source of the virus as well as by reducing the population of the vector. One way to contain the virus in the foothills is to harvest sugarbeets early in the fall before leafhopper migration. This greatly reduces the amount of virus for vector transmission in the spring. Scattered overwintering beets infected with the virus could sustain large populations of insects that can infect cultivated plants on the west side of the valley, or infect weed hosts to provide virus inoculum for the emerging spring brood.

Relative Attraction of Two Plant Species (*Salsola paulsenii* and *Salsola iberica*) for Beet Leafhopper*

Plant species	Number of leafhoppers recovered†
Salsola paulsenii (barb wire thistle)	13.0
Salsola iberica (tumbleweed)	58.7

*From Magyarosy and Duffus, *Journal of the American Society of Sugar Beet Technologists* 19, 16-18 (1977).

†Values significant to 1.0% and represent the average of ten experiments.

Early planting of sugarbeets to avoid leafhopper migrations is widely accepted. The theory behind this cultural practice is that, as they grow older, plants become more resistant to the virus and better able to tolerate infection that occurs in the spring during the migratory flights. These cultural practices aimed at combating the disease are important for lessening the over-all importance of the disease in California.

Introduction of resistant sugarbeet varieties in 1943 greatly aided in reducing curly top damage. Although some of the early varieties now appear less resistant, partly because of the appearance of more virulent virus isolates, under certain conditions tolerant plants are the only effective way to cope with the disease.

Despite the efforts of many researchers to develop methods of prevention, curly top disease still takes its annual economic toll, particularly in years of low rainfall. It has been noted that a period of wet years reduces the amount of curly top damage. Hence, large-scale spraying in wet years may not be warranted. With increased emphasis on the environment and possible future restrictions on the use of insecticides, perhaps certain tests should be done now to discover the effect of less spraying during wet years.

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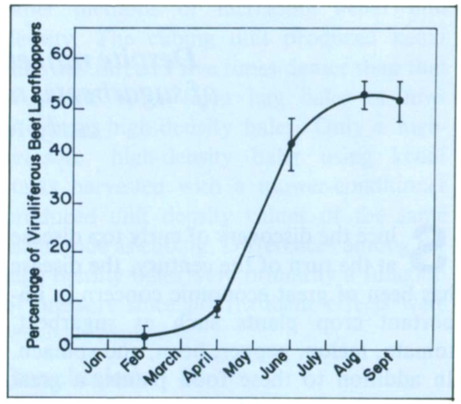
Increased occurrence of viruliferous leafhoppers from January to September in the San Joaquin Valley. From three different locations, 150 and 200 leafhoppers were collected each month for a period of four years and tested for their ability to transmit curly top.



Save money— apply trace elements only as needed

David Ririe ■ Keith S. Mayberry

Insurance-type applications of trace elements are a wasteful and unnecessary practice in the Salinas and Imperial valleys.

Trace minerals and micronutrients of various kinds are frequently promoted for California row-crop production. Zinc, iron, manganese, chlorine, boron, copper, and molybdenum have been proved to be essential for growth of higher plants, but these elements are rarely needed in amounts greater than those naturally supplied by California soils. Nevertheless, it is standard practice in some areas to apply micronutrients in "shotgun mixtures" which supply several trace elements. They may be included in a fertilizer mix, in combination with plant-protective spray materials, or as special soil or foliar treatment. (Because magnesium is sometimes used in combination with trace elements, it has been included in these studies, although it is not technically a trace element.)

Although the research described in this article was not conducted to test for toxic effects of trace-element applications, it should be noted that the literature does contain reports of ill effects from some of the elements listed above when they occur in excessive amounts in soils or irrigation water or are applied in amounts above those required by the crops.

Are general applications justified? Recently conducted research in the Salinas and Imperial valleys indicates that crop responses to trace-element applications are rare. In fact, supplemental application of trace elements is often of no value. In the Salinas Valley, for example, chelated trace elements and magnesium were applied as foliar sprays in 13 separate experiments. When the yield results were statistically analyzed, it was found that in all cases crop yields were not significantly better than the check plants which did not receive trace elements. Crops treated included lettuce, cabbage, broccoli, cauliflower, onions, peas, carrots, small white beans, sugarbeets, and lima beans. In one test, cauliflower head size was slightly larger in plots sprayed with manganese than in the check plot. In the same test, however, a shotgun spray containing, in addition to manganese, the elements zinc, iron, magnesium, copper, and molybdenum produced no yield increase.

Whereas foliar sprays of trace elements may have produced an occasional yield benefit, there is little evidence to suggest an economic return for such sprays for most of the crops grown.

In other tests in the Salinas and Imperial valley areas, chelated trace elements were applied to soils that were felt to be most likely to produce yield response. Crops in the Salinas Valley tests included Brussels sprouts, silage corn, broccoli, lettuce, and small white beans. In the Imperial Valley, lettuce, cotton, and sugarbeets were tested.

In the Salinas Valley only one test—with small white beans on a Chualar sandy loam soil—showed a significant response to soil-applied manganese and foliar-applied zinc. Soil-applied zinc chelate produced no significant effect on yield. (See table 1.)

The effects of applications on lettuce in the Salinas Valley (table 2) and the Imperial Valley (table 3) are more typical. A Salinas Valley field was selected in which lettuce yields had been below the average for the district. Calmar lettuce was planted and trace elements applied on July 24, 1974, by injection into the bed shoulder. Leaf samples were taken September 20, and the crop was harvested in three cuts beginning October 8. The soil was an Antioch loam with iron and zinc contents of 99 and 3.3 parts per million, respectively. The yield and trace element contents of the plant tissue are reported in table 2.

Typical of the other experiments, no difference in plant nutrient content resulted from trace element application. This indicated that the soil was already adequately supplied with trace nutrients.

In the Imperial Valley lettuce test a sandy field was fertilized, bedded up, and planted to Vanguard lettuce. Shortly after the lettuce was up, zinc and iron chelates were injected into the bed shoulder. (Table 3 contains results.)

There were no differences in yield due to application of iron or zinc. Zinc levels in lettuce tissue, however, were significantly increased with liquid Sequestrene zinc applications over the dry zinc formulations. There were no uptake differences due to soil application of iron. Cotton trials using chelated iron, zinc, and manganese applied preplant, early sidedress, and mid-season foliar did not result in yield increases over the check. Similar results were found with sugarbeets from soil-chelated micronutrient applications at thinning.

Conclusions

This series of tests has shown that economic responses of crops to trace nutrient applications should not be generally expected in the Salinas and Imperial valleys. In all of the tests conducted, the only response obtained was with zinc and manganese on small white beans at one location.

Based on these results it is suggested that insurance-type applications of trace elements are a wasteful and unnecessary practice in the areas investigated. Only when a particular trace element has been demonstrated to be beneficial to a crop should it be used. Foliar and soil analyses may indicate zinc responses and could be the basis for zinc applications.

In cases where a particular trace nutrient is needed for one crop there is no guarantee that it will be beneficial if applied to other crops in the rotation. In the interest of conserving energy, money, and protecting the environment it is therefore suggested that trace elements be applied only to crops for which benefits have been proved on a particular soil.

TABLE 1. Yield and Leaf Tissue Content of Small White Beans—1974 Test

		PPM Zn			PPM Fe			% Mg			PPM Mn		
Treatment	Yield (lbs/A)	8/28	9/13	10/2	8/28	9/13	10/2	8/28	9/13	10/2	8/28	9/13	10/2
Check	1386	41	34	26	600	303	285	1.02	0.55	0.57	506	698	559
Zn	1433	44	32	27	663	271	220	0.95	0.51	0.55	393	723	624
Fe	1434	44	34	27	554	349	311	1.01	0.55	0.59	585	878	828
Mg	1428	44	35	29	596	281	266	0.93	0.51	0.57	378	650	721
Mn	1508	43	34	29	583	275	299	0.91	0.49	0.57	476	638	483
Foliar Zn	1487	44	36	27	573	288	267	1.02	0.51	0.59	595	795	626
LSD 0.05	94	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	247	230

TABLE 2. Yield and Leaf Trace Element Contents of Salinas Valley Lettuce—1974 Test

Treatment	Cu PPM	Fe PPM	% Mg	Mn PPM	Zn PPM	% Cut	Yield (cartons/acre)
Check	5.2	557	0.49	257	57	80	667
Cu	5.2	626	0.55	310	52	74	609
Fe	5.1	476	0.50	244	53	75	629
Mg	5.6	529	0.46	268	53	76	643
Mn	4.8	488	0.46	282	53	69	602
Zn	5.1	528	0.50	276	55	77	665
LSD 5% level	NS	NS	NS	NS	NS	NS	NS

TABLE 3. Leaf Trace Element Contents of Imperial Valley Lettuce 1972 Test

	% Cut lettuce	Petiole analyses			
		Iron (PPM)		Zinc (PPM)	
Treatment—lbs. material/A	3/13/72	1/20	3/4	1/20	3/4
Check	29.1	310	84	50.0	12.3
0.45 Fe Sequestrene	33.4	400	89	34.3	10.6
0.45 Fe GA-5-110	35.7	404	89	33.3	11.2
0.9 Fe Sequestrene	36.4	370	96	39.5	12.3
0.9 Fe GA-5-110	34.9	460	102	38.5	15.3
0.86 Zn Sequestrene dry	31.5	321	89	41.5	14.0
0.86 Zn liquid Sequestrene	33.6	258	96	38.8	15.7
1.7 Zn Sequestrene dry	36.1	354	91	44.3	15.0
1.7 Zn liquid Sequestrene	30.9	318	85	47.0	20.5
LSD 5% level	NS	NS	NS	NS	4.7

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