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EFFECT OF NITROGEN AND POTASSIUM FERTILIZATION WITH OR WITHOUT SPRAYING BY IRON COMBINED WITH MANGANESE ON SOME PHYSIO-CHEMICAL PROPERTIES, PRODUCTIVITY AND QUALITY OF SUGAR BEET CROP

BY

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ABSTRACT

Two field experiments were conducted out during 2003-2004 and 2004-2005 seasons at Sakha Agriculture Research Station, Kafr El-Sheikh Governorate, Egypt to study the effect of N-fertilization at rates 80, 100 and 120 kg N/fed, K-fertilization at rates of 24 and 48 kg K_2O/fed with or without spraying by iron combined with manganese at levels 0.06 % FeEDTA (6% Fe) with 0.03 % of MnEDTA (13% Mn) and their interactions on some physio-chemical properties, productivity and quality of sugar beet crop.

A multigerm sugar beet variety, Panther poly was used. The experimental design was split plot design with three replicates in the two seasons. After 120 days from sowing average leaf area/ plant cm^2 Photosynthetic pigments (chlorophyll a, b and carotenoides) mg/g.f.w. as well as nutrients uptake N and K (g/plant), also Fe and Mn uptake (mg/plant) in leaves and root were determined. At harvesting yield of top, root and sugar (tons/ fed), as well as juice quality i.e. sucrose%, purity% and impurities% (Na, K and α-amino nitrogen %) were determined in both seasons. The obtained results indicated that:

- Foliar spraying with Fe + Mn increased average leaf area/ plant. Photosynthetic pigments (chlorophyll a, b and carotenoides) and nutrients uptake (N, K, Fe and Mn) in both leaves and root of sugar beet plant, yield of top, root and sugar, sucrose% and purity % in both seasons. Otherwise, Fe + Mn treatment significantly decreased impurities% (Na, K and α-amino nitrogen %) in sugar beet juice in both seasons.
- Soil fertilization with nitrogen and potassium increased significantly average leaf area/ plant, photosynthetic pigments (chlorophyll a, b and carotenoides) and nutrients uptake (N, K, Fe and Mn) in both leaves and root of sugar beet plant in both seasons. Meantime, yield of top, root and sugar, as well as juice quality percentages i. e. sucrose, purity and impurities (Na, K and α-amino nitrogen) significantly differed by nitrogen and potassium fertilization in both seasons.
- Spraying by iron combined with manganese under fertilization with 120 kg N/fed and 48 kg K_2O/fed as soil application gave the highest value of average leaf area/ plant. Photosynthetic pigments (chlorophyll a, b and

carotenoides) and nutrients uptake in leaves and root (N, K, Fe and Mn) after 120 days from sowing. Similar trend have been detected for top yield and potassium content in root juice at harvest in both seasons.

- Spraying by Fe + Mn, N- fertilization at a rate of 100 kg N/ fed and k-fertilization at rate 48 kg K_2O/ fed produced the highest root and sugar yields (tons/ fed), sucrose and purity percentages, as well. Impurities content in root juice (Na, K and α-amino nitrogen) in both seasons showed vice verse trend.

Key words: Sugar beet- N-fertilization- K-fertilization- Iron- Manganese- Photosynthetic pigments- Leaf area- yield- quality.

INTRODUCTION

Sugar beet is one of just two crops (the other being sugar cane) which constitute the only important sources of sucrose. Sugar beet nutrition includes nitrogen and potassium fertilization and trace elements such as iron and manganese always have a high priority wherever, the sugar beet grown. In this connection, Cari and Roger (2001) reported that nitrogen is important for assimilation into amino acids for protein and amino acid synthesis, component of chlorophyll and vegetative growth. Potassium important for enzyme activation, carbohydrate transportation, amino acid synthesis, photosynthesis, translocation of assimilates nitrogen uptake, nutrient balancing. Iron is a component of plant cells and enzymes; it is involved in nitrogen fixation, respiration and photosynthesis. Manganese acts as an enzyme activator involved in carboxylic acid cycle and carbohydrate metabolism.

Many investigators studied the effect of these elements on sugar beet plant. Concerning the effect of nitrogen and potassium as soil fertilizers; Aly and Abou Bakr (1995) found that potassium application increased leaf area (cm^2), sucrose% and sugar yield (tons/ fed). Ramadan (1997) indicated that increasing N-rate up to 120 kg N/ fed increased impurities (Na, K and α- amino nitrogen), while sucrose and purity percentages, sugar yield (tons/ fed) decreased. Kochi (1979) found that both nitrogen and potassium fertilization were affect root quality which influenced plant sugar content. Sugar concentration decreased linearly with the increase in N fertilization rate. On the other hand, sugar content was increased as K supply increased. Krauss (2000) reported that potassium is the vital nutrient for quality, via stimulation of assimilation and translocation of sugar from leaves into beet root. He added that potassium prepares somatically the beet cells to store large amount of sugars. EL-Shafai (2000) indicated that nitrogen rate at 92 kg N/fed and potassium rate at 48 Kg K_2O/ fed was significantly increased root and sugar yield, while root sucrose % decreased. Barik (2002) found that nitrogen doses at 150 kg N/ ha alone or with potassium fertilization at 150 Kg K_2O/ ha gave the maximum root and sugar yield. Grzebisz and Bartog (2002) showed that the insufficient N fertilization has a negative effect on yield, while overrated N application decreases yield of top, root and sugar. Ismail *et al.* (2002) found that potassium treatment was affected significantly purity% and yield of root and sugar (tons/ fed). El Kadi *et al.* (2003) indicated that the effect of K fertilization on sugar beet yield was associated with the higher rate of N application. Lucie *et al.* (2004) showed that sugar content and yield were diminished as increases dose of nitrogen fertilizer increased. Moustafa, Shafika *et al.* (2003) found that increasing nitrogen fertilization rate up to 110 kg N/ fed increased sugar yield, juice impurities (Na, K and α- amino nitrogen) and photosynthetic pigments (chlorophyll a, b and carotenoides) mg/ cm^2. Pytlarz, Maria (2005) found that the increase in N rate from 90 to 180 kg/ ha caused a significant increase in average root mass, potassium and α- amino nitrogen in root, and lowered sugar content.

Dealing with the effect of iron and manganese, Morsy and Taha (1986) reported that Mn increased uptake of N, K and Mn in both top and root of sugar beet plant. Negm and Hassan (1998) found that the amount of root yield and nutrient uptake were significantly higher in the combined treatment (Fe + Mn). Shalaby (1998) concluded that foliar application of Fe in combination with Zn and Mn was very effective in increasing root yield, sugar content and sugar yield, as well as juice purity. Ouda, Soheir (2000) found that application of iron and manganese, increased significantly root and top yield. Osman *et al.* (2003) found that application of Mn increased sucrose% and sugar yield in sugar be*et al.*so.

The main target of this work is to study the effect of nitrogen and potassium fertilization and spraying by iron combined with manganese on some physio- chemical properties, productivity and quality of sugar beet crop.

MATERIALS AND METHODS

Two field trails were conducted in 2003-2004 and 2004-2005 seasons at Sakha Agriculture Research Station, Kafr El-Sheikh governorate, Egypt, to study the effect of nitrogen and potassium fertilization with or without iron combined with manganese as foliar application and their interactions on some phyio-chemical properties, productivity and quality of sugar beet crop. The soil analysis was taken before planting and prepared for the determination physical and chemical analysis according to Chapman and Paratt (1961). The obtained results are shown in Table (1). It is clear from soil chemical analysis that the soil is tend slightly to alkalinity (pH >8), where iron and manganese frequently fixed and become are scarcely available to plant root (Shalaby, 1998). So iron and manganese as foliar application in particular useful under those condition.

A multigerm sugar beet variety, Panther poly was planted on 11th and 28th October in 2003 and 2004 seasons, respectively. The experimental design was split split plot design with three replicates. Irons combined with manganese were arranged in the main plots, while the nitrogen and potassium fertilization were randomly distributed in sub and sub sub plots. Plots size was 21 m^2 (6 ridges, 7 m long and 50 cm apart). Nitrogen fertilization was applied in the form of urea (46.1%) at the rates of 80, 100 and 120 Kg N/ fed; (namely N1, N2 and N3, respectively) in two equal doses the first was applied after thinning and the other was applied 30 days later. Potassium fertilization was applied in the form of potassium sulfate, (48% K_2O) at two rates 24 and 48 Kg K_2O/ fed; (namely K1 and K2, respectively) being added in one dose after thinning, iron in combination with manganese were applied as foliar applications at levels of 0.06% as FeEDTA (6% Fe) and 0.03% of MnEDTA (13% Mn) after 45 and 75 days from sowing. Phosphorus fertilization was added during land preparation and before sowing at a rate of 30 Kg P_2O_5/fed as calcium super phosphate (15.5% P_2O_5). The normal practices of sugar beet cultivation were maintained at level to assure optimum production.

Table (1): Physical and chemical analysis of experimental soil.

Soil analysis	2003	2004
Particle size distribution:		
Sand %	17.2	16.9
Silt %	27.8	28.5
Clay%	55.0	54.6
Textural class	**Clay**	**Clay**
Chemical analysis		
Soluble ions meL^{-1}		
Ca^{++}	16.42	19.0
Mg^{++}	8.87	10.0
Na^{+}	28.37	33.0
K^{+}	0.36	0.52
Cl^{-}	26.24	26.00
CO_3^{--}	-	-
HCO_3-	2.01	2.60
SO_4^{--}	25.77	33.92
$CaCO_3$ %	1.80	1.94
EC dSm-1(soil paste)	3.02	3.95
pH (1:2.5)	8.00	8.20
Available nutrients (mg kg^{-1})		
N	122	135
K	260	289
Fe	9.68	10.03
Mn	3.66	3.85

I- After 120 days from sowing date, seven successive guarded plants were taken randomly from each plot to determine the following traits in both seasons:

1- Average leaf area/ plant (cm^2) was determined using the area meter, model: 3000A.
2- Photosynthetic pigments (mg/ g.f.w) i.e. chlorophyll a, b and carotenoides according to Wettstein (1957).
3- Nutrients uptake of nitrogen (N) and potassium (K); as g/ plant, iron (Fe) and manganese (Mn) as mg/ plant in both leaves and roots were determined in the digested solution of the dried powder as described in A.O.A.C (1990). Nitrogen was determined using micro-kjeldahl method, potassium was determined by Flame photometer (Page, 1982), iron and manganese were measured using the Atomic Adsorption Spectrophotometer, model 22 Brooklyn AVE.

II- After 210 days from sowing (at harvest) the following traits were determined in both seasons:

1- Yield of tops and roots (tons/ fed) were determined from the four guarder rows. Sugar yield (tons/ fed) was calculated according to the following equation: Sugar yield (tons/ fed) = Root yield (tons/ fed) x Sucrose %

2- Juice quality was analyzed using an Automatic French System (HYCEL). - Sucrose % was polarimaterically determined according to the methods of Le-Docte (1927).
   - Total Soluble Solids % was measured using hand refractometer.
   - Purity % was determined according to formula
     Purity%= (Sucrose%/Total Soluble Solids %) x 100
   - Juice impurities including Na, K and α- amino nitrogen, Na% and K% were determined using Flame photometer as described by Page (1982), while α- amino nitrogen was determined using hydrogennation method according to Carruthers *et al.* (1962).

Data were statistically analyzed according to Snedecor and Cochran (1981), and treatment means were compared by using the LSD at 0.05 level of probability.

RESULTS AND DISCUSSION

I- Effect of nitrogen and potassium fertilization and spraying by iron combined with manganese on sugar beet plant after 120 days from sowing:

1- Average leaf area/ plant:

Data in Table (2) show significant increase in average leaf area/ plant cm^2 due to nitrogen and potassium fertilization, and also with spraying the foliage by iron combined with manganese in both seasons. A similar trend was found by Aly and Abou Bakr (1995) for the effect of potassium fertilization on leaf area. Regarding interactions effect in the first season the significant differences were detected for the interactions between Fe + Mn and N- fertilization, as well as N and K-fertilization, whereas, the other two interactions (Fe+ Mn x K and Fe+ Mn x N x K) were insignificant differences, while the interaction between Fe + Mn and N-fertilization showed a positive and significant effect on leaf area in the second season. Meantime, data in Table (2) cleared that maximum leaf area/ plant was recognized at the highest rate of N and K-fertilization, (120 kg N/fed and 48 kg K_2O), combined with spraying by Fe + Mn in both first and second seasons which recorded 187.4 and 192.9cm^2, respectively.

2-Photosynthetic pigments content:

Data in Table (2) presented the effects of N and K-fertilization, and foliar spraying with Fe + Mn and there interactions on the content of chlorophyll a, b and carotenoids (mg. g.f.w) in beet leaves. It is clear from data that all the individual treatments significantly increased photosynthetic pigments content, except chlorophyll a in both seasons and chlorophyll a and b at second season. Moustafa, Shafika (2005) found the same trend for the effect of nitrogen in photosynthetic pigments.

Table (2): Effect of nitrogen and potassium fertilization and foliar application by iron combined with manganese on average leaf area/plant $(cm)^2$ and photosynthetic pigments (Chlirophyll a, b and carotenoides (mg/ g.f.w) after 120 days from sowing on 2003/2004 and 2004/2005 seasons.

Treatments		Average leaf area/plant		Mean	Chlorophyll a (mg/g.f.w)		Mean	Chlorophyll b (mg/g.f.w)		Mean	Carotenoides (mg/g.f.w)		Mean
		-	+		-	+		-	+		-	+	
2003/2004													
N1	K1	92.33	114.9	**103.6**	5.12	5.20	**5.16**	2.83	3.00	**2.91**	0.95	0.96	**0.95**
	K2	111.0	126.4	**118.8**	5.18	5.33	**5.25**	2.94	3.09	**3.01**	0.98	1.01	**1.00**
Mean		**101.7**	**120.7**	**111.2**	**5.15**	**5.26**	**5.21**	**2.88**	**3.04**	**2.96**	**0.97**	**0.98**	**0.98**
N2	K1	127.7	139.0	**133.3**	5.25	5.39	**5.32**	3.05	3.12	**3.09**	1.02	1.07	**1.05**
	K2	131.5	149.8	**140.6**	5.32	5.46	**5.39**	3.11	3.24	**3.17**	1.08	1.14	**1.11**
Mean		**129.6**	**144.4**	**137.0**	**5.28**	**5.42**	**5.35**	**3.08**	**3.18**	**3.13**	**1.05**	**1.11**	**1.08**
N3	K1	139.2	162.5	**150.8**	5.39	5.58	**5.48**	3.25	3.37	**3.31**	1.15	1.20	**1.18**
	K2	152.8	187.4	**170.1**	5.45	5.85	**5.65**	3.40	3.39	**3.44**	1.19	1.31	**1.25**
Mean		**146.0**	**174.9**	**160.5**	**5.42**	**5.71**	**5.57**	**3.33**	**3.43**	**3.38**	**1.17**	**1.25**	**1.21**
Mean of Fe+Mn		**125.8**	**146.7**	**136.2**	**5.28**	**5.47**	**5.38**	**3.10**	**3.22**	**3.16**	**1.06**	**1.12**	**1.09**
Mean Of	K1	119.7	139.8	**129.3**	5.25	5.39	**5.32**	3.04	3.16	**3.10**	1.04	1.08	**1.06**
	K2	131.8	154.6	**143.2**	5.32	5.54	**5.43**	3.15	3.27	**3.21**	1.09	1.15	**1.12**
LSD at 5 %A				12.4			N.S			0.08			0.05
B				4.93			0.13			0.04			0.02
C				4.02			0.05			0.03			0.02
AB				6.97			0.09			N.S			0.03
AC				N.S			N.S			N.S			N.S
BC				6.90			N.S			N.S			N.S
ABC				N.S			N.S			N.S			N.S
2004/2005													
N1	K1	98.1	120.0	**109.0**	4.89	5.21	**5.05**			**2.97**	1.95	1.96	**1.95**
	K2	114.7	131.2	**122.9**	5.22	5.36	**5.29**			**3.06**	1.98	2.01	**2.00**
Mean		**106.4**	**125.6**	**116.0**	**5.05**	**5.29**	**5.17**	**2.94**	**3.09**	**3.01**	**1.97**	**1.98**	**1.98**
N2	K1	131.7	142.9	**137.3**	5.29	5.42	**5.35**	3.10	3.17	**3.14**	2.02	2.07	**2.05**
	K2	137.1	154.4	**145.7**	5.35	5.49	**5.42**	3.15	3.29	**3.22**	2.09	2.14	**2.12**
Mean		**134.4**	**148.7**	**141.5**	**5.32**	**5.45**	**5.39**	**3.13**	**3.23**	**3.18**	**2.06**	**2.11**	**2.08**
N3	K1	144.5	169.4	**156.9**	5.42	5.91	**5.66**	3.30	3.42	**3.36**	2.15	2.20	**2.18**
	K2	157.6	192.9	**175.3**	5.79	6.08	**5.93**	3.44	3.53	**3.49**	2.19	2.31	**2.25**
Mean		**151.0**	**181.1**	**166.1**	**5.60**	**6.00**	**5.80**	**3.37**	**3.48**	**3.42**	**2.17**	**2.25**	**2.21**
Mean of Fe+Mn		**130.6**	**151.8**	**141.2**	**5.32**	**5.58**	**5.4**	**3.15**	**3.27**	**3.21**	**2.07**	**2.12**	**2.12**
Mean of	K1	124.7	144.1	**134.4**	5.20	5.51	**5.36**	3.10	3.21	**3.16**	2.04	2.08	**2.06**
	K2	136.5	159.5	**148.0**	5.45	5.64	**5.55**	3.20	3.32	**3.26**	2.09	2.15	**2.12**
LSD at 5% A				12.17			N.S			0.06			0.05
B				5.39			0.24			0.04			0.02
C				4.40			N.S			N.S			0.03
AB				7.63			N.S			0.03			002
AC				N.S			N.S			N.S			N.S
BC				N.S			N.S			N.S			N.S
ABC				N.S			N.S			N.S			N.S

Various interactions degree among the three variables insignificantly affected photosynthetic pigments in both seasons, except the interaction between Fe+ Mn x N which significantly affected chlorophyll a, b and carotenoides in the first season and chlorophyll b and carotenoides in the second season Table (2). Spraying beet plant with Fe+ Mn in mixture, in addition to nitrogen at 120 kg N/ fed and K at 48 kg/ fed as soil application maximized the three photosynthetic pigments Table (2).

3-Nutrients uptake in sugar beet leaves:

Date collected in Table (3) reveals that each of the three factors i.e. Fe+ Mn, N and K; increased significantly the uptake of N, K, Fe and Mn, except Fe + Mn treatment which insignificantly affected N uptake in the first season and K in both season. Similar effect had been observed also, for K fertilization on K and Mn uptake in the first season only Table (3).

Concerning the effects of various interactions degrees on the uptake of N, K, Fe and Mn in sugar beet leaves; it is clear from data in Table (3) that most of the interactions insignificantly increased minerals such as N, K, Fe and Mn in both seasons. In this connection Morsy and Taha (1986) found that application of Mn increased the uptake of N, K and Mn in sugar beet leaves.

3-Nutrients uptake in sugar beet roots:

Data of sugar beet roots on the following nutrients uptake i.e. nitrogen, potassium, iron and manganese revealed that increasing N or K-fertilization rates and spraying with Fe + Mn significantly increased the measured nutrients uptake in both seasons, except spraying with Fe + Mn on N uptake, where the increased was too small to reach the level of significance (Table, 4).It is worth to mention that the positive effect of Fe+ Mn on the uptake of K may be responsible for the increase in root biomass reflection the vital role of K element on translocation ion and accumulation of sugars in roots (Negm and Hassan. 1998).

Most the interactions order among N, K fertilization and spraying by Fe + Mn were insignificantly increased the nutrient uptake of N, K, Fe and Mn in sugar beet roots.

II- Effect of nitrogen and potassium fertilization and spraying by iron combined with manganese on productivity and root quality at harvest:

1- Yield of roots, tops and sugar:

The effect of nitrogen, and potassium fertilization, as well as spraying by iron in combination with manganese on tops, roots and sugar yield (tons/ fed) are presented in Table (5). Data cleared that spraying with Fe + Mn and increasing the rate of N and K fertilization up to 120 kg N/ fed and 48 kg K_2O/ fed, respectively increased significantly tops, roots and sugar yield (tons/ fed) in both seasons compared with the lowest rates of N and K fertilization, but the increase of tops and roots yield were too small to reach the level of significant with respect to Fe + Mn treatment at second season

Table (3): Effect of nitrogen and potassium fertilization and foliar application by iron combined with manganese on Nitrogen, Potassium, Iron and Manganese uptake in sugarbeet leaves after 120 days from sowing on 2003/2004 and 2004/2005 seasons.

Treatments		N (g/plant)		Mean	K (g/plant)		Mean	Fe(mg/plant)		Mean	Mn(mg/plant)		Mean
		2003/2004											
		-	+		-	+		-	+		-	+	
N1	K1	1.71	2.01	**1.86**	2.20	2.33	**2.27**	5.73	8.06	**6.89**	1.81	3.20	**2.50**
	K2	1.98	2.04	**2.01**	2.23	2.52	**2.37**	6.45	9.19	**7.82**	2.39	3.78	**3.08**
Mean		**1.84**	**2.02**	**1.93**	**2.21**	**2.43**	**2.32**	**6.09**	**8.63**	**7.36**	**2.10**	**3.49**	**2.79**
N2	K1	2.95	3.15	**3.05**	3.19	3.31	**3.25**	8.89	13.54	**11.21**	3.14	5.20	**4.17**
	K2	3.24	3.16	**3.20**	3.40	3.06	**3.22**	9.95	13.95	**11.95**	3.86	5.34	**4.60**
Mean		**3.09**	**3.15**	**3.12**	**3.30**	**3.17**	**3.23**	**9.42**	**13.74**	**11.58**	**3.50**	**5.27**	**4.39**
N3	K1	3.99	4.16	**4.08**	3.62	3.94	**3.78**	12.62	20.82	**16.72**	**4.36**	6.59	**5.47**
	K2	4.30	4.27	**4.29**	3.88	4.00	**3.94**	13.96	23.07	**18.52**	**5.35**	6.81	**6.08**
Mean		**4.15**	**4.22**	**4.18**	**3.75**	**3.97**	**3.86**	**13.29**	**21.94**	**17.62**	**4.85**	**6.70**	**5.78**
Mean of Fe+Mn		**3.03**	**3.13**	**3.08**	**3.09**	**3.19**	**3.14**	**9.60**	**14.77**	**12.19**	**3.48**	**5.15**	**4.32**
Mean of	K1	2.88	3.11	2.99	3.00	3.19	**3.10**	9.08	14.14	**11.61**	3.10	5.00	**4.05**
	K2	3.17	3.16	**3.17**	3.17	3.18	**3.18**	10.12	15.41	**12.76**	3.87	5.31	**4.59**
LSD at 5% A				N.S			N.S			0.89			0.97
B				0.14			0.19			0.89			0.94
C				0.12			N.S			0.80			N.S
AB				N.S			N.S			1.39			N.S
AC				0.16			N.S			N.S			N.S
BC				N.S			N.S			N.S			1.33
ABC				N.S			N.S			N.S			N.S
		2004/2005											
N1	K1	1.63	1.92	**1.78**	1.92	2.27	**2.10**	5.44	7.54	**6.49**	1.77	3.23	**2.50**
	K2	1.92	2.00	**1.96**	2.05	2.46	**2.57**	6.85	8.82	**7.83**	2.32	3.72	**3.02**
Mean		**1.78**	**1.96**	**1.87**	**1.98**	**2.37**	**2.18**	**6.14**	**8.18**	**7.16**	**2.04**	**3.48**	**2.76**
N2	K1	2.75	3.01	**2.88**	2.96	3.11	**3.03**	8.37	12.54	**10.46**	2.81	4.43	**3.62**
	K2	3.03	3.11	**3.07**	3.08	3.01	**3.05**	9.86	14.32	**12.09**	3.32	5.32	**4.32**
Mean		**2.89**	**3.06**	**2.97**	**3.02**	**3.06**	**3.04**	**9.12**	**13.43**	**11.27**	**3.07**	**4.87**	**3.97**
N3	K1	3.87	4.04	**3.95**	3.47	3.78	**3.63**	12.81	18.83	**15.82**	4.14	6.38	**5.26**
	K2	4.04	4.22	**4.13**	3.74	3.81	**3.78**	13.48	22.44	**17.96**	4.79	7.96	**6.38**
Mean		**3.95**	**4.13**	**4.04**	**3.60**	**3.80**	**3.70**	**13.14**	**20.64**	**16.89**	**4.46**	**7.17**	**5.82**
Mean of Fe+Mn		**2.87**	**3.05**	**2.96**	**2.87**	**3.07**	**2.97**	**9.47**	**14.08**	**11.77**	**3.19**	**5.17**	**418**
Mean of	K1	2.75	2.99	**2.87**	2.87	3.05	**2.92**	8.87	12.97	**10.92**	2.91	4.68	**3.79**
	K2	3.00	3.11	**3.05**	2.96	3.09	**3.03**	10.06	15.19	**12.63**	3.48	5.67	**4.57**
LSD at 5% A				0.09			N.S			0.77			0.28
B				0.11			0.12			0.80			0.33
C				0.09			0.10			0.32			0.27
AB				N.S			0.17			1.13			0.46
AC				N.S			N.S			N.S			N.S
BC				N.S			N.S			N.S			N.S
ABC				N.S			N.S			N.S			N.S

Table (4): Effect of nitrogen and potassium fertilization and foliar application by iron combined with manganese on Nitrogen, Potassium, Iron and Manganese uptake in sugarbeet root after 120 days from sowing on 2003/2004 and 2004/2005 seasons.

Treatments		N (g/plant)		Mean	K (g/olant)		Mean	Fe(mg/plant)		Mean	Mn(mg/p;ant)		Mean
		-	+		-	+		-	+		-	+	
2003/2004													
N1	K1	1.03	1.31	**1.17**	1.28	1.53	**1.40**	5.65	7.57	**6.61**	1.65	2.19	**1.92**
	K2	1.38	1.51	**1.44**	1.55	1.81	**1.68**	7.04	8.97	**8.00**	2.13	2.72	**2.43**
Mean		**1.21**	**1.41**	**1.31**	**1.41**	**1.67**	**1.54**	**6.34**	**8.27**	**7.30**	**1.89**	**2.54**	**2.17**
N2	K1	1.91	1.99	**1.95**	2.14	2.45	**2.29**	9.23	11.66	**10.44**	2.80	3.52	**3.16**
	K2	2.51	2.24	**2.37**	2.39	2.77	**2.58**	10.23	13.35	**11.79**	3.25	3.79	**3.52**
Mean		**2.21**	**2.11**	**2.16**	**2.26**	**2.61**	**2.44**	**9.72**	**12.50**	**11.12**	**3.02**	**3.65**	**3.34**
N3	K1	2.30	2.36	**2.33**	2.17	2.52	**2.35**	10.58	14.21	**12.39**	3.35	4.00	**3.67**
	K2	2.54	2.45	**2.49**	2.42	2.70	**2.56**	11.77	16.04	**13.91**	3.67	4.38	**4.03**
Mean		**2.42**	**2.41**	**2.41**	**2.30**	**2.61**	**2.45**	**11.17**	**15.12**	**13.15**	**3.51**	**4.19**	**3.85**
Mean of Fe+Mn		**1.95**	**1.98**	**1.96**	**1.99**	**2.30**	**2.15**	**9.08**	**11.96**	**10.52**	**2.81**	**3.43**	**3.12**
Mean Of	K1	1.75	1.89	**1.82**	1.86	2.17	**2.02**	8.48	11.14	**9.81**	2.60	3.24	**2.92**
	K2	2.14	2.07	**2.10**	2.12	2.43	**2.27**	9.68	12.79	**11.23**	3.02	3.63	**3.32**
LSD at 5% A				N.S			0.07			0.62			0.11
B				0.22			0.10			0.39			0.14
C				0.18			0.08			0.32			0.11
AB				N.S			N.S			0.55			N.S
AC				N.S			N.S			N.S			N.S
BC				N.S			N.S			N.S			N.S
ABC				N.S			N.S			N.S			N.S
2004/2005													
N1	K1	1.36	1.54	**1.45**	1.70	1.84	**1.77**	6.78	8.77	**7.78**	2.21	2.84	**2.52**
	K2	1.78	1.67	**1.72**	1.94	2.12	**2.03**	7.98	10.32	**9.15**	2.68	4.51	**3.59**
Mean		**1.57**	**1.60**	**1.59**	**1.82**	**1.98**	**1.90**	**7.38**	**9.55**	**8.46**	**2.44**	**3.77**	**3.06**
N2	K1	2.04	2.01	**2.02**	2.17	2.38	**2.27**	9.74	11.59	**10.66**	3.06	3.82	**3.44**
	K2	2.23	2.16	**2.20**	2.40	2.69	**2.55**	10.57	13.41	**11.99**	3.46	4.10	**3.78**
Mean		**2.14**	**2.09**	**2.11**	**2.28**	**2.54**	**2.41**	**10.15**	**12.50**	**11.33**	**3.26**	**3.96**	**3.61**
N3	K1	2.53	2.74	**2.63**	2.34	2.71	**2.53**	11.10	15.27	**13.18**	3.64	4.50	**4.07**
	K2	2.89	2.81	**2.85**	2.57	2.94	**2.75**	13.34	17.74	**15.54**	4.09	4.94	**4.52**
Mean		**2.71**	**2.77**	**2.74**	**2.46**	**2.82**	**2.64**	**12.22**	**16.51**	**14.36**	**3.87**	**4.72**	**4.29**
Mean of Fe+Mn		**2.14**	**2.15**	**2.14**	**2.19**	**2.45**	**2.32**	**9.92**	**12.85**	**11.38**	**3.19**	**4.12**	**3.65**
Mean of	K1	1.98	2.09	**2.04**	2.07	2.31	**2.19**	9.21	11.88	**10.54**	2.97	3.72	**3.35**
	K2	2.30	2.21	**2.26**	2.30	2.58	**2.44**	10.63	13.82	**12.23**	3.41	4.52	**3.96**
LSD at 5% A				N.S			0.15			0.11			0.52
B				0.12			0.11			0.44			0.48
C				0.10			0.09			0.37			0.39
AB				N.S			N.S			0.63			N.S
AC				0.14			N.S			N.S			N.S
BC				N.S			N.S			0.63			N.S
ABC				N.S			N.S			0.90			N.S

Table (5) Effect of nitrogen and potassium fertilization and foliar application by iron combined with manganese on yield of sugarbeet root, top and sugar (tons/ fed) at harvest in 2003/2004 and 1004/2005 seasons.

Treatments		2003/2004									2004/2005								
		Root yield		Mean	Top yield		Mean	Sugar yield		Mean	Root yield		Mean	Top yield		Mean	Sugar yield		Mean
		-	+		-	+		-	+		-	+		-	+		-	+	
N1	K1	23.33	23.77	**23.55**	4.18	4.38	**4.28**	3.82	4.06	**3.94**	22.83	23.50	**23.17**	3.99	4.24	**4.11**	3.97	4.25	**4.11**
	K2	24.87	25.17	**25.02**	4.57	4.69	**4.63**	4.42	4.74	**4.58**	24.50	25.00	**24.75**	4.39	4.47	**4.43**	4.57	4.96	**4.76**
Mean		**24.10**	**24.47**	**24.28**	**4.12**	**4.53**	**4.46**	**4.12**	**4.40**	**4.26**	**23.67**	**24.25**	**23.96**	**4.19**	**4.35**	**4.27**	**4.27**	**4.60**	**4.44**
N2	K1	26.57	27.17	**26.87**	5.68	5.84	**5.76**	4.03	4.49	**4.26**	26.90	26.60	**26.75**	5.19	5.33	**5.26**	4.37	4.66	**4.51**
	K2	27.57	28.47	**28.02**	5.97	6.08	**6.02**	4.74	4.99	**4.86**	26.93	27.80	**27.37**	5.43	5.85	**5.46**	4.90	5.25	**5.08**
Mean		**27.07**	**27.82**	**27.44**	**5.82**	**5.96**	**5.89**	**4.39**	**4.74**	**4.56**	**26.92**	**27.20**	**27.06**	**5.31**	**5.59**	**5.45**	**4.64**	**4.95**	**4.80**
N3	K1	25.80	26.30	**26.05**	6.73	6.93	**6.83**	3.71	4.17	**3.94**	25.43	25.50	**25.47**	6.17	6.32	**6.24**	3.92	4.37	**4.14**
	K2	26.63	27.10	**26.87**	7.10	7.30	**7.20**	4.31	4.58	**4.44**	26.00	26.47	**26.23**	6.50	6.70	**6.60**	4.48	4.73	**4.60**
Mean		**26.22**	**26.70**	**26.46**	**6.92**	**7.12**	**7.02**	**4.01**	**4.37**	**4.19**	**25.72**	**25.98**	**25.85**	**6.33**	**6.51**	**6.42**	**4.20**	**4.55**	**4.37**
Mean of Fe+Mn		**25.79**	**26.33**	**26.06**	**5.71**	**5.87**	**5.79**	**4.17**	**4.50**	**4.33**	**25.43**	**25.81**	**25.62**	**5.28**	**5.48**	**5.38**	**4.37**	**4.70**	**4.53**
Mean Of	K1	25.23	25.74	**25.49**	5.53	5.72	**5.63**	3.86	4.24	**4.05**	25.06	25.20	**25.13**	5.12	5.29	**5.20**	4.09	4.43	**4.26**
	K2	26.36	26.91	**26.63**	5.88	6.02	**5.95**	4.49	4.77	**4.63**	25.81	26.42	**26.12**	5.44	5.67	**5.56**	4.65	4.98	**4.82**
LSD at 5%																			
	A			0.52			0.15			0.33			N.S			N.S			0.15
	B			0.33			0.29			0.15			0.50			0.31			0.16
	C			0.27			0.24			0.12			0.41			0.25			0.13
	AB			N.S			N.S			N.S			N.S			N.S			N.S
	AC			N.S			N.S			N.S			N.S			N.S			N.S
	BC			N.S			N.S			N.S			N.S			N.S			N.S
	ABC			N.S			N.S			N.S			N.S			N.S			N.S

On light of these results, it is worth to mention that increasing tops and roots yield with the increase in N-fertilization may be attributable to the increase in N uptake which positively influenced photosynthesis process indirectly through its enhancement leaf area and chlorophyll content as show in Table (2), which reflecting on top and root growth and consequently by enhanced and ultimately higher yield. In addition, the enhancing effect of spraying with Fe + Mn on yield could be attributed to that iron is involved in protein synthesis and root- tip merstem growth (Mangel and Dirkby, 1979)

Considering the interactions effects among nitrogen, potassium fertilization and spraying by iron combined with manganese; data in Table (5) cleared that the highest root and sugar yield were obtained by foliar application with Fe + Mn beside soil fertilization by N and K at rates 100 kg N/ fed and 48 kg K_2O, respectively. Furthermore, the highest top yield was recorded when spraying the foliage of sugar beet plant by Fe + Mn and fertilized with the highest rates of nitrogen and potassium (120 kg N/ fed and 48 kg K_2O), these results are true in both seasons. These results are in good agreement with those found by Ouda, Soheir (2000) for the effect of Fe + Mn, Barik (2002) and El-Kadi *et al.* (2003) on the interaction effect between N and K fertilization, Moustafa, Shafika *et al.* (2005) and Pytlarz, Maria (2005) on the effect of N-fertilization.

2- Juice quality of beet root:

a- Sucrose and purity contents:

Sugar beet quality depends primarily on sugar content, the content of soluble amino compounds, and minerals in particular potassium and sodium. The presence of soluble amino compounds and minerals disturbs crystallization during sugar processing and thus affects the sugar output and its purity

Sucrose and purity percentages data in Table (6) revealed that foliar application with Fe + Mn and potassium fertilization as well had a positive effect on each of them, while nitrogen application especially at the highest rate (120 kg N/ fed) decreased sucrose% and purity significantly. This may be due to that excess N was responsible for the sugar reduction in beet plant, where N promotes the protein formation and depressed carbohydrate accumulation. In this respect Mangel and Kirkby (1979) demonstrated that at the high level of N-nutrition, photosynthesis is diverted from filling root tissue with sugar and are utilized to a marked extent for the growth of new leaves. Also, the drop in juice purity largely reflects increasing concentration of amino compounds caused by excess uptake of nitrate. This was in accordance with the finding of Pytlarz, Maria (2005). Also, Neveryanskaya *et al.* (1978) stated that treating sugar beet plant with trace elements has a considerable influence on the metabolic activities in plant and hence in turn exerts an increase in plant sugar content.

Data in Table (6) reveal that the maximum sucrose and purity percentages recorded were 18.80 and 91.10 %, in the first season and 19.80% and 92.10% in the second season when sugar beet plant sprayed with Fe + Mn (this may be because manganese acts as activator in enzymes involved in carboxylic acid cycle and carbohydrate metabolism) and fertilized with 100 kg N/ fed and 48 kg K_2O/ fed as soil application.

Table (6): Effect of nitrogen and potassium fertilization and foliar application by iron combined with manganese on sucrose, purity and impurities (Na, K and α-amino N) percentages in sugarbeet juice at harvest in 2003/2004 and 2004/2005 seasons

Treatments		Sucrose% -	Sucrose% +	Mean	Purity % -	Purity % +	Mean	Impurities: Na % -	Na % +	Mean	K % -	K % +	Mean	α-amino N % -	α-amino N % +	Mean
2003/2004																
N1	K1	15.17	16.47	15.82	88.37	88.63	88.50	0.78	0.71	0.74	1.22	1.15	1.18	1.79	1.51	1.57
	K2	17.17	17.87	17.52	89.27	89.83	89.55	0.69	0.61	0.63	1.43	1.33	1.38	1.64	1.38	1.41
Mean		16.17	17.17	16.67	88.82	89.23	89.02	0.73	0.66	0.70	1.32	1.24	1.28	1.56	1.42	1.49
N2	K1	16.37	17.07	16.72	89.83	90.57	90.20	0.56	0.49	0.53	1.64	1.52	1.58	1.83	1.65	1.74
	K2	17.80	18.80	18.30	90.63	91.10	90.87	0.43	0.35	0.39	1.93	1.80	1.86	1.55	1.42	1.49
Mean		17.08	17.93	17.51	90.23	90.83	90.53	0.49	0.42	0.46	1.78	1.66	1.72	1.69	1.53	1.61
N3	K1	14.37	15.77	15.07	86.73	87.30	87.02	1.23	1.13	1.18	2.09	1.97	2.03	1.94	1.87	1.90
	K2	16.13	16.83	16.48	87.77	88.20	87.98	1.04	0.89	0.96	2.49	2.25	2.37	1.73	1.59	1.66
Mean		15.25	16.30	15.77	87.25	87.75	87.50	1.14	1.01	1.07	2.29	2.11	2.20	1.84	1.73	1.78
Mean of Fe+Mn		16.17	17.13	16.65	88.77	89.27	89.52	0.79	0.70	0.74	1.80	1.67	1.73	1.70	1.56	1.63
Mean Of	K1	15.30	16.43	15.87	88.31	88.83	88.57	0.86	0.78	0.82	1.65	1.55	1.60	1.89	1.67	1.74
	K2	17.03	17.83	17.43	89.22	89.71	89.47	0.72	0.62	0.67	1.95	1.79	1.87	1.64	1.45	1.52
LSD at 5%	A			0.57			0.27			0.02			0.06			0.08
	B			0.43			0.43			0.04			0.06			0.06
	C			0.35			0.35			0.01			0.05			0.05
	AB			N.S			N.S			N.S			N.S			N.S
	AC			N.S			N.S			N.S			N.S			N.S
	BC			N.S			N.S			0.05			0.08			N.S
	ABC			N.S			N.S			N.S			N.S			N.S
2004/2005																
N1	K1	17.37	18.07	17.72	90.83	91.57	91.20	0.66	0.59	0.63	0.95	0.88	1.08	1.31	1.21	1.26
	K2	18.63	19.80	19.22	91.63	92.10	91.87	0.59	0.53	0.56	1.10	1.07	0.91	1.19	1.04	1.11
Mean		18.00	18.93	18.47	91.23	91.83	91.53	0.63	0.56	0.59	1.02	0.97	1.00	1.25	1.12	1.19
N2	K1	16.17	17.47	16.82	89.37	89.63	89.50	0.45	0.39	0.42	1.36	1.30	1.54	1.53	1.28	1.40
	K2	18.17	18.87	18.52	90.27	90.83	90.55	0.33	0.25	0.29	1.61	1.47	1.33	1.25	1.12	1.19
Mean		17.17	18.17	17.67	89.82	90.23	90.02	0.39	0.32	0.36	1.48	1.38	1.43	1.39	1.20	1.30
N3	K1	15.37	16.77	16.07	87.73	88.30	88.02	1.12	1.04	1.08	1.79	1.69	2.10	1.64	1.57	1.60
	K2	17.13	17.83	17.48	88.77	89.20	88.98	0.91	0.78	0.84	2.22	1.99	1.74	1.43	1.29	1.36
Mean		16.25	17.30	16.77	88.25	88.75	88.50	1.01	0.91	0.96	2.00	1.84	1.92	1.54	1.43	1.48
Mean of Fe+Mn		17.14	18.13	17.63	89.77	90.27	90.02	0.68	0.60	0.64	1.50	1.40	1.45	1.39	1.25	1.32
Mean of	K1	16.30	17.43	16.87	89.31	89.83	89.57	0.74	0.68	0.71	1.37	1.29	1.58	1.49	1.35	1.42
	K2	17.98	18.83	18.41	90.22	90.71	90.47	0.61	0.52	0.56	1.64	1.51	1.33	1.29	1.15	1.22
LSD at 5%	A			0.45			0.27			0.06			N.S			0.07
	B			0.44			0.43			0.04			0.06			0.07
	C			0.36			0.35			0.03			0.05			0.06
	AB			N.S			N.S			N.S			N.S			N.S
	AC			N.S			N.S			N.S			N.S			N.S
	BC			N.S			N.S			0.06			0.09			N.S
	ABC			N.S			N.S			N.S			N.S			N.S

b- Impurities percentages:

Regarding the effect of nitrogen and potassium as soil application and trace elements; iron combined with manganese as foliar application on juice impurities i.e. Na, K and α-amino nitrogen %, it could be notice from Table (6) that all the individual treatments has a significant and positive effect on juice impurities in both seasons, except spraying with Fe + Mn on potassium content was insignificant in the second season. In general, spraying the foliage of sugar beet plant with Fe + Mn decreased the impurities percentages (Na, K and α-amino nitrogen %). Furthermore the higher rate of K-fertilization (48 kg K_2O/ fed) decreased significantly the concentration of sodium and α-amino nitrogen % but increased K concentration. The same trend was found in both seasons. The lowest α-amino nitrogen % that occurred under the higher rate of K fertilization could be due to the promoting effect of K on the incorporation of N into protein, thus the amount of soluble α-amino nitrogen % in cell sap was decreased. This stands in accordance with Mengel and Kirkby (1979).

For the interaction effects, data in Table (6) cleared that the interaction between N and K fertilization only has a significant effect in sodium and potassium percentages in juice of sugar beet roots in both seasons. It is worth to mention to that the lowest Na, K and α-amino nitrogen % were obtained with spraying the of sugar beet foliage with Fe + Mn and applying 100 kg N/ fed and 48 kg K_2O/ fed as soil application. Such effect be attributed to noxious effect of nitrogen in beet under adequate potash supply compared to plants that received inadequate potash because potash also improve nitrogen metabolism (Krauss, 2000).

Perusal of the obtained results, it could be concluded that under the condition of this work when foliar application of iron in combination with manganese and fertilized with nitrogen and potassium as soil application under the rates of 100 kg N/ fed and 48 kg K_2O/ fed were very effective in increasing root and sugar yield, purity, sucrose, as well as reducing Na, K and α-amino nitrogen percentage which in turn improved sugar extractability.

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تأثير التسميد النيتروجيني والبوتاسي مع أوبدون الرش بخليط الحديد و المنجنيز علي بعض الصفات الفسيوكيميائيه وإنتاجيه وجوده محصول بنجر السكر

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اقيمت تجربتان حقليتان في موسمي ٢٠٠٣/٢٠٠٤ و ٢٠٠٤/٢٠٠٥ في محطه بحوث سخا بمحافظه كفر الشيخ لدراسه تأثير التسميد النيتروجيني و البوتاسي بمعدلات ٨٠ و ١٠٠ و ١٢٠ كجم/فدان والتسميد بالبوتاسيوم بمعدلات ٢٤ و ٤٨ كج بو٢أ/فدان مع أو بدون مخلوط الحديد و المنجنيز بتركيز ٠٦ و % Fe EDTA (٦ % حديد) و ٠٣ و % MnEDTA (١٣ % منجنيز) وأيضا التداخلات بينهم علي بعض الصفات الفسيوكيمائيه وإنتاجيه وجوده محصول بنجر السكر ٠

إستخدم الصنف بانثير عديد الأجنه. كان التصميم المستخدم قطعا منشقه مرتين في ثلاث مكررات في كلا موسمي الزراعه٠ تم تقدير متوسط مساحه الورقه/نبات سم٢ وصبغات البناء الضوئي (كلوروفيل أ و ب والكارتينويدات) محم/حم . وزن طازج وأيضا إمتصاص العناصر النيتروجين والبوتاسيوم (جم/نبات) والحديد والمنجنيز (محم/نبات) في كل من الأوراق والجذور في كلا من موسمي الزراعه بعد ١٢٠ يوم من الزراعه وأيضا تم تقدير محصول العرش والجذور والسكر طن/فدان وجوده العصير مثل النسب المؤيه لكل من السكروز و النقاوه وأيضا الشوائب مثل الصوديوم و البوتاسيوم و الأحماض الأمينيه النيتروجينيه عند الحصاد. أوضحت النتائج ما يلي :

- أدي الرش بالحديد مع المنجنيز إلي زياده متوسط مساحه الورق/نبات وصبغات البناء الضوئي (كلوروفيل أ ، ب والكاروتينويدات) محم/حم ماده طازجه وإمتصاص العناصر (نيتروجين وبوتاسيوم وحديد ومنجنيز) في كلا من الأوراق والجذور في نبات بنجر السكر وكذا محصول العرش والجذور والسكر (طن/ فدان) وكذلك النسب المنويه للسكروز والنقاوه في كلا موسمي الزراعه ٠

- أدي الرش بالحديد والمنجنيز الي انخفاض فى محتوي الشوائب (صوديوم وبوتاسيوم والأحماض الأمينيه النيتروجينيه) في عصير البنجر في موسمى الزراعه ٠
- أدي التسميد بالنيتوجين والبوتاسيوم كل علي حده الي زياده معنويه لمتوسط مساحه الورقه/نبات وكلوروفيل أ و ب والكاروتنويدات وامتصاص المغذيات في الأوراق والجذور في كلا الموسمين. لوحظ أيضا زياده في محصول العرش والجذر والسكر وأيضا جوده العصير مثل النسب المئويه للسكروز والنقاوه والشوائب (الصوديوم والبوتاسيوم والأحماض الأمينيه النيتروجينيه) كنتيجه لتأثير التسميد بالنيتروجين والبوتاسيوم في كلا موسمى الزراعه ٠
- أعطي الرش بالحديد مع المنجنيز مع المعامله ب ١٢٠ كجم ن/فدان و٤٨ كجم بو٢أ/ فدان كتسميد أرضى أعلي قيم لمتوسط مساحه الورقه/نبات وصبغات البناء الضوئي والمغذيات الممتصه في الأوراق والجذور (نيتروجين وبوتاسيوم وحديد ومنجنيز) بعد ١٢٠ يوم من الزراعه وأيضا محصول العرش ومحتوي البوتاسيوم عند الحصاد في كلا موسمي الزراعه .
- أدى الرش بالحديد مع المنجنيز والتسميد بالنيتروجين بمعدل ١٠٠ كجم ن/فدان مع التسميد بالبوتاسيوم بمعدل ٤٨ كجم بو٢أ/ فدان إلى الحصول على أعلي محصول للجذر والسكر ونسبه مئويه للسكروز والنقاوه. وعلى العكس من ذلك فقد حدث انخفاض واضح فى النسبه المؤيه للشوائب (% صوديوم و % للأحماض الأمينيه النيتروحييه) في كلا موسمي الزراعه.