Effect of Iron chelate consumed and non-consumed tea on corn plant

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Abstract

The factorial experiment was conducted during autumn season 2009, from 10th July to 29th September to study effect of three Fe-chelate comp- ounds and two types of tea residue (consumed and non consumed tea) each of them with 5 levels which equivalent (0 , 2.5 , 5 , 7.5 and 10 mg Fe Kg^{-1} soil) and their interactions on growth, iron and chlorophyll concentration in corn plant using completely randomized design with 3 replicates.The results indicated significant effect of type, levels of compounds and their interaction on total chlorophyll ,iron concentration in plant and dry weight the highest values of them (16.32 $mg.g^{-1}$ dry matter , 136.86 $\mu g.g^{-1}$ dry matter and 119.2 $g.pot^{-1}$ were recorded from interaction treatments (Fe-EDTA*L_5 , Fe-EDDHA 6% *L_4 and 1% of consumed tea * L_2) respectively.

Key words: Fe-chelates, consumed tea, non-consumed tea.

Introduction

Iron is the fourth of the most abundant element in the earth's crust, consisting about 5.6 percent. The total Fe content of soils ranged between 200-100000 $\mu g.g^{-1}$ in soils (Sauchelli; (1969)).

Iron (Fe) is very insoluble in aerobic conditions at neutral and alkaline pH. Iron exist either in divalent (Fe^{++}) or trivalent status and the divalent state is absorb by plants and to least extent as Fe-chelates. (Barker and Pilbeam; (2007))

Iron chlorosis is considered to be one of the most difficult micronutrient deficiencies to correct in the field (Tisdale et al; (1997)). The most common fertilizer for soil application is ferrous sulphate. However, the soil application option is generally not preferred owing to the rapid oxidation and immo- bilization of the ferrous to ferric iron in the soil. The efficiency of soil applied ferrous sulphate improves where it is mixed with organic manure and applied, while it is efficiency decreases with increasing of $CaCO_3$ content of the soil.

The commonly recommended method of Fe application is through foliar sprays either as inorganic salts or preferably through chelates of Fe with EDTA, EDDHA… etc. The Fe-EDTA chelate is useful only in slightly acid soil while Fe- EDDHA is unique as its stability remains constant over a wide range (4–9) of pH.

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Iron deficiency in calcareous soil causes iron chlorosis that becomes evident as a typical yellowing of new plant leaves which known as (Lime inducezd-chlorosis) because the plant cannot produce adequate amount of chlorophyll, this causes a decrease in dry matter yield (Wallace and Mueller; (1980)). However iron availability is related to two important functions in the plant, it is a part of the catalytic group for many redox enzymes and it requires for the synthesis of chlorophyll, important redox enzymes including the hem containing cytochromes and

non-heme iron-sulfur proteins (ferredoxin) in- volved in photosynthesis and respiration (Hopkins; (1999)).

Since there are little available studies about the effect of iron chelate type and tea residues on iron availability and corn growth at Erbil governorate, for this reason this study was selected to study the effect of different levels of iron chelates, consumed and non consumed tea as organic fertilizer on:

1-Dry matter weight of corn plant.
2-Chlorophyll and iron content of corn plant.
3-Available iron in the soil.

Materials and Methods

Soil sampling:

Soil sample was collected from Grdarasha location at Erbil governorate the samples were taken from soil surface (0-30) cm depth, which considered as the active zone for plant root.

Quantitative amounts of soil samples were taken for pot experiment. Some physical and chemical properties of the soil were analyzed according to Black; (1980) in College of Agriculture, Salahaddin University, Department of Soil and Water (table,1)

Table (1): Some physical and chemical properties of the studied soil.

No.	Some physical and chemical properties		
1	pH		7.65
2	EC $dS.m^{-1}$ at 25^0C		0.63
3	Organic Matter $g.Kg^{-1}$		10.01
4	Total $CaCO_3$ $g.Kg^{-1}$		335
5	CEC $Cmol_c.Kg^{-1}$		23.40
6	Bulk Density $Mg.m^{-3}$		1.27
7	Textural name		SiCL
8	Particle Size distribution $g.Kg^{-1}$	Clay	35.6
		Silt	54.6
		Sand	9.7

9	Water Content%	Saturate percentage		58.45
		F.C		31.42
		W.P		16.89
10	Concentration.mmol$_c$.L^{-1}		Ca^{2+}	2.75
			Mg^{2+}	1.92
			Na^{+}	1.39
			K^{+}	0.12
			Cl^{-}	1.20
			HCO_3^{-}	3.32
			NO_3^{-}	0.45
			SO_4^{2-}	1.08
	mgL^{-1}		Fe	0.044

Pot experiment:

A Pot experiment was conducted from (10\7\2009) at the experimental farm of College of Agriculture University of Salahaddin at Grdarasha field, (3.5km to the south of Erbil city (36^0 ON, $44^0$01E), (0411359, 03997002 UTM), it is a part of a wide plain, 411m above mean sea level). The pot experiment included the response of corn plant to 5 type of compounds (chelates + tea residue) each of them with 5 levels (0 , 2.5 , 5 , 7.5 and 10µg Fe.g^{-1} soil) using factorial CRD with (3) replicates, table (2) shows the levels of factors and their combinations.

Each pot (23cm height, 25cm top diameter and 17cm bottom diameter), after packing 1.0 kg of stone in each pot, 6 kg of air dried soil was packed in each pot after passing through 4 mm sieve.

On 19 July 2009. 5 seeds of corn (*Zea mays*.L.var. ***DKC 6418)*** were planted in each pot at 5 cm depth, and then thinned to 3 seedlings Pot^{-1} after two weeks of germination.

Plants (shoots and leaves) were oven dried at 65^0C for 72 hrs then digested using 1:1 H_2SO_4:H_2O_2 then Fe was determined using atomic absorption spectroscopy (Schuffeelen and Schauwenburg (1961)). While available soil Fe was determined after extraction with AB-DTPA using AAS (Pupose; (2001)).

Plant leaves and stems (materials) were digested according to Schu- ffeelen and Schauwenburg; (1961) using (1:1 conc. H_2SO_4 and H_2O_2). mixture and chemical analysis were conducted as mentioned in soil analysis which clarified before: After 40 days from sowing chlorophyll a, b, and total chlorophyll were estimated by using ethanol 100% as solvent. The leaf blades (*third leaf from top plant*) were cut into small pieces with sterilized scissors and 0.25g was folded in a 25 ml dark bottle with 5 ml ethanol caped and stored in a dark place for 24 hours. The dissolved materials including chlorophyll were decanted into another dark bottle, while the bottles, contain- ning the remaining leaf pieces were rinsed twice with 5 ml of 100% ethanol and again incubated for 24 hours each time. The rinsing solutions were collected in the original dark bottle and broad to 15 ml with 100% ethanol.

Table (2): Types and levels of applied chelates and tea residue in pot experiment.

Chelate compounds and tea residue (consumed and non consumed tea)	mg Fe.kg^{-1} soil				
	L_1(0)	L_2(2.5)	L_3(5)	L_4(7.5)	L_5(10)
Fe-EDTA (13.2%Fe)	0	2.5	5	7.5	10
Fe-EDDHA (6%Fe)	0	2.5	5	7.5	10

Fe-Chelate liq.(5%Fe)	0	2.5	5	7.5	10
1%of non-consumed tea *	0	2.5	5	7.5	10
1% of consumed tea *	0	2.5	5	7.5	10

* The amount of tea applied per pot is equivalent the levels of applied Fe from chelate compounds.

The extracted solution was filtered through a filter paper (Ø 110 mm), and then the available iron was determined by atomic absorption spectro- photometer (Pupose; (2001)).

Plant analysis:

-Chlorophyll a,b and total chlorophyll were determined after 40days from planting using the following equations as mentioned by (knudson et al.; (1977)).

µg Chl a/ ml solution = (13.70) (A665nm) – (5.76)(A649nm)……...1

µg Chl b/ ml solution = (25.80) (A649nm) – (7.60)(A665nm)…….....2

Results and Discussion

Effect of types, levels of (chelate compounds, consumed and non-consumed tea and their interaction on total chlorophyll content of corn:

As shown from table (3) the types of chelate compounds, consumed and non-consumed tea affected significantly ($p \leq 0.01$) the total chlorophyll content of corn plant. The highest value (14.61 $mg.g^{-1}$ dry matter) was recorded from (Fe-Chelate liq. 5%) while the lowest value (12.72 $mg.g^{-1}$ dry matter) was recorded from the application of 1% non consumed tea this may be not due to dilution effect since the iron uptake for treatment Fe-Chelate liq.5% = 14.61 * 103.19 =1057.6 mg pot^{-1} ,while its value for 1% non consumed tea =12.72*112.52 =1431.3 mg pot^{-1},it means after conversion concentration to uptake the results were the same (table,3 and 6) the behavior of total chlorophyll is similar to both of chlorophyll a and b similar results were recorded by Al-Mulk ;(1986) and Mustafa ;(2003).

The levels of applied from chelates and tea affected significantly the concentration of total chlorophyll at ($p \leq 0.01$). The highest value (14.57 $mg.g^{-1}$ dry matter) was recorded from L3 and lowest value (12.20 $mg.g^{-1}$ dry matter) was recorded from level L1. Figure (1) shows there is a significant correlation coefficient (r=0.89*) between levels of applied iron and total chlorophyll content of corn. this may be due to the application of iron to certain level enhanced the chlorophyll formation, because the adequate concentration of iron in soil solution causes increase in plant chlorophyll content due to the role of Fe in chlorophyll formation (Mengel and Kirkby; (1987))

The combination treatments affected significantly ($p \leq 0.01$) on total chlorophyll content of corn plant, the highest value (16.32 $mg.g^{-1}$ dry matter) was recorded from combination between Fe-EDTA (13.2%) and level 5 ,while the lowest value (11.15 $mg.g^{-1}$ dry matter) was recorded from combination between 1% non consumed tea and level 4 (table,5). Similar results were obtained by khawakarm; (2003) and Abdullah; (2006), they recorded the highest value of total chlorophyll of wheat and barley in case of application 5 $mg.kg^{-1}$soil Fe-EDTA but the lowest value may be due to allelopathic effect of non consumed tea (%1).

Table (3): The effect of types, levels of chelate compounds, consumed and non consumed tea and their interaction on total Chlorophyll (mg.g^{-1} dry matter).

Chelate compounds and tea residue	Levels					Means
	L1	L2	L3	L4	L5	
Fe-EDTA (13.2%)	12.20	11.28	16.05	15.05	16.32	14.18
Fe-EDDHA (6%)	12.20	14.56	15.74	13.75	13.98	14.04
Fe-Chelate liq.(5%)	12.20	15.41	13.42	15.99	16.03	14.61
%1 of non-consumed tea	12.20	14.04	14.92	11.15	11.30	12.72
%1 of consumed tea	12.20	13.50	12.81	13.03	15.44	13.40
means	12.20	13.76	14.57	13.79	14.61	

Tukey's value for both treatments 1.03, Tukey's value for interaction 2.92

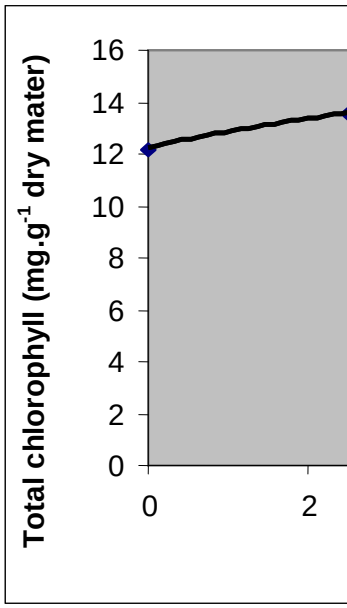

Figure (1): The relation between levels of applied Fe and total chlorophy- ll content of corn plant (mg.g^{-1} dry matter).

Effect of types, levels of chelate compounds, consumed and non-consumed tea and their interaction on iron content in corn plant:

Table (4) shows that the types of chelates affected significantly ($p \leq 0.01$) the iron concentration of corn. The highest value (112.08 µg Fe.g^{-1}dry matter) was recorded from application of Fe-EDTA 13.2% while the lowest value (97.08 µg Fe.g^{-1}dry matter) was recorded from application of %1 non consumed tea. The significant difference was recorded only between appli- cation of EDTA and all other treatments.

The levels applied Fe were affected significantly on concentration of iron in corn plants, the significant difference was recorded between L3 and all other levels of applied iron, the lowest

value (86.82 µg $Fe.g^{-1}$ dry matter) was recorded from L3, while the highest value (108.64 µg $Fe.g^{-1}$ dry matter) was recorded from L2; this could be due to nutrient imbalance and dilution effect (table, 6). These results are not agree with those recorded by Mulk (1986) and this may be due to the difference in environmental conditions of this research in comparing with the environmental condition of his research such as type of plant, age of plant at the end of experiment, number of plants per pot…etc. In general the Fe content of plant is not deficient. Figure (2) shows a significant correlation coefficient (r=0.60) between levels of applied iron and iron content of corn plant.

Chelate compounds and tea residue	Levels					Means
	L1	L2	L3	L4	L5	

The combination treatment affected significantly at ($P \leq 0.01$) (table, 4), the highest value (146.11 µg $Fe.g^{-1}$ dry matter) was recorded from combi- nation between Fe-EDTA 13.2% and L2 and lowest value (63.89 µg $Fe.g^{-1}$dry matter) was recorded from combination between Fe-EDDHA (6%) and L3. The above combinations may created different growth conditions for plants, for example the combination between Fe-EDTA and L2 may created the best condition for plant growth and the combination between %1 consumed tea and L2 may created the worst condition for corn growth, in addition to the dilution effect (table, 6).

Table (4): The effect of types, levels of compounds, consumed and non-consumed tea and their interaction in Iron concentration (µg $Fe.g^{-1}$ plant dry matter).

Fe-EDTA (13.2%)	103.89	146.11	87.70	107.15	115.56	112.08
Fe-EDDHA (6%)	103.89	109.67	63.89	136.86	92.78	101.41
Fe-Chelate liq. (5%)	103.89	119.82	96.30	92.22	79.63	98.38
%1 of non-consumed tea	103.89	90.75	73.15	101.49	116.11	97.08
%1 of consumed tea	103.89	76.85	113.08	95.30	106.11	99.04
Means	103.89	108.64	86.82	106.60	102.04	

Tukey's value for both treatments = 8.9 , Tukey's value for interaction =25.36

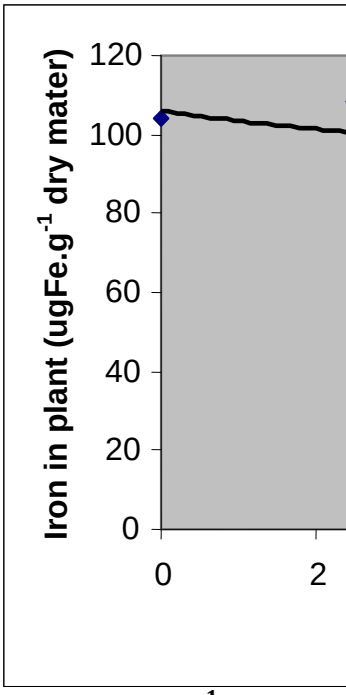

Figure (2): The relation between levels of applied iron and iron in the plant (µg.g^{-1} dry matter)

Effect of types, levels of chelate compounds, consumed and non - consu-med tea and their interaction on soluble iron in the soil:

Table (5) shows that the types of chelates, consumed and non-consumed tea affected significantly at ($p \leq 0.01$) the available Fe content of the soil after harvest. The highest value (7.93 µg Fe.g^{-1} soil) was recorded from application of Fe-EDTA (13.2%) and the lowest value (6.72 µg Fe.g^{-1}soil) was recorded from application of %1 consumed tea this may be due to that compounds (chelates) may originate as root exudates, from the degradation of organic matter, as metabolic products of microorganisms, or as Fe chelate fertilizer added to the soil (Jurkevitch et al.; (1986)). The lowest values were recorded with increasing of applying consumed and non consumed tea, this may be due to the increase in phosphorus availability then precipitation a part of iron with phosphorus at root surface in a form of $Fe_3(PO_4)_2$ since application of tea cause increase in available phosphorus which may react with iron at root surface (Mengle and Kirkby; (1986) and Muhammad; (2010)).

The levels of applied iron from chelates, consumed and non-consumed tea affected significantly at ($p \leq 0.01$) the available iron content of the soil, the highest value (8.14 µg Fe.g^{-1} soil) was recorded from application of 5.00 µg Fe.g^{-1} soil (level 3) and lowest value (6.60 µg Fe.g^{-1}soil) was recorded from (L1). On the other hand there are no significant differences between application of (2.5 , 5 , 7.5 and 10)µg Fe.g^{-1} soil it means the application of 2.5 µg Fe.g^{-1} soil is adequate for corn plant under this condition. Figure (3) shows a significant correlation coefficient (r=0.92*) between levels of applied iron and iron in soil. Crowley et al.; (1987) pointed out that

under conditions of low Fe solubility in soils, Fe chelates are extremely important for mobilizing Fe and increasing its availability to plants these results agree with those recorded by Abdullah; (2006).

The combination between (chelate compounds and tea) and their levels affected significantly at ($p \leq 0.01$) the Fe content of the soil, the highest value 9.45 µg $Fe.g^{-1}$ soil was recorded from combination between Fe–chelate. (5%) and application of 7.5 µg $Fe.g^{-1}$ soil (L4), while the lowest value 6.51 µg $Fe.g^{-1}$ soil was obtained from combination between application of 1% consumed tea and application of 2.5 µg $Fe.g^{-1}$ soil (L 2). This may be due to the reasons mentioned before.

Chelate compounds and tea residue	Levels					Means
	L1	L2	L3	L4	L5	
Fe-EDTA (13.2%)	6.60	7.36	9.18	9.10	7.42	7.93
Fe-EDDHA (6%)	6.60	7.49	7.93	8.19	8.18	7.65
Fe-Chelate liq.(5%)	6.60	7.04	9.45	8.45	7.60	7.83
%1 of non-consumed tea	6.60	6.74	6.74	7.03	6.90	6.80
%1 of consumed tea	6.60	6.51	7.38	6.57	6.54	6.72
Means	6.60	7.03	8.14	7.85	7.32	

Table (5): The effect of types, levels of chelate compounds, consumed and non-consumed tea and their interaction on Iron in soil (µg.g^{-1} soil) after harvest.

Tukey's value for both treatments 1.80, Tukey's value for interaction 3.07

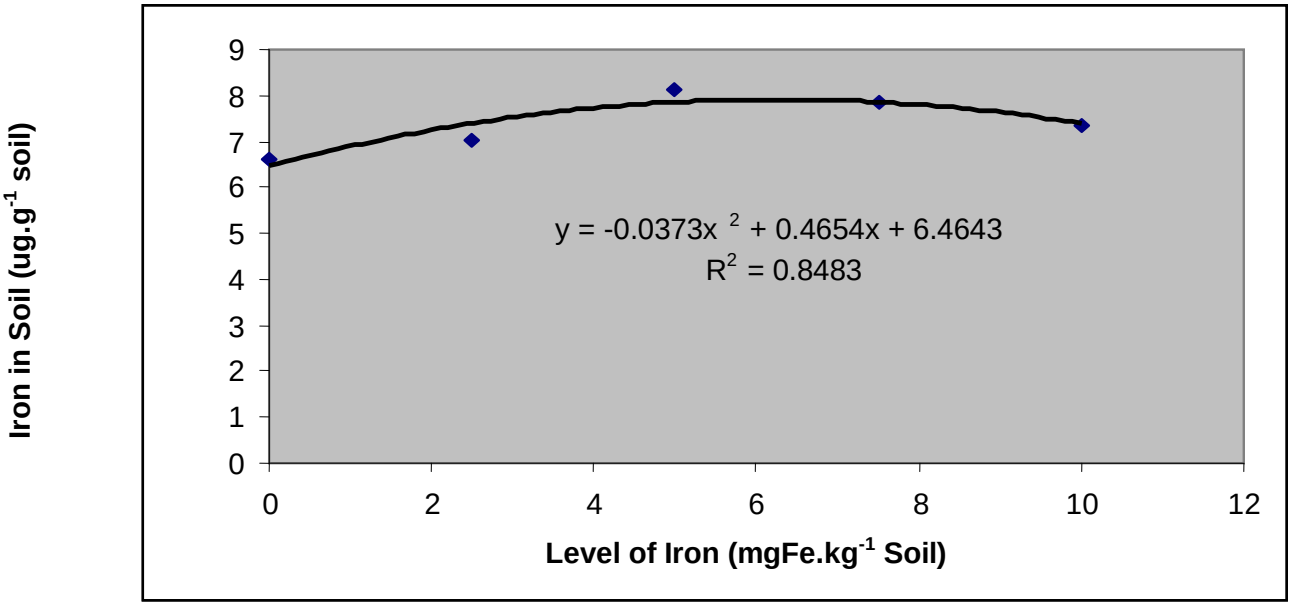

Figure (3): The relation between levels of applied iron and iron in the soil (µg $Fe.g^{-1}$ soil)

Effect of types, levels of chelate compounds, consumed and non - consu- med tea and their interaction on dry matter:

Table (6) indicated a significant effect of type of chelates and non-consumed tea application ($P \leq 0.01$) on dry matter weight, the highest value (112.52 $g.pot^{-1}$)was recorded from application %1 non consumed tea, while the lowest value (99.20 $g.pot^{-1}$) was recorded from application of Fe EDDHA (6%). The increase in dry matter weight may be attributed to Fe deficiency and requirement of plants to Fe–fertilization since the amount of available Fe in calcareous soil is not adequate for plant requirements in a longest growth season (Lindsay and Schwab;(1982) , Rachhpal and Sinha; (1977)) indicated that the application of iron in mineral and chelate form to corn grown in calcareous soil caused a significant increase in dry matter weight of corn plant the similar results was obtained by Muhammad; (2010) who obtained the increase in dry mater weight of plant with application of tea residue to a certain level. Figure (4) shows a significant correlation coefficient (r= 0.82) between levels of applied iron and dry weight of corn. Table (6) shows that the combination treatments affected significantly on dry matter yield at ($p \leq 0.01$) the highest value (128.29 $g.pot^{-1}$) was recorded from combination between Fe-EDTA (13.2%) and L3 while the lowest value (88.02 $g.pot^{-1}$ was recorded from combination treatment Fe-EDTA (13.2%) and L5. This result is agree with those recorded by Rachhpal and Sinha; (1977) they indicated that the application of iron in mineral and chelate to corn grown in calcareous soil causes a significant increase in dry matter weight of corn plant, similar results were obtained by: Khwakaram; (2003) and Abdullah; (2006).

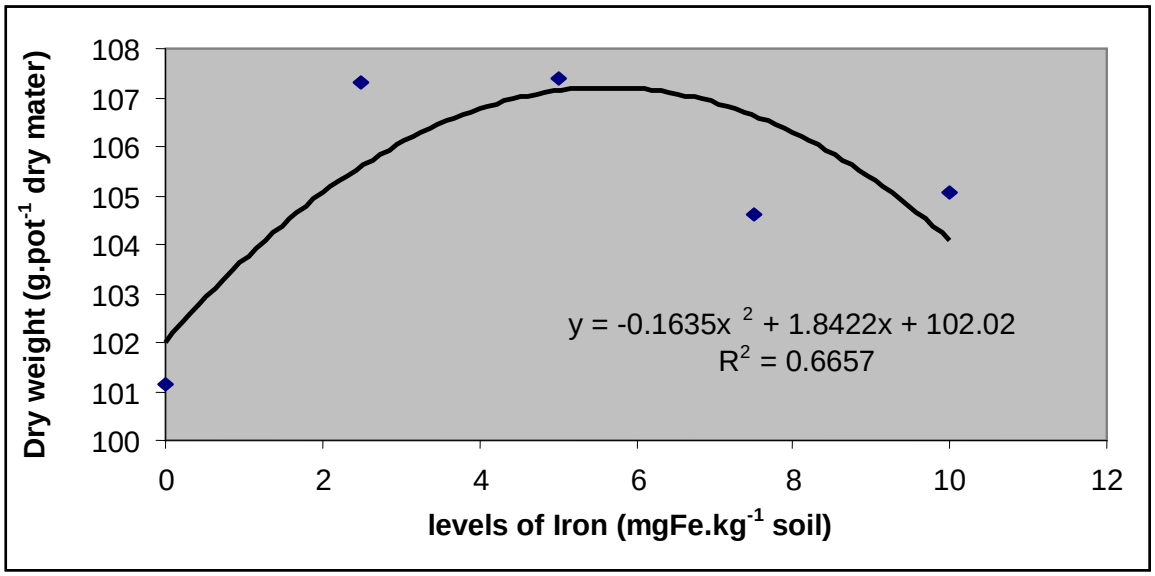

Figure (4): The relation between levels of applied Fe and Dry weight content of corn plant ($mg.g^{-1}$ dry matter)

Table (6): The effect of types, levels of chelate compounds, consumed and non-consumed tea and their interaction on dry weight ($g.pot^{-1}$)

Chelate	Levels	Means

	L1	L2	L3	L4	L5	
Fe-EDTA (13.2%)	101.13	103.22	128.29	115.22	88.02	107.17
Fe-EDDHA (6%)	101.13	105.18	92.67	92.35	104.69	99.20
Fe-Chelate liq. (5%)	101.13	99.57	96.92	102.97	115.34	103.19
%1 of non-consumed tea	101.13	119.2	114.31	111.68	116.29	112.52
%1 of consumed tea	101.13	109.30	104.73	100.92	100.93	103.40
Means	101.13	107.29	107.38	104.62	105.05	

Tukey's value for treatments =7.57 ,Tukey's value for interaction 21.55

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تأثير الحديد المخلبي والشاي المستهلك وغير المستهلك على نبات الذرة الصفراء

اكرم عثمان اسماعيل خديجة محمد علي رسول
جامعة صلاح الدين – كلية الزراعة

الخلاصة

اجريت التجربة العاملية خلال الموسم الخريفى ٢٠٠٩ (من ١٠ حزيران الى ٢٩ ايلول ٢٠٠٩) لدراسة تاثير ثلاث مركبات مخلبية للحديد و نوعان من الشاى (بعد الاستخدام و قبل الاستخدام) كل منهم بخمس مستويات و التداخل بينهما فى النمو و تركيز الكلوروفيل و الحديد فى الذرة الصفراء باستخدام التصميم العشوائى الكامل. تشير النتائج الى وجود تاثير معنوى لنوع و مستوى المركب و التداخل بينهما فى تركيز الكلوروفيل الكلي و تركيز الحديد و وزن المادة الجافة حيث سجلت اعلى القيم لهم (١٦,٣٢ ملغم.غم$^{-1}$ مادة جافة و ١٣٦,٨٦ مايكروغرام.غم$^{-1}$ مادة جافة و١١٩,٢غم/سندانة) فى المعاملات العاملية EDTA*L_5, EDDHA6%*L_4 و 1% Consumed tea *L_2) على التوالى.