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CORRECTION OF IRON CHLOROSIS OF AVOCADOS GROWING IN CALCAREOUS SOILS

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Iron chlorosis of avocados growing under calcareous conditions is not unusual in the Homestead area; however, the problem has become more critical during the last 4-5 years due to its increased severity and widespread occurrence. The reasons for this are not clearly understood. Chlorosis seems to be a cyclic condition, which increases in severity during dry seasons and disappears or becomes less pronounced during periods of abundant rainfall.

Efforts to correct iron chlorosis in avocados with sprays containing iron have not been entirely successful (3). Chlorotic trees usually have sparse and weak foliage which is very susceptible to injury. Promising spray materials which do not cause discernible damage to chlorotic leaves of limes and other citrus are very phytotoxic when used at the same concentration in avocados. When concentrations are lowered to avoid damage, they no longer produce a noticeable result.

Previous experiments in Rockdale soils with pound applications of iron chelates have shown that Sequestrene 138 (Sodium ferric ethylenediamine di (o-hydroxyphenylacetate) or NaFeEDDHA containing 6% Fe) is the only iron chelate which will correct iron chlorosis in avocados rapidly (2, 3). Reports from other areas on the effectiveness of this ehelate in correcting iron chlorosis in calcareous soils have been contradictory (4, 5, 7). In Florida, due to the cyclic nature of avocado chlorosis and to some unsatisfactory results, the value of iron chelates, including Sequestrene 138, has been questionable (2).

This paper reports work undertaken to reevaluate the performance of Sequestrene 138 and the economic soundness of its use in large scale applications in commercial avocado groves growing on Rockdale soils. Also, Sequestrene 138 was compared with Hampol, (Iron sodium Khanolethylenediamine triacetate or Fe NaEEDT containing 9% Fe) a chelate of undetermined effectiveness in the Homestead area and ferrous sulfate.

MATERIALS AND METHODS

The experiment began on September 13, 1965 in a 25-year-old avocado grove on Rockdale soil. This grove was chosen because of the severity and the uniformity of the chlorosis within the individual varieties. The experiment included the varieties 'Pollock,' 'Lula,' 'Booth 8' and 'Waldin.' 'Lula trees were far more chlorotic than the other varieties (Fig. 1), as has also been observed in other groves. Almost without exception the 'Lula' trees had necrosis of leaf tips and dieback of the twigs in the uppermost branches.

According to the owner the chlorosis s the worst ever observed in this grove. The trees had been under severe drought conditions for several months.

Each treatment consisted of 28 trees in two adjacent rows of 14 trees each, and included four 'Pollock' trees and eight trees each of the 'Lula,' 'Booth 8' and 'Waldin' varieties. Between the treatments there were two untreated rows, which were used as buffers and controls.

A preliminary root survey of a large number of the trees involved in the experiment revealed that all trees sampled contained very few "feeder" roots. The amount of these roots appeared to be inversely correlated with the degree of the chlorosis of each tree. In nearly all cases "feeder" roots were most abundant in the area within two feet of the trunk of each tree. Each material was dissolved in three gallons of water before its application and washed into the soil with approximately 30 gallons of water. The following treatments were compared:

Treatment 1. Sequestrene 138 at 1.0 lb/tree.

Treatment 2. Sequestrene 138 at 0.75 lb/tree.

Treatment 3. Hampol at 3.0 Ibs/tree.

Treatment 4. Hampol at 6.0 lb/tree.

Treatment 5. Ferrous sulfate at 10 lb/tree.

RESULTS

Response to Sequestrene 138 treatments was first seen two weeks after application as a greening of the young chlorotic leaves. After a month the difference between these trees and the controls was quite obvious. After 2%-3 months all leaves on trees treated with 1.0 Ib of Sequestrene 138 had become completely green. Trees which received 0.75 Ib of Sequestrene 138 were somewhat slower in recovering and after three months had not recovered as completely as those receiving 1.0 Ib. All trees treated with Hampol, regardless of dosage, were much slower in recuperating from the chlorosis. However, 6.0 Ib of this chelate were more effective than the lower rate. After three months none of these trees were as green as those which received Sequestrene 138. The 10 Ib treatment of ferrous sulfate was entirely ineffective, and all the trees that received this treatment remained as chlorotic as the controls.

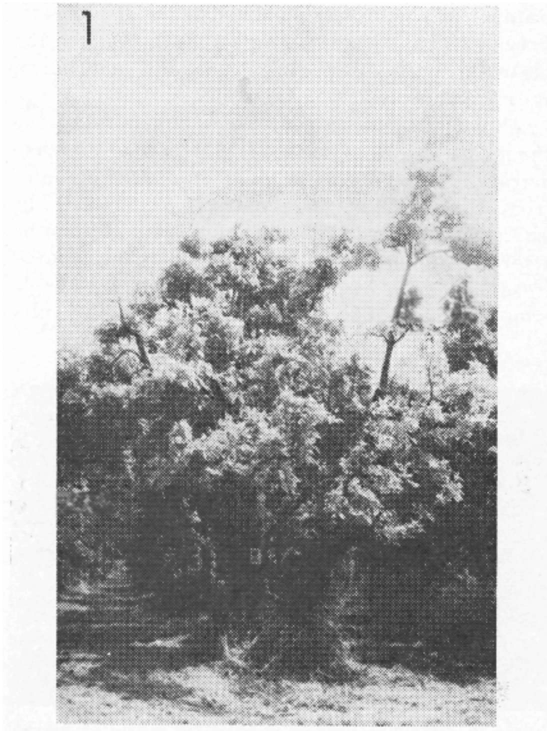

Fig. 1.—Chlorotic 'Lula' avocado trees with severe die back of uppermost branches.

Perhaps the most dramatic difference was noticed during the blooming season in March, six months after the beginning of the experiment. All plants which received 1.0 Ib of Sequestrene 138 bloomed abundantly and set a normal crop of fruit (Fig. 2 and 3). However, blooming and fruit set were less abundant in those trees which received 0.75 Ib of Sequestrene 138 or either rate of Hampol. Six Ib rate of Hampol was definitely superior to the 3.0 Ib rate. Trees which received ferrous sulfate and the controls, with a few exceptions, did not bloom or set any fruit.

In an attempt to evaluate quantitatively the effects of the Sequestrene 138 treatments, spectographic analyses were made of 20-leaf samples from 'Lula' trees and chlorotic controls. The leaf samples were taken in July 1966, 10 months after treatments ware applied, when the treated trees had fully recuperated and had a sizeable crop of fruit (Fig. 4). Table 1 shows results of leaf analyses for 10 essential elements. Except for Fe there were no significant differences in the mineral composition between the chlorotic and Sequestrene 138-treated avocados. Leaves from trees receiving the 1.0 Ib rate of this chelate contained twice as much Fe as the ones receiving the 0.75 Ib rate or the controls.

Fig. 2.—'Lula' tree which received 1.0 lb/tree of Sequestrene 138 (left), and control (right). Fruit is abundant on the treated tree, but is absent from the control.

Fig. 3.—Branches from treated and untreated trees of Fig. 2, showing fruit set and color of leaves.

Fig. 4.—'Booth 8' tree 10 months after treatment with 1.0 lb/tree of Sequestrene 138. Weight of fruit caused considerable limb breakage in some trees.

Table 1. Results of spectrographic analyses of leaf samples from untreated 'Lula' trees and from those receiving 1.0 lb/tree and 0.75 lb/tree of Sequestrene 138.

	Sequestrene 138 1.0 lb/tree 8 trees sampled Range in composition			Sequestrene 138 0.75 lb/tree 7 trees sampled Range in composition			Untreated trees 8 trees sampled Range in composition		
	Low	High	Avg.	Low	High	Avg.	Low	High	Avg.
K%	1.10	1.66	1.29	1.24	1.68	1.39	1.64	2.57	1.83
P%	.18	.22	.20	.20	.25	.21	.19	.24	.21
Ca%	1.50	3.20	2.02	1.54	2.46	1.85	.93	2.17	1.63
Mg%	.29	.57	.39	.30	.44	.37	.24	.44	.34
Mn ppm	32	140	67	45	75	50	45	94	59
Fe ppm	50	93	69	25	46	33	18	57	33
B ppm	30	56	40	27	55	44	33	72	58
Cu ppm	12	17	14	12	16	14	8	15	11
Zn ppm	31	51	39	29	37	32	26	42	32
Mo ppm	.57	1.49	.93	.60	1.22	.88	.29	1.03	.62

DISCUSSION

Sequestrene 138 at the 1.0 lb/tree rate was more effective in correcting the chlorosis and putting the trees back in production, than the highest rate of Hampol. At the current prices 1,0 Ib of Sequestrene 138 cost about $1.00 less than 6.0 Ib of Hampol, and the difference in the capacity to correct chlorosis, under the conditions of the experiment, is greatly in favor of Sequestrene 138. The 0.75 Ib rate of Sequestrene 138 was not as effective in most cases as the 1.0 Ib rate, especially with large trees, but it was more effective than the Hampol treatments. Perhaps this rate or even a lower one would be sufficient to correct a mild chlorosis. Also, it presumably could be used in smaller amounts on small trees or for routine reapplications to larger trees. In Isreal, under somewhat similar conditions of alkalinity to the Homestead soils, routine applications of 1.0 Ib of Sequestrene 138 to correct iron chlorosis in avocados last from two or four years.* We do not have enough experience with this chelate to be able to tell how long its effects will last under our conditions. However, as a result of this experiment several growers have already used Sequestrene 138 in young and mature avocado groves with very good results.

If our observations and conclusions are correct that a severe drought induces chlorosis in "susceptible" trees by destroying a good portion of the feeder roots, then Sequestrene 138 may have to be reapplied whenever this happens. Perhaps this could be avoided by using irrigation in avocado groves during periods of low rainfall.

Several investigators have found that sometimes there are no great differences in iron content between chlorotic and green leaves (1, 2, 6). This is also indicated by results summarized in Table 1. Thus, it appears that leaf iron content is not a very reliable criterion as a quantitative measure for correction of iron chlorosis.

It may also be seen in Table 1 that K/Ca ratio of the chlorotic leaves is higher than that of the green leaves. This unexplained effect has been reported by other workers (1, 6) and is apparently a response typical of lime-induced chlorosis.

Although a detailed study of the cost of each treatment, and the financial returns from each one was not made, it is obvious that under the conditions of the experiment, the treatments of Sequestrene 138 were economically sound. Untreated trees did not bear a crop at all this season, whereas trees treated with Sequestrene 138 produced a normal crop.

* Personal communications with Israeli growers.

SUMMARY AND CONCLUSIONS

1. Sequestrene 138, Hampol and ferrous sulfate were compared as sources of iron to correct iron chlorosis in four varieties of avocados.
2. Sequestrene 138 was best in correcting the chlorosis and putting the trees back in normal production. Hampol was partly effective and ferrous sulfate was wholly ineffectual.
3. Leaf iron content was found to be unreliable as a quantitative measure for correction of iron chlorosis.
4. Considering its cost and present avocado prices, the use of 1.0 lb/tree of Sequestrene 138 to correct iron chlorosis in avocado trees could be fully justified as a sound economic investment under the conditions of this experiment.

RESUMEN

Se investigó, por medio de aplicaciones al suelo, la eficiencia de "Sequestrene 138" (FeNa EDDHA), "Hampol" (Fe Na EEDT) y sulfato de hierro, como fuentes de hierro para corregir las clorosis en cuatro variedades de aguacate en los suelos calcáreos de Homestead, Florida. Los 170 árboles usados tenían 25 años y mostraban una aguda clorosis que era uniforme para las variedades 'Pollock,' 'Booth 8' y 'Waldin,' y más marcada para la variedad 'Lula.'

Se encontró que los árboles tratados con "Sequestrene 138" reaccionaron más rápidamente produciendo clorofila en las hojas después de dos semanas del tratamiento. Se concluyó que de los tratamientos usados la dosis de 1.0 Ib/árbol de "Sequestrene 138" era el tratamiento más efectivo y el más económico, considerando la cantidad de frutos producidos seis meses después.

Análisis químico foliar en árboles de la variedad 'Lula' con dos dosis de "Sequestrene 138," mostraron muy poca diferencia en el contenido de hierro en comparación con los árboles no tratados usados como control.

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