Advances in Life Science and Technology
ISSN 2224-7181 (Paper) ISSN 2225-062X (Online)
Vol.45, 2016

Effect of Irrigation Water Salinity and Iron Fertilizers on Soil Salinity, Growth and Yield of Cucurbita pepo (L.)

Hadi Yasir Abbood Al- Janabi
University of Al- Qasim Green / College of Agriculture. Iraq

Abstract
This study was conducted in the horticulture field , college of Agriculture, University of Al-Qasim Green, during the spring season of 2014 in loamy soil under drip irrigation system to study the effect of two levels (1.4 , 4 $dS.m^{-1}$) of irrigation water salinities and methods of application of two sources of iron fertilizers on soil salinity , some growth parameters , yield and percentage of response to iron by *Cucurbita pepo (L).* , and iron availability in surface soil . Chelate - Fe EDDHA (6%Fe), and $FeSO_4.7H_2O$(20%Fe) iron fertilizer sources were used in this study. Each fertilizer source was applied at a rate of 10 kg $Fe.ha^{-1}$ by soil application at two equal doses ; first dose was after two weeks from transplanting and other dose is after six weeks; and by foliar application: Fe – EDDHA and $FeSO_4.7H_2O$ fertilizers were sprayed on the plants at six times, the first was after two weeks from transplanting and the others were at week intervals from transplanting.Organic manure at a rate of 16 $ton.ha^{-1}$ was added to the soil two months before transplanting. Urea was added to the soil at a rate of 400 $Kg.ha^{-1}$ with four equal doses through the growing season while Di ammonium Phosphate (DAP) at a rate of 200 $Kg.ha^{-1}$ and Potassium sulfate at a rate of 200 $Kg.ha^{-1}$ were added to the soil before transplanting. Split – split plot design with three replicates was used. Results of the study can be summarized as follows:Soil salinity and available soil – Fe concentration after harvest were increased by 82% , 6% and chlorophyll content , plant - Fe , dry matter ,yield were decreased by 20% , 13% , 43% , 22% respectively with increasing irrigation water salinity from 1.4 to 4 $dS.m^{-1}$. High response for soil applications of iron compared with foliar applications and for chelated iron fertilizer compared with mineral iron fertilizer was observed.
Keywords: water quality , Iron availability.

Introduction

Irrigation water salinity is one of the essential factors effecting soil salinization in central and southern parts of Iraq. A decrease in the absorbance of water and nutrient ions such as iron by plant roots was observed in saline soils (Bedair , 2016).

Although Iraqi soils contains high levels of iron (3.3 gm Fe. Kg^{-1} soil), but its availability is very low in soil solution because of high soil reaction due to high levels of lime content (Abbood , H.Y. and M.H. Kareem , 2014).

Most of Iraqi soils classified as calcareous soils in which the lime dissociates into hydroxyl and bicarbonate ions as follows:

$$CaCO_3 + H_2O \rightleftharpoons Ca^{++} + OH^- + HCO_3^-$$

Increasing soil reaction due to introducing of OH^- , HCO_3^- ions decrease soil iron availability to plant especially active iron and the plants will suffer from lime Induced chlorosis (Mengel , K.1994). Some of the applied iron fertilizers to the calcareous soils interact and precipitate at once as ferric hydroxide while the others retains available for plant absorption for a long time.

Application of iron fertilizers as chelated compounds like Fe EDDHA , Fe EDTA , Fe DTPA in calcareous soils increase iron availability for more than one month in soil solution due to the iron ion combination with the chelating material (Norvell and Lindsay , 1972).

Organic matter additions to the soil before planting has important role in increasing the soil capability for chelating iron ions by coordinate bonds or covalent bonds causing a reduction in the speed of reactions of iron (precipitation and minerals formation) in the soil system.

The iron fertilizers usually spray on the plant leaves and shoots when iron deficiency symptoms appears on the plants. The experiment aimed to study the effect of two levels of irrigation water salinity and two sources of iron fertilizers (chelate and mineral) with two methods of fertilizer application (soil and foliar) on soil salinization , availability of iron in the soil , plant content of iron , growth and yield of *Cucurbita pepo (L.)* using drip irrigation system. Our research aimed also to declare the best source of iron fertilizer and best method of application to introduce highest yield of *Cucurbita pepo (L.)* under osmotic tension conditions.

Materials and methods

The experiment was conducted in the horticulture field / Agriculture College / University of Al – Qasim Green during spring season 2014. The soil of the plastic house was plowed table (1). Sixteen $ton.ha^{-1}$ of composed organic manure was mixed with the surface soil before two months from transplanting. Four hundred $kg.ha^{-1}$ of urea divided in four doses were applied to the soil. Two hundred kilograms of Di Ammonium Phosphate (DAP) and 200 $kg.ha^{-1}$ of Potassium Sulphate were added to the soil before transplanting. The plastic house was divided into four benches by 40 cm width for each and 40 cm intervals between benches.

Cucurbita pepo (L.) seeds were planted in peatmose plates in the green house. After two months in 27/1/2014 the plants were transferred to the plastic house in 40 cm distance between plants. Each treatment consists of 10 plants. The treatments were distributed randomly in the plastic house using split split plot design with three replicates (Al – Rawi , 2000). Two sources of iron fertilizers , Fe EDDHA (6% Fe) and $FeSO_4.7H_2O$ (20% Fe) by 10 kg $Fe.ha^{-1}$ from each source with two methods of application (soil and foliar) were used. Soil application iron fertilizers were applied into two portions , 2 and 6 weeks after transplanting while foliar application iron fertilizers were sprayed in six portions (2 ,3 ,4 ,5 ,6 ,7) weeks after transplanting.

The iron fertilizers treatments were: F_0 = control , F_1 = chelate - Fe with soil application method , F_2 =chelate - Fe with foliar application method , F_3 = mineral - Fe with soil application method , F_4 = mineral - Fe with foliar application method.

Two irrigation water salinities (W_1 = 1.4 and W_2 = 4) $dS.m^{-1}$ with drip irrigation system were used table (2).

Table (1): Some physical and chemical properties of plastic house soil.

Property	unit	value
ECe	$dS.m^{-1}$	5.3
pH	----	7.8
Texture	----	Loam
<u>Soluble ions</u>		
Ca^{++}	$mmol.L^{-1}$	9.15
Mg^{++}	$mmol.L^{-1}$	8.25
Na^{+}	$mmol.L^{-1}$	13.21
K^{+}	$mmol.L^{-1}$	3.45
Cl^{-}	$mmol.L^{-1}$	27.90
$SO_4^{=}$	$mmol.L^{-1}$	10.18
HCO_3^{-}	$mmol.L^{-1}$	6.54
$CO_3^{=}$	$mmol.L^{-1}$	0.00
CEC	$cmole_c.kg^{-1}$	18.71
CaCO3	$gm.kg^{-1}$	241.52
O.M.	$gm.kg^{-1}$	10.18
Avail. N	$mg.kg^{-1}$	19.95
Avail. P	$mg.kg^{-1}$	14.86
Avail. K	$mg.kg^{-1}$	235.10
Avail. Fe	$mg.kg^{-1}$	16.12

Table (2): Some chemical properties of irrigation water used in the experiment .

Property	Irrigation water salinity		unit
	W_1	W_2	
E.C.	1.40	4.00	$dS.m^{-1}$
pH	7.85	7.80	----
<u>Soluble ions</u>			
Ca^{++}	3.15	7.43	$mmole.L^{-1}$
Mg^{++}	3.20	10.18	$mmole.L^{-1}$
Na^{+}	3.95	8.21	$mmole.L^{-1}$
K^{+}	0.18	1.31	$mmole.L^{-1}$
$SO_4^{=}$	3.13	12.34	$mmole.L^{-1}$
Cl^{-}	4.16	10.28	$mmole.L^{-1}$
HCO_3^{-}	2.05	5.17	$mmole.L^{-1}$
$CO_3^{=}$	----	----	
SAR	1.57	1.96	$(mmole.L^{-1})^{1/2}$

Leaf content of chlorophyll after two months from transplanting was measured using chlorophyll meter. The yield of each treatment during the growing season was collected in 13/5/2014. The upper fourth and fifth leaves from the plant apex were collected for each treatment and transferred the laboratory for chemical analysis.

The plant shoots were cultivated and oven dried at 65^0c. Thirty soil samples were collected after harvest for chemical analysis. The percentages of response to iron fertilizer was calculated by using the following equation (Tisdale et.al.1997).

$$\% \text{ response for iron fertilizer} = \frac{\text{Total yield (iron fertilized treatment) - Total yield (no fertilized treatment)}}{\text{Total yield (iron fertilized treatment)}} *100$$

Results and Discussion

1. Effect of irrigation water salinity , source and method of application of iron on soil salinity after harvest:

Increasing irrigation water salinity from 1.4 (W_1) to 4.0 (W_2) $dS.m^{-1}$ increased significantly soil salinity from 8.65 to 15.73 $dS.m^{-1}$ table (3).The percentage of increase in soil salinity (82%) is attributed to the accumulation of transported salts by irrigation water (Pearson , 2013) . There was appositive linear regression between irrigation water salinity and soil salinity (Ayers and Westcot , 1976).Iron fertilizer additions and their interactions with irrigation water salinity have not significant effect on soil salinity. Similar results were observed in Hallob study on cabbage (2014) and Mahmood and Al – Zaidy study on califlower (2011).

Table (3) : Effect of irrigation water salinity , source and method of iron fertilizer applications on Soil salinity $dS.m^{-1}$ after harvest

W \ F	W_1	W_2	$\bar{F}$	$F(L.S.D_{0.05})$
F_0	8.70	15.80	12.25	n.s.
F_1	8.73	15.20	11.97	
F_2	8.80	15.23	12.02	
F_3	8.23	16.30	12.27	
F_4	8.80	16.10	12.45	
$\bar{W}$	8.65	15.73	$W*F(L.S.D_{0.05})$	
$W(L.S.D_{0.05})$	0.884**		n.s.	

2.Effect of irrigation water salinity , source and method of application of iron on soil available iron after harvest:

The increasing of soil available iron by 5.5 % with increasing irrigation water salinity may be attributed to the increase in soil salinity which caused a decrease in soil reaction followed by an increase in available soil iron concentration table (4). Increasing soil salinity also caused a decrease in root and shoot growth of *Cucurbita pepo* (*L.)* plants causing a decrease in absorbance of the soil available iron by plants which means a lot of remained available iron in the soil after harvest.

Table (4) : Effect of irrigation water salinity , source and method of iron fertilizer applications on Available Soil-Fe $mg.kg^{-1}$ after harvest

W \ F	W_1	W_2	$\bar{F}$	$F(L.S.D_{0.05})$
F_0	16.00	16.54	16.27	0.711**
F_1	20.60	21.90	21.25	
F_2	15.57	17.04	16.30	
F_3	18.05	18.75	18.40	
F_4	16.02	16.88	16.45	
$\bar{W}$	17.25	18.22	$W*F(L.S.D_{0.05})$	
$W(L.S.D_{0.05})$	0.958**		n.s.	

Available soil iron after harvest in soil application method was increased by 31% , 13% for chelate and mineral iron sources respectively. The high percentages of available soil iron due to chelate fertilizer applications compared with mineral iron applications may be attributed to the attractive forces of chelating compounds to iron ions by coordinate bonds or covalent bonds causing a reduction in iron reactions (precipitation and mineral formation) in soil system. While the differences in soil available iron concentrations were not significant between chelate and mineral iron fertilizers in foliar application methods.

3. Effect of irrigation water salinity , source and method of application of iron fertilizers on chlorophyll content in plant leaves after two months from transplanting:

Increasing irrigation water salinity caused a decrease by 20% in chlorophyll content in leaves table (5). This decrease in chlorophyll content may be attributed to the increase in osmotic pressure of soil solution and a reduction in the absorbance of nutrient elements correlated with high production of the Reactant Oxygen Species (ROS) causing oxidation of the inner constituent of chloroplasts , reduction in inner stroma volume which contains most photosynthesis enzymes. The result of this process is a reduction in chlorophyll content of leaves (Al – Tae , 2013) . Di Martino et. al. (2003), Abbood , H.Y. and M. Al- Watifi (2013) ; Abbood , H.Y. and M. Kareem (2014) obtained similar results.

Table (5) : Effect of irrigation water salinity , source and method of iron fertilizer applications on Chlorophyll content, spad after two months from transplanting

W \ F	W_1	W_2	$\bar{F}$	$F(L.S.D_{0.05})$
F_0	56.33	46.67	51.50	4.349*
F_1	67.00	53.33	60.17	
F_2	65.67	54.33	60.00	
F_3	65.67	56.33	61.00	
F_4	65.33	55.33	60.33	
$\bar{W}$	64.00	53.20	$W*F(L.S.D_{0.05})$	
$W(L.S.D_{0.05})$	2.751*		n.s.	

Soil and foliar methods of chelate and mineral iron fertilizer applications caused a significant increase by (17%) compared with control treatment . Significant differences were not observed between the methods of application or between two sources of iron fertilizers in chlorophyll content in plant leaves. Increasing chlorophyll content due to iron fertilizers applications may be attributed to the assistance of iron ions in chlorophyll formation process in leaves although the iron ions is not a part of chlorophyll molecule structure. The iron ion represents the dynamic force for the most vital activities in the plant. The iron protein (ferredoxin) exists in chloroplast and playing important role in oxidation reduction reactions as electron transporter during the photosynthesis process. The most of plant iron (80%) exists in chloroplast as iron phosphoproteins (phytoferritin) (Essa , 1990).Increasing irrigation water salinity decreased chlorophyll content by 17% .The decrease may be attributed to the negative effect of salinity on the vital activities in the plant.

4.Effect of irrigation water salinity , source and method of iron application on the dry matter:

There was a significant decrease from 6.379 to 4.460 $ton.ha^{-1}$ (43%) in the dry matter due to increasing of irrigation water salinity from 1.4 to 4 $dS.m^{-1}$ (table 6).

Table (6) : Effect of irrigation water salinity , source and method of iron fertilizer applications on the dry matter of *Curcurbita pepo (L.)* $ton.ha^{-1}$

W \ F	W_1	W_2	$\bar{F}$	$F(L.S.D_{0.05})$
F_0	6.01	4.68	5.34	0.516**
F_1	6.94	5.39	6.16	
F_2	5.95	4.44	5.20	
F_3	6.93	5.01	5.97	
F_4	6.07	4.46	5.26	
$\bar{W}$	6.38	4.80	$W*F(L.S.D_{0.05})$	
$W(L.S.D_{0.05})$	0.636**		n.s.	

The decreasing of dry matter may be attributed to the accumulation of some ions inside plant tissues such as Na^+ , Cl^- to a high levels causing a decrease in meristimatic tissues activities and root and shoot growth depressions (Sakr et.al. 2007) , (Hamad , 2010) , (Al- Tai , 2013).

Soil applications of chelate and mineral iron fertilizers caused a significant increase by 15% , 12% in the dry weight respectively , while the differences in foliar applications between the two sources of iron was not significant. Increasing availability of iron in soil solution due to iron fertilizers applications increased iron absorbance by plant roots followed by increasing the enzymic activities , chlorophyll formation metabolism and photosynthesis processes leading to an increase in the dry weight of the plant. Kemira (2004) obtained a similar results.

5.Effect of irrigation water salinity , source and method of application of iron on the yield:

Increasing irrigation water salinity increased soil salinity and decreased the yield by (22%) (table 3). The decreased yield may be attributed to the increasing of Na^+ , Cl^- concentrations and decreasing of N , P , K concentrations in the plant tissues causing a depression in plant growth and yield (table 7).

Table (7) : Effect of irrigation water salinity , source and method of iron fertilizer applications on yield of *Curcurbita pepo (L.)* ton.ha^{-1}

W \ F	W_1	W_2	$\bar{F}$	$F(L.S.D_{0.05})$
F_0	62.27	50.04	56.15	3.725**
F_1	81.24	68.63	74.93	
F_2	67.89	55.30	61.59	
F_3	77.28	63.85	70.57	
F_4	67.79	53.46	60.62	
$\bar{W}$	71.29	58.26	$W * F(L.S.D_{0.05})$	
$W(L.S.D_{0.05})$	3.428**		n.s.	

There was a highly a significant relationship (r = - 0.6767) between the yield and the irrigation water salinity fig (1).

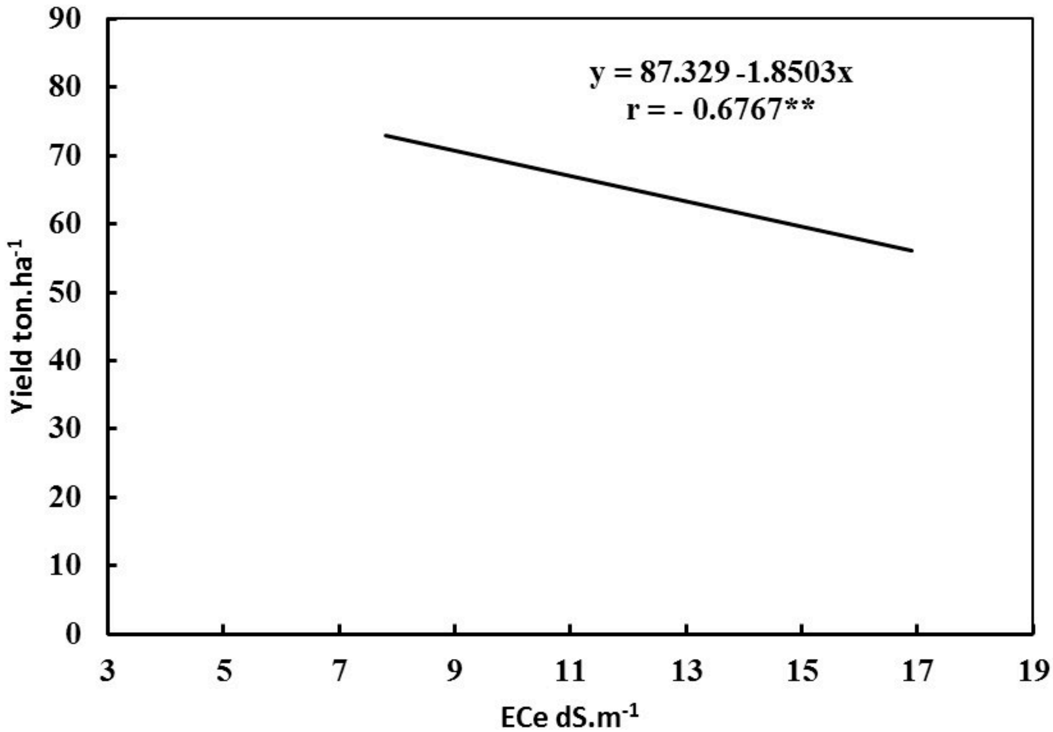

Fig.(1) : Relationship between yield of *Curcurbita pepo (L.)* ton.ha^{-1} and soil salinity dS.m^{-1}

The highest yield was in the soil applications of iron 33% , 26% while the increase in the yield was 10% , 8% in the foliar applications of iron for chelate and mineral iron fertilizers respectively compared with the control. Indeed foliar applications of iron fertilizers was the best method for curing Fe - deficiency symptoms on the plants (Hama and Juma 2000).

Fig (2) shows a significant relationship (r = 0.4375) between the yield of *Cucurbita pepo (L .)* ton. ha^{-1} and the available soil- Fe (mg Fe.kg^{-1} soil). The correlated formula between them was y= 27.78 + 2.086 x

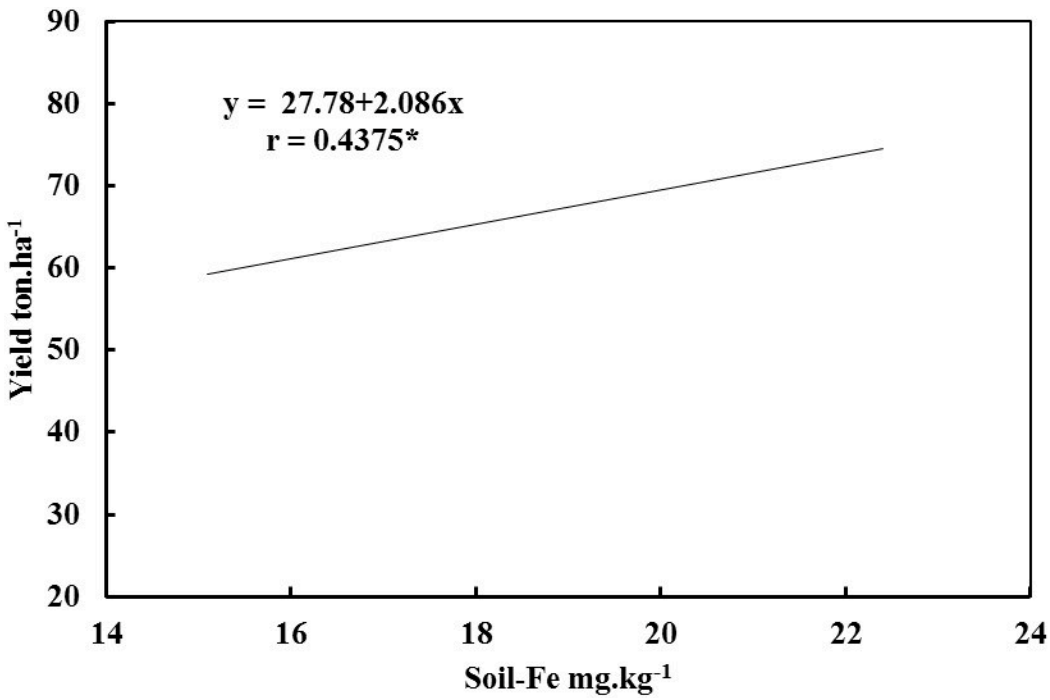

Fig.(2) : Relationship between yield of *Curcurbita pepo (L.)* ton.ha^{-1} and available Soil-Fe mg.kg^{-1}

A significant relationship (fig 3) was found also between the plant yield and chlorophyll content , spad (r = 0.6844) while correlated equation was
y = 10.81 + 0.9209 x

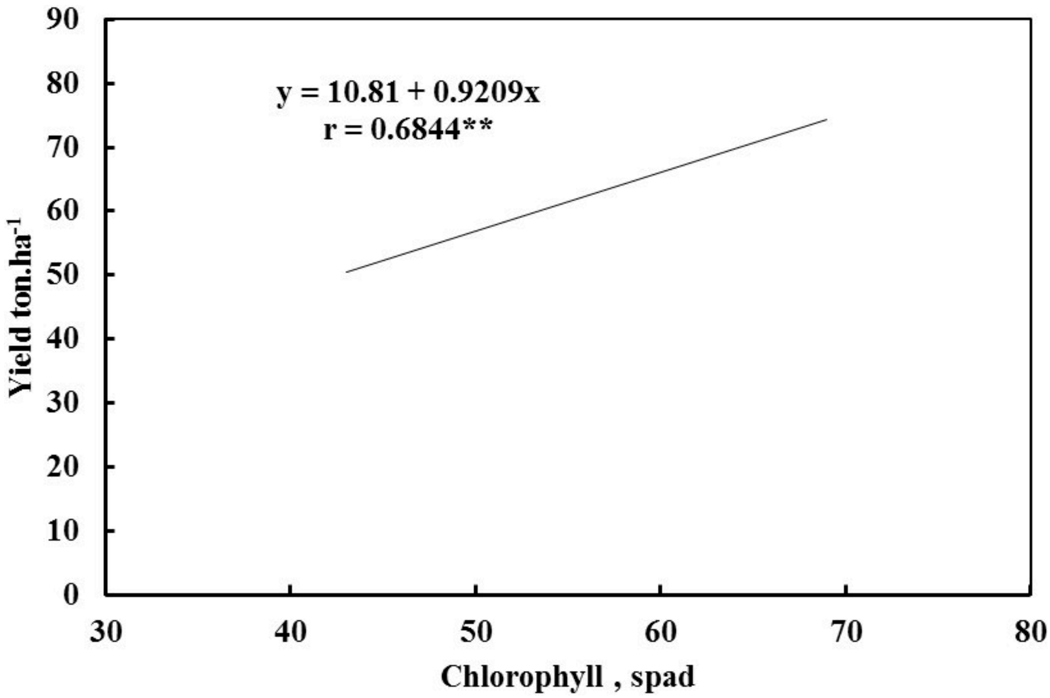

Fig.(3) : Relationship between yield of *Curcurbita pepo (L.)* ton.ha^{-1} and Chlorophyll content , spad .

The relationship between the yield ton.ha^{-1} and plant dry weight (fig 4) was highly significant (r = 0.8299) and the correlated equation was y = 16.984 + 8.5532 x

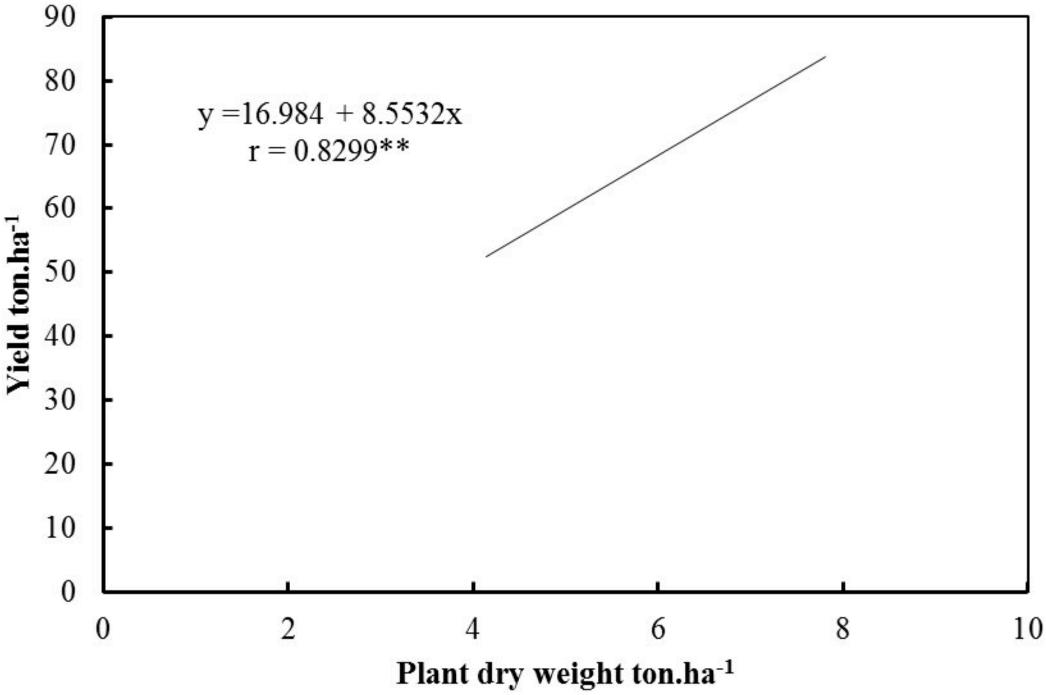

Fig.(4) : Relationship between yield of *Curcurbita pepo* L. ton.ha^{-1} and plant dry weight ton.ha^{-1}

6. Effect of irrigation water salinity , source and method of application of iron on plant- Fe concentration:

Increasing irrigation water salinity from 1.4 to 4 dS.m^{-1} decreased iron concentration in the plant tissues from 69.31 to 60.54 mgFe.kg^{-1} dry matter. This decrease may be attributed to the competition between Na^+ , Cl^- and Fe^{++} , Fe^{+++} ions in soil solution reducing iron absorbance by plant roots. Increasing osmotic pressure of soil solution also decrease iron and water absorbance by plant roots leading to a depression in iron concentration in plant tissues (Bedair , 2016). Fig (5) reflects a highly significant relationship between the yield ton.ha^{-1} and iron concentration mgFe.kg^{-1} dry matter in the plant tissue (r = 0.8799).The correlated equation was $y= -18.197 + 1.2779x$

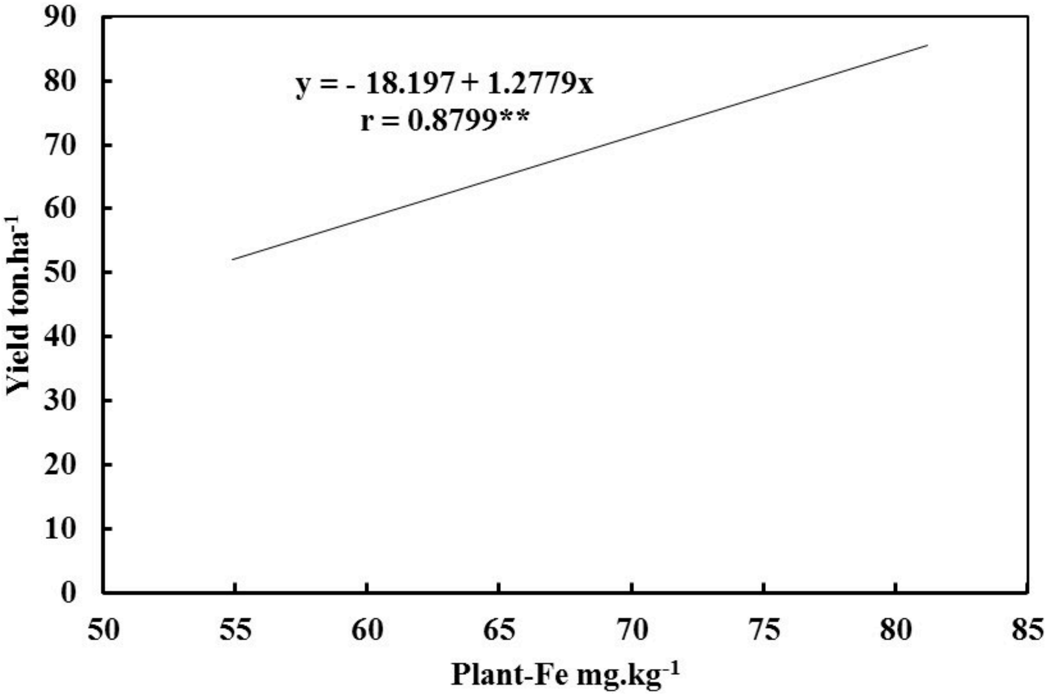

Fig.(5) : Relationship between yield of *Curcurbita pepo (L.)* ton.ha^{-1} and Plant-Fe mg.kg^{-1}

7. Effect irrigation water salinity , source and method of application of iron on the iron response percentages:
There was a high response 25.14% , 20.49% to the soil application of iron while there was a little response 8.71% , 7.04% to the foliar application of iron for chelate and mineral fertilizers respectively. The foliar application of iron fertilizers usually used when iron deficiency symptoms appeared on the plant while the soil application of iron especially chelated fertilizers had important role in increasing the yield compared with mineral iron fertilizers. The difference between the chelate and mineral iron fertilizers may be attributed to the longtime of chelate iron ion availability in soil solution to absorbance by plant roots.

The chelated compounds also increase the speed of transport of iron ion inside plant tissues. The positive charge of iron ions will neutralize the negative charge of chelate (organic) compound. The neutralized complex (iron ion + chelate compound) moves easily through the plant vessels (Al- Foli , 1987). The chelate compound had a good stability and dynamic equilibrium in soil solution through a wide range of soil reaction (4 - 10) and less affected by the dominance of different ions in soil solution such as Mg^{++} , Ca^{++} , Al^{+++} and H^{+} ions (Lindsay , 1979).

There was significant relationship (r = 0.4706) between plant- Fe $mg.kg^{-1}$ and available soil- Fe $mg.kg^{-1}$. The correlated equation was y = 37.528 + 1.545 x

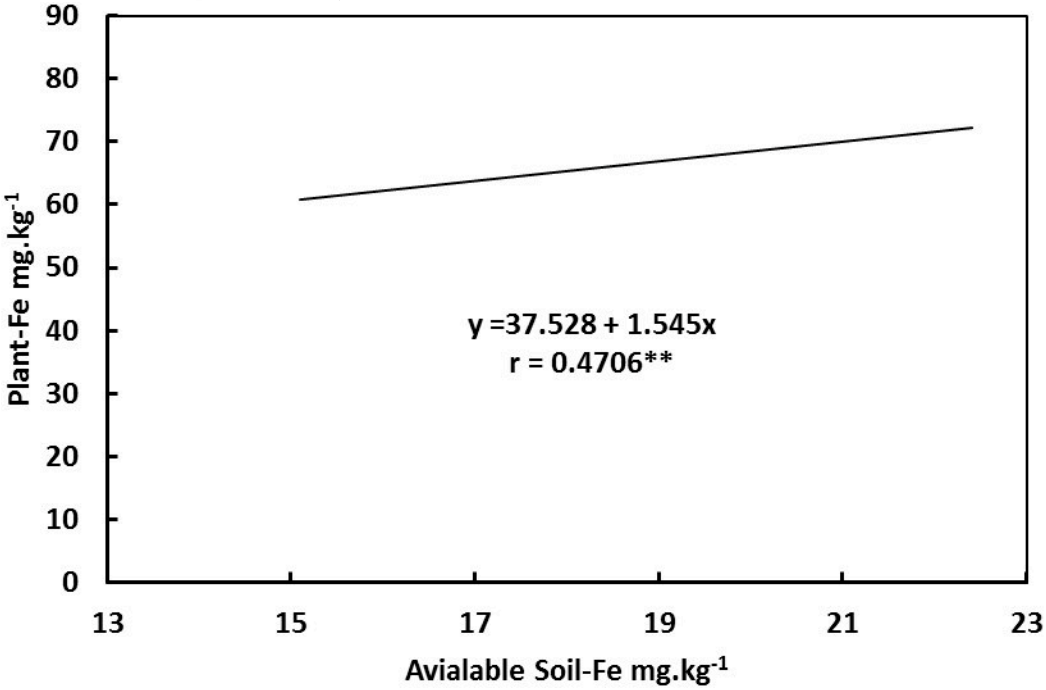

Fig.(6) : Relationship between Plant-Fe $mg.kg^{-1}$ and Available Soil-Fe $mg.kg^{-1}$

References

Abbood , H.Y. and M.H. Kareem .2014. Effect of irrigation water salinity and the levels of sewage sludge applications in some characteristics of wheat plant growth. Euphrates journal of Agriculture science. 6(2) : 295 - 303

Abbood , H.Y. and M. Al- Watefy . 2013. Effect of salicylic acid spraying and irrigation water salinity on growth and yield of wheat (*Triticum aestivum*(*L.*)) in different soil textures. Euphrates journal of Agriculture Science. 5(3) : 227 - 244.

Ayers , R.S. and D . W. Westcot . 1976. Water quality for agriculture . FAO Irrigation and Drainage Paper No . 29 Food and Agriculture Organization of the United Nations.

Bedair , A.M.2016. The interactive effect of irrigation water salinity and organic and inorganic fertilizers on some soil properties , growth and yield of cabbage (*Brassica oleracea (L.)* var. capitata). M.Sc. Dissertation , Agriculture College , University of Al- Qasim Green , Babylon ,Iraq.

Di Martino , C. , Delfine , S. , pizzuto , R. , Loreto ,F. and F. Amodio. 2003. Free amino acids and glycine betaine in leaf osmoregulation of spinach responding to increasing salt stress. New phytologist . 158 (3): 455 – 463 .

Essa , T.A. 1990. Field crops physiology. Agriculture College. University of Al- Basra. Iraq.

Al- Foli , M.M.1987. Principles of plant nutrition and micro elements problems in Egypt. National Center. Technical Cooperation with Germany.

Halloob , I.A. 2014. Effect of interaction between irrigation water salinity and organic fertilizer in some soil chemical properties and yield of Cabbage *(Brassica oleracea (L.)* var. capitata). M.Sc. dissertation , Agriculture College , University of Baghdad , Iraq.

Hamad , A.S.2010. Effect of irrigation water salinity and levels of sewage sludge applications in some physical and chemical properties of soil and growth and yield of spinach (*Spenacea oleracea (L.)*) M.Sc. dissertation. Agriculture college , Baghdad University, Iraq.

Kemira , G.H. 2004 . Application of micronutrients . pros and cons of the different application strategies . IFA International Symposium on Micronutrients .Internet / International Fertilizer Industry Association. 23 – 25 February 2004 , New Delhi , India .

Lindsay , W. L. 1979. Chemical equilibria in soils . John wiley and Sons . Inc. New york.

Mahmood , Y.A. and H.S. Al- Zaidy . 2011. Effect of irrigation water quality , organic matter and phosphorous on some soil chemical characteristics and yield of califlower (*Brassica oleraceae (L.)*). The Iraqi Agricultural Sciences journal.

Mengel, K. (1994). Iron availability in plant tissues - iron chlorosis on calcareous soils . Plant and Soil 165: 275 - 283

Norvell , W. A . and W. L. Lindsay . 1972. Reactions of DTPA chelates of iron , zinc, copper and manganese with soils . Soil Sci. Soc . Amer. Proc . 36 : 778 - 788

Pearson , K. E. 2003 . The basics of salinity and sodicity effects on soil physical properties . Water Quality and Irrigation Management. Montana State University , Bozeman . Water quality @ Montana – edu water quality .

Al- Rawi , K. and A. A. Khalafalla . 2000. Design and analysis of agricultural experiments. Agriculture College . University of Al- Mosul, Iraq .

Sakr, M.T. ,El-Emery , M.E. ,Fouda , R.A. and M.A. Mowafy ,2007 . Role of some anti-oxidants in alleviating soil salinity stress. J. Agric. Sci . Mansoura Univ. 32 : 9751 – 9763 .

Al- Tae , D.K. 2013. Response of growth characteristics , yield and effective constituents of spinach (*Spenacia oleracea (L.)*) to seeds soaking with salicylic acid and kinetin under osmotic tension conditions. Ph.D. Thesis , Agriculture college , University of Al- Kufa , Iraq.

Tisdale , S. L. , Nelson , W . L. , Beaton , J.D. and Havlin J. L. , 1997. Soil fertility and fertilizers. 5 th ed . Macmillan Publishing Co. , New york , USA.