A new look at curly top disease

Andrew C. Magyarosy

Despite rangeland spraying, use of systemic insecticides at planting of sugarbeets, new cultural methods, and resistant sugarbeet varieties, curly top continues to take its annual economic toll.

Since the discovery of curly top disease at the turn of the century, the disease has been of great economic concern in important crop plants such as sugarbeet, tomato, melon, pepper, bean, and spinach. In addition to these food plants, a great variety of weeds and ornamentals are susceptible to the virus. In North America, it is transmitted only by the beet leafhopper, *Circulifer tenellus*, a desert-living insect which apparently was introduced into the state from the Mediterranean area, where both the virus and the beet leafhopper are considered to have originated.

Characteristic symptoms of the disease in susceptible host plants are vein clearing, vein swelling, and inwardly curling leaves. The most common field symptoms include yellowing and severe stunting of plants.

Although a wealth of information on curly top disease has accumulated since its discovery, there are still many problems to be solved concerning its epidemiology and control. A discussion of these problems is timely because of recently acquired epidemiological data and because of the serious cyclical outbreaks—the latest of which occurred in 1977—which occur in spite of our state-supported control program.

Curly top cycle

To understand the problems involved in controlling curly top disease, it is appropriate to discuss briefly its cycle in California. In the fall, when the host plants of the beet leafhopper mature and the scattered weeds become unfavorable hosts, leafhoppers are forced to move to open rangelands where they seek out more favorable host plants. Such plants occupy the lower elevation of the blue oak plant community of the San Joaquin Valley, which ultimately emerges into the California grasslands. Natural breeding areas of the vector also include the valleys of the Coast Range, the largest of which is the Salinas Valley, and some of the foothills of the Sierra Nevada mountains. On these open rangelands, summer annuals and perennials are abundant and sustain congregated populations of the insect, many of which carry severe isolates of the virus obtained previously from susceptible plants grown in the valleys. As the leafhoppers feed on these host plants in the fall, their ability to transmit curly top virus is depleted. Both weakening (attenuation) and loss of virus severity are apparent.

Rainfall in the fall and winter results in the germination of annuals, which prompts the leafhoppers to move to the sunny slopes of the foothills where eggs are laid in a variety of host plants. The virus is disseminated as feeding and movement of the emerging spring brood become more pronounced. Light spring rains and mild temperatures make possible two spring generations, although heavy rainfall in the winter and spring can lessen and even wipe out an entire spring brood. As annual plants become mature and scarce, the leafhoppers, some of which have acquired mild isolates of the virus, start their spring migration from the foothills to the cultivated areas. The great potential of the leafhopper for reproduction in our favorable climate results in the development of three or four generations of the vector per year. Therefore, during the spring and summer months curly top-carrying leafhoppers increase rapidly (see figure) and susceptible crop plants may be severely damaged.

Control

Curly top disease has been partially controlled since 1931 by spraying leafhoppers in the open rangelands where leafhopper populations leaving the valleys congregate in large numbers on specific host plants in the fall. Similar congregations of leafhoppers on favorable annual host plants have been observed in the foothills before the spring migrations. In the early days of the spraying program, pyrethrum in diesel oil and DDT were used. Today, malathion is applied annually to approximately 160,000 acres of open rangeland in California.

But the plant communities of these rangelands are changing and questions are being raised regarding the effectiveness of the present spraying program. The personnel at the State Department of Agriculture have observed that the favored host of the vector, the tumbleweed (*Salsola iberica*), on which large populations of leafhoppers congregate in the late summer and fall, is gradually being replaced by the barb wire thistle (*Salsola paulsenii*), which is a poor feeding host for the beet leafhopper (see table). Therefore, the value of spraying mixed stands of thistle plants in the fall is questionable. The timing of spraying these and other host plants of the beet leafhopper is critical and cannot be overemphasized because (1) malathion has a shorter residual effectiveness than DDT and (2) the migration of the insect is influenced by complex environmental factors. Although a large number of leafhoppers are killed in the fall and spring by this spraying, the percentage of the total leafhopper population affected by the spraying program is difficult to estimate.

Another widely used chemical approach is the incorporation of systemic insecticides under seed at planting. The success of this method is well supported by experimental data obtained at the University of California at Davis.

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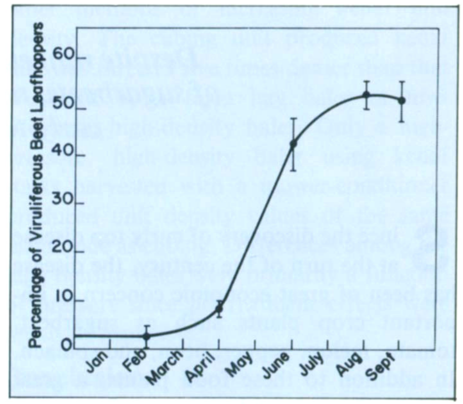
Increased occurrence of viruliferous leafhoppers from January to September in the San Joaquin Valley. From three different locations, 150 and 200 leafhoppers were collected each month for a period of four years and tested for their ability to transmit curly top.



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