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PHYSIOLOGICAL RESPONSES OF CORN PLANT TO APPLIED OF IRON AND NICKEL.

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ABSTRACT

An experiment was conducted to study the effect of iron (Fe) applied at different rates of 5 ppm $(Fe)_1$, 10 ppm $(Fe)_2$ and 20 ppm $(Fe)_3$ as well as nickel applied at the rates of 2.5 ppm $(Ni)_1$, 5 ppm $(Ni)_2$ and 10 ppm $(Ni)_3$ along with their combinations of 5 ppm Ni +5 ppm $Fe(NFC)_1$, 5 ppm Ni +10 ppm $Fe(NFC)_2$, 5 ppm Ni +15 ppm $Fe(NFC)_3$ and 5 ppm Ni +20 ppm $Fe(NFC_4)$ on plant growth , nutrient uptake and certain metabolic parameters of two corn varieties (Giza 10 and Giza 122).

The different applications of both Fe and Ni significantly increased the dry matter production of shoot ,root and shoot /root ratio along with nutrient accumulation in the two studied corn varieties at low both and moderate concerned rates. Applying high rates caused adverse effects compared to the control.

In leaves, chlorophyll content generally was increased with applied Fe and low rates of Ni, such response being dependent on the concerned variety . Furthermore, these metals induced leaf accumulation of total soluble sugars (TSS),reducing sugars (RS) and non reducing sugars (NRD) at moderate rate of both Fe , Ni and their combinations . Data suggest that application of moderate rate of Fe and low rate of nickel, either applied separately or combined together, was most suitable for plant growth.

Keywords: Iron , nickel , total soluble sugars, reducing sugars ,non reducing sugars, chlorophyll , RNA , DNA .

INTRODUCTION

Both iron and nickel are considered to be essential micronutrients for higher plants .Iron has a fundamental role in a series of processes; it is coordinated at metalloprotein -active sites.Iron is important due to its physico -chemical properties , it participates in most of the basic redox reactions required in both the production and consumption of oxygen *(Briat and Lobreaux,1997)*.

On the other hand , low concentrations of Ni are necessary in the nitrogen metabolism and the germination for plants , including both cereals and cowpeas *(Brown et al., 1987 ,1990 ; Dalton et al., 1985; Walker et al., 1985;Krogmeier et al., 1991).* In fact, nickel at sufficiently high levels may be toxic to plants *(Yang et al., 1996)*.High levels of Ni interfere with photosynthetic and respiratory activities *(Yang et al., 1996)*,mineral nutrition *(Barcelo and Poschenreider ,1990)*,enzymatic activity *(Krogmeier et al., 1991;Pandolfiniet et al.,1992)*, membrane functions *(Pandolfini et al., 1996)*,and chlorophyll content (*Pandolfini et al., 1992; Brune et al., 1995).* Accumulation of carbohydrates in shoots of *barely (Agarwala et al., 1977)* and increase of starch contents in leaves of white bean *(Rauser,1978)* ,have been demonstrated when seedlings were exposed to high levels of Ni.

The aim of this work is to study the effects of iron and nickel as well as their combinations on certain metabolic activities in corn in order to explain the inhibitory effects of these metals on plant growth.

MATERIALS AND METHODS

A greenhouse experiment was carried out and sand culture technique was used .Pots of 15 cm diameter which had a hole at bottom , to facilitate flushing , were used and received a quantity of two kilograms acid washed sand .A randomized complete design with three replications was adopted , control treatments being taken into consideration.

Corn *(Zea mazs L.)* was chosen as an indicator crop . Seeds of two varieties (Giza 10 and Giza 122) were planted , developed one week old seedlings being then thinned to five plants per pot .The pots were firstly regularly flushed with nutrient solution of *Arnon (1938)* ; except for Fe, micronutrients being involved . later on,the indicated nutrient solution was continued to be applied accompanied with the concerned rate of iron and nickel

Iron and nickel were separately applied ; treatments involved 5 ppm $(Fe)_1$,10 ppm $(Fe)_2$ or 20 ppm $(Fe)_3$ Fe as $FeSO_4$ as well as either 2.5 ppm $(Ni)_1$,5 ppm $(Ni)_2$ or 10 ppm $(Ni)_3$ Ni as $NiSO_4$.Treatments also included combinations of both Fe and Ni ; such treatments were as follows : 5 ppm Ni +5 ppm $Fe(NFC)_1$, 5 ppm Ni +10 ppm $Fe(NFC)_2$, 5 ppm Ni +15 ppm $Fe(NFC)_3$ and 5 ppm Ni +20 ppm $Fe(NFC)_4$; such treatments represent Ni:Fe ratio of 1:1,1:2 ,1:3 and 1:4 respectively.

Plant seedlings were taken after 45 days from planting . Dry matter contents of different plant parts were subjected to drying at 70 C^0 till constant weight . Plant samples were milled and digested using a mixture of sulfuric acid and hydrogen pyroxide as described by *Cottenie et al . (1982)* ; the digest was then subjected to analyses.

Nitrogen, phosphorus and potassium concentrations in plant materials were determined as described by *Chapman and Pratt (1961).*
Nucleic acids were extracted , according to the method described by *Ogur and Rosen (1950)*, to be then assayed using the method of *Astawrov (1974).* Chlorophll a ,b and carotenoids were extracted from fresh corn leaves ; their concentrations being evaluated in acetone extracts according to *Arnon (1949).*Peroxidase activity was determined according to the method described by *Allan and Hollis (1972).*Total soluble sugars were analyzed by the method described by *(A.O.A.C., (1990)* ; reducing and non –reducing sugars were determined according to the method described by *Somogi (1952*).Non- reducing sugars contents were calculated by the differences between contents of total soluble sugars and reducing sugars.

RESULTS AND DISCUSSION

Plant growth .

Data presented in Table (1) showed that, either iron or nickel generally improved significantly the growth parameters of dry weights for both shoots and roots along with their shoot /root ratio (DMS / DMR) . Such improvement was dependent upon corn variety as well as the rate of applied nutrient, plant part under consideration being also effective . In fact , V_1 (Giza 10) compared to V_2 (Giza 122) was superior ; superiority was significant only for dry weights of shoots and shoot /root ratio of developed plants.

Results also showed that the treatment of $V_1(Fe)_1$, representing Giza 10 (V_1) receiving the rate of 5 ppm Fe ,was superior in dry matter for both shoot and root as well as shoot /root ratio. This is true although dry matter production of the two corn varieties was decreased with increasing the level of either Fe or Ni and their combination; $(FNC)_2$ treatment, representing 5 ppm Ni and10 ppm was relatively superior for both corn varieties.

Table (1) : Effect of iron and nickel on dry weight (g/plant) of the studied corn plants .

Treat .	Variety					
	V_1(G10)			V_2 (G122)		
	shoot	root	shoot/ root	shoot	Root	shoot/ root
Cont.	0.63	0.80	0.78	0.81	0.93	0.88
$(Fe)_1$	1.04	1.05	1.03	0.91	1.07	0.85
$(Fe)_2$	0.87	0.92	0.94	0.88	1.05	0.85
$(Fe)_3$	0.79	0.84	0.95	0.73	0.82	0.89
$(Ni)_1$	0.92	0.93	0.99	0.92	0.92	1.00
$(Ni)_2$	0.88	1.06	0.83	0.85	0.84	1.01
$(Ni)_3$	0.81	1.00	0.82	0.83	0.81	1.02
$(FNC)_1$	0.82	0.74	1.12	0.67	0.86	0.83
$(FNC)_2$	0.94	0.92	1.02	0.83	1.00	0.84
$(FNC)_3$	0.85	0.83	1.02	0.72	0.82	0.89
$(FNC)_4$	0.75	0.78	0.97	0.60	0.62	0.98

LSD at 5% level		**LSD at 5% level**		**LSD at 5% level**	
For shoot :-		**For root :-**		**For shoot/root :-**	
For varieties (A)	=0.18	For varieties (A)	=0.11	For varieties (A)	=0.09
For Treatments (B)	= 0.19	For Treatments (B)	= 0.09	For Treatments (B)	= 0.059
For Rate of application (C)	= 0.064	For Rate of application) (C)	= 0.091	For Rate of application (C)	= 0.088
For (A) X (B)	= 0.084	For (A) X (B)	= 0.129	For (A) X (B)	= 0.084
For (A) X (C)	= 0.091	For (A) X (C)	= 0.128	For (A) X (C)	= 0.124
For (B) X (C)	= 0.11	For (B) X (C)	= 0.157	For (B) X (C)	= 0.152
For (A) X (B) X (C)	= 0.157	For (A) X (B) X (C)	= 0.222	For (A) X (B) X (C)	= 0.216

Obtained results agree with those of *Mengel, (1995)*and *Briat and Lobreaux ,(1997)* who found that dry matter production of corn was improved with Fe supplied to plants , such effect being reported to be possibly due to the role of Fe in most of the basic redox reactions required in both the production and consumption of oxygen; increasing Fe level was , however , observed to reduce dry matter yields *(Olaleye et al.,2001)* .On the other hand, *Baccouch et al., (1998)* found that nickel stress reduces dry matter production , more significantly in root system which accumulates large amounts of Ni .*Gabbrielli et al., (1990)* added that growth reduction caused by Ni may be , generally , linked to be a loss of cellular turgor resulting in either a decrease of mitotic activity and /or an inhibition of cell elongation. .According to *Wainwright and Woolhouse (1977)*, the loss of cellular turgor seems to be as a result of K^+ leakage.

Nutrient uptake by developed plants.

Data inTable (2) showed the nitrogen , phosphorus and potassium contents of both shoots and roots of the studied corn plants .

Table (2) : Effect of iron and nickel on macronutrients uptake (mg/plant) in corn plants.

A: Nitrogen uptake

Treat.	Variety					
	V_1(G10)			V_2 (G122)		
	shoot	root	shoot/root	shoot	root	shoot/ oot
Cont.	23.0	18.4	1.25	38.9	22.2	1.75
$(Fe)_1$	39.0	21.8	1.82	44.8	24.8	1.81
$(Fe)_2$	36.3	18.9	1.94	40.9	20.8	1.97
$(Fe)_3$	28.7	18.1	1.59	27.5	19.8	1.39
$(Ni)_1$	32.9	19.7	1.67	39.5	22.5	1.86
$(Ni)_2$	34.8	22.2	1.56	34.0	18.6	1.83
$(Ni)_3$	30.3	17.6	1.72	32.4	17.2	1.90
$(FNC)_1$	31.1	14.7	2.15	26.9	18.9	1.53
$(FNC)_2$	37.9	21.5	1.76	31.8	23.2	1.40
$(FNC)_3$	31.9	19.6	1.64	28.3	18.1	1.60
$(FNC)_4$	27.4	14.7	1.86	27.8	13.5	2.01

LSD at 5% level		LSD at 5% level		LSD at 5% level	
For shoot :-		For root :-		For shoot/root :-	
For varieties (A)	=7.44	For varieties (A)	=3.05	For varieties (A)	=0.091
For Treatments (B)	= 3.23	For Treatments (B)	= 2.65	For Treatments (B)	= 0.23
For Rate of application (C)	= 3.31	For Rate of application (C)	= 2.20	For Rate of application (C)	= 0.27
For (A) X (B)	= 4.57	For (A) X (B)	= 3.75	For (A) X (B)	= 0.32
For (A) X (C)	= 4.68	For (A) X (C)	= 3.11	For (A) X (C)	= 0.39
For (B) X (C)	= 5.73	For (B) X (C)	= 3.81	For (B) X (C)	= 0.47
For (A) X (B) X (C)	= 8.11	For (A) X (B) X (C)	= 5.39	For (A) X (B) X (C)	= 0.67

B :Phosphorus uptake

Treat.	Variety					
	V_1(G10)			V_2 (G122)		
	shoot	Root	shoot/root	shoot	root	shoot/ root
Cont.	2.24	1.39	1.73	3.58	2.03	1.84
$(Fe)_1$	5.11	2.55	2.38	4.05	2.31	1.76
$(Fe)_2$	3.15	2.02	1.86	3.63	2.51	1.44
$(Fe)_3$	3.06	1.86	1.65	2.48	1.77	1.41
$(Ni)_1$	4.43	1.55	3.15	5.41	2.03	2.69
$(Ni)_2$	5.29	1.96	2.97	4.35	1.93	2.26
$(Ni)_3$	3.37	1.95	1.71	3.97	1.70	2.36
$(FNC)_1$	3.77	1.72	2.63	2.09	1.56	1.84
$(FNC)_2$	5.17	2.45	2.11	4.17	2.26	1.91
$(FNC)_3$	3.54	2.30	1.56	2.69	1.80	1.56
$(FNC)_4$	3.09	2.14	1.42	2.35	1.26	1.87

LSD at 5% level		LSD at 5% level		LSD at 5% level	
For shoot :-		For root :-		For shoot/root :-	
For varieties (A)	=1.29	For varieties (A)	=0.301	For varieties (A)	=0.53
For Treatments (B)	= 0.42	For Treatments (B)	= 0 37	For Treatments (B)	= 0.59
For Rate of application (C)	= 0.53	For Rate of application (C)	= 0.34	For Rate of application (C)	= 0.52
For (A) X (B)	= 0.59	For (A) X (B)	= 0.52	For (A) X (B)	= 0.84
For (A) X (C)	= 0.75	For (A) X (C)	= 0.48	For (A) X (C)	= 0.74
For (B) X (C)	= 0.11	For (B) X (C)	= 0.58	For (B) X (C)	= 0.909
For (A) X (B) X (C)	= 1.30	For (A) X (B) X (C)	= 0.82	For (A) X (B) X (C)	= 1.29

C: Potassium uptake

Treat.	Variety					
	V1(G10)			V2 (G122)		
	shoot	Root	shoot/ root	shoot	root	shoot/ root
Cont.	23.7	12.7	1.91	24.2	16.7	1.46
$(Fe)_1$	33.9	16.5	2.02	33.5	19.1	1.74
$(Fe)_2$	32.5	12.6	2.58	28.6	15.6	1.87
$(Fe)_3$	23.9	12.4	1.96	19.8	13.9	1.44
$(Ni)_1$	36.0	14.9	2.43	28.8	15.5	1.88
$(Ni)_2$	30.5	16.3	1.90	27.1	13.5	2.01
$(Ni)_3$	26.8	15.5	1.80	25.9	10.8	4.74
$(FNC)_1$	33.3	11.9	2.91	20.3	17.6	1.22
$(FNC)_2$	35.6	14.5	2.44	29.3	16.9	1.77
$(FNC)_3$	27.5	13.9	2.00	19.7	13.3	1.52
$(FNC)_4$	26.9	13.7	1.98	15.6	10.8	1.43

LSD at 5% level		LSD at 5% level		LSD at 5% level	
For shoot :-		For root :-		For shoot/root :-	
For varieties (A)	=9.04	For varieties (A)	=4.43	For varieties (A)	=1.60
For Treatments (B)	= 3.79	For Treatments (B)	= 1.03	For Treatments (B)	= 0.71
For Rate of application (C)	= 3.60	For Rate of application (C)	= 2.05	For Rate of application (C)	= 0.79
For (A) X (B)	= 5.37	For (A) X (B)	= 1.45	For (A) X (B)	= 1.01
For (A) X (C)	= 5.10	For (A) X (C)	= 2.90	For (A) X (C)	= 1.13
For (B) X (C)	= 6.25	For (B) X (C)	= 3.56	For (B) X (C)	= 1.38
For (A) X (B) X (C)	= 8.84	For (A) X (B) X (C)	= 5.03	For (A) X (B) X (C)	= 1.96

Results showed that the values of nutrients uptake frequently increased significantly in both studied plant parts by application of either Fe or Ni, as compared to control, responses being dependent on the concerned plant part. This is true in spite of decreased nutrient uptake at both moderate and high levels of both Fe and Ni . This was reflected on the calculated S/R ratio of the indicated nutrients which was ,however, significantly affected nutrients uptake.

Obtained data agree with findings obtained by *Welch, (1995)* who found that low concentrations of Ni are necessary in the nitrogen metabolism and the germination for plants such as cereals *(Walker et al.,1985 and Krogmeier et al., 1991)*. On the other hand , Ni at high levels interferes with mineral nutrition (*Barcelo and Poschenreider, 1990*) and decreases plant growth *(Bingham et al., 1986)*.

Nickel may also restrict phosphorus absorption by the root system *(Palacios et al., 1998)* whose absorption for potassium was ,however ,increased . In fact , the combination of Fe and Ni treatments seemed to be relatively inferior in spit of superiority to control .

It may be worth to mention that Fe absorption and accumulation were negatively and significantly correlated with Ni content in the nutrient medium *(Yang et al., 1996)*. This seemed to be an explanation for the general superiority of the $(FNC)_2$ treatment,at least for the V_2 variety.

Chlorophyll contents:-

Data illustrated by Fig (1) indicated that , the concentrations of both chlorophylls a,b and caroteins in fresh tissue of the studied leaves increased as the Fe supply was increased for V_1 variety. An adverse effect for the high rate being ,however, was obtained with V_2 variety. For the two studied varieties, high rate of Ni was not favorable, as compared to relatively low rates. As far as the combinations of Fe and Ni are concerned, $(FNC)_4$ was relatively superior for V_1 variety while adverse effect being encountered with

V_2 variety. Obtained results agree with those of *Abadia et al., (1989)* who reported that foliar application of Fe was beneficial for chlorophllys Physiologically , such Fe application increases the thylakoidal membrane system in higher plants and increases in photosynthetic pigments, . especially chlorophyll a (chl a), chlorophyll b (chl b) and caroteines *(Val et al., 1987)*.On the other hand ,*Baccouch et al., (1998)* found that an excess of Ni reduces the chlorophyll content in maize seedlings.

Finally , it may be worth to mention that positive effect of Fe and Ni on chlorophyll content was suggested by *Mishra and Kirkby ,(1974)* who reported that ,Ni was proved to be not effective for improving the content of Fe which was beneficial for chlorophylls .

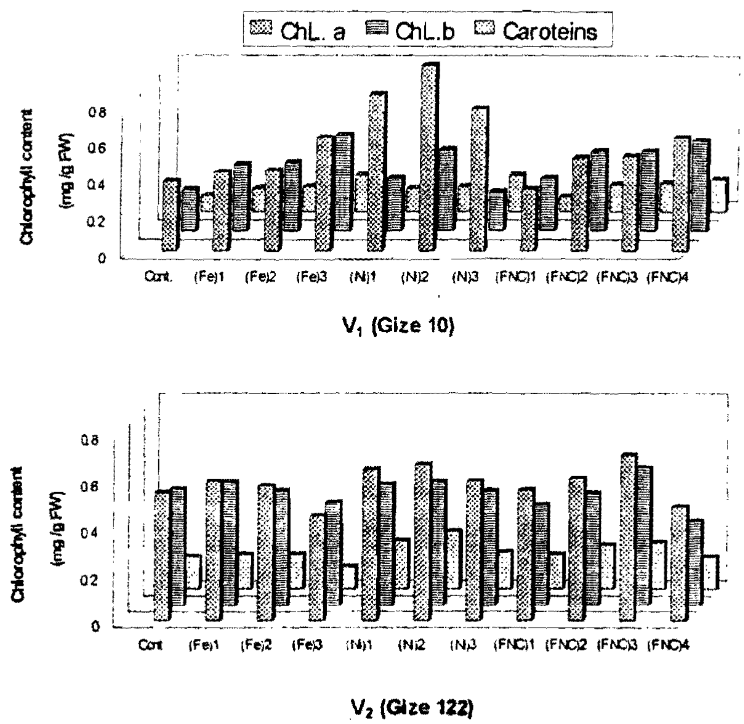

Fig (1) :Effect of both iron and nickel concentrations on chlorophyll a ,chlorophyll b and caroteins content (mg /g fresh weight) in thetwo studied corn vareities.

Carbohydrate fractions :

Dáta in Fig (2) showed that , the content of total soluble sugars (TSS) in leaves of corn , was generally higher in V_1(G10) variety , compared to V_2 (G122) variety; the same trend is true for the content of non- reducing sugars (NRD),an opposite trend being obtained for that of reducing sugars (RD).

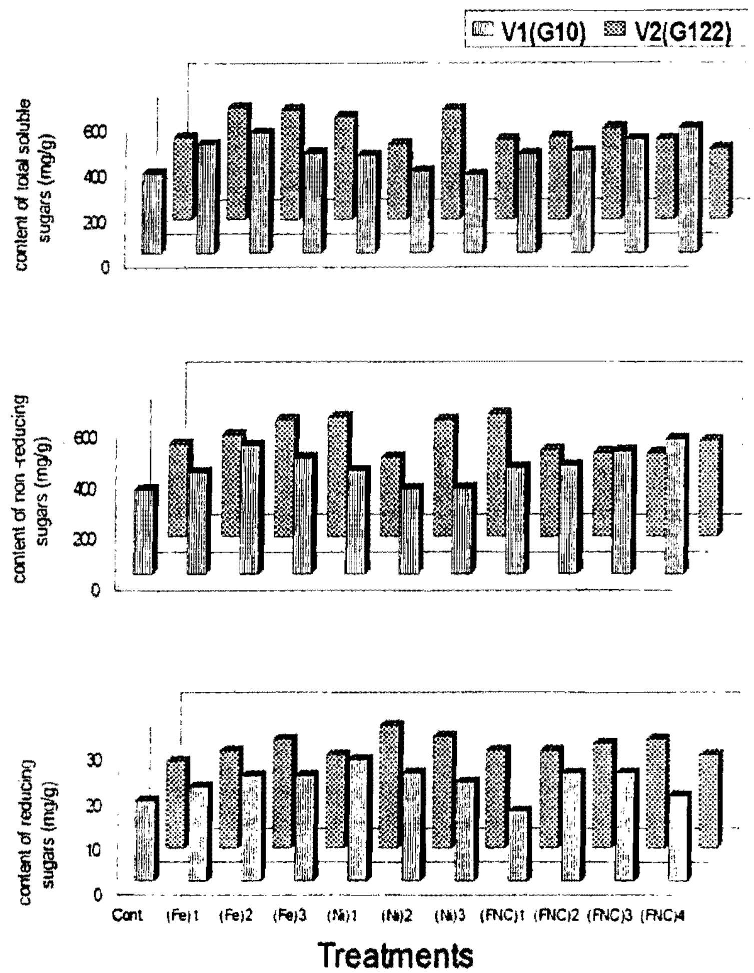

Fig (2):- Effect of different iron and nickle treatments on the contents of total soluble sugars(TSS) ,reducing sugars (RD) and non- (RD) and non-reducing sugars (NRD) in the leaves of the two studied corn varieties.

Data also showed that the contents of TSS, RD and NRD were positively responded to most of the studied treatments . For the two studied varieties, the high rate of either Fe or Ni was not favorable , as compared to relatively low rates,it is even hazardous if the control is taken in consideration

As far as the combinations of Fe and Ni are concerned ; $(NFC)_4$ was the only combination relatively unfavorable for TSS , RD compared to the other concentrations for both V_1 and V_2 varieties ,such trend may resemble that of high rates of both $Fe(Fe)_3$ and Ni $(Ni)_3$ This may assure the beneficial effect of Fe in reducing the hazardous influence of Ni previously suggested for responses of nutrient uptake.

Finally , it may be worth to mention that moderate rate of this studied combination $(NFC)_2$ was the superior for TSS leaves of V_2 variety, high rate of such combination($NFC)_4$ being the superior for NRD in leaves of the same variety.

Obtained data agree with findings obtained by *(Agarwala et al.,1977,Samarakoon and Rauser,1979)* who found that nickel causes an accumulation RD sugars .The combination of photosynthate can not be , in any way, due to an over production at the time that photosynthatesis is impaired by the severe decrease in chlorophyll content .Such accumulation of RD sugars and starch would be alternatively, interpreted , by a reduction of their translocation from leaves to the other parts of seedlings ,particularly the root system .On the other hand , *(Baccouch and El-Ferjani, 1998)* reported that high sugars accumulation lead to a decrease in photosynthatesis .This feedback inhibition may occur either (I) by an inhibition of dark reactions of photosynthatesis,particularly a decrease in Rubisco activity *(Langford and Wainwright, 1987; Desjardins et al.,1994)* ,or (ii)by a negative effect on activities of enzymes involved in starch and sucrose synthesis ,such as ADPG pyrophosphorylase and sucrose syntheses, respectively *(Van Huylenbroeck and Debergh,1996)*

Peroxidase activity:

Fig(3) show that, peroxidase activity was generally higher in V_2(G122) variety ,compared to V_1 (G10)variety.

Data also indicate that, both of Fe and Ni were enhance of peroxidase activity in two variety .High rates of Fe and Ni were not favorable or toxicity, as compared to relatively lower rate ;as well as applied of low rates having adverse effects in both variety .

As far as the combinations of Fe and Ni are concerned;($FNC)_4$ was only combination relatively hazardous or toxic of both variety. Such combination along with treatments of moderate rates of (Fe and Ni) being with adverse effects on peroxidase activity in both varieties.

Obtained data agree with findings obtained by *Pandolfini et al (1996) and Baccouch et al.(2001)* who found that nickel toxicity can directly or indirectly induce the production of reactive free radicals, thus causing oxidative damage to cell membranes and , as an indirect effect, the stimulation of oxidative defense enzymes *(De Vos et al .,1989;De Vos et al, 1991;Vangronsveld and Clijsters,1994)* .The increase in the activity of peroxidases is particularly well documented . The increase in oxidative defense enzymes is strictly correlated to metal plant tissue concentration and growth reduction *(Vangronsveld and Clijsters,1994)*.

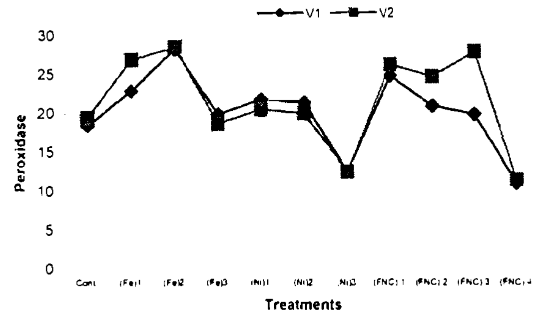

Fig (3) :-Peroidase enzyme activities (as abs/min /g FW)in leaves of two corn variety as affected by both iron and nickle treatments.

Nucleic acids :

Data presented in Fig (4) indicated that the content of RNA was generally higher in V_2(G122) variety the opposite is true for the content of DNA.

For the two studied varieties , high rate of both Fe and Ni were toxic , as compared to relatively lower rates for RNA,and even ralatively hazared for DNA. Such high rate of both Fe and Ni $((Fe)_3$ and $(Ni)_3)$were more toxicity for DNA and RNA.

Obtained results show that the combinations of Fe and Ni are concerned; $(FNC)_3$ and $(FNC)_4$ were the combination relatively toxic for RNA and DNA of both varieties , such combination ($FNC)_3$ was adverse effects on RNA of only V_1variety.

It may be worth to mention that the moderate rate of the studied combination $(FNC)_2$ was the superior for both DNA and RNA in leaves of both variety in spite of that values of RNA was superior in V_1variety under $(FNC)_3$ combinations.

Obtained data agree with findings obtained by *Mengel (1995),* Who reported the green plants require a continuous supply of Fe as they grow. Any interference with the Fe supply or any Fe deficiency in the plant can depress plant growth. According to recent results, the reduction of ribonucleotide to deoxyribonucleotide is brought about by a reductase in which Fe plays an essential role *(Reichard,1993)* .This reduction is fundamental, being the prerequisite for the DNA synthesis required for cell growth and cell division and ultimately for plant growth and development *(Ruiz et al.,2000).*

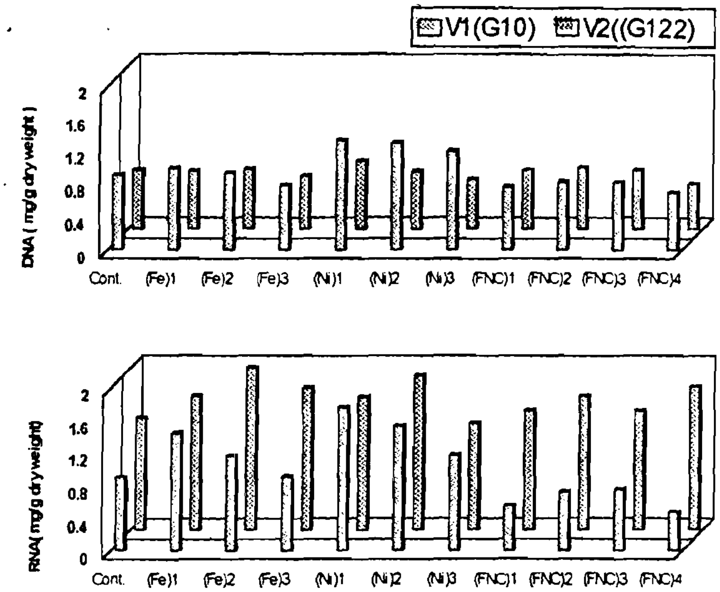

Fig (4) :Effect of Iron and nickle on the nucleic acids content in the leaves of the two investigated corn varieties .

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الاستجابة الفسيولوجية لنباتات الدرة لإضافة كل من الحديد والنيكل .

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أجريت تجربة لدراسة تأثير الحديد (Fe) والدى أضيف بمعدل ٥ ppm $(Fe)_1$ ، ١٠ ppm $(Fe)_2$ ، ٢٠ ppm $(Fe)_3$ والنيكل بمعـدل ٢,٥ ppm $(Ni)_1$ ، ٥ ppm $(Ni)_2$ ، ١٠ ppm $(Ni)_3$ بالاضافة الى مخاليط من كل منهمـا تتضـمن ٥ ppm Ni + ٥ ppm Fe $(NFC)_1$ ، ٥ ppm Ni + ١٠ ppm Fe $(NFC)_2$ ، ٥ ppm Ni + ١٥ ppm Fe $(NFC)_3$ ، ٥ ppm Ni + ٢٠ ppm Fe $(NFC)_4$ علـى النمو وامتصاص العناصر وبعض الصفات الحيوية لنبات الدرة صنفى جيزة ١٠ ،جيزة ١٢٢ .

اشارت الدراسة الى ان التركيزات المنخفضة والمتوسطة لكل من الحديد والنيكل قد ادت الى زيادة معنوية للمادة الجافة لكل من الساق و الجدر ونسبة الساق : الجـدر وكـدلك أدى الـى حدوث تراكم للعناصر في نوعى الدرة تحت الدراسة اما التركيزات العاليـة للعنصـرين تحـت الدراسة فقد أدت الى تأثير عكسي على نمو النبات.

وجد ان محتوى الكلورفيل فى الاوراق قد زاد باضافة الحديد والتركيزات المنخفضة من النيكل وكانت هده الاستجابة متوقفة على صنفى الدرة تحت الدراسة وكدلك ادت المعـاملات الـى حدوث تراكم للسكريات الكلية الدائبة (TSS) والسكريات المختزلة (RS) والسـكريات غيـر المختزلة (NRS) عند التركيزات المتوسطة لكل من الحديد والنيكل وكدلك عند استخدام مخـاليط لكل من العنصرين ز مما يقترح ان اضافة الحديد والتركيز المنخفض من النيكل يكون د ات تاثير ايجابى على النمو وكدلك على العمليات الفسيولوجية سواء تم اضافتهم بصورة منفردة اومخلوط من كل منهما.