Iron Induced Manganese Deficiency in 'July Elberta' Peach Trees[1]

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Abstract. Sodium ferric ethylenediamine di-(o-hydroxphenylacetate) at 113.4 g per tree depressed the concn of Mn, Zn, P, K, and N in 'July Elberta' peach leaves and reduced Fe chlorosis. At 226.8 g, the chelate increased the concn of Fe; depressed the concn of Mn, Zn, and K; and reduced Fe chlorosis in the leaves. The Mn-Fe ratio remained essentially the same in the leaves as the season progressed where no fertilizer was applied; whereas, the 226.8 g rate of $FeNa_2$-EDDHA reduced the ratio. There were no discernable treatment effects on trunk and shoot growth.

Shive et al. (4, 6, 7) and Twyman (9, 10) reported that high levels of Mn depressed Fe absorption from nutrient solutions and thereby lowered the levels of water-soluble Fe in plant tissue. High levels of Fe likewise depressed absorption of Mn from nutrient solutions and reduced the level of water-soluble Mn in plant tissue, although to a much lesser degree than the effects of Mn on Fe (11). These results were obtained in greenhouses. Kochan (2) treated peach trees with $FeNa_2$-EDDHA[3] and prevented Fe chlorosis but observed mild foliar symptoms of Mn deficiency.

Previous work by the present author (3) indicated that $FeNa_2$-EDDHA at 56, 113, and 226 g plus 1620 g $(NH_4)_2SO_4$ per tree depressed the concn of Mn in bearing 'Sungold' peach trees. My present purposes were to study effects of 2 rates of Fe chelate on levels of Fe, Mn, Zn, N, P, and K in the leaves; leaf color; trunk and shoot growth; and Fe-Mn relation by month (June, July, August, and September) of 'July Elberta' peaches in the field in western Colorado.

Materials and Methods

Three treatments were applied to a mesa clay loam soil on single tree plots replicated 8 times in a randomized block design: 1) control-no fertilizer; 2) 113.4 g of $FeNa_2$-EDDHA; 3) 226.8 g of $FeNa_2$-EDDHA. Chelated Fe was applied, in October 1967 and in April 1968 and 1969, along 2 irrigation furrows on either side of the trees and covered with 1 to 2 inches of soil.

Samples of 100 leaves per tree were taken from the middle of terminal shoots in June, July, August, and September. Leaf-N was determined by the Kjeldahl method; and Fe, Zn, and Mn, by atomic absorption spectroscopy. Phosphorus was determined with a Bausch and Lomb Spectronic 20 Spectrophotometer (venadomolybdophosphoric yellow method); and K, by a Beckman DU with a flame attachment. Leaf color was measured as described in previous work (3). Trunk and shoot growth was measured in cm and the analysis of variance was calculated according to the methods of Snedecor (5).

Results and Discussion

Effects of 2 rates of $FeNa_2$-EDDHA on mineral content of leaves, leaf color, trunk growth, and shoot growth; and on Fe-Mn relationship by month (June, July, August, and September) of 'July Elberta' peach trees are shown in Figs. 1 through 4 and Tables 1 through 4.

Iron. The high rate of Fe chelate increased the Fe concn in peach leaves when compared to the low rate or to the non-fertilized trees. The Fe concn of peach leaves treated with the 226.8 or 113.4 g rate decreased significantly as the season progressed. The non-fertilized trees did not. In a previous study (3) $FeNa_2$-EDDHA at 226 g rate plus 1620 g $(NH_4)_2SO_4$ increased the Fe content of 'Sungold' peach leaves when compared to 56 g or 113 g plus 1620 g of $(NH_4)_2SO_4$. Also in prior studies regression coefficients indicated that for each 56 g of $FeNa_2$-EDDHA applied, the Fe in 'Sungold' peach leaves increased by 3.40 ppm and Mn decreased 2.82 ppm (3).

Manganese. Both rates, 113.4 and 226.8 g of $FeNa_2$-EDDHA, reduced the concn of Mn in peach leaves when compared to the non-fertilized trees. The high rate had a significantly greater depressing effect than the low one. All peach trees that received 226.8 g of $FeNa_2$-EDDHA showed Mn-deficient leaves the first year after treatment, and those that received 113.4 g showed symptoms the second year. A greater number of Mn-deficient leaves could be seen on the peach trees during August and September than during June and July. Epstein and Lilleland (1) found that deficiency symptoms in peach leaves could usually be associated with a Mn content less than 17 ppm. The 2-yr combined analysis showed that the interaction treatments x months for Mn was significant at the 1% level. This was not true for Fe. The Mn:Fe ratio remained essentially the same in the peach leaves as the season progressed where no fertilizer was applied; whereas, the 226.8 g rate of $FeNa_2$-EDDHA reduced it (1:5.47 to 1:10.76). In a previous study $FeNa_2$-EDDHA at 226 g plus 1620 g of $(NH_4)_2SO_4$ spread the Mn:Fe ratio in bearing 'Sungold' peach tree leaves from 1:2.86 in non-fertilized trees to 1:6.43 in trees treated with 226 g $FeNa_2$-EDDHA plus 1620 g of $(NH_4)_2SO_4$ (3).

Zinc. $FeNa_2$-EDDHA at 113.4 g and 226.8 g depressed the concn of Zn in the peach leaves when compared to no fertilizer.

Nitrogen. $FeNa_2$-EDDHA at 113.4 g reduced N when compared to the 226.8 g rate and no fertilizer.

Phosphorus. $FeNa_2$-EDDHA at 113.4 g reduced the concn of P in the peach leaves when compared to the 226.8 g rate and no fertilizer.

Potassium. The concn of K in the peach leaves was significantly and equally depressed by 113.4 or 226.8 g of $FeNa_2$-EDDHA when compared to no fertilizer.

Color of leaves. Both rates of $FeNa_2$-EDDHA reduced Fe chlorosis significantly (Table 2). Iron chlorosis is a serious problem in western Colorado orchards. In prior work regression coefficients showed that the luminous reflectance of leaves was lowered .22 with each 56 g of $FeNa_2$-EDDHA and the yellow color reduced by .28 in 'Sungold' peach trees (3). Previous work

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[3]Ethylenediamine di-(o-hydroxphenylacetate) containing 8.5% iron expressed as Fe.

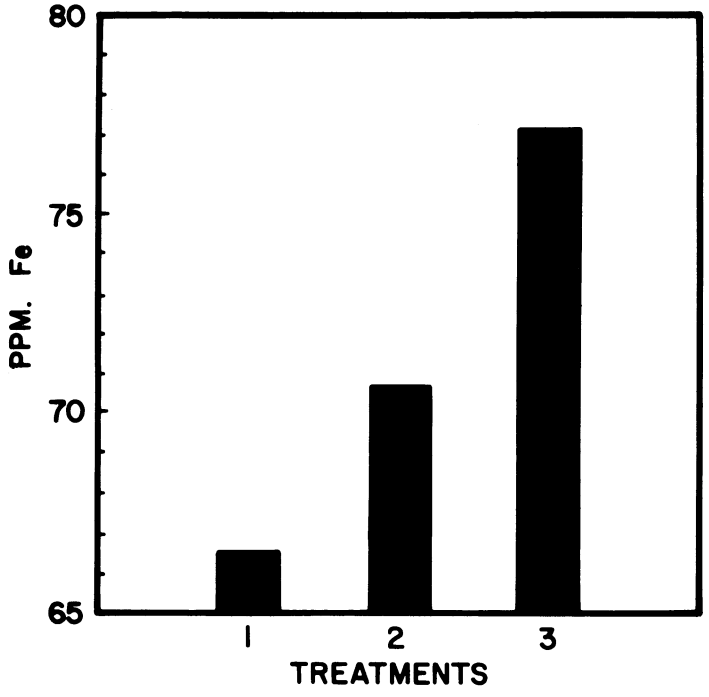

Fig. 1. Two-yr (1968-1969) effects of 2 rates of $FeNa_2$-EDDHA on concn of Fe in 'July Elberta' peach leaves. The 3 treatments were: 1) no fertilizer, 2) 113.4 g $FeNa_2$-EDDHA, and 3) 226.8 g $FeNa_2$-EDDHA. See Table 1 for statistical significance.

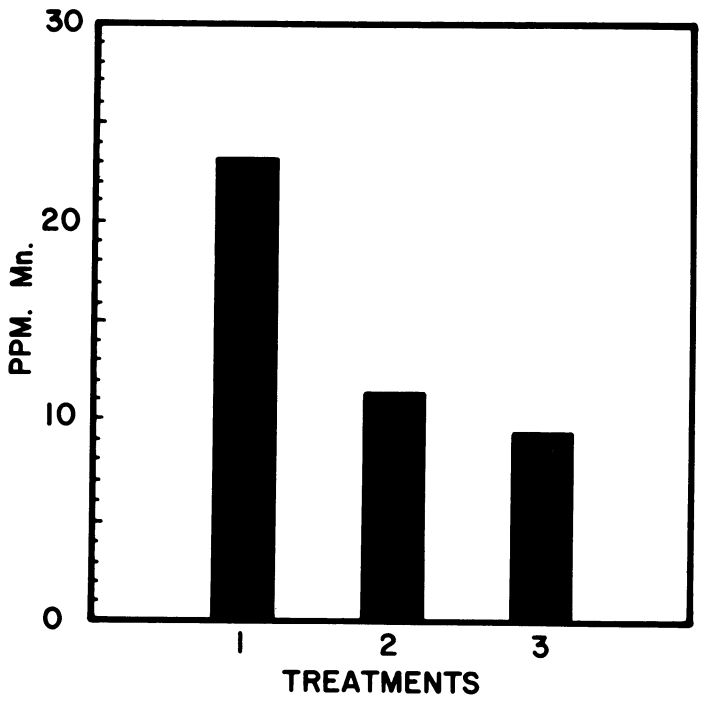

Fig. 2. Two-yr (1968-1969) effects of 2 rates of $FeNa_2$-EDDHA on concn of Mn in 'July Elberta' peach leaves. The 3 treatments were: 1) no fertilizer, 2) 113.4 g $FeNa_2$-EDDHA, and 3) 226.8 g $FeNa_2$-EDDHA. See Table 1 for statistical significance.

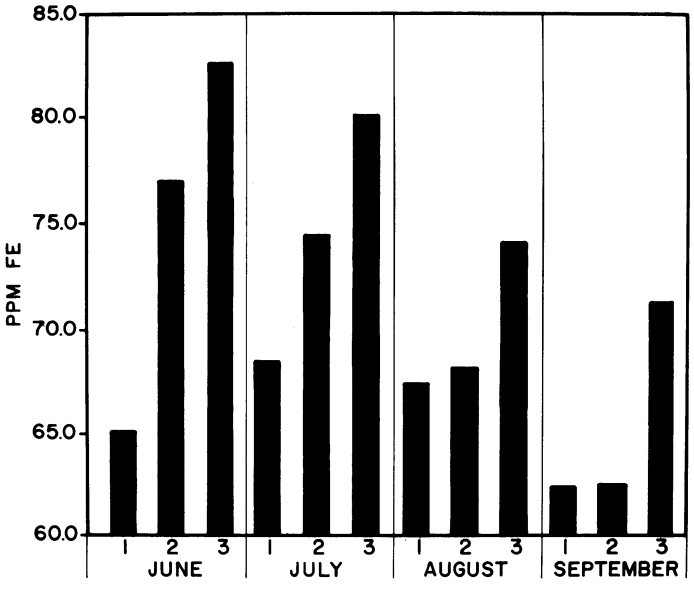

Fig. 3. Two-yr (1968-1969) effects of 2 rates of $FeNa_2$-EDDHA on concn of Fe by month in 'July Elberta' peach leaves. The treatments were: 1) no fertilizer, 2) 113.4 g $FeNa_2$-EDDHA, and 3) 226.8 g $FeNa_2$-EDDHA. See Table 1 for statistical significance.

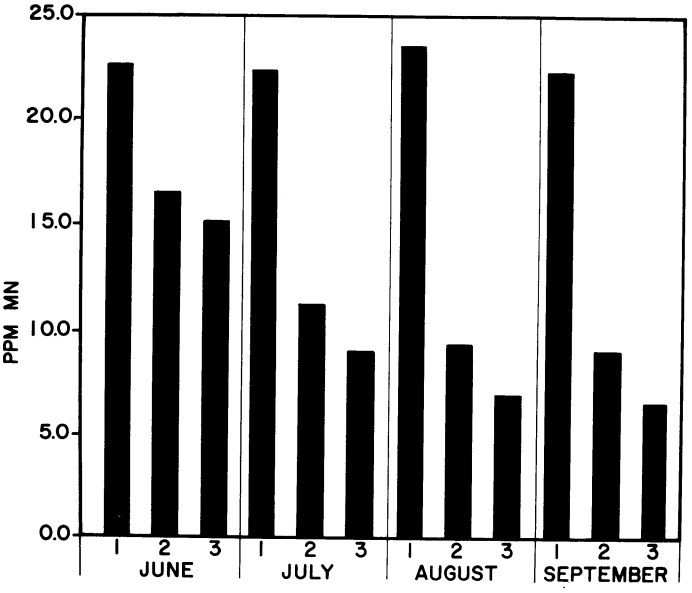

Fig. 4. Two-yr (1968-1969) effects of 2 rates of $FeNa_2$-EDDHA on concn of Mn by month in 'July Elberta' peach leaves. The 3 treatments were: 1) no fertilizer, 2) 113.4 g $FeNa_2$-EDDHA, and 3) 226.8 g $FeNa_2$-EDDHA. See Table 1 for statistical significance.

Table 1. Comparative analysis of 2-yr (1968-1969) data on the effects of 2 rates of $FeNa_2$-EDDHA on the percentages of N, P, K, ppm Zn, Fe, and Mn in 'July Elberta' peach leaves.

Compared treatments	Nutrient content of leaves N	P	K	Zn	Fe	Mn
113.4 g $FeNa_2$-EDDHA	3.19**	.147**	1.77**	17.42*	70.63	11.54**
A. vs.	vs.	vs.	vs.	vs.	vs.	vs.
None (control)	3.32	.165	2.15	19.31	66.53	21.11
226.8 g $FeNa_2$-EDDHA	3.29**	.159	1.86**	17.46*	77.15**	9.46**
B. vs.	vs.	vs.	vs.	vs.	vs.	vs.
None (control)	3.32	.165	2.15	19.31	66.53	23.11
113.4 g $FeNa_2$-EDDHA	3.19**	.147**	1.77	17.42	70.63**	11.54**
C. vs.	vs.	vs.	vs.	vs.	vs.	vs.
226.8 g $FeNa_2$-EDDHA	3.29	.159	1.86	17.46	77.15	9.46

*Significant at the 5% level.
**At the 1% level.

Table 2. Comparative analysis of 2-yr (1968-1969) data on the effects of 2 rates of $FeNa_2$-EDDHA on leaf color, shoot and trunk growth of 'July Elberta' peach.

Compared treatments	Rd[z]	"a" Green	"b" Yellow	Shoot growth length cms	Trunk growth 1969 Area cm^2
113.4 g $FeNa_2$-EDDHA	23.48**	23.91**	9.95**	42.41	107.72
A. vs.	vs.	vs.	vs.	vs.	vs.
None (control)	26.35	25.75	13.03	44.80	113.79
226.8 g $FeNa_2$-EDDHA	23.14**	23.65**	9.79**	44.96	114.20
B. vs.	vs.	vs.	vs.	vs.	vs.
None (control)	26.35	25.75	13.03	44.80	113.79
113.4 g $FeNa_2$-EDDHA	23.48*	23.91	9.95	42.41	107.72
C. vs.	vs.	vs.	vs.	vs.	vs.
226.8 g $FeNa_2$-EDDHA	23.14	23.65	9.79	44.96	114.20

*Significant at the 5% level.
**At the 1% level.
[z]Rd-luminous reflectance. The lower the number, the greener the leaf.

Table 3. Two yr (1968-1969) effects of 2 rates of $FeNa_2$-EDDHA on the Mn:Fe ratio in 'July Elberta' peach trees.

Treatments	June	July	August	September	Combined
1. Control - no fertilizer	1:2.85	1:3.07	1:2.87	1:2.78	1:2.88
2. 113.4 g of $FeNa_2$-EDDHA	1:4.66	1:6.60	1:7.16	1:6.84	1:6.12
3. 226.8 g of $FeNa_2$-EDDHA	1:5.47	1:8.86	1:10.53	1:10.76	1:8.15

Table 4. Comparative analysis of 2-yr (1968-1969) data on the effects of 2 rates of $FeNa_2$-EDDHA on ppm Mn and Fe in 'July Elberta' peach leaves.

Compared treatments	June Mn	June Fe	July Mn	July Fe	August Mn	August Fe	September Mn	September Fe
113.4 g $FeNa_2$-EDDHA	16.56**	77.16**	11.29**	74.49**	9.54**	68.29	9.15**	62.57
A. vs.	vs.	vs.	vs.	vs.	vs.	vs.	vs.	vs.
None (control)	22.87	65.12	22.26	68.32	23.59	67.66	22.46	62.50
226.8 g $FeNa_2$-EDDHA	15.10**	82.67*	9.04**	80.13**	7.05**	74.26*	6.65**	71.55*
B. vs.	vs.	vs.	vs.	vs.	vs.	vs.	vs.	vs.
None (control)	22.87	65.12	22.26	68.32	23.59	67.66	22.46	62.50
113.4 g $FeNa_2$-EDDHA	16.56*	77.16**	11.29**	74.49**	9.54**	68.29**	9.15**	62.57**
C. vs.	vs.	vs.	vs.	vs.	vs.	vs.	vs.	vs.
226.8 g $FeNa_2$-EDDHA	15.10	82.67	9.04	80.13	7.05	74.26	6.65	71.55

*Significant at the 5% level.
**At the 1% level.

showed that $FeNa_2$-EDDHA at 56, 113, or 226 g plus 1620 g $(NH_4)_2SO_4$ corrected Fe chlorosis in 'Sungold' peach trees (3). Stebbins (8) noted that the yellow color and luminous reflectance of 'Elberta' peach leaves were lowered if trees received 2.0 lb. N as ammonium sulfate plus 1/2 lb. $FeNa_2$-EDDHA.

Shoot growth. In 1969, $FeNa_2$-EDDHA at 113.4 and 226.8 g increased shoot growth when compared to no fertilizer. Neither the 2-yr combined analysis nor the 1968 data showed significant difference between treatments (Table 2).

Trunk growth. The treatments had no significant effect on trunk growth.

$FeNa_2$-EDDHA will correct lime-induced Fe chlorosis in 'Sungold' peach trees but its overuse induces Mn deficiency (3). This study suggests that 'July Elberta' peaches are more susceptible to $FeNa_2$-EDDHA induced Mn deficiency than 'Sungold'. Also, the Mn:Fe ratio changes through the growing season where $FeNa_2$-EDDHA is applied. Future work should determine the amount of $FeNa_2$-EDDHA needed to overcome Fe chlorosis in peach trees without inducing Mn deficiency and the appropriate amounts of Mn needed to overcome Mn deficiency induced by application of $FeNa_2$-EDDHA.

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Extension of Vase-Life of Cut Flowers by Use of Isoascorbate - Containing Preservative Solutions[1,2]

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Abstract. A floral preservative solution containing iso-ascorbic acid, 100 ppm, sucrose, 4%, and 8-hydroxyquinoline sulfate, 50 ppm, extended cut rose life and was equal to other preservative formulations for carnations and snapdragons. Biochemical and other changes in rose petals resulting from the use of this preservative solution are described.

The extension of cut flower vase-life and improved post harvest development and maintenance is of great economic importance. Accomplishing this depends on post harvest cut flower handling and a preservative solution ensuring an ample supply of water, metabolites, and regulatory substances to petals and leaves. Various aqueous solutions of chemical compounds have been compared (4, 7, 8, 13, 18, 22, 23, 24, 38).

Our purpose was to develop a preservative solution better than those now used. This was done and the relevant flower changes including the composition and physical properties of rose petals were compared for roses kept in this and other solutions.

Materials and Methods

Blooms of roses, *Rosa hybrida* L. 'Forever Yours', 'Better Times', 'Baccara' and 'Regal Gold', carnation, *Dianthus caryophyllus* L. 'Cardinal Sim' and 'Improved White Sim', and snapdragons, *Anthirrhinum majus* L. 'Pennsylvania' were cut from greenhouse-grown plants managed according to standard cultural practices (19). 'Forever Yours' was used in most of the histological and biochemical experiments. The longevity of cut flowers was used to compare the efficiency of each preservative solution or their components. Roses (45 cm long stem), carnations, and snapdragons were kept in the test solutions in a controlled environment room under fluorescent illumination (0.5 lux/cm^2), at 27°C, and 60% relative humidity.

Longevity was the number of days from cutting, when the first 2 or 3 petals of rose were unfolding, to petal drop or when "bent neck" developed. Carnations were discarded when the blooms lost color or became "sleepy" and snapdragons when half of the florets lost their crisp appearance and color. Experiments were repeated at least 4 times during fall and early winter months, using 10 blooms per treatment each time.

The aqueous solutions of the floral preservative mixtures or their ingredients, selected from preliminary experiments, were: 50 ppm 8-hydroxyquinoline sulfate (8-HQS); 100 ppm Na iso-ascorbate (Na-isoAA); 4% sucrose; "Cornell" solution (5% sucrose + 200 ppm 8-HQS + 50 ppm silver acetate); and the complete mixture (4% sucrose + 50 ppm 8-HQS + 100 ppm Na-isoAA), designated the "Ottawa" solution. The pH of this solution was 4.8 using distilled water.

Various concn of aqueous Na-isoAA or 8-HQS were compared for water uptake and inhibition of plugging of xylem in rose. Tests were conducted by placing 15 cm long stem sections, cut 3 cm below the apical bud and each bearing a single 5-leaflet leaf, in solutions. The sections were equilibrated for 24 hr in a growth room at conditions previously described and were weighed and re-weighed after a further 24 hr. Any change in fresh wt, differing from that of the water control, was

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