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Evaluation of Various Treatments As Soil Application In Correcting Iron Chlorosis in Peach Trees

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SUMMARY

This research was carried out in order to determine effectiveness of various additives in correcting of iron chlorosis indicating peach trees in Bursa region. Peach trees with moderate and severe chlorosis were supplied in early spring with Coated iron mixture (190 g/tree), Prototype II (150 g/tree), Sequestrene 138 Fe (250 g/tree), $FeSO_4$ + S (2.0 kg + 2.0 kg/tree), $FeSO_4$ + K_2SO_4 (2.0 kg + 2.0 kg/tree) and S (2 kg/tree) through soil as a band application around drop-fall of the crown. Control trees were untreated. The Fe-EDDHA was the only treatment that resulted in complete overcoming of iron deficiency, as shown by complete re-greening, plant scoring, active and total iron concentrations in leaves. Limited re-greening was obtained with application of Coated iron mixture, Prototype II and mixture of $FeSO_4$ and S. Levels of P and Mn in leaves were markedly affected as depending on effectiveness of treatments on chlorosis.

Key words: Iron, peach, fertilization.

ÖZET

Topraktan Uygulanan Çeşitli Gübrelerin Şeftali Ağaçlarında Görülen Demir Klorozunun Giderilmesinde Etkinliklerinin Belirlenmesi

Bu çalışma, Bursa yöresinde şeftali ağaçlarında görülen demir klorozunun düzeltilmesinde değişik gübrelerin etkinliklerinin belirlenmesi amacıyla yapılmıştır. Araştırmada gübre olarak; CIM, 190 g/ağaç; Prototype II, 150 g/ağaç; Sequestrene 138 Fe, 250 g/ağaç; 2 kg $FeSO_4$ + 2 kg S/ağaç; 2

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kg $FeSO_4$ + 2 kg K_2SO_4/ağaç; S 2 kg/ağaç, dozlarında olmak üzere hafif ve şiddetli klorotik şeftali ağaçlarının taç izdüşümlerine bant halinde erken ilkbaharda uygulanmıştır. Sequestrene 138 Fe'in yaprakların toplam ve aktif demir içeriklerini arttırdığı, kloroz derecelerini azalttığı ve ağaçlarda tam bir yeşillenme sağladığı, CIM, Prototype II ve $FeSO_4$ + S gübrelerinin ise sınırlı düzeyde etkili oldukları belirlenmiştir. Yaprakların P ve Mn içerikleri ise uygulamaların kloroz üzerindeki etkinliklerine bağlı olarak önemli düzeyde değişmiştir.

Anahtar kelimeler: Demir, şeftali, gübreleme.

INTRODUCTION

Iron chlorosis is one of the major problems in numerous crops grown on calcareous soils in Turkey. Among the crops grown in calcareous soils of Bursa plain, peach has of economic and traditional importance. But, Fe chlorosis is often observed in peach plantations by yield reduction. Causes for Fe deficiency in plants are related with high soil pH, high lime soils, imbalance of metallic ions, such as Zn, Cu and Mn, excess soil moisture, heavy soil texture, high levels of HCO^-_3 in soil, low Fe/Mn ratio in soil solution, excess amounts of P in soil, soluble salts, compaction, soil dispersion, redox potential and soil microbial activity (Harley and Lindler, 1945; Penington, 1971; Olson and Carlson, 1949; Boxma, 1972; Wallace ve Lunt, 1960; Chen and Barak, 1982). Among all above mentioned factors, lime-induced chlorosis is very much associated with iron deficiency in the plant, caused by limited iron uptake or by its inactivation in the plant (Hagin and Tucker, 1982). Because of soil application of inorganic Fe sources are not effective in supplying Fe for the crops, iron in chelated forms are the most effective Fe source as a soil application (Mortvedt, 1991). However, high cost of the Fe chelates limits their extensive use to most of the crops in correcting chlorosis. As an alternative to iron chelate applications, incorporation of K_2SO_4 with $FeSO_4$ or alone, acidifiying soil additives and iron in slow-release products were reported as effective treatments on reducing Fe chlorosis in various crops (Marsolek and Hagstrom, 1982; Shaviv and Hagin, 1987; Mikkelsen and Behel, 1988).

The objective of this study was to test the effectiveness of various compounds commonly applicable for the growers in overcoming iron chlorosis in peach trees.

MATERIAL AND METHODS

Peach *(Prunus persica L.)* orchard planted with the J.H. Hale cultivar were chosen one of the orchards located at Karabalçık district having chlorotic trees from moderate to severe at Bursa province. The experiment was conducted in factorial design with completely randomized design with four replications. The treatments were applied at rates given in table 1. Because of the effect of the treatments would vary with the chlorosis degree of trees, Trees were divided into two groups on a scale between moderate chlorotic (degree of chlorosis, 40-60 %) and severe chlorotic (degree of chlorosis, 70 - 90 %). All treatments were separately applied to both moderately chlorotic and severely chlorotic trees. Chlorosis degree of the trees were scored a year before the experiment started and at two different stages in growing season by independent observations of 3 people. Band application of the fertilizers were done into the soil around drop-fall of the crown at the blooming stage in early spring.

Leaf samples were taken from 5th, 6th and 7th leaves in annual shoots (Ballinger, et. al., 1966), on day 45 and on day 90 after application. For evaluation of nutrition uptake of the trees, plant materials were washed with deionized water with 0.1 % Teepol, rinsed in tap water and finally deionized water, successively; dried at 70°C; ground. The dried leaf samples were wet digested in a mixture of nitric acid: perchloric acid (HNO_3 : $HClO_4$) (4:1) and Mg, Zn, Fe, Mn, Cu contents in digest were determined by Atomic Absorbtion; K and Ca by atomic emission; P by the vanadomolybdophosphoric method (Kacar, 1972). Active iron determination in fresh leaf samples was done according to Takkar and Kaur (1984).

In order to determine some chemical and physical properties of the soil, Composed soil samples were taken from drop-fall of ramdomly chosen trees at 2 different dephts. Results of the soil analysis are shown in table 2.

Table: 1
Application Rates and Some Properties of Treatments Used as Fertilizers in the Experiment

Treatments	Symbol	Content %,		Material Applied	Remarks
		Fe	K	Per Tree	
Control	CONT.	-	-	-	-
CIM	CIM	8	-	190	Coated iron mixture as FeEDTA
Prototype II	PRT	10	-	150	Iron coated as FeEDTA
Sequestrene 138 Fe	SEQ	6	-	250	Iron as Fe-EDDHA
Iron Sulphate, Sulphur	FeS	20	-	2 kg $FeSO_4$, 2 kg S	-
Iron Sulphate, Potassium Sulphate	FePS	20	44	2 kg $FeSO_4$, 2 kg K_2SO_4	-
Sulphur	S	-	-	2 kg	Elemental S

Table: 2
Some Physical and Chemical Properties of Soil of Peach Orchard Used in Experiment

Parameter	Soil Depth, cm	
	0 - 25	25 - 50
Textural Class	clay loam	clay loam
pH (soil: water = 1:2.5)	7.70	7.80
Total $CaCO_3$, %	17.60	21.30
Active lime, %	5.77	6.09
Total soluble salt, %	0.074	0.068
O.M., %	1.45	1.31
Available P, ppm	10.79	10.39
Available K, ppm	418.29	359.82
Micro elements in DTPA, ppm		
Fe	38.66	38.00
Zn	1.66	1.29
Mn	23.00	23.04
Cu	3.72	2.02

Results were statistically analyzed using the LSD (least significant differences) test ($p < 0.05$) with the aid of the computer program TARİST.

RESULTS AND DISCUSSION

1. Effect of Treatments on Active Iron and Total Iron Concentrations in Leaves and Leaf Chlorosis

Extent of chlorotic symptoms in peach trees were idenfied with active iron and total iron concentration in leaves and degree of chlorosis of the trees. Active and total iron contents and degree of chlorosis of leaves as an average of two dates of sampling in both moderate and severe chlorotic trees are presented in table 3. As can be seen in table 3, Application of SEQ corrected chlorosis and yielded the highest active and total iron concentrations in leaves. CIM and PRT had a very slight correcting effect on chlorosis. By application of CIM and PRT active iron and total iron concentration in leaves were found to be very slightly higher than control treatment. Meanwhile, degree of chlorosis was very slightly lower than control treatment in accordance with active and total iron concentrations. A mixture of iron sulphate with sulphure treated trees showed responses similar to those of CIM and PRT. The effect of elemental S and combination of iron sulphate with potassium sulphate on chlorosis were not clear and seemed to be more or less similar to control treatment.

Table: 3
Effect of Treatments on Total Iron and Active Iron Contents and Leaf Chlorosis of Peach (Means of 4 Replications)*

Treatment	Chlorosis score %,		Active Fe (ppm, fresh leaf)		Total Fe (ppm, dry leaf)	
	Moderately Chlorotic	Severely Chlorotic	Moderately Chlorotic	Severely Chlorotic	Moderately Chlorotic	Severely Chlorotic
Control	65	80	7.51 de	6.65 e	52.05 cde	59.16 bc
CIM	35	55	9.12 cd	7.90 de	55.30 bcd	60.48 bc
PRT	20	55	9.93 bc	7.52 de	62.99 bc	52.39 cde
SEQ	0	0	16.45 a	18.28 a	87.73 a	85.69 a
FeS	20	55	11.22 b	8.37 cde	65.47 b	41.56 e
FePS	40	65	8.08 cde	7.16 de	62.31 bc	45.50 de
S	45	75	9.00 cd	6.86 e	55.58 bcd	55.38 bcd

* Treatment means within columns followed by the same letter are not statistically different at the 5 % level.

Results obtained from the experiment showed that the most effective treatment in correcting iron chlorosis was SEQ in a great agreement with earlier mentioned research results (Razeto, 1982; Başar and Özgümüş, 1995). CIM and PRT treatments resulted in relatively lesser increases in active and total iron concentrations in the leaves. This may be due to low stable form of the iron chelate coated as slow release fertilizer in calcareous soils (Lindsay, 1974). A mixture of iron sulphate with potassium sulphate and of iron sulphate with elemental sulphur were not effective as expected. It is assumed that beneficial effects of the treatments were screened by soil conditions inducing iron chlorosis. Use of elemental S alone or in combination with iron sulphate were not sufficient to overcome chlorosis meant that, amounts of S applied to acidify the root zone was not sufficient. Similar findings were reported by Razeto (1982) and Wallace, et. al. (1982).

2. Effect of Treatments on Nutrient Uptake

The levels of several macro and micro nutrient contents of different fertilizers treated trees were tabulated in table 4. The data indicated that K, Ca and Mg contents were not significantly affected by the treatments. P content in both moderate and severe chlorotic trees were significantly higher in control and in Sulphur treatments than other treatments. P concentration in Fe deficient leaves was reported to be higher than green leaves by many workers (Nelson and Jolley, 1984; Özgümüş, 1988; Köseoğlu, 1995). But, Contrary to being expected, less effective treatments of CIM, PRT and FeS decreased P concentrations in leaves as same extent as SEQ. In spite of Zn and Cu contents of leaves were significantly varied by application of different treatments. There was in sight no reasonable relationship among Zn, Cu, total and active Fe in leaves, degree of chlorosis and treatments.

Table: 4
Effect of Treatments on Mineral Composition of Peach (Means of 4 Replications)

		TREATMENTS						
	Degree of Chlorosis	Control	CIM	PRT	SEQ	FeS	FePS	S
P, %	Moderate	0.80a	0.24c	0.21c	0.23c	0.16c	0.23c	0.66ab
	Severe	0.83a	0.25c	0.26c	0.22c	0.19c	0.64b	0.69ab
K, %	Moderate	2.24	1.96	1.87	1.93	1.74	1.99	2.19
	Severe	1.76	1.99	1.91	1.92	1.61	1.32	1.76
Ca, %	Moderate	3.12	2.90	3.38	2.69	3.15	2.96	2.81
	Severe	2.84	2.98	2.72	2.86	2.48	2.50	2.68
Mg, %	Moderate	0.97	0.72	0.76	0.66	0.78	0.76	0.66
	Severe	0.83	0.76	0.70	0.68	0.68	0.64	0.69
Zn, ppm	Moderate	32.50abc	35.58ab	29.35bcde	23.33cde	28.11bcde	41.87a	31.43abcd
	Severe	26.00bcde	28.95bcde	27.78bcde	27.34bcde	20.50de	17.53e	18.27e
Mn, ppm	Moderate	70.80bcd	69.70bcd	86.68ab	42.81ef	85.24ab	70.14bcd	93.46a
	Severe	62.49cde	72.53abc	62.36cde	39.86f	45.94ef	52.06cdef	48.56def
Cu, ppm	Moderate	10.34abc	11.06ab	9.86abc	9.98abc	9.64bc	10.93ab	10.31abc
	Severe	8.66cd	9.62bc	9.56bc	12.01a	8.55cd	7.31d	8.48cd

* Treatment means within lines followed by the same letter are not statistically different at the 5 % level.

Mn contents were most influenced and decreased by application of SEQ. This is consistent with findings of Wikoff and Moroghan (1986), who indicated that Mn content of flax was greatly reduced by SEQ. On the other hand, Başar and Özgümüş (1997) reported that SEQ significantly reduced leaf Mn contents and Mn content of leaves was negatively correlated with active iron (r = -0.282**) and not correlated with the total iron contents of leaves. All those results pointed that Mn concentration in leaves would be considered as an indicator related to occurance and incidence of chlorosis in peach trees.

CONCLUSIONS

The results clearly show that Fe-EDDHA is the most effective compound in correcting chlorosis among all treatments examined in this experiment. However, slight effects of coated iron mixture, Prototype II and Iron sulphate-

Sulphure mixture were determined in alleviating of iron chlorosis. Although, Iron sulphate-sulphure mixture did not correct chlorosis successfully, application of slightly effective treatments accompanying other cultural practices should be considered for economically solving chlorosis problems.

Effects of the treatments on nutrient uptake were much evident in P and Mn levels. Especially, there was a significantly adverse relationship between Fe applied as Fe-EDDHA (SEQ) and Mn concentrations in leaves. This relationship may be attribute to an example of antogonism between Fe and Mn.

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