Plant Archives Vol. 19 No. 1, 2019 pp. 1853-1860 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF FOLIAR SPRAYING STAGE BY MANGANESE AND BORON ON GROWTH PARAMETERS OF CORN (*ZEA MAYS* L.)

Ali Sahib Mohammed Al-Sultani* and Momtaz Sahib Mohammed Al-Hakim

Al-Mussaib Technical College, Al-Furat Al-Awsat Technical University, 51006, Babylon, Iraq.

Abstract

A field experiment was conducted in Al-Nile district (7 km northeast of Babylon province) for the spring and autumn seasons of 2017 in sedimentary soil with Silt Clay texture. The experiment was designed according to split-split block design in The Randomized Complete Block Design (RCBD). The study included three levels of manganese with concentrations of (0, 25, 50 $mg.L^{-1}$), three levels of boron with concentrations of (0, 2, 4 $mg.L^{-1}$) and three stages for spraying, the period between them is 15 days, where the first spraying after 20 days of cultivation. Nitrogen, Phosphate and Potassium Fertilizers were added according to their recommendations. The results indicated that the spraying treatment with Manganese at concentration (50 $mg.L^{-1}$), the spraying treatment with boron at concentration of (4 $mg.L^{-1}$) and spraying stage (45 days) were significantly excelled by giving them the lowest averages for number of days from cultivation to emergence of 75% of male inflorescences, number of days from cultivation to emergence of 75% of female inflorescences, and the highest averages for the traits of plant height, leaf area, total chlorophyll and stem diameter.

Key words : Manganese, Boron, Foliar nutrition, Corn.

Introduction

Yellow corn *(Zea mays* L.) is considered one of the world's leading grains along with rice and wheat for its functions as a source of food for both humans and animals, The estimating indicates to that it all, provide at least 30% of dietary calories to more than 4.5 billion person in 94 developing countries. *Zea mays* L belongs to Poaceae family. Its importance in the multiplicity of its uses and cereals included in the basic components of diet because it contains a good proportion of starch, protein, oil, vitamins and minerals as well as other uses. The total cultivated area of this crop worldwide was around 182 million hectares and produced about 824 million tons (FA.O, 2012). Despite the importance of this crop economically, its productivity in Iraq is still low and did not meet the ambition. The cultivated area was about 117 thousand hectares and produced about 287 thousand tons at a rate of 2282 kg.h. (Arab Organization for Agricultural Development, 2000). Recent studies have sought to find methods and techniques for adoption in the processing of plants with nutrients in order to increase production and improve its quality by reducing and problems facing the elements availability in the soil to the method of foliar feeding by spraying these elements in the form of diluted solutions on the vegetative of plant, it Can represent about 85% of plant needs and is a complementary method for soil fertilization (Abdul, 1988). Foliar nutrition is effective if there are determinants of absorption by roots or when there are anaerobic conditions, low temperatures or problems with the nutrient uptake from soil (F.A.O, 2000). Kupper (2003) found that foliar nutrition has faster results than soil fertilization, Increased fertilizer efficiency by 20 to 8 times than foliar fertilization compared with soil fertilization, as well as ensuring meet the request plant nutrient during the critical growth stages that the roots may be unable to achieve. Or meet them. Al-Sahuki *et al.*, (2009) indicated that the addition of fertilizers in a balanced manner is leading to a earliest maturity of crop about one week from those that have not been fertilized. Good nutrition increases the efficiency of water use and then increases the yield. Manganese is considered a micronutrient elements important to the plant and has an important role in regulating the plant's Osmotic pressure (Abu Dhahi and Al-Yunis, 1988) Which is Participate the reduction of nitrates within the plant and the provider of ketonic acids in Krebs Cycle, which is associated with

***Author for correspondence :** E-mail : Alsultani_ali@yahoo.com

Ammonia resulting from the reduction of nitrates and the formation of amino acids, which substance essential for formation of proteins (Mengel and Kirkby 1987). In addition, manganese has a role in raising the efficiency of the plant in use of the potassium fertilizers that adding to the soil (Al-Alusi, 2002), which have important role in regulating the mechanism of opening and closing the Stoma and this helps absorption the manganese element (Zeiger and Taiz, 2010). The boron is a micro element and is no less than the manganese element. Studies have shown that it participates in the water balance process for plant cells, which may be attributed to its importance in raising the efficiency of the plant in the absorption of potassium. Where expected that the good foliar nutrition with boron leads to increase absorption of plant for potassium, which has a significant role in the transfer of water from the roots to the leaves through its control on the process of closing and opening of Stoma, as well as its important role in the cells division and participation in the growth of Pollen tube, both pollination and fertilization processes, and in the transmission of photosynthesis products from leaves to active areas of the plant through the formation of esters with sugars and then their transition from the source by potassium to the Sink (Zeiger and Taiz, 2010). One of the factors that negatively affect the readiness of boron in Iraqi soils is pH soil which should be between (5-7). If the reaction rate exceeds this rate, it will affect the absorption of Boron (Prasad and Power, 1997) Soil, so it is one of the most micro elements lacking in the plant (Gold boch, 1997). Therefore, paper feeding with this element can play a distinct role for provide the plant in the appropriate quantities of this element. The boron plays an important role in the plant growth. It participates in cell division, forming buds, leaves and flowers, forming cell walls, growing roots, increasing chlorophyll content, facilitating the movement and transmission of photosynthesis products from leaves to active areas of the plant. Boron also contributes to fertilization, (Khalil and Mohamed, 1992). In a Vaughan (1997) study of yellow maize, he observed that the germination of the pollen tube discourages when the temperature is higher than 21°C in the absence of boron. This confirms the importance of boron in the reproduction growth stage of maize, especially in the spring season. Brown *et al.,* (2002). A slow growth in pollen production and a decrease in female flowering rates when the yellow maize is exposed to a deficiency of element a week before the emergence of male flowers until the maturity of the seeds. This is because yellow corn is a sensitive crop to show boron deficiency, resulting in low production, small and few grains (Al-Beiruty *et al.,* 2009). This study aims to knowing the best level of foliar spraying with manganese and boron, their interaction and the different spraying stages in their effect on some indicators of vegetative growth for yellow corn plant.

Materials and Methods

A field experiment was conducted in the Nile district (7 km northeast of Babylon province) for the spring season of 2017in sedimentary soil with silty clay texture (Table 1). Its Physical and chemical properties were determined at 30 cm deep according to the methods mentioned by Jakcson (1958) and Black (1965). The experiment was designed according to the split plot design inside to the Randomized Complete Block Design (R.C.B.D). The study included three levels of manganese with concentrations of (0, 25, 50 $mg.L^{-1}$), Three levels of boron with concentrations (0, 2, 4 $mg.L^{-1}$) and three spraying stages, the period between them 15 days, the first after 20 days of cultivation. The soil was plowed with a moldboard plow perpendicularly, then smoothing by using a harrow, soil was then stalled and divided into plots with dimensions (2 × 3 m). Nitrogen fertilizer was added with the rate of (200 kg N. h^{-1}) of urea fertilizer (46% N) in two patches, the first one after two weeks from cultivating, while the second after four weeks from cultivating and the phosphate fertilizer (Tricalcium superphosphate) (P_2O_5% 20) (60 kg P_2O_5 h^{-1}) in one patch when soil prepared for cultivation. and Potassium fertilizer (Potassium Sulphate) (K_2O 41.6%) was added with the rate of (160 kg K. h^{-1}) in three patches : at cultivation, after 45 and 75 days of cultivation (Al-Yunis, 1993). On the 27/3/2017, the yellow corn seeds synthetic varieties (5018) were cultivated in depth (5 cm) and 25 cm between pit and other, and 75 cm between line and other, And the rate of 3 seed in the pit diluted to one plant

Table 1: Some physical and chemical properties of the study soil before cultivation.

Traits	Unit	Value
pH 1:1	----	7.41
EC 1:1	$ds.m^{-1}$	2.79
available *Manganese*	$Mg.L^{-1}$	0.063
available *Boron*	$Mg.L^{-1}$	0.633
available nitrogen	$Mg.L^{-1}$	0.66
available Potassium	$Mg.L^{-1}$	638
available Phosphorus	$Mg.L^{-1}$	0.28
Organic matter	%	13.27
Sand	$g.kg^{-1}$ soil	380.80
Clay	$g.kg^{-1}$ soil	320.00
Silt	$g.kg^{-1}$ soil	300.20
Soil Texture	----	Silty Clay loam

*Soil samples were analyzed in the Laboratory Soil and Water Department, College of Agriculture, University of Kufa.

Table 2: Effect of foliar spraying stages with manganese and boron and their interaction in the average The number of cultivation days until 75% of the male inflorescences.

Spraying stage from cultivation(day)	Spraying with manganese (mg.L^{-1})	Spraying with boron (mg.L^{-1})			Average
		0	2	4	
15	0	55.27	55.13	54.77	55.06
	25	55.37	54.70	54.27	54.78
	50	55.17	54.50	54.17	54.61
30	0	55.17	54.27	53.87	54.43
	25	54.17	53.60	53.23	53.67
	50	53.30	52.53	52.23	52.69
45	0	55.10	51.27	50.47	52.28
	25	53.33	51.10	49.43	51.29
	50	50.03	49.10	47.57	48.90
Average		54.10	52.91	52.22	
LSD *0.05*		Boron = 0.14		interaction =0.42	
Spraying stage × Boron					**Average**
15	55.27	54.78	54.40		54.81
30	54.21	53.47	53.11		53.60
45	52.82	50.49	49.16		50.82
LSD *0.05*	0.24				0.22
Spraying stage × Manganese					**Average**
15	55.18	53.56	53.03		53.92
30	54.29	53.13	52.31		53.24
45	52.83	52.04	51.32		52.07
LSD *0.05*	0.24				0.19

after cultivation. The controlled process of thicket was conducted with the Altrazin pesticide in (3/4/2017), controlled process of corn stem borer in (18/4/2017) with the Diaznone herbicide by Pruning it at the apical plant using hand by placing several granules of the pesticide and for all the field plants, and after two weeks, the field was controlled again. The study levels (manganese and boron) were sprayed in the concentrations above mentioned in three stages using a backpack sprayer capacity 12 liter. The spraying process was considered Of in the early morning, preceded by irrigating the field before the day, in order to open the Stoma with the addition Dish washing liquid for the purpose of reducing surface tension on the leaves. The service operations were conducted such as irrigation and manual grubbing for the thicket as needed. At the end of the experiment (20/7/2017). Harvesting process was conducted for selected plants for the purpose of study and studied the following traits:

1. The number of cultivation days until 75% of the male inflorescences (Alsahookie, 1990)
2. The number of cultivation days until 75% of the female inflorescences (Alsahookie, 1990)
3. Plant height (cm): measured from the first node above the surface of the soil to the last lower node Of the stem carried of the male inflorescences after the completion of male Flowering (AlMousavi 2010).
4. leaf area (cm2): According to the equation: leaf area = Square length of the leaf under the leaf of the cob × 0.65 (AL-Sahookie, 1985)
5. Total chlorophyll: using Chlorophyll-meter in the unit (Spad).
6. Stem diameter (mm): using micro vernier takes from the middle of the stem when the flowering is complete (Alsahookie, 1990).

The results were statistically analyzed according to the methods mentioned in (Al-Rawi and Khalaf Allah, 1990) using the Excel program and comparing the averages using the least significant difference.

Results and Discussion

The number of cultivation days until 75% of the male inflorescences

Table 2 shows that there are significant differences between the treatments of the effect in the number of cultivation days until 75% of the male inflorescences. the spraying treatment with Manganese at concentration of 50 mg.L^{-1} was excelled with gave the lowest values (52.07 days), compared with the control treatment (without spraying) which gave the highest values was (53.92 days). As for the boron spraying, the treatment (4 mg.L^{-1}) was excelled with gave the lowest values (52.22 days), compared with the without spraying treatment which gave the highest values was (54.10 day). while the spraying stage (45 days) after cultivating was excelled by giving it the lowest values amounted of (50.82 days), compared to the spraying stage (15 days) after cultivating, which gave the highest values amounted to (54.81 days). As for the Bi-interactions, the same table indicates significant differences between the bi-interactions treatments. bi-interactions treatment between (manganese spray with 50 mg.L^{-1}and boron 4 mg.L^{-1}), which gave the lowest values (51.32 days), Compared with the treatment without spraying, which gave the highest (55.06 days).

The number of cultivation days until 75% of the

Table 3: Effect of foliar spraying stages with manganese and boron and their interaction in the average. The number of cultivation days until 75% of the female inflorescences.

Spraying stage from cultivation(day)	Spraying with manganese (mg.L^{-1})	Spraying with boron (mg.L^{-1})			Average
		0	2	4	
15	0	60.23	60.27	60.17	60.22
	25	60.50	59.83	59.60	59.98
	50	60.43	59.80	59.53	59.92
30	0	60.40	59.53	59.27	59.73
	25	59.37	58.60	57.93	58.63
	50	58.50	58.00	57.40	57.97
45	0	58.33	57.00	56.50	57.28
	25	56.87	55.57	54.97	55.80
	50	55.27	54.40	52.80	54.16
Average		58.88	58.11	57.57	
LSD *0.05*		Boron = 0.14		interaction =0.41	

Spraying stage × Boron				Average
15	60.43	59.94	59.72	60.03
30	59.46	58.83	58.20	58.83
45	56.87	55.80	54.59	55.75
LSD *0.05*	0.24			0.40

Spraying stage × Manganese				Average
15	60.39	59.97	59.77	60.04
30	59.42	58.71	58.20	58.78
45	56.82	55.66	54.76	55.74
LSD *0.05*	0.24			0.23

female inflorescences

Table 3 shows that there are significant differences between the treatments of the effect in the number of cultivation days until 75% of the female inflorescences. The spraying treatment with Manganese at concentration of 50 mg.L^{-1} was excelled with gave the lowest values (57.35 days),compared with the control treatment (without spraying) which gave the highest values was (59.08 days), As for the boron spraying, The treatment (4 mg.L^{-1}) was excelled with gave the lowest values (57.57 days), compared with the without spraying treatment which gave the highest values was (58.88 day), While the spraying stage (45 days) after cultivating was excelled by giving it the lowest values amounted of (55.74 days),compared to the spraying stage (15 days) after cultivating, which gave the highest values amounted to (60.04 days).

Plant height (cm)

Table 4 shows that there are significant differences between the treatments of the effect in plant height (cm). The spraying treatment with Manganese at concentration of 50 mg.L^{-1} was excelled with gave the highest values (180.14 cm), compared with the control treatment (without spraying)which gave the lowest values (171.04 cm). As for the boron spraying, the treatment (4 mg.L^{-1}) was excelled with gave the highest values were (179.56 cm), compared with the without spraying treatment which gave the lowest values (173.01 cm). While the spraying stage (45 days) after cultivating was excelled by giving it the highest values amounted of (185.93 cm), compared to the spraying stage (15 days) after cultivating, which gave the lowest values amounted to (171.13cm). As for the Bi-interactions, the same table indicates significant differences between the bi-interactions treatments. bi-interactions treatment between (manganese spray with 50 mg.L^{-1} and boron 4 mg.L^{-1})which gave the highest values (186.06 cm), Compared with the treatment without spraying, which gave the (163.78 cm), As for the treatment (Spraying manganese at a concentration of 50 mg.L^{-1} and 45 days after cultivation) and gave the highest values (191.50 cm), Compared with the treatment without spraying, which gave the (164.64 cm). As for the interaction between the boron and the spray stage, the interaction treatment (spraying with boron at concentration of 4 mg.L^{-1} and in the stage of 30 days after cultivating) was excelled by giving it the highest values of (192.97 cm), compared to the treatment without spraying which gave the lowest value of (167.31 cm). In the triple interaction, the interaction treatment (spraying with manganese at concentration of 50 mg.L^{-1}, boron with a concentration of 4 mg.L^{-1} and spraying after 45 days of cultivation) gave the highest value of (198.17 cm), compared to the treatment without spraying which gave the lowest value of (153.47 cm).

Leaf area (cm^2)

Table 5 shows that there are significant differences between the treatments of the effect in leaves area (cm^2). The spraying treatment with Manganese at concentration of (50 mg.L-1) was excelled with gave the highest values (4217.75 cm^2), compared with the control treatment (without spraying) which gave the lowest values (3707.55 cm^2). As for the boron spraying, the treatment (4 mg.L^{-1}) was excelled with gave the highest values were (4253.50 cm^2), compared with the without spraying treatment which gave the lowest values (3715.92 cm^2)

Table 4: Effect of foliar spraying stages with manganese and boron and their interaction in the average Plant height (cm).

Spraying stage from cultivation(day)	Spraying with manganese (mg.L^{-1})	Spraying with boron (mg.L^{-1})			Average
		0	2	4	
15	0	153.47	175.13	165.33	164.64
	25	172.33	176.80	170.00	173.04
	50	176.13	165.00	186.00	175.71
30	0	173.73	173.00	173.13	173.29
	25	172.67	169.80	168.67	170.38
	50	172.67	172.93	174.00	173.20
45	0	164.13	176.00	185.40	175.18
	25	186.00	192.00	195.33	191.11
	50	186.00	190.33	198.17	191.50
Average		173.01	176.78	179.56	
LSD *0.05*		Boron = 2.99 interaction = 8.97			
Spraying stage × Boron					**Average**
15	167.31	172.31	173.78		171.13
30	173.02	171.91	171.93		172.29
45	178.71	186.11	192.97		185.93
LSD *0.05*	5.18				2.08
Spraying stage × Manganese					**Average**
15	163.78	174.71	174.62		171.04
30	177.00	179.53	178.00		178.18
45	178.27	176.09	186.06		180.14
LSD *0.05*	5.18				2.63

While the spraying stage (45 days) after cultivating was excelled by giving it the highest values amounted of (4113.54 cm^2), compared to the spraying stage (15 days) after cultivating, which gave the lowest values amounted to (3692.61 cm^2). As for the Bi-interactions, the same table indicates significant differences between the bi-interactions treatments. bi-interactions treatment between (manganese spray with 50 mg.L^{-1} and boron 4 mg.L^{-1}), which gave the highest values (4614.44 cm^2), Compared with the treatment without spraying, which gave the (3463.22 cm^2). As for the treatment (Spraying manganese at a concentration of 50 mg.L^{-1} and 45 days after cultivation) and gave the highest values (4430.51 cm^2), Compared with the treatment without spraying, which gave the (3464.56 cm^2). As for the interaction between the boron and the spray stage, the interaction treatment (spraying with boron at concentration of 4 mg.L^{-1} and in the stage of 30 days after cultivating) was excelled by giving it the highest values of (4483.83 cm^2), compared to the treatment without spraying which gave the lowest value of (3555.39 cm^2). In the triple interaction, the interaction treatment (spraying with manganese at concentration of 50 mg.L-1, boron with a concentration of 4 mg.L^{-1} and spraying after 45 days of cultivation) gave the highest value of (198.17 cm^2) compared to the treatment without spraying which gave the lowest value of (153.47 cm^2).

Total chlorophyll (spad)

Table 6 shows that there are significant differences between the treatments of the effect in Total chlorophyll (spad). The spraying treatment with Manganese at concentration of 50 mg.L^{-1} was excelled with gave the highest values (39.15 spad), compared with the control treatment (without spraying)which gave the lowest values (36.96 spad). As for the boron spraying, the treatment (4 mg.L^{-1}) was excelled with gave the highest values were (40.08 spad), compared with the without spraying treatment which gave the lowest values (35.75 spad). While the spraying stage (45 days) after cultivating was excelled by giving it the highest values amounted of (39.79 spad), compared to the spraying stage (15 days) after cultivating, which gave the lowest values amounted to (37.17 spad). As for the Bi-interactions, the same table indicates significant differences between the bi-interactions treatments. bi-interactions treatment between (manganese spray with 50 mg/l and boron 4 mg.L^{-1}), which gave the highest values (42.16 spad), Compared with the treatment without spraying, which gave the (35.39 spad). As for the interaction between the boron and the spray stage, the interaction treatment (spraying with boron at concentration of 4 mg.L^{-1}and in the stage of 45 days after cultivating) was excelled by giving it the highest values of (41.90 spad) compared to the treatment without spraying which gave the lowest value of (36.08 spad). As for the treatment (Spraying manganese at a concentration of 50 mg.L^{-1}and 45 days after cultivation) and gave the highest values (43.04 spad), compared to the treatment without spraying which gave the lowest value of (35.44 spad). In the triple interaction, the interaction treatment (spraying with manganese at concentration of 50 mg.L^{-1}, boron with a concentration of 4 mg.L^{-1} and spraying after 45 days of cultivation) gave the highest value of (47.00 spad), compared to the treatment without spraying which gave the lowest value of (35.24 spad).

Table 5: Effect of foliar spraying stages with manganese and boron and their interaction in the average Leaves area (cm^2).

Spraying stage from cultivation(day)	Spraying with manganese ($mg.L^{-1}$)	Spraying with boron ($mg.L^{-1}$)			Average
		0	2	4	
15	0	3276.67	3461.33	3655.67	3464.56
	25	3710.70	3752.00	3829.00	3763.90
	50	3678.80	3722.67	4146.67	3849.38
30	0	3552.00	3705.33	4191.33	3816.22
	25	3839.13	4174.00	4256.00	4089.71
	50	4162.00	4206.77	4751.33	4373.37
45	0	3561.00	3945.63	4019.00	3841.88
	25	3524.67	4192.90	4487.17	4068.24
	50	4138.33	4207.87	4945.33	4430.51
Average		3715.92	3929.83	4253.50	
LSD *0.05*		Boron = 80.11 interaction =240.33			
Spraying stage × Boron					**Average**
15	3555.39	3645.33	3877.11		3692.61
30	3851.04	4028.70	4399.56		4093.10
45	3741.33	4115.47	4483.83		4113.54
LSD *0.05*	138.76				92.90
Spraying stage × Manganese					**Average**
15	3463.22	3704.10	3955.33		3707.55
30	3691.50	4039.63	4190.72		3973.95
45	3993.04	4045.77	4614.44		4217.75
LSD *0.05*		138.76			89.64

Table 6: Effect of foliar spraying stages with manganese and boron and their interaction in the average Total chlorophyll (spad).

Spraying stage from cultivation(day)	Spraying with manganese ($mg.L^{-1}$)	Spraying with boron ($mg.L^{-1}$)			Average
		0	2	4	
15	0	35.24	36.17	36.84	36.08
	25	35.33	38.40	38.53	37.42
	50	35.74	38.46	39.80	38.00
30	0	35.20	36.37	37.67	36.41
	25	35.95	37.67	39.04	37.55
	50	35.58	37.40	39.67	37.55
45	0	35.73	39.17	40.23	38.38
	25	36.33	39.00	41.90	39.08
	50	36.67	42.03	47.00	41.90
Average		35.75	36.17	40.08	
LSD *0.05*		Boron = 0.43 interaction =1.29			
Spraying stage × Boron					**Average**
15	35.44	37.67	38.39		37.17
30	35.58	37.14	38.79		37.17
45	36.24	40.07	43.04		39.79
LSD *0.05*	0.74				0.34
Spraying stage × Manganese					**Average**
15	35.39	37.23	38.25		36.96
30	35.87	38.36	39.82		38.02
45	36.00	39.30	42.16		39.15
LSD *0.05*	0.74				0.52

Stem diameter (mm)

Table 7 shows that there are significant differences between the treatments of the effect in Stem diameter (mm). The spraying treatment with Manganese at concentration of 50 $mg.L^{-1}$ was excelled with gave the highest values 15.95 mm compared with the control treatment (without spraying) which gave the lowest values (14.61 mm). As for the boron spraying, the treatment (4 $mg.L^{-1}$) was excelled with gave the highest values were (17.28 mm), compared with the without spraying treatment which gave the lowest values (12.78 mm). While the spraying stage (45 days) after cultivating was excelled by giving it the highest values amounted of (16.84 mm) compared to the spraying stage (15 days) after cultivating, which gave the lowest values amounted to (13.72 mm). As for the Bi-interactions, the same table indicates significant differences between the bi-interactions treatments. Bi-interactions treatment between (manganese spray with 50 $mg.L^{-1}$and boron 4 $mg.L^{-1}$), which gave the highest values (18.27 mm), Compared with the treatment without spraying, which gave (12.40 mm). As for the interaction between the boron and the spray stage, the interaction treatment (spraying with boron at concentration of 4 $mg.L^{-1}$and in the stage of 45 days after cultivating) was excelled by giving it the highest values of (17.64 mm), compared to the treatment without spraying which gave the lowest value of (13.18 mm), As for the treatment (Spraying manganese at a concentration of 50 $mg.L^{-1}$ and 45 days after cultivation) and gave the highest values (19.09 mm), compared to the treatment without spraying which gave the lowest value of (12.16 mm). In the triple interaction, the interaction treatment (spraying with manganese at concentration of 50 $mg.L^{-1}$, boron with a concentration of

Table 7: Effect of foliar spraying stages with manganese and boron and their interaction in the average Stem diameter (mm).

Spraying stage from cultivation(day)	Spraying with manganese (mg.L^{-1})	Spraying with boron (mg.L^{-1})			Average
		0	2	4	
15	0	11.83	13.20	14.50	13.18
	25	12.13	14.10	14.53	13.59
	50	12.50	14.23	16.47	14.40
30	0	12.50	15.30	16.50	14.77
	25	12.70	17.13	18.10	15.98
	50	12.80	16.43	18.17	15.80
45	0	12.87	16.60	18.20	15.89
	25	13.50	18.57	18.90	16.99
	50	14.17	18.60	20.17	17.64
Average		12.78	16.02	17.28	
LSD *0.05*		Boron = 0.18 interaction =0.53			

Spraying stage × Boron				Average
15	12.16	13.84	15.17	13.72
30	12.67	16.29	17.59	15.51
45	13.51	17.92	19.09	16.84
LSD *0.05*	0.30			0.29

Spraying stage × Manganese				Average
15	12.40	15.03	16.40	14.61
30	12.78	16.60	17.18	15.52
45	13.16	16.42	18.27	15.95
LSD *0.05*	0.30			0.19

4 mg.L^{-1} and spraying after 45 days of cultivation) gave the highest value of (20.17 mm), compared to the treatment without spraying which gave the lowest value of (11.83 mm).

(Table 2, 7) show significant differences in the decrease from the number of flowering days, whether male or female, and the increase of vegetative growth indices. The level (50 mg.L^{-1}) was excelled by giving it the highest values for the traits. It can be attributed to the fact that manganese contributes to the photosynthesis process and it is accompanied by the effectiveness of a large number of enzymes within the plant, leading to its important role in the production of chlorophyll despite It also plays a major role in preventing chlorophyll degradation by increasing the proline acid which prevents the senescence of the plant. Manganese increases plant susceptibility to inappropriate environmental conditions. Manganese also contributes to nitrogen synthesis by building amino acids by activating the enzymes responsible for nitrate reduction, ammonia transfer and formation of organic acid, which leads to produce amino acids. Manganese plays an important role with potash fertilizers in the open mechanism and regulation of plant stoma, which increases the resistance of crops to drought conditions. All important processes that reflect the role of manganese in plant growth can contribute to the growth of vegetative growth indicators (Barney 2007; Yu-tong *et al.,* 2010; Verma and Verma, 2010; Dessouki, 2008, Tcaiz and zeiger, 2010; Al-Amiri *et al.*, 2015). The same results in the tables above show that the use of boron at high levels reaches (4 mg.L^{-1}) led to a significant increase in All indicators of studied vegetative growth and can be due to the role of the element in the cells division, the formation of leaves and flowers buds and cell walls, root growth, increase the leaves content of chlorophyll and facilitate the movement and transmission of the Photosynthesis products from the leaves to the active areas of the plant, which is reflected in the increase in the vegetative growth indicators (Mengel and Kirkby, 1987). Moeinian *et al.*, (2011) showed that the addition of boron to the soil increases elongation and cell division, which increases plant height, leaf area and stem diameter, and boron plays an important role in the rapid growth of metastatic tissue by increasing the cytokinines hormones Which play a role in delaying the plant senescence, Boron also contributes to the organization, processing and production of Auxins that contribute to the process of oxidation such as the IAA Hormone (Attia and Jadwa, 1999). We conclude from the results of the study that the interaction treatment among the spraying with manganese (50 mg.L^{-1}), the spraying with boron at concentration of (4 mg.L^{-1}) and the spraying stage of 45 days were significantly excelled by giving it the lowest averages for the number of cultivation days until emergence 75% of male inflorescences and the lowest number of cultivation days until the emergence of 75% of female inflorescences, and increase the average indicators of vegetative growth, which include plant height, leaf area, total chlorophyll, stem diameter.

References

Abu Dahi, Y.M. and M. Ahmed Al-Yunis (1988). Directory of Plant Nutrition. Ministry of Higher Education and Scientific Research Baghdad University.

Al-Alusi, Y.A.M. (2002). Effect of iron and manganese spraying in Differentiated soil with potassium availability in growth

and yield of wheat. PhD. thesis. College of Agriculture. Baghdad University.

Al-Beiruty, R.Z., A. Fissah, R.A.J. Jallow and S.H. Shakir (2009). Response of maize to foliar application of boron at different growth periods. *Iraqi Agriculture Journal*, **14(2)**: 76-86.

Al-Dasouki, H.SA. (2008). Fundamentals of Plant Physiology. Library of the island of roses. Mansoura. Egypt.

Al-Rawi, K.M. and M.A. Khalaf Allah (1990). Design and analysis of agricultural experiments. Dar Al-Hikma for Printing and Publishing. University of Baghdad. Iraq.

Elsahookie, M.M., A.O. Alfalahi and A.F. Almehemdi (2009). Crop and soil management and breeding for drought tolerance. *Journal of Agricultural Sciences of Iraq*, **40 (2):** 1 - 28.

Al-Sahuki, M.M. (1990). Yellow corn production and improvement. Baghdad University. Ministry of Higher Education and Scientific Research. University of Baghdad.

Al-Amiri, A.A., R.L. Attia, A.N. al-Moussawi and H.A. Khashan Al-Fartousi (2015). Response of three genotypes of yellow corn to foliar nutrition with manganese and boron under calcareous soil in some growth and yield traits. *Al-Baher journal*, **1(1, 2) :** 31-42).

Abdul, K.S. (1988). The Physiological of the nutrient elements in the plant. Directorate of Dar Al Kutub for printing and publishing. Ministry of Higher Education and Scientific Research. University of Salahaddin.

Attia, H.J. and K.A. Jadoua (1999). Plant Growth regulators. Baghdad. Dar Al Kuttab For Printing. Ministry of Higher Education and Scientific Research. Baghdad University.

Arab Organization for Agricultural Development (2000). Drought phenomenon and its impact on agricultural production and the technologies used to prevent it. *Journal of Agriculture and Development in the Arab World*, **35-24:** 2.

Barney, G. (2007). Manganese nutrition of Glyphosate – Resistant and conventional soybeans better crops. *J. Exp. Bot.*, **91-No(4):** 71-78.

Black, C.A. (1965). Methods of Soil Analysis. Am. Soc. Agron. No. 9, Part 1. Madison, Wisconsin. USA.

Brown, P.H., N.Wimmer, M.A. Basil, E.S. Ruiz, J. Hu, H. Pfeffer, F. Dannel and V. Romheld (2002). Boron in Plant Biology. Plant Biology, 4:205-223. Goldbach, H.E. 1997. A critical review on current hypotheses concerning the role ofboron in higher plants: suggestions for further research and methodological requirements. *J. Trace and Microprobe Tech.*, **15(1):** 51-

Jackson, M.L. (1958). Soil Chemical Analysis. Prentic Hall, Inc Englewood Cliff, N. J USA. P.225-276.

Kupper, G. (2003). Foliar fertilization appropriate technology transfer for rural areas (ATTRA).National sustainable agriculture service..www.attra.ncat.org.

Mengel, K. and E.A. Kirkby (1987). Principles of Plant Nutrition. 3rd. Ed. Int. Institute Bern, Switzerland. *Plant Biology*, **4:** 205-223.

Mohammed, H.A. and Y.M. Abu Dahi (2013). Role of leaf nutrition by manganes and boron in water strees for maize (*Zea mays* L.) 11.Grain yield and water use efficiency. *Diyala Journal of Agricultural Sciences*, **5(2):** 456 – 479.

Mohammed, S.M. and M.M. Khalil (1992). Effect of tryptophan and arginine on growth and flowering of some winter annuals. *Egypt J. Applied Sci.*,**7(10):** 82 -93.

Marschner, H. (1995). Mineral Nutrition of Higher Plants. 2nd. London.UK:Academic press.

Moeinian, M.R., Z. Kaveeh and H. Javad (2011). Effect of Boron Foliar Spraying Application on Quality characteristics and Growth Parameters of Wheat Grain under Drought stress. *American –Eurasian J.Agric. Environ.Sci.*,**10(4):** 593-599.

Page, A.L., H. Miller and D.R. Kenny (1982). Method of soil analysis part (2) Agronomy 9. Madison W.I.

Prasad, R. and J.F Power (1997). Soil Fertility Management for Sustainable Agriculture. Lewis Publisher, New York.

Taiz, L. and E. Zeiger (2010). Plant Physiology. 5th (ed.), Sianauer Associates, Sunderland, UK :p 629.

Vaughan, A.K.F. (1977). The relation between the concentration of boron in the reproductive and vegetative organs of maize plants and their development. *Rhod. J.Agric.*,**15:** 163–70

Verma, S.K. and M. Verma (2010). AText Book of Plant Physiology,Biochemistry and Biotechnology. S. Chand and Company Ltd. Ramangar, New Delhi.p.112.

Yu-Tong, W., W. Kun and S. Xin-qing (2010). Manganese delays the Senescence induced by drought in Perennial ryegrss (*Loliumperenne* L.). *African J.of Agricultural Research*, **22(5):** 3035-3040.