Active Iron in Tomato Plants as Affected by Potassium to Calcium Ratio Applied to the Soil

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THE SUITABILITY of five chemical extractants (EDTA, DTPA, O-Ph, 2,2'Bip and HCl) to estimate the amount of active iron, is studied in greenhouse experiments, using tomato plants. Different levels of Fe (0, 5 and 10 ppm) in combination with various ratios of K: Ca fertilization (1:20, 1:10 and 1:5) were used. The shoots of the harvested plants after 60 and 75 days from planting were analyzed for their total Fe, K, Ca, P and active Fe content <u>as</u> extracted by the abovementioned extractants.

The highest dry matter yield of tomato shoots at the two stages of growth were associated with 0 ppm Fe and 1:20 (K: Ca) ratio treatment and the least yield was recorded at the case of 0 ppm Fe and 1:5 (K: Ca) ratio. Iron application significantly increased the Ca content of the plants but decreased both K and P, while total iron showed an insignificant increase. Increasing K: Ca ratio increased K, P and Fe but decreased Ca content.

Active iron extracted using the previous methods increased with iron application increment and decreased by increasing K: Ca ratio. The extractability power, of the five solutions has the following ascending order: EDTA < DTPA < O.Ph < 2,2'Bip < HCl.

The data illustrate that deficiency is expected at active iron levels less than 58, 67, 116, 146 and 221 (mg/kg), for the 60-days old tomato shoots, and 49, 56, 63, 84 and 105 (mg/kg) for the 75 days old tomato shoots in the same order.

Keywords: Active iron, Chemical extractants, Tomato plants.

Iron is an essential element for plant growth and iron-deficiency induced chlorosis is a widespread nutritional problem. This disorder becomes evident as a typical yellowing of young leaves of plants in many crops and affects leaf and flower mineral composition and is responsible for significant decreases in yield, crop size and the quality of many species (Tagliavini and Rambola, 2001).

Plant analysis is one of the accepted tools for diagnosing deficiency disorders. Deficient plants, if analyzed at the right stage usually contain lower amount of the deficient element than the corresponding healthy checks. Perhaps, iron is the only essential element which often evades this most simple definition of deficiency,

since instance is not uncommon when the total content of iron in the chlorotic plants was higher than in the green plants (Mehrotra *et al.*, 1990).

Several techniques based on plant tissue analysis have been proposed for diagnosis of iron deficiency in plants (Katyal and Sharma, 1980 and Mehrotra *et al*, 1985). Various extractants have been proposed to extract the fraction of total iron, which is metabolically active and is related to occurrence of iron chlorosis. These extractants include water, dilute acids (hydrochloric acid, acetic acid, oxalic acid and citric acid), chelating agents such as EDTA, DTPA, tartaric acid and some organic solvents including 22'Bipyridyi and its derivatives, o-phenanthroline and several other compounds.

Some recent studies showed that when the chlorosis symptoms occurred, K contents of the plant were found high at these chlorotic plant samples (Torres *et al.*, 2006 and Çelik and Katkat (2007) . Hence the iron status of a leaf is also governed by relative amounts of potassium and calcium (DeKock, 1981). Abadia *et al.* (1985) studied the effect of Fe chlorosis on the mineral composition of field grown Peach tree leaves in two different areas in the Ebro valley. They found that potassium and K/Ca ratio were significantly higher in chlorotic than in green or slightly chlorotic samples.

This study aims to identify the suitability of five chemical extractants to estimate the amount of iron, as an index of iron nutrition in the tissue of tomato plants grown under different levels of added Fe in combination with application of various ratios of K: Ca.

Materials and Methods

Greenhouse experiment was carried out with tomato plant, as an indicator for active iron. Different levels of Fe in combination with various ratios of K: Ca fertilization were used. Five kilograms of pure fine sand were introduced into plastic pots. Ten seeds of tomatoes were uniformly sown per pot and brought daily to field moisture capacity by addition of Hoagland solution throughout the growth period. Two weeks after sowing, the plants were thinned to five plants per pot. At the same time both K: Ca and $CaCl_2$ solutions having 1:20, 1:10 and 1:5 K: Ca ratios were mixed with Hoagland solution to each pot. Also, iron was sprayed to the plants at a rate of 0, 5 or 10 (mg/kg) Fe-EDTA. The experiment comprised of nine treatments with 10 replicates of each.

After 60 days, top of the plants of five replicates of each treatment was harvested. Active iron in the fresh plant materials was determined using five specific reagents as follows:
- O-phenanthroline solution (O.Ph) (1.5%, pH 3.0) according to the method described by Katyal and Sharma (1980 & 1984).
- 2,2' Bipyridyl solution (2,2'Bip.) (1.5%, pH 7.0), according to the method described by Abadia (1984).

- 0.1N ethylendiamine tetraacetic acid (EDTA), pH 7.0, according to the method described by Mehrotra *et al.* (1985).
- 0.1N diethylen triamine pentaacetic acid (DTPA) pH 7.0, according to the method described by Mehrotra *et al.* (1985).
- 0.1N HCl, according to the method described by Takkar and Kaur (1984).

The procedure involves extraction of 2 g of washed chopped fresh plant material by 20 ml of each of the five reagents and Fe^{2+} was estimated directly in the filtrate by using atomic absorption spectrophotometer. (Unicam 969 AA Spectrometer, JERMANY) according to Page *et al.* (1982). The total iron and Ca were determined in plant digest using atomic absorption spectrophotometer. Potassium was determined in plant digest using flame photometer as described by Page *et al.* (1982). Phosphorus was determined in plant digest using ascorbic acid method described by Page *et al.* (1982).

The age of the extractant solution may play a role because 1,10-phenanthroline had lost part of its chelation capacity after 6 weeks. The ratio of leaf weight:extractant volume did not influence the amount of Fe extracted, provided the same amount of chelator was supplied (Zohlen, 2000).

Results and Discussion

Data in Table 1 and Fig.1 illustrate the response of dry matter yield of tomato shoots to different levels of iron and (k : Ca) ratio at the two stages of tomato plants growth.

Dry matter yield of tomato shoots increament after 60 and 75 days was 40 and 54%, when the iron application was increased from 5 to 10 (mg/kg), respectively. For all iron treatments and at the two stages of growth, the dry matter formation of shoots gradually decreased as the K: Ca ratio increased. The reduction in dry matter of shoots increased as the K: Ca ratio increased. After 60 days from planting, the reduction in dry matter reached 20.37 and; 5.47% as an average due to the increase in K:Ca ratio from R_1 (1:20) to R_2 (1:10) and from R_2 (1:10) to R_3 (1:5), respectively, while after 75 days, the effect of increasing the K:Ca ratio was more pronounced resulting in a decrease percentage of 22.06 and 33.70 as the ratio increased for R_1 to R_2 and R_2 to R_3 , respectively. This clearly shows the adverse effect of increasing the K: Ca ratio on the dry matter production of tomato plants. Similar results were obtained by Guzmaz *et al.* (l986) and Therios *et al.*(2005).

Statistical analysis showed a highly significant effect of the interaction between added iron and K: Ca ratios on the dry matter of tomato plants at the two stages of growth (60 and 75 days). Such interaction was more pronounced with the application of 10 ppm Fe than the other two levels (0 and 5 ppm Fe) at all ratios of K/Ca.

Total iron content
The total iron content of shoots after 60 and 75 days from planting is presented

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in Table 2. The data showed that no marked differences were observed in the total iron contents between plants supplied or non with iron. It could be concluded that the total iron content does not always give a good indication of the iron status of the plant. Katyal and Sharma (1980 and 1984) indicated that total iron concentrations in plant are a poor indicator of iron status of plants. In several cases the deficient or chlorotic plants may contain similar or even more iron than the healthy ones.

Total leaf iron (Fe) does not often correlate well with Fe deficiency symptoms. The extraction of 'active' Fe by 1 M HCl or Fe chelators, *e.g.,* 1,10-phenanthroline, may reflect the relation between chlorosis and Fe-concentration in the leaves better than total Fe does (Zohlen, 2000).

TABLE 1. Dry matter content (g/pot) of tomato plants.

Iron Treatment	K/Ca ratios			Mean
	R_1	R_1	R_1	
	First sample			
Fe_0	1.38	1.11	0.67	1.05
Fe_1	2.00	1.64	1.57	1.73
Fe_2	2.97	2.31	2.02	2.43
Mean	2.11	1.68	1.42	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(.05)	0.25		0.44	
(.01)	0.35		0.61	
	Second sample (leaves + stems)			
Fe_0	4.07	2.68	1.63	2.79
Fe_1	5.36	4.25	2.57	4.06
Fe_2	7.71	6.43	4.66	6.26
Mean	5.71	4.45	2.95	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(.05)	0.65		1.12	
(.01)	0.89		1.55	

Fe0 : 0 ppm Fe   R1 : 0.05 K/Ca ratio
Fe1 : 5 ppm Fe   R2 : 0.10 K/Ca ratio
Fe2 : 10 ppm Fe   R3 : 0.20 K/Ca ratio
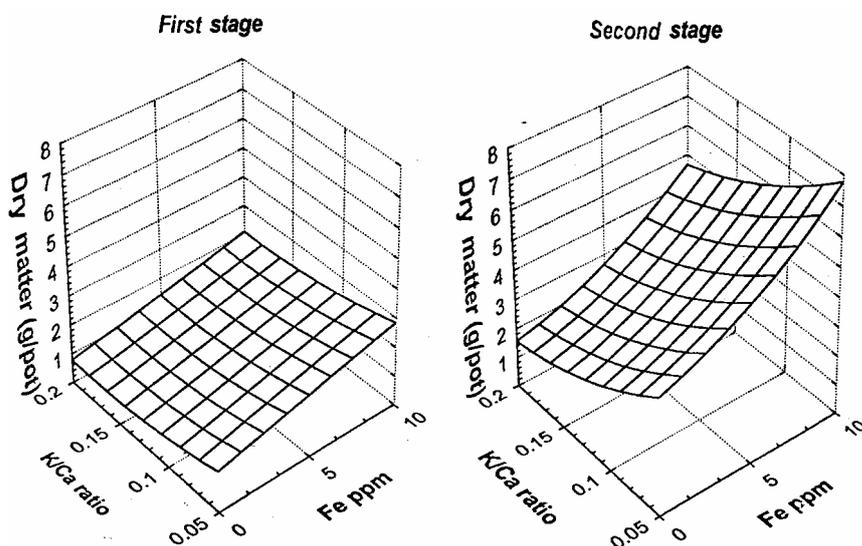
Fig. 1. Dry matter yield of tomato shoots grown under different levels of iron and K/Ca ratio at two stage of growth.

TABLE 2. Total iron content (mg/kg) in tomato plants.

Iron treatments	K/Ca ratios			Mean
	R_1	R_2	R_3	
	First sample			
Fe_0	465.00	486.33	499.00	483.44
Fe_1	507.00	533.33	572.33	537.55
Fe_2	533.67	570.67	585.00	563.11
Mean	501.89	530.11	552.11	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(.05)	*106.94*		*185.23*	
(.01)	*147.35*		*255.21*	
	Second sample			
Fe_0	474.83	503.94	515.76	498.17
Fe_1	505.58	516.58	525.50	515.88
Fe_2	526.66	543.47	545.97	538.70
Mean	502.35	521.33	529.07	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(.05)	*99.01*		*171.49*	
(.01)	*136.42*		*236.29*	

Moreover, the increase in the K: Ca ratio brought about slight but

insignificant increases in the total iron concentration.

Total potassium content

Data of total potassium contents in plant tissues are given in Table 3. The obtained results show that potassium concentration ranged between 1.78 and 4.24% in the 60 days old shoots. Corresponding values for the shoots at 75 days old plants were 1.64 - 3.30%. Application of Fe at the two levels of 5 and 10 (mg/kg) lead to gradual decrease in K content of shoots under different ratios of K: Ca at the two stages of growth. Similar results were obtained by Allen *et al.* (2006). Potassium and iron are the main elements that are of great importance in soilless medium in terms of tomato yield and fruit quality. The interaction between potassium and iron applications was significant in yield. These results indicated interactive effects between potassium and iron applications on fruit quality and yield are more complex structure, (Filiz and Sahriye, 2010)

Moreover, total K contents of shoots significantly increased as the K: Ca ratio increased, under conditions of all iron treatments, and at the two stages of growth. Statistical analysis showed that the interaction between added iron and K: Ca ratios had highly significant effect on the potassium content in tomato plants at the two stages of growth (60 and 75 days).

TABLE 3. Total contents of potassium (%) in tomato plants.

Iron	K/Ca ratios			Mean
treatments	R_1	R_2	R_3	
	First sample			
Fe_0	2.27	3.41	4.24	3.30
Fe_1	2.07	3.07	3.94	3.02
Fe_2	1.78	2.80	3.70	2.76
Mean	2.04	3.09	3.96	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca	
(.05)	0.26		0.44	
(.01)	0.35		0.61	
	Second sample			
Fe_0	1.83	2.72	3.30	2.61
Fe_1	1.71	2.44	3.14	2.43
Fe_2	1.64	2.25	2.92	2.27
Mean	1.72	2.47	3.12	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca	
(.05)	0.15		0.26	
(.01)	0.21		0.36	

Fe_0 :   0 ppm Fe R_1 : 0.05 K/Ca ratio
Fe_1 :   5 ppm Fe R_2 : 0.10 K/Ca ratio
Fe_2 : 10 ppm Fe R_3 : 0.20 K/Ca ratio

Total calcium content

Table 4 shows that, as the level of iron application increased the calcium concentration in plants. Application of Fe at the two levels of 5 and 10 ppm increased the Ca content of shoots under different ratios K:Ca at the two stages of growth. Moreover, as the K:Ca ratio increased significant decreases in Ca concentration were obtained. Similar conclusion was recorded by Cook *et al.* (1991)

TABLE 4. Total contents of calcium (%) in tomato plants.

Iron	K/Ca ratios			
treatments	R_1	R_2	R_3	Mean
	First sample			
Fe_0	2.10	1.67	1.32	1.69
Fe_1	2.41	1.91	1.62	1.98
Fe_2	2.50	2.10	1.98	2.19
Mean	2.33	1.89	1.64	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(.05)	0.20		0.35	
(.01)	0.31		0.56	
	Second sample			
Fe_0	1.90	1.50	1.01	1.48
Fe_1	2.10	1.76	1.10	1.68
Fe_2	2.20	1.89	1.58	1.89
Mean	2.06	1.71	1.23	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(.05)	0.19		0.32	
(.01)	0.25		0.41	

Fe_0 : 0 ppm Fe R_1 : 0.05 K/Ca ratio
Fe_1 : 5 ppm Fe R_2 : 0.10 K/Ca ratio
Fe_2 : 10 ppm Fe R_3 : 0.20 K/Ca ratio

Statistical analysis of the data showed that the interaction between added iron and K:Ca ratios on the calcium concentration in tomato plants at the two stages of growth (60 and 75 days) was highly significant.

Total phosphorus content

Results of phosphorus concentration in plant tissue are given in Table 5. Iron application significantly decreased phosphorus concentration. Phosphorus content in shoots was higher in treatment received no iron than those supplied with iron. The increase of K: Ca ratio was associated with a slight increase in P concentration.

TABLE 5. Total contents of phosphorus (%) in tomato plants.

Iron treatments	K/Ca ratios			Mean
	R_1	R_2	R_3	
First sample				
Fe_0	0.84	0.86	0.98	0.89
Fe_1	0.69	0.78	0.87	0.78
Fe_2	0.59	0.61	0.73	0.64
Mean	0.70	0.75	0.86	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(0.05)	*0.17*		*0.30*	
(0.01)	*0.24*		*0.42*	
Second sample				
Fe_0	0.62	0.70	0.77	0.69
Fe_1	0.54	0.58	0.66	0.59
Fe_2	0.44	0.52	0.60	0.52
Mean	0.53	0.60	0.67	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(0.05)	*0.07*		*0.13*	
(0.01)	*0.10*		*0.18*	

Fe_0 : 0 ppm Fe R_1 : 0.05 K/Ca ratio
Fe_1 : 5 ppm Fe R_2 : 0.10 K/Ca ratio
Fe_2 : 10 ppm Fe R_3 : 0.20 K/Ca ratio

Active iron concentration:

Results recorderd in Table 6 show that the active iron extracted from the shoots of the two sampling dates increased by iron application and decreased by increasing the K:Ca ratio (Fig. 2- 6).

TABLE 6. Active iron concentration (mg/kg) extracted by different methods from tomato plants.

Iron treatments	First samples K/Ca ratios			Mean	Second samples K/Ca ratios			Mean
	R_1	R_2	R_3		R_1	R_2	R_3	
	EDTA							
Fe_0	74.17	59.93	45.15	59.75	63.51	54.25	40.48	52.74
Fe_1	95.54	70.81	58.19	74.84	71.54	62.11	48.28	60.64
Fe_2	124.57	100.00	84.56	103.04	82.70	72.04	56.67	70.47
Mean	98.09	76.91	62.63		72.58	62.80	48.47	
L.S.D	Fe and K/Ca ratio		(Fe X K/Ca ratio)		Fe and K/Ca ratio		(Fe X K/Ca ratio)	
(.05)	11.10		19.23		4.39		7.62	
(.01)	15.30		26.50		6.06		10.49	
	DTPA							
Fe_0	88.15	70.66	52.94	70.58	72.05	58.72	44.96	58.57
Fe_1	98.84	83.04	62.80	81.56	83.16	68.68	55.92	69.25
Fe_2	130.00	112.45	93.29	111.91	99.52	88.08	62.63	83.41
Mean	105.66	88.71	69.66		84.91	71.82	54.50	
L.S.D	Fe and K/Ca		(Fe X K/Ca		Fe and K/Ca		(Fe X K/Ca	
(.05)	9.79		16.14		4.56		7.91	
(.01)	12.83		22.23		6.29		10.89	

TABLE 6. Cont.

Iron treatment	First samples				Second samples			
	K/Ca ratios			Mean	K/Ca ratios			Mean
	R_1	R_2	R_3		R_1	R_2	R_3	
	O-Ph.							
Fe_0	103.03	74.10	69.44	82.19	82.83	77.77	65.86	75.48
Fe_1	123.01	100.00	91.70	104.90	104.17	86.83	72.39	87.79
Fe_2	159.55	132.10	111.00	134.21	125.51	109.44	83.82	106.25
Mean	128.53	102.06	90.71		104.17	91.34	74.02	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)		Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(.05)	10.93		18.64		4.57		7.91	
(.01)	14.82		25.68		6.29		10.91	
	2,2'Bip.							
Fe_0	132.73	104.70	82.44	106.62	99.53	91.20	72.06	87.59
Fe_1	158.50	127.94	108.68	131.70	124.11	105.33	85.16	105.86
Fe_2	192.05	161.84	137.03	163.64	147.85	131.16	95.19	124.73
Mean	161.09	131.49	109.38		124.83	109.23	84.13	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)		Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(.05)	21.58		40.85		5.43		9.41	
(.01)	30.50		56.29		7.49		12.97	
	HCl							
Fe_0	243.49	201.60	168.90	204.66	135.76	125.03	88.45	116.41
Fe_1	277.25	231.11	215.75	241.37	160.70	137.71	118.56	138.99
Fe_2	342.47	294.18	232.90	289.85	188.54	164.77	132.79	162.03
Mean	287.73	242.29	205.85		161.66	142.50	113.26	
L.S.D	Fe and K/Ca ratio		(Fe x K/Ca ratio)		Fe and K/Ca ratio		(Fe x K/Ca ratio)	
(.05)	33.45		57.94		16.54		28.66	
(.01)	46.09		79.84		22.80		39.49	

Fe$_0$: 0 ppm Fe R_1 : 0.05 K/Ca ratio
Fe$_1$: 5 ppm Fe R_2 : 0.10 K/Ca ratio
Fe$_2$: 10 ppm Fe R_3 : 0.20 K/Ca ratio
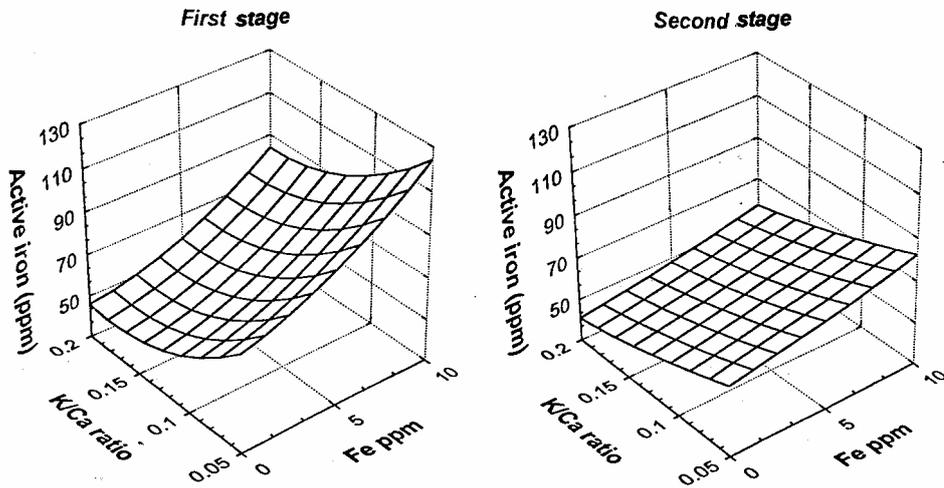
Fig. 2. Active Fe extracted by EDTA (mg/kg) of tomato shoots under different levels of iron and K/Ca at two stages of growth.
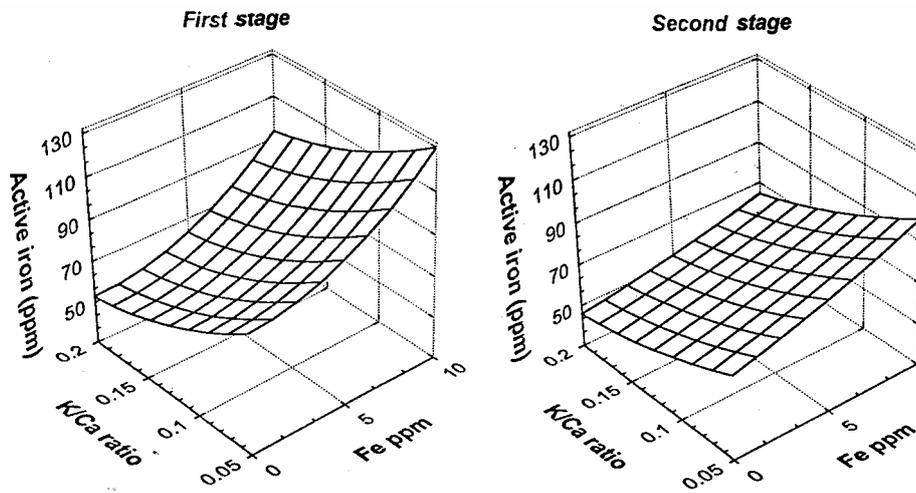
Fig. 3. Active Fe extracted by DTPA (mg/kg) of tomato shoots under different levels of iron and K/Ca at two stages of growth.
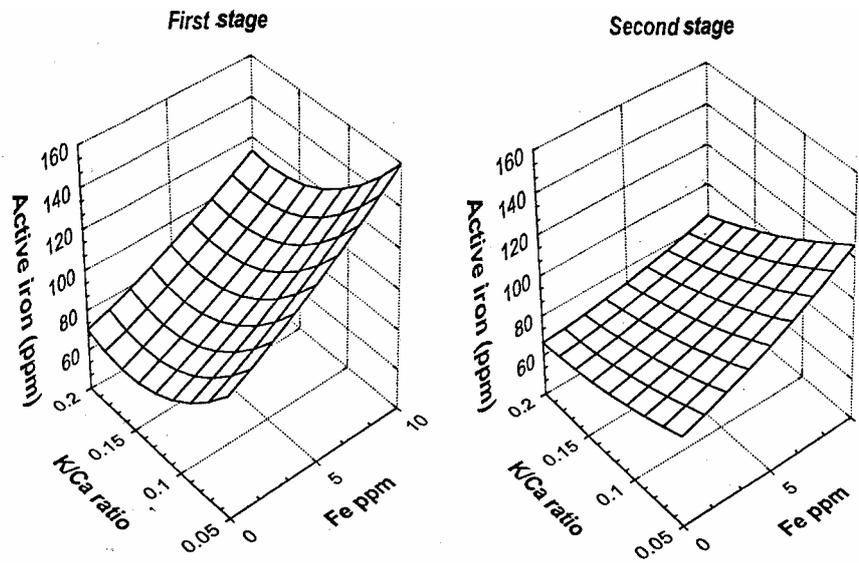
Fig. 4. Active Fe extracted by O-ph (mg/kg) of tomato shoots under different levels of iron and K/Ca at two stages of growth.
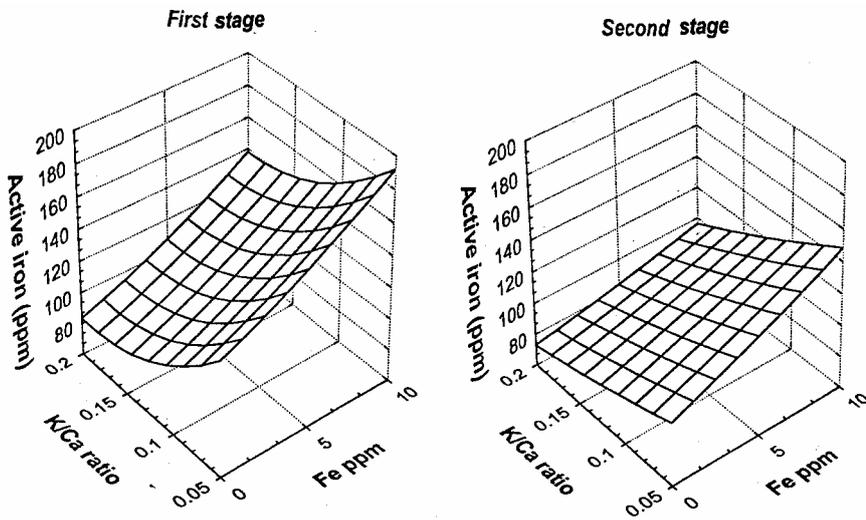
Fig.5. Active Fe extracted by 2,2'Bip (mg/kg) of tomato shoots under different levels of iron and K/Ca at two stages of growth.
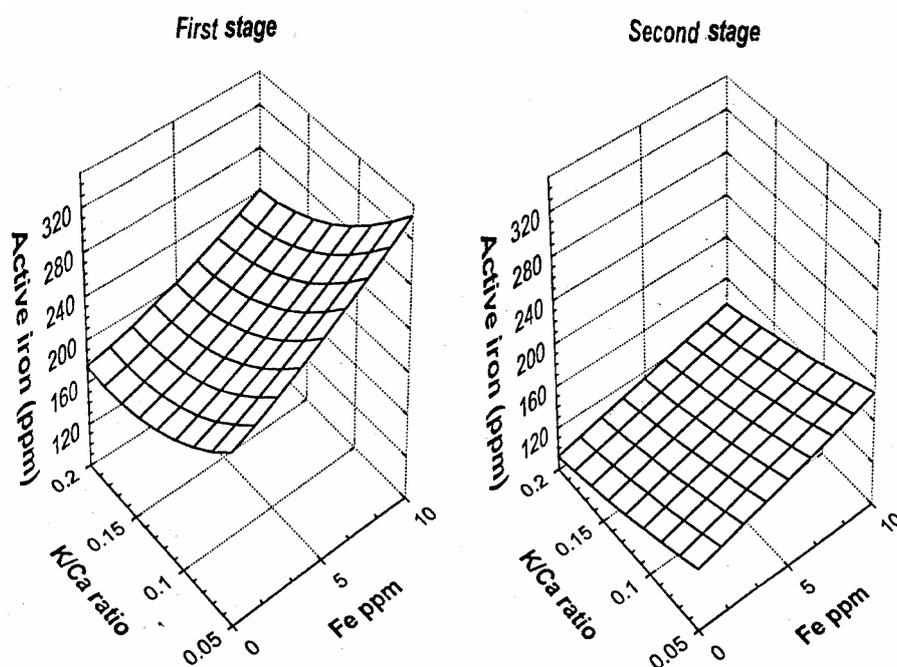
Fig. 6. Active Fe extracted by HCl (mg/kg) of tomato shoots under different levels of iron and K/Ca at two stages of growth

Statistical analysis showed that the interaction between added iron and K: Ca ratios had highly significant effect on the active iron in tomato plants at the two stages of growth (60 and 75 days). In general, the highest active iron content of shoots was associated with the treatment of 10 ppm Fe and 1:20 K: Ca ratio, while the lowest one was observed at 0 ppm Fe and 1:5 K: Ca ratio.

The correlation coefficients between active iron concentration and each of dry matter yield and total Fe content in the shoots of tomato plants at the two stages of growth are presented in Table 7. Significant correlations were obtained between dry matter yield of the first and second samples of shoots. However, no significant correlations were found between total iron content in the shoots at both stages of growth and dry matter yield. These results clearly demonstrate that none of the extractants examined in this study could be used for the assessment of the iron status in tomato plant. These findings agree with those reported by Mehrotra *et al.* (1985); Rao *et al.* (1987) and Aly (1994). Moreover, no significant correlations were obtained between the amount of Fe extracted from the shoots by any of the abovementioned extractants and total Fe content of the shoots at the two samples.

TABLE 7. Correlation coefficients between active iron extracted in different methods and each of dry matter yield and total iron contents in tomato plants at two stage of growth.

.	Correlation coefficient (r)			
Extraction method	**First sample**		**Second sample**	
	Dry matter	**Total Fe**	**Dry matter**	**Total Fe**
EDTA	0.81^{**}	ns	0.91^{**}	ns
DTPA	0.85^{**}	ns	0.93^{**}	ns
O-Ph.	0.82^{**}	ns	0.90^{**}	ns
2,2' Bip.	0.70^{**}	ns	0.86^{**}	ns
HCl	0.63^{**}	ns	0.76^{**}	ns
Total Fe	ns	--	ns	--

ns : not significant

* : significant at 5% probability.

** : significant at 1% probability.

Generally, the statistical analysis showed highly significant correlations between the values of active iron extracted by the five methods (EDTA, DTPA, o-Ph, 2,2'Bip and HCl) from tomato shoots after 60 or 75 days from planting (Table 8). Thus, each of these extractants could be effectively used to describe Fe status in the plants which grown in Egyptian soils.

TABLE 8. Correlation matrix between different methods used to extract active iron from tomato plant at two stages of growth.

Extractants				
	EDTA	**DTPA**	**O-Ph.**	**2,2' Bip.**
HCl	First sample			
	0.57^{**}	0.38^{*}	0.67^{**}	0.73^{**}
2,2' Bip.	0.74^{**}	0.65^{**}	0.91^{**}	
O-Ph.	0.88^{**}	0.72^{**}		
DTPA	0.57^{**}			
	Second sample			
HCl	0.71^{**}	0.71^{**}	0.43^{*}	0.65^{**}
2,2' Bip.	0.90^{**}	0.89^{**}	0.55^{**}	
O-Ph.	0.51^{**}	0.53^{**}		
DTPA	0.71^{**}			

* : significant at 5% probability.

** : significant at 1% probability.

The active Fe extracted by each of EDTA, DTPA, o-Ph, 2,2'Bip and HCl from tomato plants is calibrated against dry matter. Values of such critical level for the active iron extracted are shown in Table 9. As regards the yield response as a function of each of EDTA, DTPA, o-Ph, 2,2'Bip and HCl-extractable active iron, the data illustrate that deficiency is expected at active iron levels less than 57.76, 66.73, 116.30, 146.30, and 220.95 ppm, for the 60-days old shoots, respectively. Corresponding expected deficiency values for the 75-days old shoots are 48.79, 55.94, 63.37, 83.94 and 105.02 for the five extractants previously mentioned in the same order. In this respect, it could be observed that the critical level of active iron in the second sample for the five extractants is much lower than those in the first sample. This indicates that tomato plants require high amounts of Fe during their early stages of growth.

TABLE 9. Critical values of active iron (mg/kg) extracted by different extraction to clarify tomato plant iron status at the two stages of growth .

Extraction	Critical values	
	First sample	Second sample
EDTA	57.76	48.79
DTPA	66.73	55.94
O-Ph.	116.30	63.37
2,2' Bip.	146.30	83.94
HCl	220.95	105.02

Conclusion

Higher concentrations of active Fe were found in the non chlorotic leaves. These results are in accordance with other researchers (Karaman 1999 and Başar 2000 & 2003) . High concentrations of total iron in chlorotic leaves show that total iron is not a good indicator of the iron status of plants (Sönmez and Kaplan, 2004). This is evident from the negative correlation between active Fe and the degree of chlorosis (Köseoğlu & Açıkgöz, 1995 and Sönmez & Kaplan, 2004). For evaluation of plant responses to various factors affecting Fe availability in the soil and Fe nutrition in plants, the concentration of active iron in leaves is recognized as a better nutritional iron indicator than total iron and has been also suggested by Mengel (1995).

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الحديد النشط في نباتات الطماطم ومدى تأثره بنسبة البوتاسيوم الى الكالسيوم المضاف الى التربة

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اجريت دراسة بهدف دراسة مدى ملائمة خمسة مستخلصات كيماوية لتقدير كمية الحديد (EDTA, DTPA, O-Ph, 2,2'Bip and HCl) النشط كدليل على حالة الحديد في أنسجة نباتات الطماطم النامية في الصوبة تحت مستويات مختلفة من الحديد(0، 5 ؛ 10 جزء في المليون) ونسب مختلفة من البوتاسيوم : الكالسيوم (1 : 20، 1 : 10، 1 : 5)

وقد تم حصاد النباتات لكل معاملة بعد 60 ، 70 يوم من الزراعة. وتم تقدير الحديد النشط في النبات الأخضر بواسطة الخمسة مستخلصات السابق ذكرها. بالإضافة الى تقدير الحديد الكلى و البوتاسيوم و الكالسيوم و الفوسفور في المادة الجافة للنبات الطماطم.

أظهرت النتائج أن أعلى محصول من المادة الجافة لنبات الطماطم في مرحلتي النمو كانت في معاملة الـ 10 جزء في المليون حديد مع نسبة بوتاسيوم : كالسيوم 20:1 واقل محصول للمادة الجافة كان فى معاملة صفر جزء في المليون حديد مع نسبة بوتاسيوم : كالسيوم 5:1. وقد زاد تركيز الكالسيوم و انخفض تركيز كلا من البوتاسيوم و الفوسفور في نباتات الطماطم مع زيادة مستويات الحديد المضافة و لم تحدث زيادة معنوية فى محتوى الحديد الكلى في النبات . بينما انخفض تركيز الكالسيوم و زاد تركيز كلا من البوتاسيوم و الفوسفور و الحديد الكلى في نباتات الطماطم بزيادة نسبه البوتاسيوم : الكالسيوم المضافة.

وقد أظهرت نتائج الحديد النشط المستخلص بواسطة المستخلصات المختلفة من المجموع الخضري للنباتات فى مرحلتي النمو زيادة معنوية نتيجة إضافة الحديد بينما حدث نقص معنوي في تركيز الحديد النشط بزيادة نسبة البوتاسيوم : الكالسيوم . وطبقا لقدرة الاستخلاص فان المستخلصات الخمسة المستعملة يمكن ترتيبها كما يلي:

EDTA < DTPA < O-Ph < 2,2'Bip. < HCl
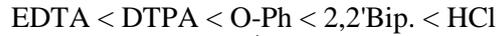
وتوضح النتائج المتحصل عليها أن المستوى الحرج لتركيز الحديد النشط فى النبات والذي اذا انخفضت النسبة عنه فإن النباتات تعانى من نقص الحديد هي 58، 67، 116، 146، 211 جزء في المليون حديد نشط و ذلك لعمر 60 يوم من الزراعة للمستخلصات السابقة فى حين كانت القيم المقابلة لعمر 75 يوم من الزراعة هي 49، 56، 63، 84، 105 جزء في المليون حديد نشط لنفس المستخلصات على التوالي.