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Effect of Zinc and Iron on the Chlorosis of Mandarin*

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ABSTRACT

The effect of the foliar sprays of $ZnSO_4$ and $FeSO_4$ at three concentration viz., 0.5, 0.75 and 1.0 per cent given twice in the year in April and September was studied on the Kinnow mandarin at the Haryana Agricultural University, Hissar. Reduction of chlorosis was more with 1.0 per cent $ZnSO_4$ and 0.5 per cent $FeSO_4$. Reduction in chlorosis was more after April spray and less after September spray. After initial reduction following the spray, the chlorosis increased in both the seasons but in March there was again a reduction in chlorosis which was very marked in sprayed trees than the control trees.

The correction of chlorosis was more with zinc than with iron. It is recommended that two sprays of 1.0 per cent $ZnSO_4$ would be beneficial for Kinnow mandarin trees.

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INTRODUCTION

Kinnow mandarin, a hybrid between King and Willow Leaf is being grown on a commercial scale in Haryana. One of the maladies affecting Kinnow, as in other citrus crops, is chlorosis characterised by interveinal yellowing of leaves. The soils in the Haryana and Punjab are alkaline and calcareous and availabilities of zinc and iron are low. Deficiency of zinc is most wide-spread and it is closely followed by iron (Kanwar and Randhawa, 1967).

Several workers have observed marked recoveries from the chlorosis in different citrus species through the foliar applications, of zinc and iron. Bhatt (1945) corrected die-back associated citrus chlorosis with the sprays of zinc and ferrous sulphate. Som Dutt (1962) and Prithvipal Singh (1963) observed that 0.8 and 1.0 per cent zinc sulphate sprays and 0.4 and 0.6 per cent ferrous sulphate sprays were more effective in reducing the chlorosis in Blood Red Sweet Orange. Aiyappa *et al.* (1968 and 1968a) observed significant effects of foliar sprays of zinc in reduction of chlorosis in Coorg mandarin-seedling trees and mandarin-orange trees. Dube and Saxena (1971) observed that chlorosis of orange leaves was completely corrected by four sprays of $ZnSO_4$ (0.5 per cent) and Zn-EDTA (0.25 per cent).

The fact that the citrus chlorosis could be corrected with zinc and iron sprays establishes that it is mainly due to the deficiency of these elements. The study was undertaken mainly for assess-

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ing the effect of sprays of three concentrations each of zinc and ferrous sulphates during two flushes of the year in April and September, on Kinnow mandarin orange trees.

MATERIALS AND METHODS

The present study was carried out at the experimental Orchard of the Department of Horticulture, Haryana Agricultural University, Hissar, during the year 1975-76 on eight year-old fruit bearing Kinnow trees raised on Jatti Khatti (*Citrus jambhiri* Lush) rootstock. The soil of the experimental orchard was analysed. The data on the chemical analysis of the soil are given in Table 1.

TABLE 1

Chemical analysis of the soil profile.

Depth (cm)	*Available nutrients (ppm)*					*pH (1 : 2)*	*E.C. (1 : 2) (m.mhos/cm)*
	N	*P*	*K*	*D.T.P.A. extractable*			
				Zn	*Fe*		
0–15	140.7	21.1	121.2	0.46	4.8	8.4	0.15
15–30	139.3	12.8	108.5	0.32	4.5	8.5	0.23
30–45	130.7	10.6	76.5	0.21	3.9	8.3	0.37
45–60	90.7	7.2	62.9	0.09	3.0	8.4	0.38
60–75	54.3	4.3	53.2	0.17	2.9	8.5	0.43
75–90	47.0	2.6	46.5	0.16	2.3	8.6	0.40

The experiment was laid out according to Randomized Block Design. Twentyone Kinnow trees of uniform growth and vigour were selected. The treatments were replicated three times, keeping one tree as a unit. The treatments were as under:

1. $ZnSO_4$ 0.5, 0.75 and 1.00%
2. $FeSO_4$ 0.5, 0.75 and 1.00%
3. Control (Water spray only).

Both the compounds, viz., $ZnSO_4$ and $FeSO_4$ were sprayed in aqueous form using fresh solution at each spray. To each solution a quantity of hydrated lime equal to half the quantity of the compound was added. Ten litres of the spray solutions were sprayed on each tree.

First spray was applied in the month of April and the second spray was applied in the month of September which coincide with spring and autumn flushes of growth respectively.

In order to study the efficacy of the spray treatments in the correction of chlorosis, ten uniform one year old shoots were selected on all the sides of the tree before each spray, the number of healthy and chlorotic leaves was counted on the selected shoots to work out the percentage of chlorosis. Similar observations were recorded one month after each spray and at the end of each growth flush.

RESULTS AND DISCUSSION

The results of the effect of zinc and iron sprays on the intensity of chlorosis are presented in Tables 2 and 3. The data reveal that one month after the

TABLE 2

Effect of foliar sprays of zinc and iron on the incidence of chlorosis-spray-I.

Sr. No.	*Treatments*	*Mean per cent chlorosis*						
		Before spray-I (April 25, 1975)		*After spray (May 28, 1975)*	*Mean increase/decrease (May 28, 1975)*		*August 27, 1975*	*Mean increase (August 27, 1975)*
1.	$ZnSO_4$ 0.5%	15.51	(23.15)	3.48	−12.03	(−12.48)	19.66	4.15 (3.12)
2.	$ZnSO_4$ 0.75%	18.04	(25.05)	4.73	−13.31	(−12.58)	20.78	2.74 (1.99)
3.	$ZnSO_4$ 1.0%	17.32	(24.55)	1.73	−15.59	(−17.08)	18.53	1.21 (0.91)
4.	$FeSO_4$ 0.5%	17.77	(24.95)	6.36	−11.41	(−10.36)	20.91	3.14 (2.26)
5.	$FeSO_4$ 0.75%	16.84	(24.18)	7.14	−9.70	(−8.71)	23.09	6.25 (4.50)
6.	$FeSO_4$ 1.0%	17.00	(24.28)	11.64	−5.36	(−4.44)	25.41	8.41 (5.94)
7.	Control (Water spray only)	16.01	(23.56)	17.23	−1.22	(−0.92)	31.40	15.39 (10.49)
	C.D. at 5%		N.S.			1.68		1.92
	C.V.%		7.33			10.22		25.94

Figures in parentheses indicate angular transformation.

TABLE 3

Effect of foliar sprays of zinc and iron on the incidence of chlorosis spray-II.

Sr. No.	Treatments	Mean Per Cent Chlorosis									
		Before spray-II (September 21, 1975)		*After spray (Octo, 21, 1975)*	*Mean increase/ decrease (October 21, 1975)*		*Nov. 21, 1975*	*Mean increase (Nov. 21, 1975)*		*March, 21, 1976*	*Mean increase/ decrease (March 21, 1976)*	
1.	$ZnSO_4$ 0.5%	20.90	(27.14)	12.49	–8.41	(–6.62)	37.27	16.37	(10.42)	14.28	–6.62	(–4.97)
2.	$ZnSO_4$ 0.75%	21.64	(27.73)	12.07	–9.57	(–7.57)	36.31	14.67	(9.28)	14.45	–7.19	(–5.45)
3.	$ZnSO_4$ 1.0%	18.83	(25.67)	5.88	–12.95	(–11.77)	29.05	10.22	(6.90)	10.21	–8.62	(–7.09)
4.	$FeSO_4$ 0.5%	22.58	(28.33)	13.37	–9.21	(–7.02)	42.24	19.66	(12.08)	16.62	–5.96	(–4.29)
5.	$FeSO_4$ 0.75%	25.38	(30.22)	18.40	–6.98	(–4.89)	48.31	22.93	(13.69)	21.09	–4.29	(–2.88)
6.	$FeSO_4$ 1.0%	28.27	(32.10)	23.87	–4.40	(–2.95)	59.45	31.18	(18.36)	25.62	–2.65	(–1.69)
7.	Control (Water spray only)	34.70	(36.00)	49.96	–15.26	(8.96)	72.08	37.38	(22.44)	74.26	31.56	(–3.63)
	C.D. at 5%		2.92			3.12			7.62			4.26
	C.V. %		5.53			38.60			32.19			6.11

Figures in parentheses indicate angular transformation.

April spray i.e. in May, all the zinc and iron treatments resulted in a significant decrease in the initial level of chlorosis in comparison to control wherein intensity of chlorosis increased consistently. Zinc sulphate at 1.0 per cent concentration showed significant reduction (-15-59 per cent) of chlorosis and registered only 1.73 per cent chlorosis as against 17.23 per cent in control. The chlorosis in sprayed trees was less than in unsprayed trees even in August but it was higher than the level of chlorosis in May after the April spray which could be due to increased demand of Fe and Zn by new flush and developing fruits. The effect of the spray was obviously transitory and wore out in course of time, the extent of wearing out being more with dilute sprays of zinc sulphate (Table 2).

The analysis of leaves for Zn and Fe in September, five months after the spring spray and before the September spray (Table 4) also reveals that the concentrations of Fe and Zn are higher in 1.0 per cent sprayed trees than those sprayed with lower concentrations. Nevertheless, the concentration of 19.3 ppm is less than the minimum value of 25 ppm suggested by Chapman (1961) of Zn, which underlines the need for repetition of spray. With iron sprays, it was 0.5 per cent which gave less incidence of chlorosis in August than higher concentrations. The $FeSO_4$ sprays at 0.5 per cent were more effective among iron treatments. Similar observations were made by Prithvipal Singh (1963) and Chitkara and Bhambota (1971) with $FeSO_4$ sprays at 0.6 per cent. Dekock (1955 and 1956) has shown that the manifestation of iron chlorosis depends on the relative amounts of Fe and P absorbed by the plant. This was also shown to correlate well with Ca/K ratios in lime-induced chlorosis. It was also shown by Radiske and Biddulph (1953) that with the same amount of Fe in culture solution, increase of phosphorus levels and pH caused chlorosis. They also reported that the mobility of injected iron was best at low concentration. The fixation of absorbed iron in sprayed leaves and the intolerance to higher concentration was also reported by Kanwar and Randhawa (1960). It is seen that leaf levels in September are in the higher range even with 0.5 per cent spray and pass on into the excess range with 0.75 per cent and 1.0 per cent [As suggested by Smith (1966) leaves containing (i) less than 35 ppm were rated to be deficient, (ii) 35 to 49 ppm low, (iii) 50 to 120 ppm optimum, (iv) 130 to 200 ppm high and (v) more than 250 ppm in excess range]. Manchanda (1967) and Manchanda *et al.* (1972) had even observed increased chlorosis with application of iron. The better results with lower concentration of iron sprays are, therefore, dependent on a complexity of several features (Table 4).

TABLE 4

Effect of foliar sprays of zinc and iron on their levels in Kinnow leaves.

Sr. No.	*Treatments*		*Zn (ppm)*	*Fe (ppm)*
1.	$ZnSO_4$	0.5%	16.3	110.0
2.	$ZnSO_4$	0.75%	17.7	103.3
3.	$ZnSO_4$	1.0%	19.3	108.3
4.	$FeSO_4$	0.5%	10.7	171.7
5.	$FeSO_4$	0.75%	10.3	186.6
6.	$FeSO_4$	1.0%	11.0	238.3
7.	Control (water spray only)		10.3	120.0
	C.D. at 5%		2.8	65.4
	C.V.%		11.72	24.79

It is evident from the data for the second spray (Table 3) that one month after the second spray i.e. in October, the results indicated a similar trend as

was observed one month after the first spray though the reduction in incidence of chlorosis was not so much as in May. But during November, the intensity of chlorosis increased in both sprayed and unsprayed trees, however, the treatments ($ZnSO_4$ at 1.0 per cent and $FeSO_4$ at 0.5 per cent) maintained their superiority over cotnrol. The increased chlorosis in November could be attributed to low temperature wnich creates quiescent metabolic conditions which might reduce the uptake and translocation of minerals leading to a higher degree of chlorotic condition in the plant. Aiyappa *et al.* (1968 a) reported that a plant under stress developed more chloiosis from November to February in Coorg mandarins which may be true of the rainfed trees. Further, under the low temperature the plants were relatively inactive to make full use of zinc.

During March, 1976, a significant reduction in chlorosis was again noticed in all the treated trees over control wherein it increased consistently. The maximum reduction was observed in 1.0 per cent $ZnSO_4$ (-8.62 per cent) and 0.5 per cent $FeSO_4$ (-5.96 per cent) treatments in their respective groups.

Similar reduction in chlorosis with the commencement of spring growth has been noted in the studies of Prithvipal Singh (1963), Som Dutt and Bhambota (1967) and Chitkara and Bhambota (1971). Since a comparable improvement is absent in control trees, it suggests that the zinc and iron of the autumn spray held unused in the older leaves is utilized by the new flush which is healthy without chlorosis.

Comparatively lesser improvement of chlorosis resulted from the September spray than that of spring spray. The greater efficacy of spring spray has been reported by many workers (Malan, 1946; Heymann-Herschberg, 1956; Kanwar and Dhingra, 1961 and Chitkara and Bhambota, 1971). The superiority of spring over autumn spray in correcting chlorosis noted in this study may be because of the probably higher requirements of developing fruits in autumn which might be causing a severe deficiency in the leaves. It needs to be investigated whether application of higher concentration of zinc in the autumn spray helps or not.

In the present investigations, $ZnSO_4$ at 1.0 per cent was the most effective treatment in correcting the chlorosis. These observations are in conformity with the earlier findings of Benton (1937), Malan (1946), Chowdhury (1954), Heymann-Herschberg (1956), Prithvipal Singh (1963) and Som Dutt and Bhambota (1967) who also obtained similar response with 1.0 per cent $ZnSO_4$ sprays in relation to chlorosis.

It was seen that the response to zinc was more than iron in the present study. This has been mainly due to the fact that available zinc was low in the experimental field (less than 0.5 ppm, Grewal *et al.* 1968) whereas iron was 4.5 ppm in the top soil which is not in the deficient range.

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REFERENCES

Aiyappa, K. M., K. C. Srivastava and K. M. Bojappa 1968 a. Effect of foliar sprays of micronutrients on *Citrus reticulata* Swingle (Mandarin-orange trees) under irrigation and non-irrigation regimes. *Indian J. Hort.* **25** : 1-15.

Aiyappa, K. M., K. C. Srivastava; K. M. Bojappa and U. V. Sulladmath 1968. Studies on the effect of micronutrient sprays singly and in various combinations on *Citrus reticulata* Blanco (Coorg Mandarin-seedling trees). *Indian J. Hort.* **25** : 104-115.

Benton, R. J. 1937. Mottle-leaf of citrus trees control by zinc sulphate sprays demonstrated. *Agric. Gaz. N.S.W.* **58** : 57-72, 580.

Bhatt, S. S. 1945. The die-back disease of citrus trees. *Indian Fmg.*, **6** : 250-253.

Chapman, H. D. 1961. The status of present criteria for the diagnosis of nutrient conditions in citrus. *Plant analysis and fertilizer problems.* Amer. Instt. Bio. Sci. Publn. Washington. **3** : 454.

Chitkara, S. D. and J. R. Bhambota 1971. Effect of different concentrations of iron sprays on the incidence of chlorosis in sweet orange (*Citrus sinensis*). *Indian J. Hort.* **28** : 16-21.

Chowdhury, S. 1954. Deficiency diseases of citrus in Assam, India. *F.A.O. Plant Prot. Bull.* **2** : 151-153.

Dekock, P. C. 1955. Iron nutrition of plants at high pH. *Soil Science*, **79** : 167-175.

Dekock, P. C. 1956. *Ann. Botany* (London), **20** : 133-141.

Dube, S. D. and H. K. Saxena 1971. Effectiveness of zinc chelate (Zn-EDTA) Vs. Zinc sulphate ($ZnSO_4$) in orange (*Citrus sinensis* Osbeck). *Punjab Hort. J.*, **11** : 246-250.

Grewal, J. S., N. S. Randhawa and D. R. Bhumbla 1968. Correlation of soil test with response to the application of zinc to wheat. *J. Indian Soc. Soil Sci.*, **6** : 97-102.

Heymann-Herschberg, L. 1956. Effect of combined zinc and sulphur application on orange trees. *Ktavin*, **6** : 83-89.

Kanwar, J. S. and D. R. Dhingra 1961. Chlorosis of citrus in Punjab. *Punjab Hort. J.*, **1** : 92-95.

Kanwar, J. S. and N. S. Randhawa 1960. Probable causes of chlorosis of citrus in the Punjab. *Hort. Adv.* **4** : 61-67.

Kanwar, J. S. and N. S. Randhawa 1967. Micronutrient research in soil and plants in India–a review. I.C.A.R., New Delhi.

Malan, P. F. 1946. Spring citrus trees for mineral deficiencies. *Fmg. S. Afr.* **21** : 8-18.

Manchanda, H. R. 1967. Effect of different micronutrient sprays on chlorosis, granulation, fruit fall, yield and fruit quality of sweet orange. Var. Blood Red. *J. Res. Punjab Agric. Univ.*, **4** : 508-515.

Manchanda, H. R., U. C. Shukla and N. S. Randhawa 1972. Effect of soil and foliar applications of Zn and foliar applications of Cu, Mn, Fe alone and in combination with Zn on the incidence of chlorosis, fruitfall, granulation and fruit quality in sweet orange var. Blood Red. *Indian J. Hort.* **29** : 19-29.

Prithvipal Singh 1963. Effect of different schedules and varying concentrations of zinc and iron sprays on the incidence of chlorosis in citrus (*C. sinensis* Osbeck). M.Sc. Thesis submitted to P.A.U., Ludhiana.

Rediske, J. H. and O. Biddulph 1953. The absorption and translocation of iron. *Pl. Physiol.* **28** : 576-593.

Smith, P. F. 1966. Temperate to Tropical Fruit Nutrition (Ed. Childers, N.F.). Somerset Press New Jersey, pp. 207-228.

Som Dutt, 1962. Effect of micronutrients on chlorosis, vigour, yield and quality of sweet orange. M.Sc. Thesis submitted to Punjab University, Chandigarh.

Som Dutt and J. R. Bhambota 1967. Effect of different concentrations of zinc on the incidence of chlorosis in sweet orange (*Citrus Sinensis*) *Indian J. Hort.* **24** : 50-59.