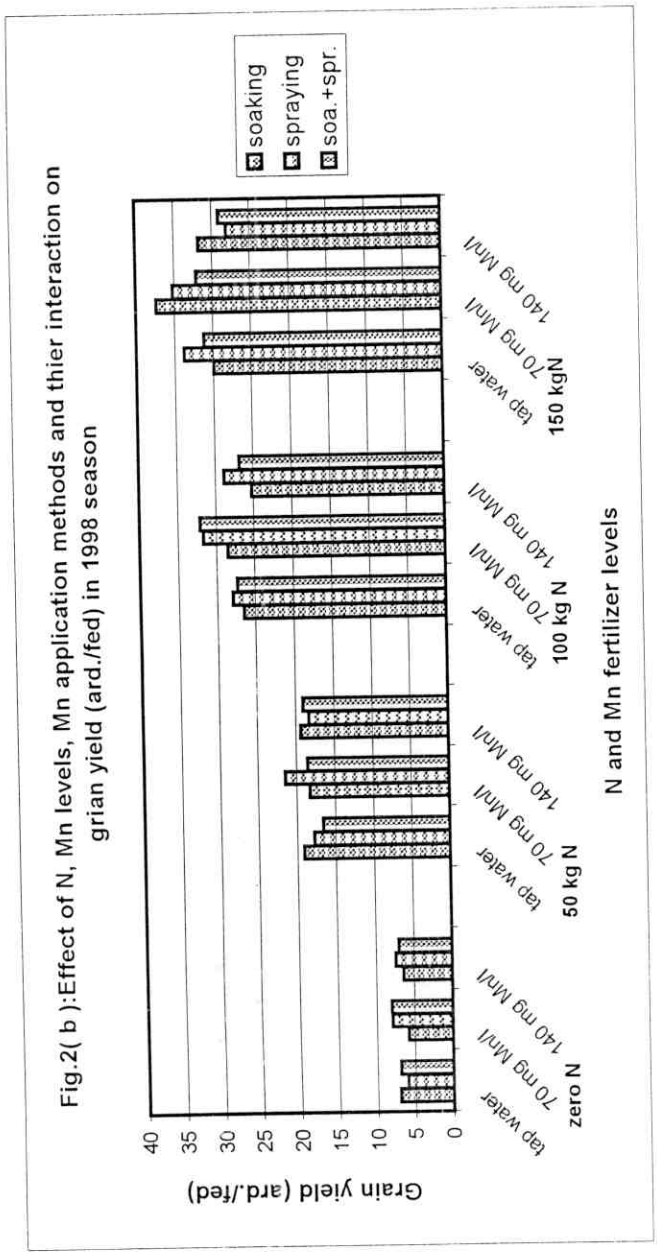
Fig.2(b):Effect of N, Mn levels, Mn application methods and thier interaction on grian yield (ard./fed) in 1998 season
soaking
spraying
soa.+spr.
Grain yield (ard./fed)
0
5
10
15
20
25
30
35
40
tap water
70 mg Mn/l
140 mg Mn/l
zero N
50 kg N
100 kg N
150 kgN
N and Mn fertilizer levels

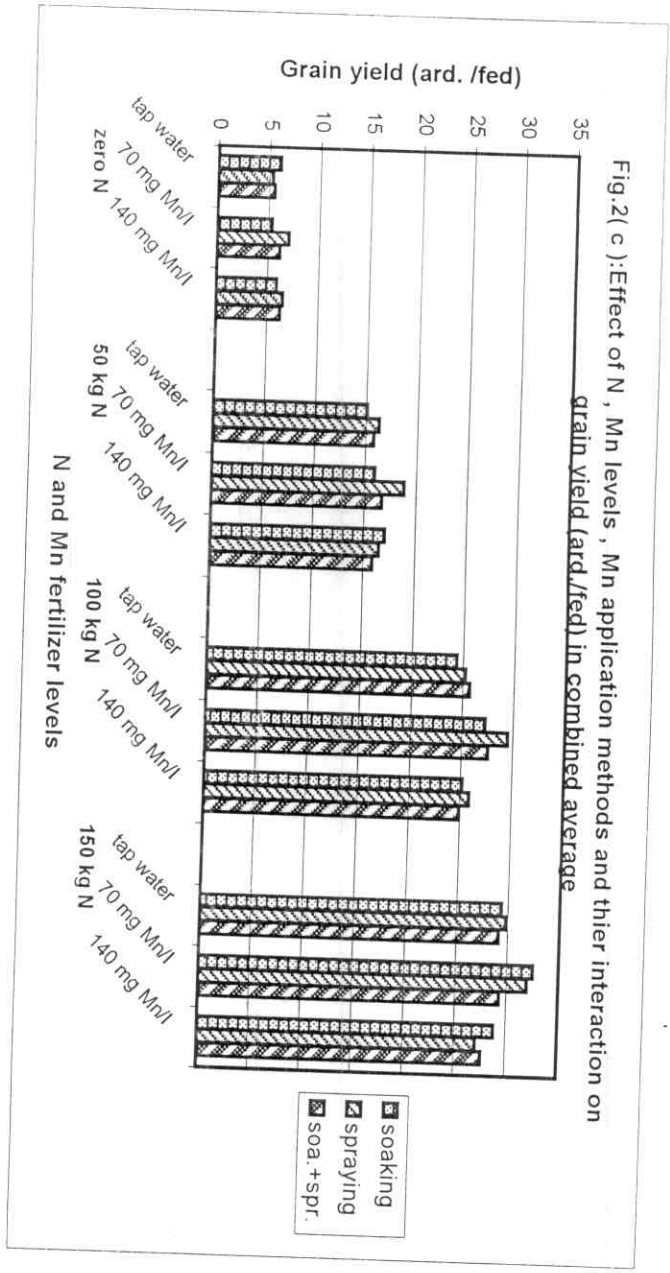

Fig.2(c):Effect of N , Mn levels , Mn application methods and thier interaction on grain yield (ard./fed) in combined average

1-1-Effect of nitrogen application:

The results in Table (25) showed clearly that N fertilizer significantly increased grain yield in both seasons as well as in the combined average .

Applying 50, 100 and 150 kg N / fed. increased the grain yield over control treatment by 9.04, 18.95 and 21.88 ardab /fed. in 1997 season and by 11.80, 21.38 and 25.11 ardab / fed. in 1998 season. Being 10.42, 20.16 and 23.50 ardab/fed. in the combined average at the same levels of N fertilizer . These increases correspond to 178.7, 374.5 and 432.4 % in 1997 season and 171.2, 310.1 and 364.3 % in 1998 season ,being 174.4, 337.3 and 393.1 % in the combined average, respectively.

The higher N level (150 kg N / fed.) was more effective in increasing grain yield in both seasons and in the combined average . The increase in grain yield due to application of higher rate of N may by attributed to the increase in plant growth and most of studied yield components.

The present results indicated clearly the vital role of N in plant life and its contribution in increasing the grain yield. Such results clarified that N is essential for cell division and elongation as well as the root growth and dry matter content of maize plants. The response indicates a progressive increase in plant growth and yield components. This reflects a need for high N to obtain high grain yield of maize.

Increased grain yield and yield components due to application of high N were reported by **Shafahak et al. (1994a); Badr et al. (1997) ;El-Sheikh (1998) and Nofal (1999)** who found that the highest N level (135 kg N / fed) induced increase

in grain yield over the check treatment by 146 and 200 % in the 1st and 2nd growing seasons, respectively. However, **Salwau and Shams El-Din (1992)** showed no significant difference between 60 and 150 kg N / fed levels in grain yield of maize.

1-2-Effect of manganese application:

The results from the same Table showed that grain yield / fed. was significantly increased by applying 70 mg Mn / l. While, it decreased when a concentration of 140 mg Mn / l. was applied. However in this respect, the difference between control treatment and 140 mg Mn /l. was not significant. This is true in both growing seasons and in the combined average.

Applying 70 mg Mn / l. increased the grain yield / fed. over the control treatment by 1.19, 2.24 and 1.72 ardab / fed in the 1st ,2nd seasons and combined average, respectively. These increases correspond to 6.97, 10.79 and 9.07 % in 1997, 1998 and combined average, respectively.

It could be concluded that the grain yield / fed significantly increased as a result of adding 70 mg Mn / l level. On the other hand, the higher Mn of 140 mg / l. did not effect on the grain yield / fed of maize as compared with zero. Such trend might be due to the slight toxic effect of higher Mn level. This result indicated that a level of 70 mg Mn / l. applied could be recommended to cover the requirement of maize plant for Mn under similar conditions.

This result is expected since applying 70 mg Mn / l. significantly increased plant growth, dry matter content, number of ears / plant , ear weight, grain yield / ear , 100- kernel weight , grain yield / plant and significantly decreased 50 % tasseling and

silking dates.

The significance decrease in grain yield / fed due to the application of higher level of Mn up to 140 mg Mn / l. might be attributed to the retarding effect of higher level of Mn on plant height, ear height, number of green leaves / plant , area of topmost ear leaf, ear weight, grain yield /ear , 100- kernel weight and grain yield / plant.

The increases in grain yield due to applying Mn is a reflection of increased plant growth and yield components. Therefore, contents of 8.5 mg Mn (DTPA- extractable) shown by the soil of the current study are not enough for a high yield of grain (Table 1). Such content would indicate a need for Mn addition. The effect of Mn on growth characters, yield and yield components could be explained through the role of Mn in cell division, respiration, N metabolism and activation of enzymes in growth plant and reproductive phase. **(Gardner et al 1985 and Marschner 1995).**

These results agree with those obtained by **Genaidy et al.. (1987), Ghaly et al (1991), Allam and El-Naggar (1992) and Abdel- Salam et al. (1993 a)** they found that Mn significantly increased grain yield / fed when spraying with 1200 to 1800 mg / l. (mineral Mn) or 60 to 90 mg / l. (organic Mn).

1-3- Effect of manganese application methods:

It is obviously clear that the methods of Mn application did not exhibit any difference in the average grain yield in the 1st, 2ndseasons and combined analysis of two seasons. However, the data revealed that foliar application method gave the highest values of grain yield / fed. but this increase not reached the level

of significance.

1-4- Interaction effects :

The results in Table (25) showed that all effects of the interactions between the studied factors were not significant which indicates that each factor acted independently in affecting grain yield / fed in maize plant.

2-Straw yield (kg / fed) :

The results in Table (26) indicated the effect of nitrogen , manganese levels, methods of Mn application and their interactions on straw yield of maize plants in 1997 and 1998 seasons as well as their combined average.

2-1- Effect of nitrogen application:

Straw yield of maize as affected by N application is represented in Table (26). It was significantly and consistently increased by increasing N levels up to 150 kg N / fed. This was true in both seasons and combined average.

In 1997season, the straw yield increased over the control by 1527.8, 2347.3 and 2826.4 kg due to the nitrogen levels equal to 50, 100 and 150 kg N /fed. respectively. The corresponding values in 1998 season were 1722.2 , 2437.5 and 2621.5 kg / fed, respectively . Being 1625.0 , 2392.3 and 2723.9 kg in the combined average of two seasons . The increase in straw yield attributed to the increase in N levels is mainly due to the increase in plant growth, dry matter content and some yield components.

These results coincide with those obtained by **Ashoub et al. (1996); El-Habbak and Shams El-Din (1996); Lamlom (1997) and Zaghluol (1999)** who found that straw yield

Table 26. Effect of N,Mn levels , methods of Mn application and their intractions on straw yield kg/ fed. in 1997 and 1998 seasons and their combined data .

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	3187.5	3187.5	2937.5	3104.2	3437.5	3312.5	3250.0	3333.3	3312.5	3250.0	3093.8	3218.8
	70	2875.0	3000.0	2812.5	2895.8	3468.8	3531.3	3187.5	3395.8	3171.9	3265.6	3000.0	3145.8
	140	2812.5	2812.5	2875.0	2833.3	3437.5	3437.5	3437.5	3437.5	3125.0	3125.0	3156.3	3135.4
	Mean	**2958.3**	**3000.0**	**2875.0**	**2944.4**	**3447.9**	**3427.1**	**3291.7**	**3388.9**	**3203.1**	**3213.5**	**3083.3**	**3166.7**
50	0	4250.0	4375.0	4250.0	4291.7	5156.3	5281.3	5000.0	5145.8	4703.1	4828.1	4625.0	4718.8
	70	4625.0	4937.5	4437.5	4666.7	5062.5	5375.0	5125.0	5187.5	4843.8	5156.3	4781.3	4927.1
	140	4500.0	4500.0	4375.0	4458.3	5125.0	5062.5	4812.5	5000.0	4812.5	4781.3	4593.8	4729.2
	Mean	**4458.3**	**4604.2**	**4354.2**	**4472.2**	**5114.6**	**5239.6**	**4979.2**	**5111.1**	**4786.5**	**4921.9**	**4666.7**	**4791.7**
100	0	4875.0	5375.0	5312.5	5187.5	5687.5	5812.5	5750.0	5750.0	5281.3	5593.8	5531.3	5468.8
	70	5375.0	5625.0	5312.5	5437.5	6000.0	6000.0	5687.5	5895.8	5687.5	5812.5	5500.0	5666.7
	140	5375.0	5250.0	5125.0	5250.0	5687.5	5750.0	6062.5	5833.3	5531.3	5500.0	5593.8	5541.7
	Mean	**5208.3**	**5416.7**	**5250.0**	**5291.7**	**5791.7**	**5854.2**	**5833.3**	**5826.4**	**5500.0**	**5635.4**	**5541.7**	**5559.0**
150	0	5937.5	6062.5	6125.0	6041.7	6250.0	6375.0	5875.0	6166.7	6093.8	6218.8	6000.0	6104.2
	70	5812.5	5875.0	5750.0	5812.5	6000.0	6000.0	5906.3	5968.8	5906.3	5937.5	5828.1	5890.6
	140	5500.0	5562.5	5312.5	5458.3	5750.0	5906.3	6031.3	5895.8	5625.0	5734.4	5671.9	5677.1
	Mean	**5750.0**	**5833.3**	**5729.2**	**5770.8**	**6000.0**	**6093.8**	**5937.5**	**6010.4**	**5875.0**	**5963.5**	**5833.3**	**5890.6**
Mnxappl.	0	4562.5	4750.0	4656.3	4656.3	5132.8	5195.3	4968.8	5099.0	4847.7	4972.7	4812.5	4877.6
	70	4671.9	4859.4	4578.1	4703.1	5132.8	5226.6	4976.6	5112.0	4902.3	5043.0	4777.3	4907.6
	140	4546.9	4531.3	4421.9	4500.0	5000.0	5039.1	5085.9	5041.7	4773.4	4785.2	4753.9	4770.8
	Mean	**4593.8**	**4713.5**	**4552.1**		**5088.5**	**5153.6**	**5010.4**		**4841.1**	**4933.6**	**4781.3**	

Comparisons:				
LSD (0.05	N-level	(A)	220.45	193.39	136.33
	Mn-level	(B)	124.15	N.S	86.79
	Appli. Methods	(C)	124.15	N.S	86.79
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

significantly increased with increasing N levels up to 150 kg / fed.

2-2-Effect of manganese application:

From the same Table it was clear that Mn nutrient significantly increased straw yield / fed due to applying 70 mg Mn / l. While, increasing Mn level up to 140 mg / l. resulted a decrease it. This is true in the 1st season and in the combined average. However, there was no significant difference between zero and 70 mg Mn / l. Higher concentration of Mn (140 mg / l) may cause a poisonous effect on maize plant. The same trend was obtained in the 2nd season without significant differences between all Mn rates. The highest average of straw yield due to used 70 mg Mn / l. were 4703.1 , 5112.0 and 4907.6 kg / fed in the 1997 , 1998 and in the combined average, respectively.

This result might be attributed to the significant positive effect of Mn on plant height, ear height, number of green leaves, ear leaf area and dry mater / plant.

These results agree with those obtained by **Ashoub et al. (1998).**

2-3-Effect of manganese application methods:

The data presented in Table (26) indicate that Mn application methods significantly affected straw yield of maize plant. The results showed that using foliar spraying caused a significant increment in straw yield of the 1st season and in the combined average. The same trend was obtained in the 2nd season without significant differences among all Mn application methods. The highest average of straw yield were 4713.5 , 5153.6 and 4933.6 kg / fed when using foliar application method

in the 1st ,2nd seasons and combined average, respectively.

2-4-Interaction effects:

The results presented in Table (26) showed that none of the interactions among the experimental factors significantly affected straw yield either in both seasons or their combined average.

3-Biological yield(kg / fed):

The results in Table (27) and Fig. 3 (a, b and c) indicated the effects of N , Mn levels ,Mn application methods on biological yield data in 1997 and 1998 seasons as well as their combined average.

3-1- Effect of nitrogen application :

The average values in Table (27) indicated that any of the applied N rates caused a significant increase in the average biological yield compared to the control in the two studied seasons as well as in the combined analysis. Increasing N level from 0 to 50, 100, and 150 kg / fed significantly increased biological yield by 76.5 , 136.9 and 161.2 % in 1997 season, respectively. The corresponding increases in 1998 season were 77.4 , 124.7 and 140.9 % for the respective N levels. The increases in biological yield over the two growing seasons average were 76.9 , 130.3 and 150.2 % respectively.

This results might be due to the significant effect of N on plant growth , yield components as well as grain yield /fed.

Similar data in increasing the biological yield as a result of nitrogen application were obtained by **Abdel-Samie (1994);El-Amin (1994); Lamlom (1997) and Zaghluol (1999)**

Table 27. Effect of N,Mn levels , methods of Mn application and their intractions on biological yield (kg\fed.) in 1997 and 1998 seasons and their combined data

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	3900.52	3836.85	3516.07	3751.14	4411.46	4150.12	4206.66	4256.08	4155.99	3993.48	3861.36	4003.61
	70	3551.84	3848.12	3416.51	3605.49	4277.17	4635.92	4295.96	4403.02	3914.51	4242.02	3856.23	4004.25
	140	3561.72	3592.63	3652.10	3602.15	4332.17	4469.33	4407.40	4402.97	3946.95	4030.98	4029.75	4002.56
	Mean	**3671.36**	**3759.20**	**3528.23**	**3652.93**	**4340.27**	**4418.46**	**4303.34**	**4354.02**	**4005.81**	**4088.83**	**3915.78**	**4003.47**
50	0	5783.93	6424.03	6317.72	6175.23	7797.25	7762.01	7324.94	7628.06	6790.59	7093.02	6821.33	6901.64
	70	6529.10	7212.29	6500.67	6747.35	7615.64	8370.43	7719.78	7901.95	7072.37	7791.36	7110.23	7324.65
	140	6543.47	6555.66	6155.71	6418.28	7836.80	7620.49	7474.16	7643.82	7190.13	7088.08	6814.93	7031.05
	Mean	**6285.50**	**6730.66**	**6324.70**	**6446.95**	**7749.89**	**7917.64**	**7506.29**	**7724.61**	**7017.70**	**7324.15**	**6915.50**	**7085.78**
100	0	7986.96	8535.19	8672.60	8398.25	9389.57	9713.49	9564.70	9555.92	8688.26	9124.34	9118.65	8977.09
	70	9016.67	9435.12	8546.90	8999.56	9984.74	10430.63	10172.24	10195.87	9500.70	9932.87	9359.57	9597.72
	140	8891.42	8459.30	8335.68	8562.13	9211.14	9774.78	9816.50	9600.81	9051.28	9117.04	9076.09	9081.47
	Mean	**8631.68**	**8809.87**	**8518.39**	**8653.31**	**9528.48**	**9972.97**	**9851.15**	**9784.20**	**9080.08**	**9391.42**	**9184.77**	**9218.76**
150	0	9969.63	9671.81	9904.07	9848.50	10430.04	11101.84	10238.27	10590.05	10199.83	10386.83	10071.17	10219.28
	70	9674.52	9888.29	9458.51	9673.77	11228 30	10919.48	10397.75	10848.51	10451.41	10403.88	9928.13	10261.14
	140	9118.12	9213.02	8987.89	9106.35	10189.02	9825.61	10090.83	10035.15	9653.57	9519.31	9539.36	9570.75
	Mean	**9587.42**	**9591.04**	**9450.16**	**9542.87**	**10615.79**	**10615.64**	**10242.28**	**10491.24**	**10101.60**	**10103.34**	**9846.22**	**10017.06**
Mnxappl.	0	6910.26	7116.97	7102.61	7043.28	8007.08	8181.86	7833.64	8007.53	7458.67	7649.42	7468.13	7525.40
	70	7193.03	7595.95	6980.65	7256.54	8276.46	8589.11	8146.43	8337.34	7734.75	8092.53	7563.54	7796.94
	140	7028.68	6955.15	6782.85	6922.23	7892.28	7922.55	7947.22	7920.69	7460.48	7438.85	7365.03	7421.46
	Mean	**7043.99**	**7222.69**	**6955.37**		**8058.61**	**8231.18**	**7975.76**		**7551.30**	**7726.93**	**7465.57**	

Comparisons:

LSD (0.05	N-level	(A)	430.84	244.03	229.84
	Mn-level	(B)	189.00	191.56	137.25
	Appli. Methods	(C)	189.00	161.56	137.25
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

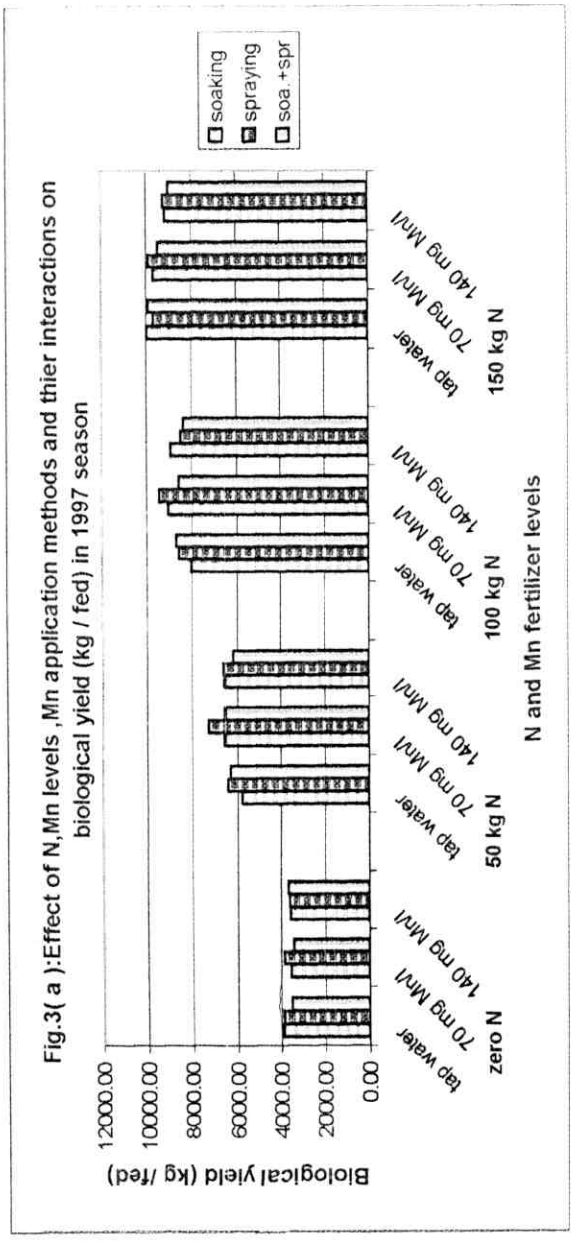
Fig.3(a):Effect of N,Mn levels ,Mn application methods and thier interactions on biological yield (kg / fed) in 1997 season
soaking
spraying
soa. +spr
Biological yield (kg /fed)
12000.00
10000.00
8000.00
6000.00
4000.00
2000.00
0.00
tap water
70 mg Mn/l
140 mg Mn/l
zero N
50 kg N
100 kg N
150 kg N
N and Mn fertilizer levels

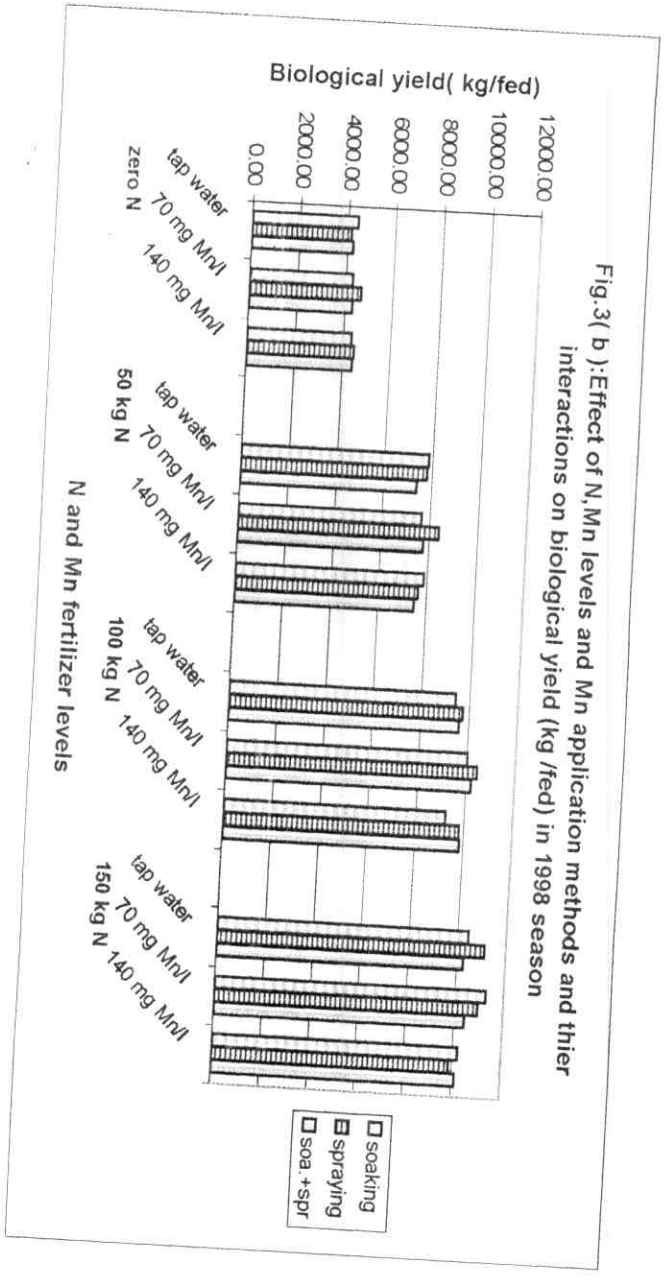

Fig.3(b):Effect of N,Mn levels and Mn application methods and thier interactions on biological yield (kg /fed) in 1998 season

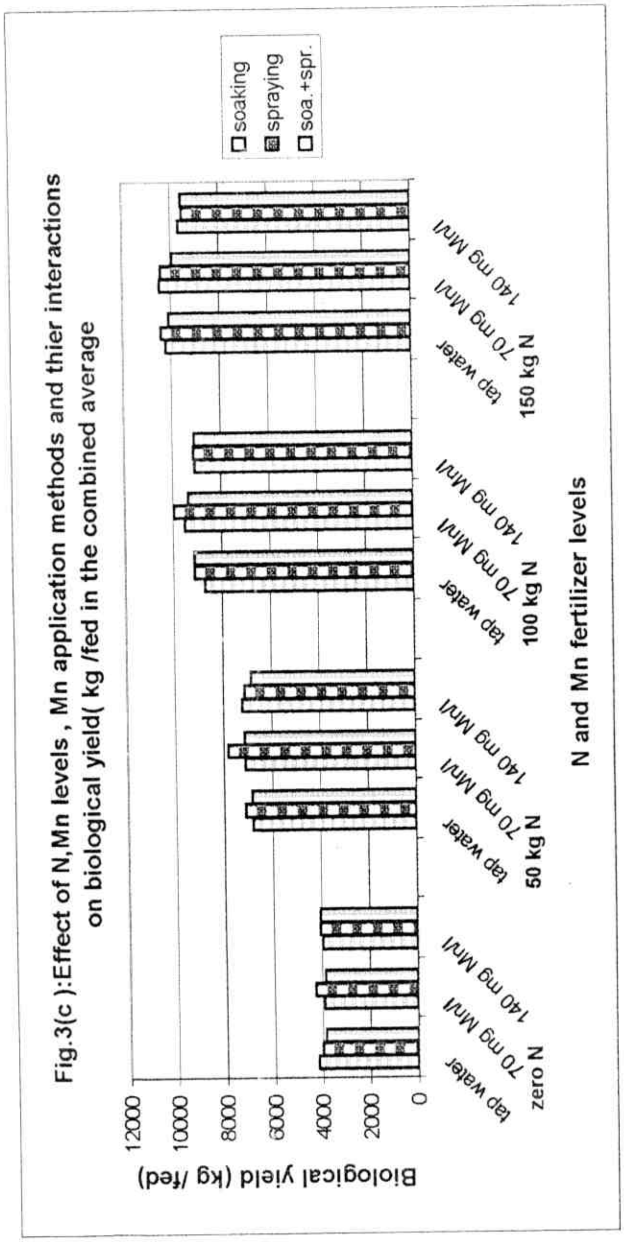

Fig.3(c):Effect of N,Mn levels , Mn application methods and thier interactions on biological yield(kg /fed in the combined average

3-2- Effect of manganese application:

Mn concentrations showed a significant effect on the biological yield as was revealed from the both seasons and combined average.(Table 27). Adding 70 mg Mn / l. increased biological yield over the control treatment by 3.02 , 4.11 and 3.61 % in the 1st , 2nd and combined average, respectively. This result is expected since Mn increases the vegetative growth ,straw yield and grain yield. While, the highest levels of Mn (140 mg / l.) decreased the biological yield as compared with the concentration 70 mg Mn / l.

Similar results were also reported by **Amberger and Yousry (1988 a&b)** they found 2.5 mg Mn / l in water culture was a critical level . Whereas, a concentration of 25 mg Mn / l was appropriate and 250 mg Mn / l was toxic.

3-3-Effect of manganese application methods:

The effect of Mn application methods in increasing the average biological yield of maize was significantly in both seasons and in the combined average. It is clear from Table (27) that the highest biological yield were produced by foliar Mn application method. By using this method the average biological yield was 7222.69, 8231.18 and 7726.93 kg / fed in the 1997,1998 and combined average. The difference was not significant as compared to the average biological yield produced by other two methods of Mn application.

3-4-Interaction effects:

All effects of the interactions did not significantly influence biological yield in both seasons and their combined average as shown in Table (27).This result indicates that each

experimental factor independently in affecting this trait.

4- Crop index :

The effect of different N , Mn levels , Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average on the crop index presented in Table (28).

4-1- Effect of nitrogen application:

Data reported in Table (28) point out that the mean values of crop index significantly increased by increasing N rates in both seasons as well as in the combined average .In 1997 season, applying N at 50 , 100 and 150 kg N / fed significantly increased crop index over the check treatment by 79.7 , 158.5 and 166.6 % ,respectively. However, the difference between 100 and 150 kg N / fed was not significant. The corresponding increases for the same N levels in 1998 season were 78.7 , 136.9 and 160.6 % respectively. being 78.7 , 146.4 and 162.9 % in the combined average. The increase in crop index is mainly due to the positive effect of N on grain yield /fed.

4-2-Effect of manganese application:

Mn concentration showed a significant effect on the crop index as was revealed from the 2nd season and in the combined average (Table 28). Adding 70 mg Mn / l. increased crop index by 10.6 and 8.7 % as compared with control treatment in the second season as well as in the combined average, respectively.

Under Mn deficiency, vegetative growth of maize is much less depressed than grain yield. In the deficient plants, anthers development is delayed and fewer and smaller pollen grains are produced with very low germination rates. In contrast, ovule

Table 28. Effect of N, Mn levels , methods of Mn application and their intractions on crop index in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	22.4	20.4	20.1	21.0	28.4	25.3	29.9	27.9	25.4	22.9	25.0	24.4
	70	24.3	29.0	21.9	25.1	23.4	31.4	35.1	30.0	23.9	30.2	28.5	27.5
	140	27.1	28.4	27.6	27.7	26.1	30.7	28.3	28.4	26.6	29.5	28.0	28.0
	Mean	**24.6**	**25.9**	**23.2**	**24.6**	**26.0**	**29.1**	**31.1**	**28.7**	**25.3**	**27.5**	**27.2**	**26.7**
50	0	35.9	47.0	48.4	43.8	52.4	46.9	46.5	48.6	44.2	46.9	47.5	46.2
	70	41.1	46.0	46.7	44.6	50.4	55.7	50.8	52.3	45.8	50.8	48.8	48.5
	140	45.7	45.8	40.8	44.1	52.9	50.6	55.7	53.1	49.3	48.2	48.2	48.6
	Mean	**40.9**	**46.3**	**45.3**	**44.2**	**51.9**	**51.1**	**51.0**	**51.3**	**46.4**	**48.7**	**48.1**	**47.7**
100	0	64.1	59.1	63.3	62.2	65.2	67.1	66.6	66.3	64.7	63.1	64.9	64.2
	70	68.0	68.0	61.2	65.7	66.5	74.1	79.0	73.2	67.2	71.0	70.1	69.5
	140	65.2	61.0	62.8	63.0	61.9	69.8	62.1	64.6	63.6	65.4	62.5	63.8
	Mean	**65.8**	**62.7**	**62.5**	**63.6**	**64.5**	**70.3**	**69.2**	**68.0**	**65.2**	**66.5**	**65.8**	**65.8**
150	0	67.8	59.6	61.7	63.0	67.0	74.1	74.4	71.8	67.4	66.8	68.0	67.4
	70	66.9	68.6	64.9	66.8	87.8	82.0	76.6	82.1	77.4	75.3	70.8	74.5
	140	65.9	65.7	69.2	66.9	77.2	66.5	67.3	70.3	71.6	66.1	68.2	68.6
	Mean	**66.9**	**64.6**	**65.3**	**65.6**	**77.3**	**74.2**	**72.7**	**74.8**	**72.1**	**69.4**	**69.0**	**70.2**
Mnxappl.	0	47.6	46.5	48.4	47.5	53.3	53.4	54.3	53.7	50.4	49.9	51.4	50.6
	70	50.1	52.9	48.7	50.6	57.0	60.8	60.4	59.4	53.6	56.8	54.5	55.0
	140	51.0	50.2	50.1	50.4	54.5	54.4	53.3	54.1	52.8	52.3	51.7	52.3
	Mean	**49.5**	**49.9**	**49.1**		**55.0**	**56.2**	**56.0**		**52.2**	**53.0**	**52.5**	

Comparisons:

LSD (0.05	N-level	(A)	7.08	4.24	3.83
	Mn-level	(B)	N.S	3.12	2.32
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

fertility was not significant affected by Mn deficiency (**Sharma et al. 1991**).

On the other hand, the highest level of Mn (140mg / l.) decreased the crop index as compared with the concentration 70 mg Mn / l. However, **Osman (1997)** who found that crop index was significant increased by using 0.15 g Mn / l.

4-3-Effect of manganese application methods:

Regarding the Mn application methods, it did not affect the crop index significantly in both growing seasons as well as in the combined average.

4-4-Interaction effects:

All effects of the interactions between the experimental factors did not significantly influence crop index in both seasons and their combined average as shown in Table (28).

5-Harvest index:

Results for the effect of N , Mn rates , Mn application methods and their interactions in 1997 and 1998 seasons as well as combined average on the harvest index are presented in Table (29).

5-1-Effect of nitrogen application:

The effect of N treatment on harvest index is shown in Table (29). It was observed that the differences among N fertilization treatments were significant. This is true in both seasons as well as in the combined average. Application of 50 to 150 kg N / fed increased this character over the control treatment by 56.4 and 102.1 % in 1997 season ,by 52.3 and 91.9 % in the 1998 season and by 54.3 and 97.1 % in the combined average, The differences between 100 and 150 kg N / fed was not

Table 29. Effect of N, Mn levels , methods of Mn application and their intractions on harvest index in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	18.3	16.8	16.6	17.2	22.1	20.2	22.9	21.7	20.2	18.5	19.8	19.5
	70	19.2	22.3	17.8	19.7	18.9	23.8	25.8	22.9	19.0	23.1	21.8	21.3
	140	21.2	21.7	21.4	21.5	20.6	23.2	22.0	22.0	20.9	22.5	21.7	21.7
	Mean	**19.5**	**20.3**	**18.6**	**19.5**	**20.6**	**22.4**	**23.6**	**22.2**	**20.0**	**21.3**	**21.1**	**20.8**
50	0	26.4	31.8	32.5	30.2	34.2	31.8	31.6	32.5	30.3	31.8	32.1	31.4
	70	29.0	31.4	31.7	30.7	33.5	35.6	33.5	34.2	31.2	33.5	32.6	32.5
	140	31.1	31.3	28.9	30.4	34.6	33.6	35.7	34.6	32.8	32.5	32.3	32.5
	Mean	**28.8**	**31.5**	**31.0**	**30.5**	**34.1**	**33.7**	**33.6**	**33.8**	**31.4**	**32.6**	**32.3**	**32.1**
100	0	38.9	37.0	38.6	38.2	39.4	40.1	39.8	39.8	39.2	38.5	39.2	39.0
	70	40.3	40.2	37.7	39.4	39.8	42.4	44.0	42.1	40.1	41.3	40.9	40.8
	140	39.4	37.7	38.5	38.6	38.1	41.1	38.2	39.1	38.8	39.4	38.4	38.8
	Mean	**39.5**	**38.3**	**38.3**	**38.7**	**39.1**	**41.2**	**40.7**	**40.3**	**39.3**	**39.8**	**39.5**	**39.5**
150	0	40.2	37.2	38.0	38.5	40.0	42.5	42.6	41.7	40.1	39.9	40.3	40.1
	70	39.9	40.5	38.9	39.8	46.4	45.0	43.2	44.9	43.2	42.7	41.0	42.3
	140	39.6	39.6	40.9	40.0	43.6	39.8	40.2	41.2	41.6	39.7	40.5	40.6
	Mean	**39.9**	**39.1**	**39.2**	**39.4**	**43.3**	**42.4**	**42.0**	**42.6**	**41.6**	**40.8**	**40.6**	**41.0**
Mnxappl.	0	30.9	30.7	31.4	31.0	33.9	33.7	34.2	33.9	32.4	32.2	32.8	32.5
	70	32.1	33.6	31.5	32.4	34.7	36.7	36.6	36.0	33.4	35.2	34.1	34.2
	140	32.8	32.6	32.4	32.6	34.2	34.4	34.0	34.2	33.5	33.5	33.2	33.4
	Mean	**31.9**	**32.3**	**31.8**		**34.3**	**34.9**	**35.0**		**33.1**	**33.6**	**33.4**	

Comparisons:

LSD (0.05	N-level	(A)	3.14	1.73	1.66
	Mn-level	(B)	N.S	1.22	0.97
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

significant in the 1st season. This results might be due to the significant effect of nitrogen on grain yield.

Similar results were also reported by **Abdel-Samie (1994)** who found that harvest index significantly increased with increasing N rates up to 120 kg N / fed.

5-2-Effect of manganese application:

Application Mn at the rate of 70 mg / l. significantly increased harvest index in 1998 season and combined average.(Table: 29).Increases in harvest index over the control treatment in the 1st , 2nd seasons and combined average reached 4.5 , 6.2 and 5.2 % at 70 mg Mn l^{-1}., respectively. This result may be due to Mn application at this level increased significantly grain yield /fed. However, there was no significant differences among Mn rates in the 1st season. While, the highest level of Mn (140 mg / l.) decreased the harvest index as compared with the rate of 70 mg / l. Similar results were also reported by **Osman (1997).**

5-3-Effect of manganese application methods:

It is clear from the same Table that the methods of Mn application did not exhibit any difference in the average of harvest index in both growing seasons as well as in the combined analysis of two seasons.

5-4-Interaction effects:

All the effect of the interactions between the experimental factors were not significant on harvest index in both seasons as well as in the combined average.

VI- Chemical composition in maize grains:

1- Crude protein percent (CP %):

The effect of different N , Mn levels , various Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average on crude protein content in grain presented in Table (30).

1-1-Effect of nitrogen application:

It was evident that the difference between N treatment were significant. Application of 150 kg N /fed resulted in the highest mean values of CP % which were 10.9 , 11.09 and 10.99 % in the 1997, 1998 seasons and combined average, respectively. applying 150 kg N fed^{-1} was significantly superior in stimulation N absorption from the soil. The effect of 150 kg N /fed on CP content in maize grains may be due to the effect of N in stimulating root growth of maize plant. N is also essential to some plant enzyme systems, chlorophyll formations, DNA,RNA and improves quality. Consequently, a good supply of N will lead to more better root growth and more metabolic activity in plant, leading in turn to a high CP% in grains.

Similar results were also obtained by **Shafshak et al. (1994b); Abdullah (1995) , Badr et al. (1997) and Nofal (1999)**

1-2-Effect of manganese application:

It is clear from the data of tha same Table Mn nutrient application caused a significant increase in CP % by adding 70 mg Mn / l. While, a further increase up to 140 mg Mn / l. decreased it this results may be due to Mn has an essential role in amino acids synthesis since it activates a number of

Table 30. Effect of N, Mn levels , methods of Mn application and their intractions on crude protein percentage in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	8.23	8.17	8.17	8.19	8.97	9.17	8.60	8.91	8.60	8.67	8.38	8.55
	70	8.70	8.70	8.50	8.63	9.10	9.60	9.17	9.29	8.90	9.15	8.83	8.96
	140	8.30	8.37	8.03	8.23	8.97	8.83	9.00	8.93	8.63	8.60	8.52	8.58
	Mean	**8.41**	**8.41**	**8.23**	**8.35**	**9.01**	**9.20**	**8.92**	**9.04**	**8.71**	**8.81**	**8.58**	**8.70**
50	0	9.00	9.13	8.90	9.01	10.03	10.33	10.00	10.12	9.52	9.73	9.45	9.57
	70	9.30	8.77	9.07	9.04	10.00	10.13	9.97	10.03	9.65	9.45	9.52	9.54
	140	8.97	9.13	8.87	8.99	9.30	10.13	9.50	9.64	9.13	9.63	9.18	9.32
	Mean	**9.09**	**9.01**	**8.94**	**9.01**	**9.78**	**10.20**	**9.82**	**9.93**	**9.43**	**9.61**	**9.38**	**9.47**
100	0	10.00	10.23	10.10	10.11	10.63	10.80	10.03	10.49	10.32	10.52	10.07	10.30
	70	9.80	10.30	9.83	9.98	10.90	11.07	10.97	10.98	10.35	10.68	10.40	10.48
	140	9.80	10.13	9.90	9.94	10.47	10.77	10.67	10.63	10.13	10.45	10.28	10.29
	Mean	**9.87**	**10.22**	**9.94**	**10.01**	**10.67**	**10.88**	**10.56**	**10.70**	**10.27**	**10.55**	**10.25**	**10.36**
150	0	10.67	11.20	11.07	10.98	10.80	10.77	10.73	10.77	10.73	10.98	10.90	10.87
	70	11.13	11.50	11.17	11.27	12.07	11.43	11.40	11.63	11.60	11.47	11.28	11.45
	140	10.93	9.87	10.57	10.46	11.27	10.53	10.77	10.86	11.10	10.20	10.67	10.66
	Mean	**10.91**	**10.86**	**10.93**	**10.90**	**11.38**	**10.91**	**10.97**	**11.09**	**11.14**	**10.88**	**10.95**	**10.99**
Mnxappl.	0	9.48	9.68	9.56	9.57	10.11	10.27	9.84	10.07	9.79	9.98	9.70	9.82
	70	9.73	9.82	9.64	9.73	10.52	10.56	10.38	10.48	10.13	10.19	10.01	10.11
	140	9.50	9.38	9.34	9.41	10.00	10.07	9.98	10.02	9.75	9.72	9.66	9.71
	Mean	**9.57**	**9.63**	**9.51**		**10.21**	**10.30**	**10.07**		**9.89**	**9.96**	**9.79**	

Comparisons:

LSD (0.05	N-level	(A)	0.26	0.25	0.16
	Mn-level	(B)	0.20	0.23	0.15
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

enzymes. **(Marschner,1995)**

1-3-Effect of manganese application methods:

It is obviously clear that the methods of Mn application did not exhibit any difference in the average CP % of maize grain in both seasons and combined average.

1-4-Interaction effects:

The results presented in Table (30) showed that none of the interactions between the experimental factors significantly affected CP% either in both seasons or their combined average.

2-Nitrogen uptake in grain:

Nitrogen uptake was determined as affected by N , Mn levels , Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average are given in Table (31).and Fig.4 (a, b and c)

2-1-Effect of nitrogen application:

The increase in nitrogen level markedly N uptake in both seasons and the combined average. Applying N at 50 , 100 and 150 kg / fed significantly increased N uptake by 19.00 , 43.76 and 56.35 kg / fed in 1997 season, respectively compared with the control level. These increases are relatively 200.63, 462.09 and 595.03 % of the N uptake of the check treatment.

In 1998 season, the three N levels 50 ,100 and 150 kg / fed increased N uptake over unfertilized treatment by 27.60 , 53.87 and 65.74 kg/fed, respectively. These increases correspond relative increases of 197.4 , 385.3 and 470.2 % of N uptake of zero N level.

Table 31 Effect of N, Mn levels , methods of Mn application and their intractions on N uptake in grain(kg/fed) in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
None	0	9.39	8.49	7.56	8.48	13.97	12.29	13.16	13.14	11.68	10.39	10.36	10.81
	70	9.42	11.81	8.22	9.81	11.77	16.97	16.26	15.00	10.60	14.39	12.24	12.41
	140	9.95	10.44	9.99	10.13	12.84	14.58	13.97	13.80	11.39	12.51	11.98	11.96
	Mean	**9.59**	**10.24**	**8.59**	**9.47**	**12.86**	**14.61**	**14.46**	**13.98**	**11.22**	**12.43**	**11.53**	**11.73**
50	0	22.09	29.94	29.44	27.16	42.90	41.02	37.20	40.37	32.49	35.48	33.32	33.76
	70	28.33	31.91	29.93	30.06	40.85	48.57	41 38	43.60	34.59	40.24	35.65	36.83
	140	29.32	30.04	25.26	28.21	40.35	41.47	40.46	40.76	34.83	35.76	32.86	34.48
	Mean	**26.58**	**30.63**	**28.21**	**28.47**	**41.37**	**43.69**	**39.68**	**41.58**	**33.97**	**37.16**	**33.95**	**35.03**
100	0	49.79	51.74	54.30	51.94	62.99	67.41	61.24	63.88	56.39	59.58	57.77	57.91
	70	57.10	57.24	50.89	55.08	69.49	78.45	78.69	75.55	63.30	67.85	64.79	65.31
	140	55.14	52.03	50.86	52.68	59.01	69.33	64.07	64.14	57.07	60.68	57.46	58.41
	Mean	**54.01**	**53.67**	**52.01**	**53.23**	**63.83**	**71.73**	**68.00**	**67.85**	**58.92**	**62.70**	**60.01**	**60.54**
150	0	68.82	64.68	66.92	66.80	72.23	81.43	74.93	76.20	70.52	73.05	70.92	71.50
	70	68.80	73.85	66.26	69.63	100.94	89.99	81.93	90.95	84.87	81.92	74.09	80.29
	140	63.29	57.63	62.14	61.02	80.02	66.05	69.93	72.00	71.66	61.84	66.04	66.51
	Mean	**66.97**	**65.38**	**65.10**	**65.82**	**84.40**	**79.16**	**75.60**	**79.72**	**75.68**	**72.27**	**70.35**	**72.77**
Mnxappl.	0	37.52	38.71	39.55	38.60	48.02	50.53	46.63	48.40	42.77	44.62	43.09	43.50
	70	40.91	43.70	38.82	41.15	55.76	58.50	54.56	56.27	48.34	51.10	46.69	48.71
	140	39.42	37.54	37.06	38.01	48.05	47.86	47.11	47.67	43.74	42.70	42.08	42.84
	Mean	**39.29**	**39.98**	**38.48**		**50.61**	**52.30**	**49.43**		**44.95**	**46.14**	**43.96**	

Comparisons:

LSD (0.05	N-level	(A)	1.52	1.25	1.34
	Mn-level	(B)	1.22	1.36	1.16
	Appli. Methods	(C)	1.22	1.36	1.16
		AXB	2.44	2.71	2.23
		AXC	2.44	2.71	2.23
		BXC	2.12	2.00	1.87
		AXBXC	4.23	4.69	3.84

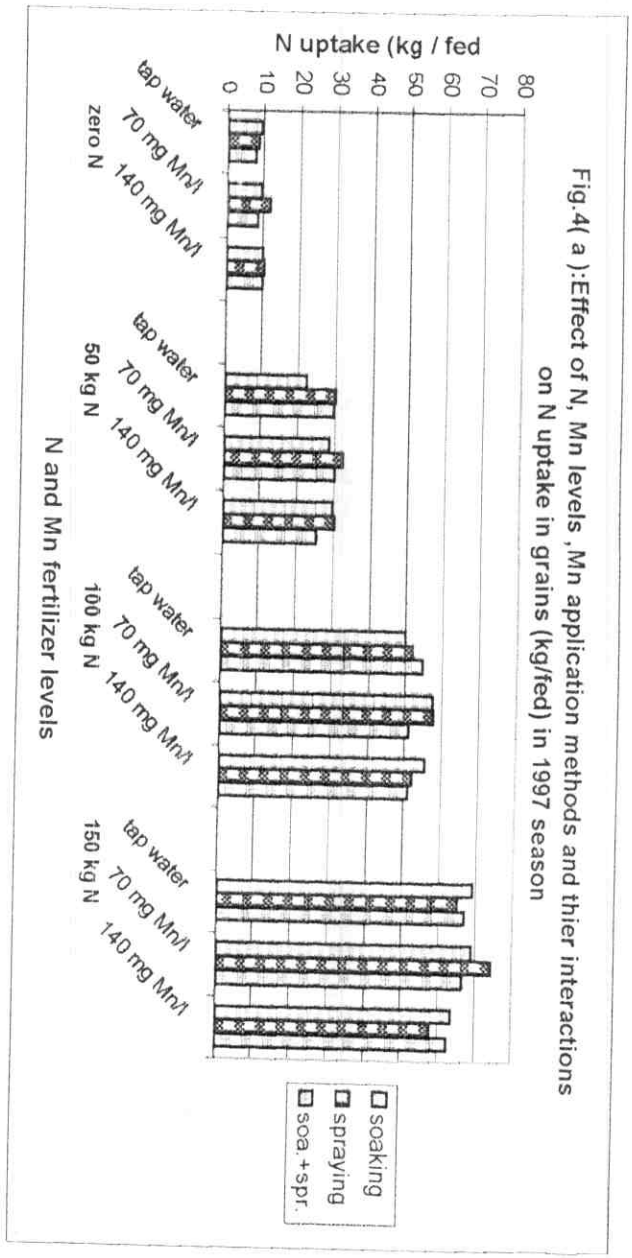

Fig.4(a):Effect of N, Mn levels ,Mn application methods and thier interactions on N uptake in grains (kg/fed) in 1997 season

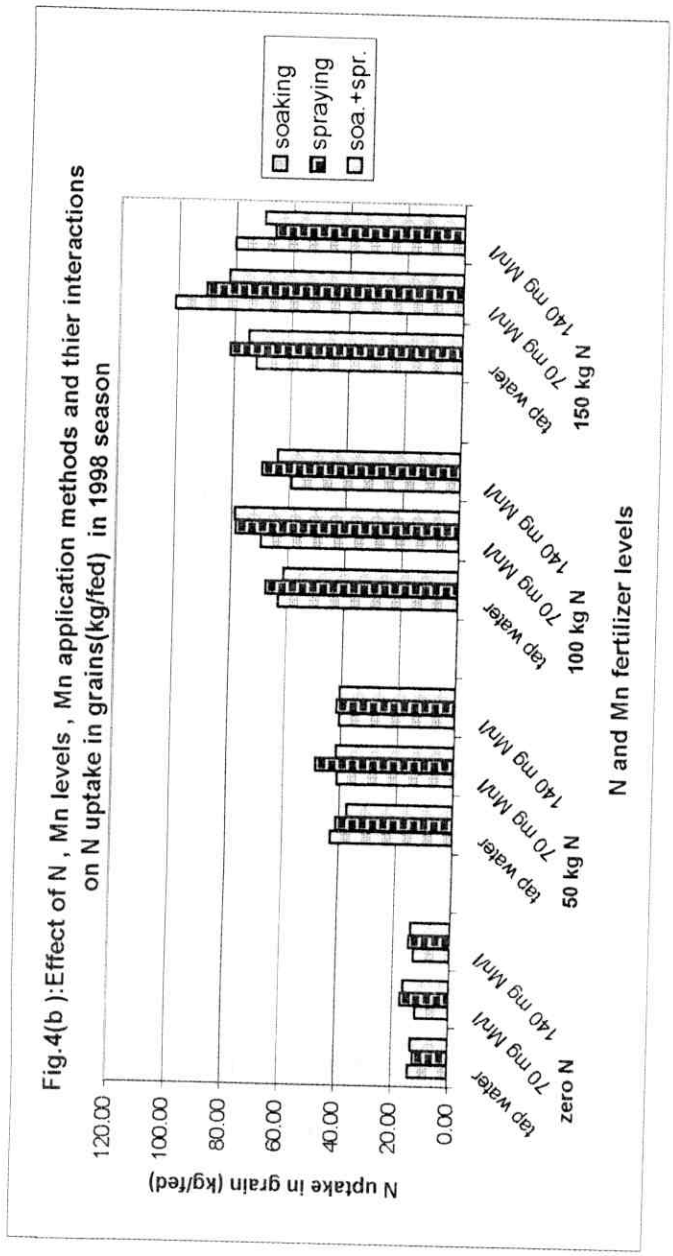
Fig.4(b):Effect of N , Mn levels , Mn application methods and thier interactions on N uptake in grains(kg/fed) in 1998 season
soaking
spraying
soa.+spr.
N uptake in grain (kg/fed)
120.00
100.00
80.00
60.00
40.00
20.00
0.00
N and Mn fertilizer levels
zero N
50 kg N
100 kg N
150 kg N
tap water
70 mg Mn/l
140 mg Mn/l

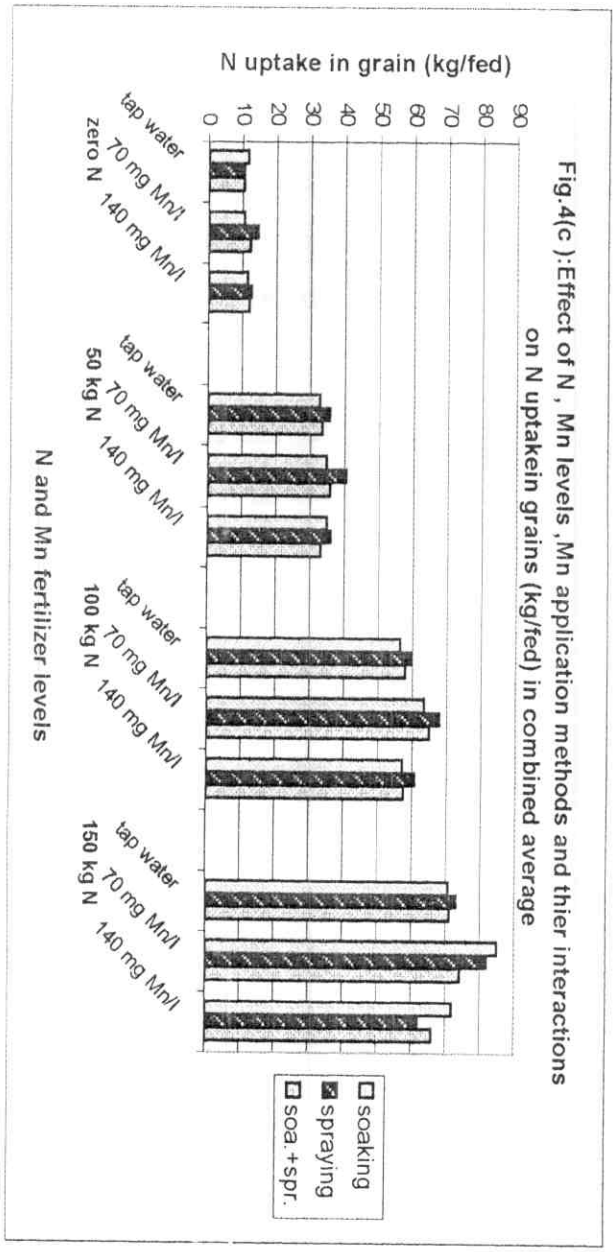

Fig.4(c):Effect of N , Mn levels ,Mn application methods and thier interactions on N uptakein grains (kg/fed) in combined average

The two seasons average indicated a marked increase in N uptake being 23.30 , 48.81 and 61.04 kg / fed due to applying 50 , 100 and 150 kg N / fed compared with control treatment. These increases are relatively 198.6 , 416.1 and 520.3 % over the control, respectively. The present results show clearly the need of maize plant to N specially when grown after wheat.

Similar results were also obtained by **Shafshak et al. (1994b); EL-Sheikh (1998) and Nofal (1999)** she found that N uptake markedly increased with increase in N level.

2-2-Effect of manganese application:

The results showed that Mn application significantly increased N uptake in both seasons (Table 31). Applying Mn at 70 mg Mn / l. increased N uptake by 6.60 , 16.26 and 11.9 % over the check treatment in 1997, 1998 and the combined average, respectively. Manganese has an essential role in N metabolisum since it activates a number of enzymes and ATP for photosynthesis (**Marschner, 1995**). An adequate supply of Mn is associated with vigorous vegetative growth and consequently increasing the uptake of N by plant.

Similar results were also obtained by **El–Sheikh (1998)** found that N uptake by grains significantly increased due to spraying 36 to 72 g Mn /fed. Increases N uptake in grain due to 36 , 72 and 108 g Mn / fed over the unsprayed treatment were 15.12 , 16.70 and 4.83 % ,respectively.

2-3-Effect of manganese application methods:

Results from the same Table indicated that foliar application method of Mn nutrient resulted a significant increase in N uptake in grain of maize. This is true in both growing

seasons as well as in the combined average. The highest mean values of N uptake when using this application method of Mn were 39.98 , 52.30 and 46.14 kg / fed in the 1st,2nd seasons and combined average, respectively.

Similar results were also reported by **Anon. (1985)** and **El –Sheikh (1998).**

2-4-Interaction effects:

The interaction effect of the various N and Mn rates was significant in the first , second seasons and combined average (Table 31). It could be concluded that the highest average N uptake (69.63 , 90.95 and 80.29 kg/fed) could be produced by combining between 150 kg N / fed + 70 mg Mn / l.

The interaction effect between the N levels and methods of Mn application on N uptake was significant in both seasons as well as in the combined average. Results indicated that the highest N uptake could be produced by applying the highest rate of N fertilizer (150 kg N /fed) and using foliar spraying as Mn application method.

Regarding the interaction effect between Mn rate and its application methods on N uptake was significant in 1997, 1998 seasons and combined average. Results showed that the highest N uptake in grain (43.7 , 58.5 and 51.1 kg /fed) could be produced by applying 70 mg Mn / l and using foliar spraying as Mn application method.

Also, the interaction between N x Mn x Mn application methods was significant. This is true in 1st,2nd seasons and combined average. The highest N uptake could be produced by combining 150 kg N / fed + 70 mg Mn / l + foliar spraying with

Mn (in1997season) or grain soaking in Mn solution (in 1998season & combined average.

Similar results were also obtained by **El-Sheikh (1998)** who found that application of 120 kg N / fed produced the highest values of N uptake which were 64.61 kg N /fed ,when Mn was spraied at 36-72 g /fed. The unfertilized N treatment produced the lowest values where Mn was present.

3-Phosphorus content in grain:

The effect of different N, Mn levels, various Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average on Phosphorus content in grain presented in Table (32).

3-1-Effect of nitrogen application:

Results presented in Table (32) show that the effect of N on P content in grain was significant in both growing seasons as well as in the combined average where a marked increase in P % was induce due to the increase in N application level. Soil application of 150 kg N /fed was significantly superior in stimulating P % absorption from the soil. The effect of the higher N level (150 kg N / fed) on P% in grains may be due to the effect of N in stimulation of root growth, vegetative growth as well as total dry matter content in maize plants.

Similar results were also showed by **Shafshak, et al. (1994b) and Badr, et al. (1997)**. On the other hand, **Salwau, (1985)** found that no effect on P % due to nitrogen application.

3-2-Effect of manganese application:

It is clear from the same Table that Mn concentrations showed a significant effect on the phosphorus content in grains

Table 32. Effect of N, Mn levels , methods of Mn application and their intractions on phosphorus content in grain in 1997 and 1998 seasons and their combined data ›

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	0.316	0.317	0.295	0.309	0.319	0.338	0.294	0.317	0.318	0.328	0.295	0.313
	70	0.358	0.328	0.342	0.343	0.332	0.357	0.331	0.340	0.345	0.343	0.337	0.341
	140	0.323	0.338	0.302	0.321	0.313	0.313	0.343	0.323	0.318	0.326	0.323	0.322
	Mean	**0.332**	**0.328**	**0.313**	**0.324**	**0.321**	**0.336**	**0.323**	**0.327**	**0.327**	**0.332**	**0.318**	**0.326**
50	0	0.353	0.356	0.322	0.344	0.346	0.339	0.329	0.338	0.350	0.348	0.326	0.341
	70	0.368	0.363	0.357	0.363	0.353	0.345	0.359	0.352	0.361	0.354	0.358	0.358
	140	0.369	0.356	0.323	0.349	0.326	0.332	0.332	0.330	0.348	0.344	0.328	0.340
	Mean	**0.363**	**0.358**	**0.334**	**0.352**	**0.342**	**0.339**	**0.340**	**0.340**	**0.353**	**0.349**	**0.337**	**0.346**
100	0	0.396	0.406	0.405	0.402	0.401	0.356	0.361	0.373	0.399	0.381	0.383	0.388
	70	0.412	0.436	0.408	0.419	0.384	0.383	0.395	0.387	0.398	0.410	0.402	0.403
	140	0.392	0.433	0.445	0.423	0.373	0.349	0.359	0.360	0.383	0.391	0.402	0.392
	Mean	**0.400**	**0.425**	**0.419**	**0.415**	**0.386**	**0.363**	**0.372**	**0.373**	**0.393**	**0.394**	**0.396**	**0.394**
150	0	0.519	0.525	0.536	0.527	0.488	0.537	0.535	0.520	0.504	0.531	0.536	0.523
	70	0.564	0.583	0.587	0.578	0.519	0.601	0.543	0.554	0.542	0.592	0.565	0.566
	140	0.566	0.570	0.518	0.551	0.545	0.547	0.561	0.551	0.556	0.559	0.540	0.551
	Mean	**0.550**	**0.559**	**0.547**	**0.552**	**0.517**	**0.562**	**0.546**	**0.542**	**0.534**	**0.561**	**0.547**	**0.547**
Mnxappl.	0	0.396	0.401	0.390	0.396	0.389	0.393	0.380	0.387	0.392	0.397	0.385	0.391
	70	0.426	0.428	0.424	0.426	0.397	0.422	0.407	0.409	0.411	0.425	0.415	0.417
	140	0.413	0.424	0.397	0.411	0.389	0.385	0.399	0.391	0.401	0.405	0.398	0.401
	Mean	**0.411**	**0.418**	**0.403**		**0.392**	**0.400**	**0.395**		**0.401**	**0.409**	**0.399**	

Comparisons:

LSD (0.05	N-level	(A)	0.023	0.026	0.024
	Mn-level	(B)	0.021	0.020	0.022
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

as was revealed from both seasons and combined average. Adding 70 mg Mn / l increased P %. While, the highest level of 140 mg Mn / l decreased it as compared with 70 mg/l level. The average P % for 70 mg Mn / l were0.426, 0.409 and 0.417 % in both studied seasons and combined average, respectively.

The same trend was observed by **Amin, et al (1987)** and **Abdel-Salam et al (1993a).**

3-3-Effect of manganese application methods:

Phosphorus content in grain was not significantly affected by methods of Mn application in both growing seasons as well as in the combined average. While, **Abdel-Salam et al. (1994)** found that soaking and soil application with Mn and different micronutrient gave more P-uptake than spraying.

3-4-Interaction effects:

The results presented in Table (32) showed that none of the interactions between the experimental factors significantly affected P % in grain either in both seasons or their combined average.

4-Potassium content in grains:

The results in Table (33) indicated the effect of nitrogen , manganese levels, and Mn application methods and their interactions on Potassium content in grains of maize in 1997 and 1998 seasons as well as their combined average.

4-1-Effect of nitrogen application:

It is clear from Table (33) that application of nitrogen fertilization levels significantly increased potassium percentage in grains in 1997 , 1998 seasons of experimentation as well as in the combined average. The higher N level (150 kg N / fed)

Table 33. Effect of N, Mn levels , methods of Mn application and their intractions on potassium contant in grain in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	0.319	0.308	0.309	0.312	0.316	0.318	0.320	0.318	0.318	0.313	0.315	0.315
	70	0.314	0.311	0.311	0.312	0.318	0.322	0.319	0.320	0.316	0.317	0.315	0.316
	140	0.310	0.310	0.318	0.313	0.321	0.324	0.324	0.323	0.316	0.317	0.321	0.318
	Mean	**0.314**	**0.310**	**0.313**	**0.312**	**0.318**	**0.321**	**0.321**	**0.320**	**0.316**	**0.316**	**0.317**	**0.316**
50	0	0.315	0.320	0.334	0.323	0.329	0.338	0.338	0.335	0.322	0.329	0.336	0.329
	70	0.344	0.340	0.332	0.339	0.344	0.350	0.349	0.348	0.344	0.345	0.341	0.343
	140	0.328	0.344	0.338	0.337	0.345	0.349	0.330	0.341	0.337	0.347	0.334	0.339
	Mean	**0.329**	**0.335**	**0.335**	**0.333**	**0.339**	**0.346**	**0.339**	**0.341**	**0.334**	**0.340**	**0.337**	**0.337**
100	0	0.359	0.358	0.358	0.358	0.358	0.359	0.356	0.358	0.359	0.359	0.357	0.358
	70	0.357	0.357	0.361	0.358	0.359	0.355	0.351	0.355	0.358	0.356	0.356	0.357
	140	0.354	0.353	0.338	0.348	0.356	0.363	0.363	0.361	0.355	0.358	0.351	0.355
	Mean	**0.357**	**0.356**	**0.352**	**0.355**	**0.358**	**0.359**	**0.357**	**0.358**	**0.357**	**0.358**	**0.355**	**0.356**
150	0	0.367	0.382	0.377	0.375	0.373	0.399	0.380	0.384	0.370	0.391	0.379	0.380
	70	0.394	0.396	0.385	0.392	0.395	0.384	0.365	0.381	0.395	0.390	0.375	0.387
	140	0.389	0.396	0.390	0.392	0.384	0.391	0.394	0.390	0.387	0.394	0.392	0.391
	Mean	**0.383**	**0.391**	**0.384**	**0.386**	**0.384**	**0.391**	**0.380**	**0.385**	**0.384**	**0.391**	**0.382**	**0.386**
Mnxappl.	0	0.340	0.342	0.345	0.342	0.344	0.354	0.349	0.349	0.342	0.348	0.347	0.345
	70	0.352	0.351	0.347	0.350	0.354	0.353	0.346	0.351	0.353	0.352	0.347	0.351
	140	0.345	0.351	0.346	0.347	0.352	0.357	0.353	0.354	0.348	0.354	0.349	0.351
	Mean	**0.346**	**0.348**	**0.346**		**0.350**	**0.354**	**0.349**		**0.348**	**0.351**	**0.348**	

Comparisons:

LSD (0.05	N-level	(A)	0.020	0.018	0.015
	Mn-level	(B)	N.S	N.S	N.S
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

significantly increased K % compared with the other N levels. This is true in both seasons and in the combined average. A higher N level (150 kg N /fed) gave the highest K content (0.386 , 0.385 and 0.386 %) in the 1st ,2nd and combined average, whereas, the unfertilized treatment gave the lowest concentration (0.312 % in 1997 season , 0.320 % in 1998 season and 0.316 % in the combined average). These results may be due to the fact that nitrogen fertilization increased root growth and the absorption of K from soil.

Result reported by **Shafshak, et al. (1994b), Badr, et al. (1997) and Lamlom (1997)** demonstrated that average of Effect of N application levels significant for grain K %.

4-2-Effect of manganese application:

Data from the same Table showed that the applied of different Mn rate insignificantly increased K % in grains of maize. This is true in both seasons and in the combined average. Similar results were obtained by **Allam (1983)**

4-3-Effect of manganese application methods:

Methods of Mn application did not exert any significant effect on the average of K content in grain of maize in both of growing seasons as well as in the combined average.

4-4-Interaction effects:

All effects of the interactions did not significantly influence K % in grain in both seasons and their combined average as shown in Table (33).

5-Mn content in grain (mg / kg):

The results in Table (34) show the effect of N ,Mn levels ,Mn application methods and their interaction of Mn content in

Table 34. Effect of N, Mn levels , methods of Mn application and their intractions on Mn content in grain (mg/kg) in 1997 and 1998 seasons and their combined data .

N-levels kg N /fed.	Mn-levels mg Mn/l	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
		soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	33.3	33.7	33.3	33.4	31.2	32.3	31.5	31.7	32.3	33.0	32.4	32.6
	70	35.5	35.6	35.3	35.5	33.7	33.8	33.8	33.8	34.6	34.7	34.6	34.6
	140	35.8	36.2	35.3	35.8	34.1	36.3	34.2	34.9	35.0	36.3	34.8	35.3
	Mean	**34.9**	**35.2**	**34.7**	**34.9**	**33.0**	**34.1**	**33.2**	**33.4**	**33.9**	**34.6**	**33.9**	**34.2**
50	0	34.2	35.0	33.8	34.3	34.8	34.1	34.0	34.3	34.5	34.6	33.9	34.3
	70	35.8	36.8	36.0	36.2	36.4	37.8	36.2	36.8	36.1	37.3	36.1	36.5
	140	36.1	36.0	36.5	36.2	38.6	38.4	38.0	38.3	37.4	37.2	37.2	37.3
	Mean	**35.4**	**35.9**	**35.4**	**35.6**	**36.6**	**36.8**	**36.0**	**36.5**	**36.0**	**36.4**	**35.7**	**36.0**
100	0	34.3	34.5	33.8	34.2	35.9	36.0	36.7	36.2	35.1	35.3	35.3	35.2
	70	36.2	36.7	35.9	36.2	38.3	38.5	39.2	38.7	37.3	37.6	37.5	37.5
	140	37.7	37.2	36.0	37.0	39.3	39.2	37.2	38.6	38.5	38.2	36.6	37.8
	Mean	**36.1**	**36.1**	**35.2**	**35.8**	**37.9**	**37.9**	**37.7**	**37.8**	**37.0**	**37.0**	**36.5**	**36.8**
150	0	33.7	34.0	35.0	34.2	36.7	36.2	35.3	36.1	35.2	35.1	35.2	35.1
	70	37.5	36.8	37.3	37.2	40.0	39.2	40.3	39.8	38.7	38.0	38.8	38.5
	140	39.0	36.3	39.7	38.3	39.7	39.7	38.2	39.2	39.3	38.0	38.9	38.8
	Mean	**36.7**	**35.7**	**37.3**	**36.6**	**38.8**	**38.3**	**37.9**	**38.4**	**37.8**	**37.0**	**37.5**	**37.5**
Mnxappl.	0	33.9	34.3	34.0	34.0	34.7	34.7	34.4	34.6	34.3	34.5	34.2	34.3
	70	36.2	36.5	36.1	36.3	37.1	37.3	37.4	37.3	36.7	36.9	36.7	36.8
	140	37.2	36.4	36.9	36.8	37.9	38.4	36.9	37.7	37.6	37.4	36.9	37.3
	Mean	**35.8**	**35.7**	**35.7**		**36.6**	**36.8**	**36.2**		**36.2**	**36.3**	**35.9**	

Comparisons:					
LSD (0.05	N-level	(A)	0.85	0.83	0.75
	Mn-level	(B)	0.62	0.69	0.60
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

maize grain in 1997 and 1998 seasons as well as in the combined average.

5-1-Effect of nitrogen application :

Results in Table (34) indicated that application of 150 kg N/fed produced the highest values of Mn content in maize grain in the 1^{st} ,2^{nd} seasons as well as in the combined average of both seasons. Which were 36.6 , 38.4 and 37.5 mg / kg, respectively. On the other hand, the unfertilized treatment gave the lowest mean values in the first and second seasons as well as in the combines average. Which were 34.9 , 33.4 and 34.2 mg /kg, respectively. The positive effect of N on Mn reflection of its positive response and improve plant growth and increased grain yield due to application N .

5-2-Effect of manganese application:

It is clear from the same Table that Mn in maize grain increased by Mn fertilizer. This is true in both seasons and in the combined average. Increases Mn content in grain due to 70 to 140 mg Mn / l over the unfertilized treatment were 7.29 and 8.75 % in the combined average, respectively .

Similar results were obtained by **Amin et al. (1987)** who found that Mn application increased Mn concentration. Also, **Abdel-Salam et al (1993a)** reported that Mn in maize grain increased by Mn application. On the other hand, **Allam (1983)** found that the effect of the applied Mn on manganese content in maize grain was insignificant.

5-3- Effect of manganese application methods :

It is evident from the same Table that the differences between the average values of Mn application method on Mn

content in maize grain were not significant in both growing seasons as well as the combined average.

5-4- Interaction effects :

All the effect of the interactions between the experimental factors were not significant on Mn content in maize grian in both seasons as well as in the combined average.

6-Mn uptake in maize grain:

The results in Table (35) and Fig.5 (a ,b and c)indicated the effect of nitrogen , manganese levels ,methods of Mn application and their interaction on Mn uptake in 1997 and 1998 seasons as well as their combined average.

6-1-Effect of nitrogen application:

Results presented in Table (35) indicated clear that Mn uptake in maize grain (g / fed) significantly increased with increases in N level in both growing seasons as well as in the combined average. Applying the highest rate of N fertilizer (150 kg N / fed) produced the highest average of Mn uptake in both seasons and combined average which were 137.9 , 172.0 and 154.9 g / fed , respectively. On the other hand, the unfertilized treatment gave the lowest mean values in the first and second seasons as well as in the combines average. Which were 24.8 , 32.3 and 28.5 g / fed, respectively. The positive effect of N on Mn reflection of its positive response and improve plant growth and increased grain yield due to application N .

6-2-Effect of manganese application:

It is clear from data of Table (35) that application of Mn increased the Mn uptake by adding 70 mg Mn / l. While, a further increase in Mn rate up to 140 mg Mn / l decreased Mn

Table 35. Effect of N, Mn levels , methods of Mn application and their intractions on Mn uptake (g/fed) in 1997 and 1998 seasons and their combined data .

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	23.7	21.9	19.3	21.6	30.4	27.0	30.2	29.2	27.1	24.4	24.7	25.4
	70	24.1	30.2	21.3	25.2	27.2	37.3	37.4	34.0	25.6	33.8	29.4	29.6
	140	26.8	28.2	27.5	27.5	30.5	37.5	33.2	33.7	28.7	32.9	30.3	30.6
	Mean	**24.9**	**26.8**	**22.7**	**24.8**	**29.4**	**34.0**	**33.6**	**32.3**	**27.1**	**30.4**	**28.1**	**28.5**
50	0	52.5	71.6	70.0	64.7	93.1	84.7	79.0	85.6	72.8	78.2	74.5	75.1
	70	68.2	83.8	74.3	75.4	93.0	113.3	93.8	100.1	80.6	98.6	84.1	87.7
	140	73.8	73.9	65.0	70.9	104.8	98.2	101.1	101.3	89.3	86.1	83.0	86.1
	Mean	**64.8**	**76.5**	**69.7**	**70.3**	**97.0**	**98.7**	**91.3**	**95.7**	**80.9**	**87.6**	**80.5**	**83.0**
100	0	106.7	108.9	113.7	109.8	133.0	140.6	140.1	137.9	119.9	124.7	126.9	123.8
	70	131.7	126.5	116.0	124.7	152.7	170.4	175.7	166.3	142.2	148.5	145.8	145.5
	140	132.7	119.3	115.6	122.5	138.6	157.8	139.5	145.3	135.6	138.5	127.6	133.9
	Mean	**123.7**	**118.2**	**115.1**	**119.0**	**141.5**	**156.3**	**151.8**	**149.8**	**132.6**	**137.2**	**133.4**	**134.4**
150	0	135.7	122.7	132.3	130.2	153.4	171.0	154.2	159.5	144.6	146.8	143.2	144.9
	70	144.7	147.8	138.2	143.6	209.1	192.7	181.2	194.3	176.9	170.3	159.7	168.9
	140	141.1	132.6	145.8	139.8	176.1	155.5	154.9	162.2	158.6	144.1	150.4	151.0
	Mean	**140.5**	**134.4**	**138.8**	**137.9**	**179.5**	**173.0**	**163.4**	**172.0**	**160.0**	**153.7**	**151.1**	**154.9**
Mnxappl.	0	79.7	81.3	83.8	81.6	102.5	105.8	100.9	103.0	91.1	93.5	92.3	92.3
	70	92.2	97.1	87.5	92.2	120.5	128.4	122.0	123.7	106.3	112.8	104.7	107.9
	140	93.6	88.5	88.5	90.2	112.5	112.2	107.2	110.6	103.1	100.4	97.8	100.4
	Mean	**88.5**	**89.0**	**86.6**		**111.8**	**115.5**	**110.0**		**100.2**	**102.2**	**98.3**	

Comparisons:

LSD (0.05	**N-level**	(A)	2.6	2.7	2.3
	Mn-level	(B)	2.0	2.1	1.9
	Appli. Methods	(C)	2.0	2.1	1.9
		AXB	4.1	4.3	4.1
		AXC	4.1	4.3	4.1
		BXC	3.5	3.7	3.2
		AXBXC	7.0	7.4	6.8

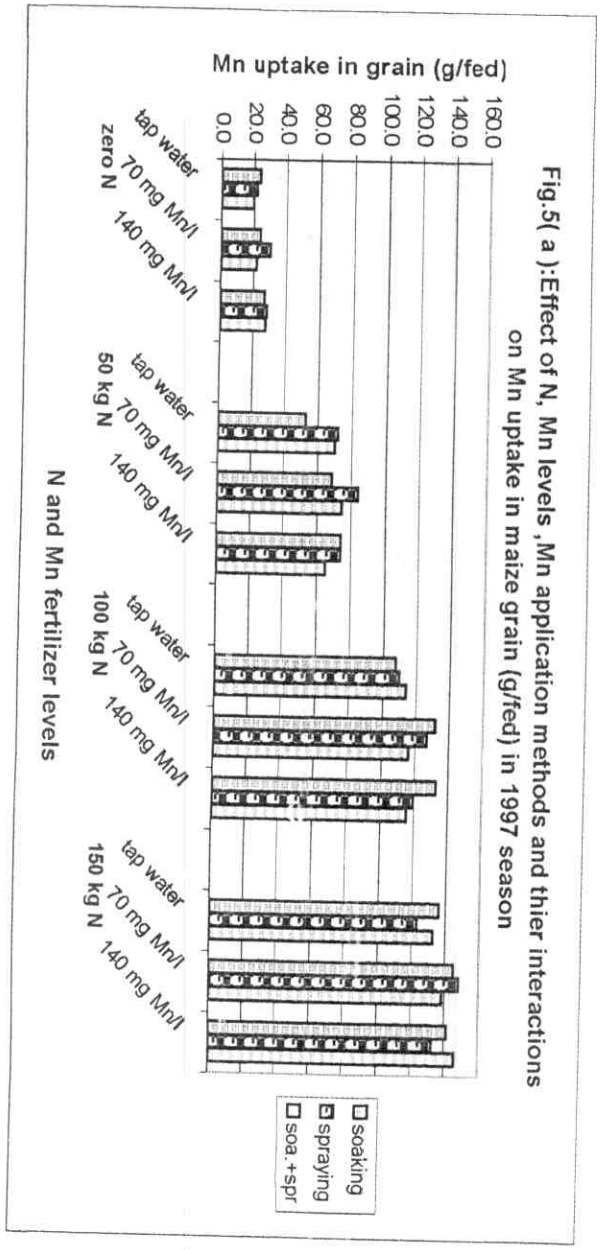

Fig.5(a):Effect of N, Mn levels ,Mn application methods and thier interactions on Mn uptake in maize grain (g/fed) in 1997 season

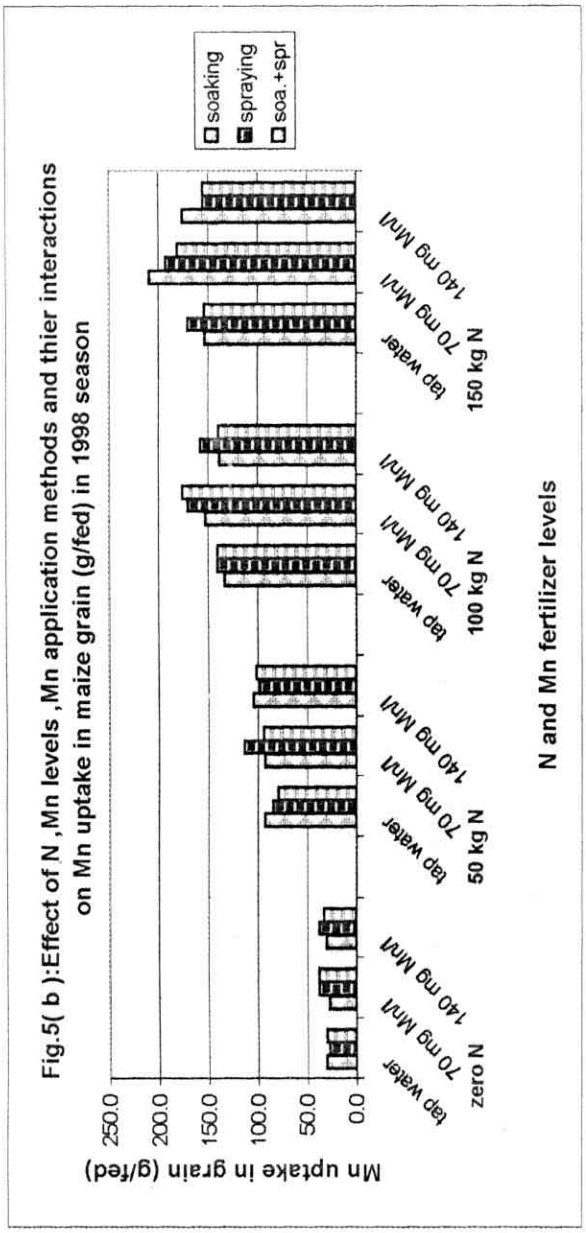
Fig.5(b):Effect of N ,Mn levels ,Mn application methods and thier interactions on Mn uptake in maize grain (g/fed) in 1998 season
Mn uptake in grain (g/fed)
250.0
200.0
150.0
100.0
50.0
0.0
soaking
spraying
soa.+spr
tap water
70 mg Mn/l
140 mg Mn/l
zero N
50 kg N
100 kg N
150 kg N
N and Mn fertilizer levels

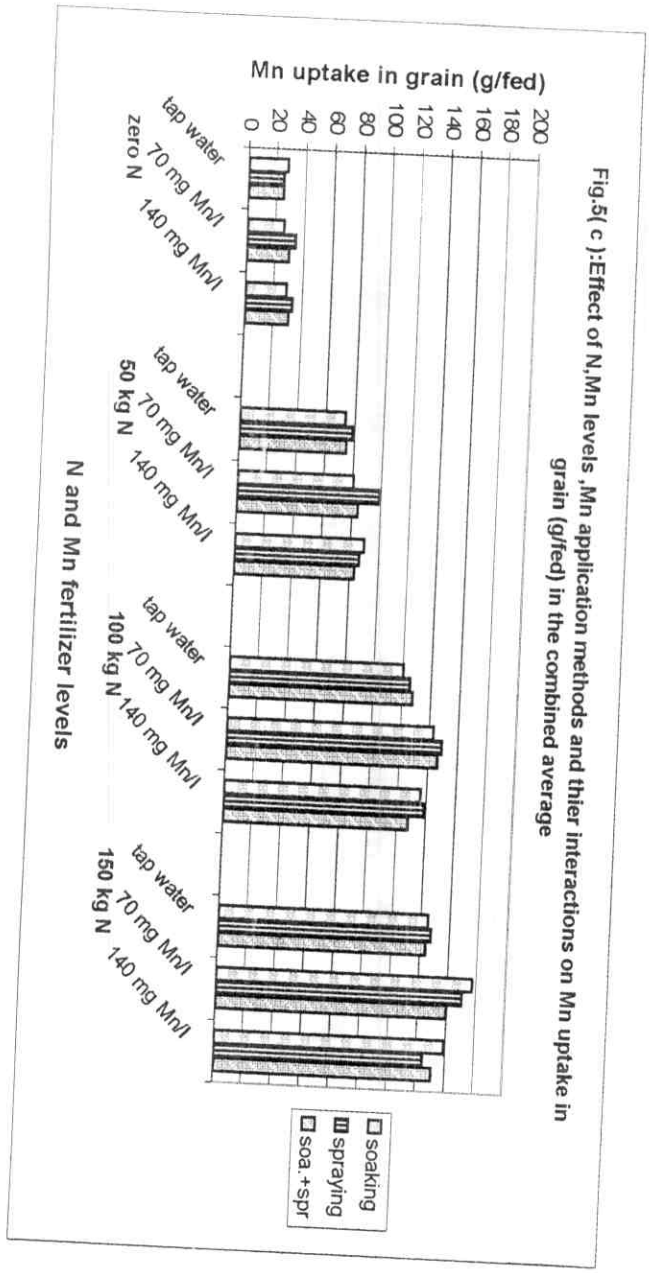

Fig.5(c):Effect of N,Mn levels ,Mn application methods and thier interactions on Mn uptake in grain (g/fed) in the combined average

uptake. Higher concentration of Mn (140 mg Mn / l) may cause a poisonous effect on maize plant. The highest Mn uptake 92.2 , 122.0 and 107.9 g / fed in 1997 , 1998 seasons and combined average respectively were obtained by applying 70 mg Mn / l.

This result agrees with those reported by **Abdel-Salam et al (1993a).**

6-3-Effect of manganese application methods:

It is clear from the same Table that foliar application methods of Mn resulted a significant increase in Mn uptake. The highest mean values of Mn uptake were 89.0, 115.5 and 102.2 g /fed produced when using foliar spraying as Mn application method in 1997, 1998 seasons and combined average, respectively.

Similar results were also reported by **Abdel-Salam et al. (1993a).**

6-4- Interaction effects:

Results in Table (35) show that the interaction effect of N x Mn rates was significant in the first , second seasons and combined average. It could be concluded that the highest average Mn uptake (143.6 , 194.3 and 168.9 g /fed) could be produced by combining between 150 kg N / fed + 70 mg Mn/l.

The interaction effect between the N levels x Mn application methods on Mn uptake was significant in both seasons as well as in the combined average. Results indicated that the highest Mn uptake could be produced by applying the highest rate of N fertilizer (150 kg N / fed) and using grain soaking as Mn application method.

The interaction effect between Mn rate and its application

methods on Mn uptake was significant in 1997, 1998 seasons and combined average. Results showed that the highest Mn uptake in maize grain (97.1 , 128.4 and 112.8 g /fed) could be produced by applying 70 mg Mn /l and using foliar spraying as Mn application method.

Also, the interaction between N x Mn x Mn application methods was significant in both seasons and in the combined average. The highest N uptake could be produced by combining 150 kg N /fed + 70 mg Mn /l + foliar spraying with Mn (in1997season) or grain soaking in Mn solution (in 1998season & combined average).

7-Oil content in maize grains:

Data on oil content in maize grain as effected by N , Mn levels , Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average are shown in Table (36).

7-1-Effect of nitrogen application:

It was clear from Table (36) that oil % was gradually increased by increasing N fertilizer level up to 150 kg N / fed in both seasons and combined average.

Applying 50 , 100 and 150 kg N /fed increased oil % over the control treatment by 3.95, 14.70 and 30.48 % in 1997 season and by 3.38 , 7.80 and 31.80 % in 1998 season , being 3.65 , 11.18 and 31.20 % in the combined average.

This results are in line with those obtained by **El-Kholy (1987)** who found that N fertilizer tended to cause a slight insignificant increase in oil %.

Table 36. Effect of N, Mn levels , methods of Mn application and their intractions on 0il % in 1997 and 1998 seasons and their combined data

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	4.43	4.63	4.50	4.52	4.80	4.77	4.57	4.71	4.62	4.70	4.53	4.62
	70	4.70	4.83	4.80	4.78	5.03	5.20	4.63	4.96	4.87	5.02	4.72	4.87
	140	4.47	4.37	4.30	4.38	4.23	4.70	4.70	4.54	4.35	4.53	4.50	4.46
	Mean	**4.53**	**4.61**	**4.53**	**4.56**	**4.69**	**4.89**	**4.63**	**4.74**	**4.61**	**4.75**	**4.58**	**4.65**
50	0	4.40	4.57	4.43	4.47	5.03	4.97	4.87	4.96	4.72	4.77	4.65	4.71
	70	4.97	5.17	4.93	5.02	4.90	5.03	5.00	4.98	4.93	5.10	4.97	5.00
	140	4.90	4.77	4.50	4.72	4.70	5.00	4.63	4.78	4.80	4.88	4.57	4.75
	Mean	**4.76**	**4.83**	**4.62**	**4.74**	**4.88**	**5.00**	**4.83**	**4.90**	**4.82**	**4.92**	**4.73**	**4.82**
100	0	5.33	5.17	5.03	5.18	5.07	5.00	5.13	5.07	5.20	5.08	5.08	5.12
	70	5.47	5.57	5.73	5.59	5.57	5.40	5.03	5.33	5.52	5.48	5.38	5.46
	140	5.13	5.17	4.50	4.93	4.87	5.13	4.83	4.94	5.00	5.15	4.67	4.94
	Mean	**5.31**	**5.30**	**5.09**	**5.23**	**5.17**	**5.18**	**5.00**	**5.11**	**5.24**	**5.24**	**5.04**	**5.17**
150	0	6.10	6.13	5.93	6.06	5.93	6.20	5.90	6.01	6.02	6.17	5.92	6.03
	70	6.17	5.73	5.80	5.90	6.30	6.43	6.40	6.38	6.23	6.08	6.10	6.14
	140	5.90	5.80	5.97	5.89	6.50	6.13	6.43	6.36	6.20	5.97	6.20	6.12
	Mean	**6.06**	**5.89**	**5.90**	**5.95**	**6.24**	**6.26**	**6.24**	**6.25**	**6.15**	**6.07**	**6.07**	**6.10**
Mnxappl.	0	5.07	5.13	4.97	5.06	5.21	5.23	5.12	5.19	5.14	5.18	5.05	5.12
	70	5.33	5.33	5.32	5.32	5.45	5.52	5.27	5.41	5.39	5.42	5.29	5.37
	140	5.10	5.03	4.82	4.98	5.08	5.24	5.15	5.16	5.09	5.13	4.98	5.07
	Mean	**5.16**	**5.16**	**5.04**		**5.24**	**5.33**	**5.18**		**5.20**	**5.24**	**5.11**	

Comparisons:				
LSD (0.05	N-level	(A)	0.36	0.15	0.16
	Mn-level	(B)	N.S	N.S	N.S
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

7-2-Effect of manganese application:

Regarding the Mn application levels, it did not affect the oil % significantly in both seasons as well as in the combined average (Table 36).

7-3-Effect of manganese application methods:

It is obviously clear that there were no appreciable significant differences in the oil % of maize grains by using the other different Mn application methods in both seasons and combined average.

7-4-Interaction effects:

All the effect of the interactions between the experimental factors were not significant on oil % in both seasons as well as in the combined average.

8-Total carbohydrate content:

Data on total carbohydrate % as effected by N , Mn levels , Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average are shown in Table (37).

8-1-Effect of nitrogen application :

It is clear from Table (37) that N levels significantly affected on total carbohydrate % in the two successive seasons and combined average.

In 1997 season, applying 50 , 100 and 150 kg N /fed decreased total carbohydrate % by 3.94, 6.57 and 6.89 % respectively. and by 4.30 , 5.55 and 5.39 % in 1998 season at the same N levels as compared with zero level of N . Similarly, the combined average N at 50 , 100 and 150 kg /fed decreased total carbohydrate % by 4.12 , 6.15 and 6.15 %, respectively

Table 37. Effect of N, Mn levels , methods of Mn application and their intractions on total carbohydrates content in 1997 and 1998 seasons and their combined data

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean	soaking	spraying	soa.+spr	Mean
None	0	71.3	71.2	71.5	71.3	70.2	70.2	69.8	70.1	70.8	70.7	70.6	70.7
	70	71.1	71.0	70.7	71.0	70.1	70.3	70.8	70.4	70.6	70.7	70.8	70.7
	140	71.8	71.5	71.2	71.5	70.2	70.6	70.2	70.4	71.0	71.1	70.7	70.9
	Mean	**71.4**	**71.2**	**71.1**	**71.3**	**70.2**	**70.4**	**70.3**	**70.3**	**70.8**	**70.8**	**70.7**	**70.8**
50	0	68.1	68.2	69.2	68.5	66.9	67.7	68.1	67.6	67.5	68.0	68.7	68.0
	70	69.1	69.1	69.1	69.1	66.9	66.5	67.4	67.0	68.0	67.8	68.3	68.0
	140	68.4	68.0	68.1	68.2	67.6	67.5	67.6	67.5	68.0	67.7	67.9	67.9
	Mean	**68.6**	**68.4**	**68.8**	**68.6**	**67.1**	**67.2**	**67.7**	**67.4**	**67.8**	**67.8**	**68.3**	**68.0**
100	0	66.2	66.8	66.1	66.4	66.6	66.8	66.2	66.5	66.4	66.8	66.1	66.5
	70	67.1	68.1	67.3	67.5	66.1	67.5	66.7	66.8	66.6	67.8	67.0	67.1
	140	66.2	67.2	67.1	66.8	67.1	66.8	65.2	66.4	66.7	67.0	66.2	66.6
	Mean	**66.5**	**67.4**	**66.8**	**66.9**	**66.6**	**67.0**	**66.0**	**66.6**	**66.5**	**67.2**	**66.4**	**66.7**
150	0	67.8	67.0	66.8	67.2	67.3	68.2	67.7	67.7	67.6	67.6	67.3	67.5
	70	66.5	66.0	67.2	66.6	66.8	66.1	66.4	66.4	66.6	66.1	66.8	66.5
	140	66.5	66.1	66.4	66.3	65.9	65.7	66.1	65.9	66.2	65.9	66.3	66.1
	Mean	**66.9**	**66.4**	**66.8**	**66.7**	**66.7**	**66.7**	**66.7**	**66.7**	**66.8**	**66.5**	**66.8**	**66.7**
Mnxappl.	0	68.4	68.3	68.4	68.4	67.8	68.2	67.9	68.0	68.1	68.3	68.2	68.2
	70	68.5	68.6	68.6	68.5	67.5	67.6	67.8	67.6	68.0	68.1	68.2	68.1
	140	68.2	68.2	68.2	68.2	67.7	67.7	67.3	67.6	68.0	67.9	67.7	67.9
	Mean	**68.3**	**68.3**	**68.4**		**67.6**	**67.8**	**67.7**		**68.0**	**68.1**	**68.0**	

Comparisons:

LSD (0.05	N-level	(A)	1.6	1.3	0.9
	Mn-level	(B)	N.S	N.S	N.S
	Appli. Methods	(C)	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

compared with the control treatment. The difference between 100 and 150 kg N / fed was not significant. However, **Badr et al. (1997)** found that N fertilizer had no effect on the content of total carbohydrate % in maize grains.

8-2-Effect of manganese application:

Mn concentrations showed insignificant effect on the total carbohydrate % in both seasons and combined average.

8-3-Effect of manganese application methods:

Methods of Mn application did not exert any significant effect on the average of total carbohydrate % in both seasons as well as in the combined average.

8-4-Interaction effects:

All the effect of the interactions between the experimental factors were not significant on total carbohydrate % in both seasons as well as in the combined average.

VII- Nitrogen economic (agronomic) efficiency and apparent nitrogen recovery in grain:

1-Nitrogen economic (agronomic) efficiency:

Results in Table (38) and Fig. 6 (a, b and c) show the values of N economic efficiency as affected by N , Mn levels , Mn application methods and their interactions in 1997 and 1998 seasons as well as in the combined average.

1-1-Effect of nitrogen application:

The results showed that applying 100 kg N /fed produced the greatest N economic efficiency in 1997 season (26.53 kg), while in 1998 season applying 50 kg N /fed recorded the highest efficiency, being 33.04 kg grain per one kg N. On the average of

Table 38. Effect of N, Mn levels , methods of Mn application and their intractions on N economic efficincey (NEE) in 1997 and 1998 seasons and their combined data

N-levels	Mn-levels	1997 Season				1998 Season				Combined analysis			
		Methods of Mn-application				Methods of Mn-application				Methods of Mn-application			
kg N /fed.	mg Mn/l	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean	soaking	spraying	soa.+spr.	Mean
50	0	16.42	27.99	29.78	24.73	33.97	32.86	27.37	31.40	25.19	30.43	28.57	28.07
	70	24.55	28.53	29.18	27.42	34.89	37.82	29.73	34.15	29.72	33.17	29.45	30.78
	140	25.89	25.51	20.07	23.82	36.34	30.52	33.84	33.57	31.11	28.02	26.95	28.69
	Mean	**22.28**	**27.35**	**26.35**	**25.32**	**35.07**	**33.73**	**30.31**	**33.04**	**28.68**	**30.54**	**28.33**	**29.18**
100	0	23.99	25.11	27.82	25.64	27.28	30.63	28.58	28.83	25.64	27.87	28.20	27.23
	70	29.65	29.62	26.30	28.52	31.76	33.26	33.76	32.93	30.71	31.44	30.03	30.73
	140	27.67	24.29	24.34	25.43	26.29	29.93	27.84	28.02	26.98	27.11	26.09	26.73
	Mean	**27.10**	**26.34**	**26.15**	**26.53**	**28.44**	**31.27**	**30.06**	**29.93**	**27.77**	**28.81**	**28.11**	**28.23**
150	0	22.13	19.90	21.34	21.12	21.37	25.93	22.71	23.34	21.75	22.91	22.02	22.23
	70	21.24	21.10	20.70	21.01	29.47	25.43	22.55	25.82	25.35	23.27	21.63	23.41
	140	19.13	19.14	19.32	19.19	23.63	19.25	20.60	21.16	21.38	19.19	19.96	20.18
	Mean	**20.83**	**20.05**	**20.45**	**20.44**	**24.82**	**23.54**	**21.95**	**23.44**	**22.83**	**21.79**	**21.20**	**21.94**
Mnxappl.	0	15.63	18.25	19.73	17.87	20.66	22.36	19.66	20.89	18.14	20.30	19.70	19.38
	70	18.86	19.81	19.05	19.24	24.03	24.13	21.51	23.22	21.44	21.97	20.28	21.23
	140	18.17	17.23	15.93	17.11	21.57	19.93	20.57	20.69	19.87	18.58	18.25	18.90
	Mean	**17.55**	**18.43**	**18.24**		**22.08**	**22.14**	**20.58**		**19.82**	**20.28**	**19.41**	

Comparisons:

LSD (0.05	**N-level**	**(A)**	3.14	3.84	2.65
	Mn-level	**(B)**	N.S	2.12	1.33
	Appli. Methods	**(C)**	N.S	N.S	N.S
		AXB	N.S	N.S	N.S
		AXC	N.S	N.S	N.S
		BXC	N.S	N.S	N.S
		AXBXC	N.S	N.S	N.S

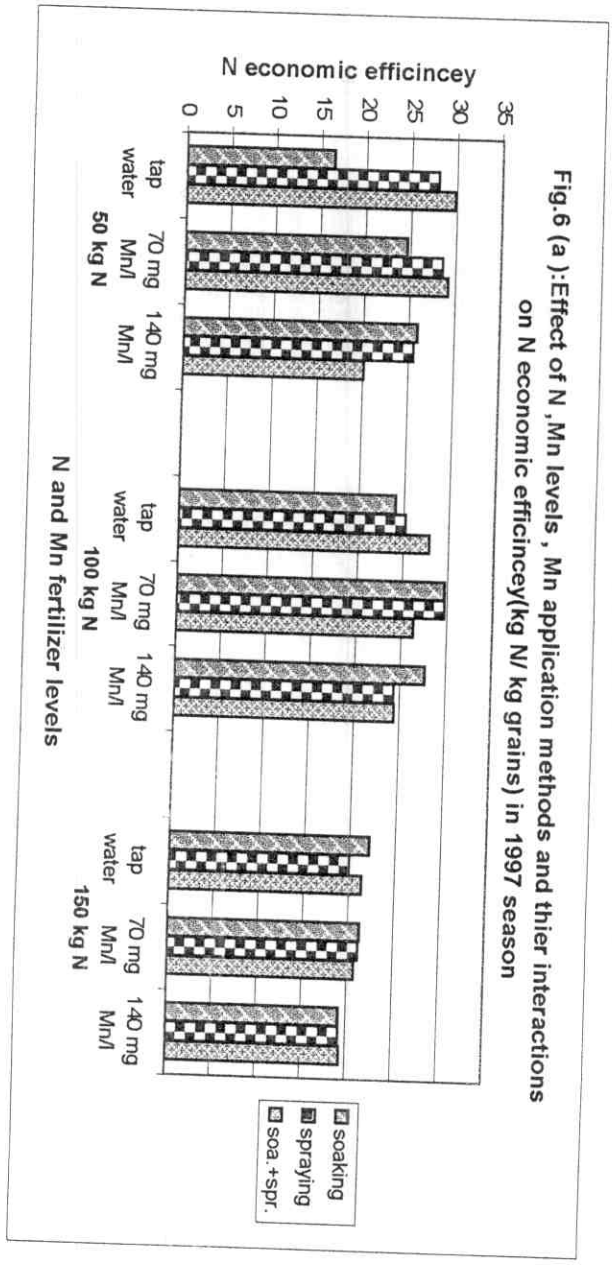

Fig.6 (a):Effect of N ,Mn levels , Mn application methods and thier interactions on N economic efficincey(kg N/ kg grains) in 1997 season

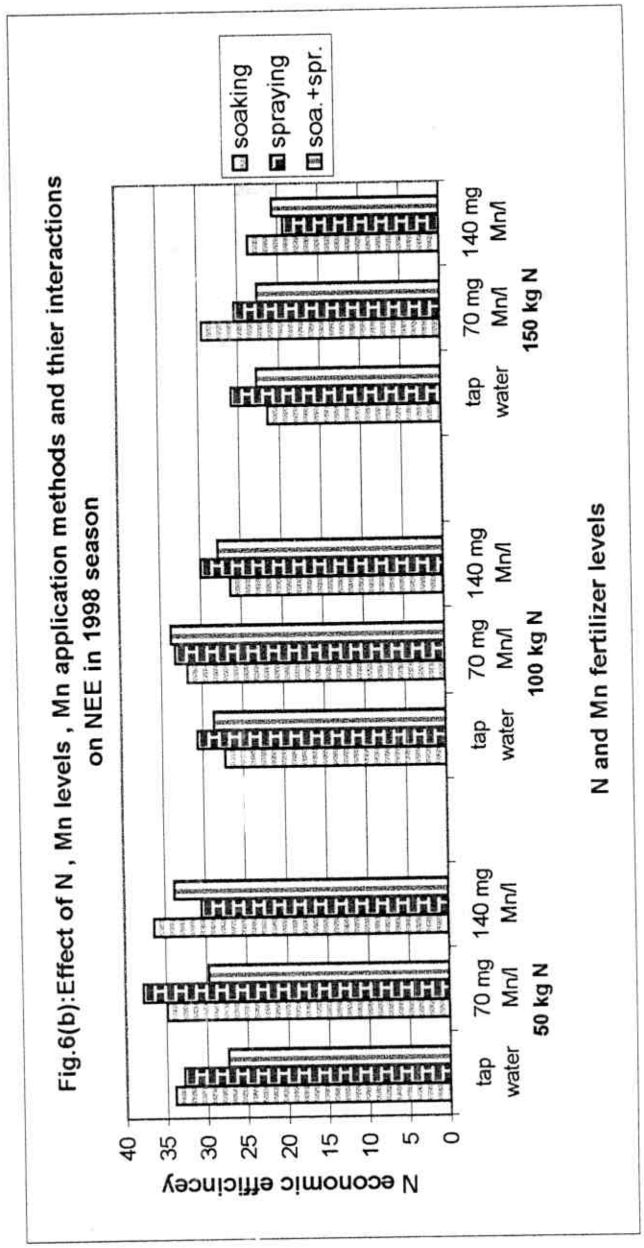

Fig.6(b):Effect of N , Mn levels , Mn application methods and thier interactions on NEE in 1998 season

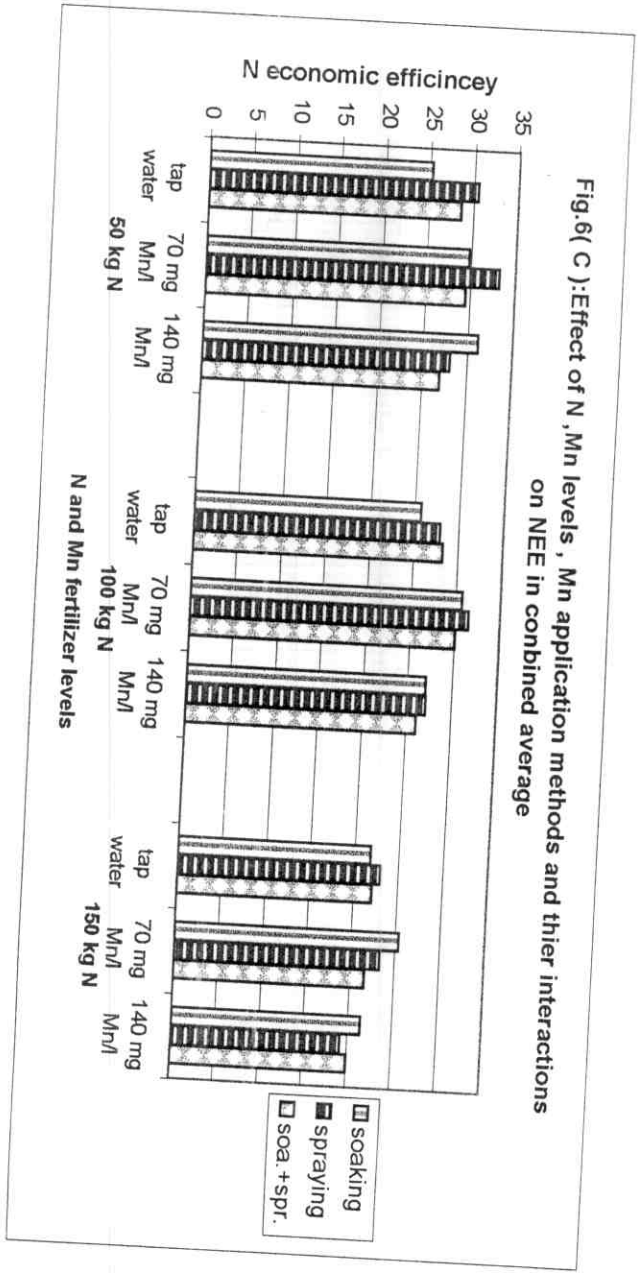

Fig.6(C):Effect of N ,Mn levels , Mn application methods and thier interactions on NEE in conbined average

both seasons, 50 kg N /fed recorded the greatest N economic efficiency, being 29.18 kg grain per one kg N. Applying the highest N levels, i.e. 150 kg N /fed recorded 20.44 , 23.44 and 21.94 kg in 1997 , 1998 and in the combined average, respectively.

The results obtained by **Nofal (1999)** reported that N economic efficiency decrased when N fertilizer increased . Also, **Zaghloul (1999)** found that application 150 kg N /fed gave the lowest values of N economic efficiency. While, **Shafshak et al (1994b)** showed that N economic efficiency markedly increased due to the increase in N level.

From the economic point of view, it is worth to indicate that the use of 150 kg N /fed would be profitable, since the price of 1 kg N is L.E. 1.33 and the price of 1 kg maize grains is L.E. 0.50 {according to the Official Prices announced on July, 1st 2000}(*).

1-2-Effect of manganese application:

It is clear from the same Table that adding 70 mg Mn /l gave the highest values of N economic efficiency (19.24, 23.22 and 21.23) in 1st,2nd seasons and combined average, respectively. However, the difference between Mn rates in the 1997 season insignificant.

Such results assert the positive effect of Mn application to such a soil having 8.5 mg Mn/ kg. Similar results were also found by **El-Sheikh (1998)** who showed that spraying 36 to 72 g Mn /fed gave the highest values of NEE.

(*) Official Prices declared by the Egyptian Agricultural Credit and Development Bank on the first of July,2000.

1-3-Effect of manganese application methods:

No observed difference was detected in average N economic efficiency (NEE) as a results of various manganese application methods in both seasons as well as in the combined average (Table 39)

1-4-Interaction effects:

The results in (Table 38) showed that all effects of the interactions between the studied factors were not significant which indicates that each factor acted independently in affecting NEF in maize plant. On the other hand, **El-Sheikh (1998)** found that application of 36 to 72 g Mn /fed gave significant increases in NEF only where 120 or 160 kg N was applied.

2- Apparent nitrogen recovery (ANR):

The results in Table (39) and Fig.7 (a, b and c) show the effect of N ,Mn levels ,Mn application methods and their interaction of N recovery in 1997 and 1998 seasons as well as in the combined average.

2-1-Effect of nitrogen application:

The results indicated that the highest apparent N recovery % was recorded by applying 100 kg N /fed in 1997 season, while in 1998 season the application of 50 kg N /fed recorded the highest recovery % ,being 43.76 and 55.20 % in 1997 and 1998 seasons respectively. On the average of both seasons, applying 50 , 100 and 150 kg N /fed recorded apparent N recovery % of 46.60 , 48.82 and 40.69 % . This results indicates generally that the ANR decreased with the increase in N level.

The results reported by **Mahgoub (1987)** indicated that N recovery tended to decrease as N fertilizer increased but the

difference between N rates were not significant. Also, **Nofal (1999)** found that the recovery % decreased with the increase in N level on the average of both seasons. While, **Zaghloul (1999)** reported that application 150 kg N/fed gave the lowest values of N recovery in maize grain. Whereas, adding 100 kg N /fed produced the highest values of N recovery. However, the difference between 50 and 100 kg N /fed was insignificant. On the other hand, **Shafshak et al (1994b)** found that N recovery was increased as N level increased from 80 to 105 and 130 kg /fed. They recorded N recovery % of 16.7 , 19.85 and 25.97 for the N levels 80 , 105 and 130 kg /fed, respectively on the average of 1991 and 1992 seasons.

2-2-Effect of manganese application:

It is clear from (Table 39) that applying 70 mg Mn /l significantly increased N recovery % in both seasons as well as in the combined average. While, a further increase up to 140 mg Mn / l decreased it. The mean values due to adding 70 mg Mn /l were 31.41 , 42.10 and 36.75 % in 1997 and 1998 seasons as well as in the combined average, respectively.

Similar results were also reported by **El-Sheikh, (1998)** who found that spraying 36-72 g Mn /fed gave the highest values of N recovery % (18.39 to 18.27 %). While, a rate of 108 g Mn /fed proved not effective.

2-3-Effect of manganese application methods:

Methods of Mn application showed a significant effect on the average N recovery % in the 2nd season and in the combined analysis. It is clear from (Table 39). That the highest N recovery % was produced by using foliar spraying or grain

soaking as Mn application methods. The average N recovery % for this application methods were 39.57 and 34.91 % for foliar spraying and 38.92 and 34.04 % for grain soaking in the 2nd seasons and combined average, respectively. Similar results were also found by **El-Sheikh, (1998).**

2-4-Interaction effects:

There was an interaction effect regarding N recovery % between all experimental factors in both seasons as well as in the combined average. (Table 39).

The interaction effect between N x Mn levels indicated that application of 100 kg N /fed produced the highest values of N recovery % which were 45.26 , 60.55 and 52.91 % in the 1997 , 1998 seasons and combined average, respectively when Mn was adding at 70 mg /l.

The interaction effect between various N level x Mn application methods was significantly in both seasons and combined average. It could be concluded that the highest average of N recovery % could be produced by applying 100 kg N /fed + grain soaking method (in 1997 season) or foliar application (in 1998 season & combined average).

Results indicated that the interaction effect between Mn levels x Mn application methods was significant in second season and combined average. In 1998 season, results showed that the highest N recovery % (43.83 and 43.34 %) could be produced by adding 70 mg Mn /l and using grain soaking or foliar spraying as Mn application methods. The same trend were obtained in the combined average of two growing seasons.

Regarding the interaction effect between N x Mn x Mn

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