Beet Leafhopper Outlook Statements[1]

HOWARD E. DORST[2]

The beet leafhopper, *Circulitfer tenellus* (Baker), is the vector of curly top, a disease of sugar beets, tomatoes, beans and cantaloupe. This disease varies in intensity from year to year and frequently causes a sharp reduction in yields of these crops. The leafhopper migrates from adjacent and distant semi-desert flora to the agricultural areas of Utah, western Colorado, southern Nevada, central Arizona and southeastern California.

Ecological studies of the leafhopper, made by the author in the desert breeding areas prior to its migration, included the determination of the relationship of this insect to certain plants and the factors which influence its distribution. Evaluation of such factors as climatic conditions and numerical abundance of the insect has provided a basis for the research worker to anticipate the time and intensity of the yearly movement. The information obtained each year has been released in the form of leafhopper outlook statements prior to the planting date of susceptible crops in the agricultural area. Information from these statements can be used to govern the planting of varieties of sugar beets most resistant to curly top when the outlook is for a year high in leafhopper numbers. The more susceptible varieties of sugar beets can be planted in years of low leafhopper numbers.

Ecological studies of the beet leafhopper in its winter, spring and summer breeding areas to determine the source of the movement into Sevier Valley, Utah, were initiated in the late 1920's. The desert areas between St. George, Utah, and Las Vegas, Nevada, were first studied; later other workers collected data in areas near Phoenix, Arizona (5),[3] Needles, California, and Las Vegas, Nevada. Except for the period from 1936 to 1942, data for each year since the beginning of the study have been accumulated on the conditions occurring in these areas during late winter and early spring months and corresponding spring and summer leafhopper population data have been taken in cultivated districts of Utah and western Colorado.

The beet leafhopper multiplies in great numbers in the winter and spring months when certain plants are present in the breeding areas. The kind of plants present, the time of their germination, and their distribution all greatly influence the degree of increase in the leafhopper population. The quantity of precipitation and time of its occurrence are directly related to the germination and sustenance of the host plants. High temperatures which follow precipitation may reduce its effectiveness because of the evaporation and loss of moisture. Winter temperatures in the southern breeding areas are not low enough to cause leafhopper mortality.

Normally little precipitation occurs in the southern breeding areas in early summer, therefore few annuals are present and the leafhopper popula-

[1] This work was carried out cooperatively by the U. S. Department of Agriculture and the Utah Agricultural Experiment Station.
[2] Entomologist, Entomology Research Branch, Agricultural Research Service, USDA.
[3] Numbers in parentheses refer to literature cited.

tion is much reduced. Summer breeding areas receive late winter, spring and summer precipitation, which germinates and sustains Russian thistle, *Salsola kali,* with one or more other plants. Large summer breeding areas covered by Russian thistle have been studied in the Escalante Desert of southern Utah, in the Wolf Hole district of northwestern Arizona and in the Douglas district of southeastern Arizona. In southern Arizona (5) precipitation which occurs between July and September may cause such plants as chinchweed, *Pectis papposa, Tridestrornia lanuginosa,* and several other annuals to germinate which serve as host plants for the leafhopper. The leafhopper population increases to large numbers on these summer host plants. In the fall, as the summer host plants dry, the leafhopper is forced to seek other food.

If precipitation has occurred in the late summer or fall in the winter and spring breeding grounds of the beet leafhopper, germination of the winter host plants may take place prior to the return movement of leafhoppers from the summer breeding areas. The more common winter host plants are alfileria, *Erodium cicutarium;* annual plantain, *Plantago insularis;* peppergrass, *Lepidium densiflorum;* spectacle-pod mustard, *Dithyrea wislizeni;* bladder-pod mustard, *Lesquerella fendleri;* roadside mustard, *Sisymbrium irio,* and borage, *Cryptantha barbigera.* If one or more of these species of plants germinates over a large area and is present when the fall movement occurs, the leafhopper is provided adequate food. However, if precipitation fails, and there is a dearth of winter annuals, the leafhopper is forced to feed on such undesirable plants as creosote-bush, *Covillea tridentata,* or some other perennial plants. Under these circumstances, a high mortality of the insect occurs within 30 to 60 days because these perennials are not favorable food, and act only as carryover host plants.

The percentage of leafhoppers which carries the curly top virus varies considerably from year to year. The reason for this variation is not well known. Certain weed host plants which leafhoppers feed upon are naturally infected with the virus disease. Nevertheless, the percentage of viruliferous hoppers collected from specific host plants varies from year to year. The percentage of viruliferous leafhoppers in the migration from the winter desert breeding grounds to the agricultural area heavily influences the amount of damage incurred.

In northwestern Mexico, southern Arizona and southeastern California, a generation of leafhoppers may be produced by January or early February. By this time in many years the winter-germinated annuals have matured, and the leafhopper has been forced to move further north for food.

If favorable host plant conditions are present, a generation of winged leafhoppers may mature in the Phoenix, Arizona, and the Blythe and Indio, California, areas by March. Movement from the south may populate the host plants in this area in February. These leafhoppers may produce a second generation by April. Cultivated crops susceptible to the curly top disease in adjacent territory and northward may be populated by the leafhoppers during February, March and even April.

If favorable host plant conditions are present, a generation of leafhoppers may mature in the Barstow-Needles, California, area by April. Leaf-

hoppers from further south could have populated this area in February and March; and if plants are favorable, these populations would be produced in late April or early May.

In the St. George, Utah; Littlefield, Arizona; Kingman, Arizona, and Las Vegas, Nevada, sectors, a generation of leafhoppers may mature by late April or early May. Leafhoppers further south may populate the annuals and continue to reproduce into mid-May.

Under favorable host plant conditions there may be an accumulation of leafhoppers by additional generations which may prolong the leafhopper movement to the cultivated districts of northern Utah and western Colorado from late March and April to mid-May.

The species, abundance and distribution of host plants during the winter and spring months greatly influence the magnitude of the movement of beet leafhoppers to cultivated districts. Since certain host plants are more favorable for the leafhopper and thereby permit the production of larger broods than others, this situation must be evaluated each year by plant and insect surveys. Xhe brood of leafhoppers produced on spectacled-pod mustard and peppergrass mustard is largest, but the acreage of these plants varies greatly from year to year. Plantain produces a larger brood than alfileria. The acreage of host plants is important in that it greatly influences the total number of leafhoppers produced in a given season for the migration.

In recent years the acreage of host plants has been determined over the vast desert breeding area by recording their absence or presence at 10-mile stops. If host plants are present they are classified as wide spread, spotted, or confined to washes and roadsides only. Plant cover at these stops has been determined by recording the number of steps in which plants touch the toe of the shoe in 50 conventional strides. Normally, a plant cover which completely shades the soil surface is not as favorable for leafhopper breeding as a sparser stand. The condition and stage of maturity of the plants have been classified as seedling, flowering, succulent, hardening or dead. The unit leafhopper populations have been determined at 50 randomized square foot samples at each stop where host plants were present. The percentage of viruliferous leafhoppers and virulence of the virus strain have been determined by inoculating individual curly top-susceptible beets in the cotyledon stage with single leafhoppers collected from different host plants in the desert breeding area. The percentage of the inoculated beets which develop curly top symptoms and the virulence of the attack are determined for the viruliferous reading.

The beet leafhopper population, host plant distribution, percentage of viruliferous leafhoppers in desert breeding areas, and percentage of tomato plants infected by curly top in northern Utah and western Colorado from 1946 to 1953 are shown in Table 1.

The highest average leafhopper population in February in the desert breeding area of southern Utah, southern Nevada, southeastern California, southern Arizona and western Arizona since the studies began was recorded

Table 1.—Beet Leafhopper Population and Conditions Observed in Desert Breeding Areas from 1946-1953.

Year	Regular 10 mile stops	Stops with widespread host distribution	Average beet leafhopper population in desert per square foot	Leafhoppers carrying virus	Tomato plants infected with curly top	
					Western Colorado	Utah
	number	percent	number	percent	percent	percent
1946	54	17	0.049	8.0		2.0
1947	72	54	0.028	..	.	8.0
1948	206	28	0.044	4.0	20.0	3.0
1949	246	32	0.013	..	0.1	0.1
1950	248	16	0.016	0	7.0	0.8
1951	200	10	0.015	2.0	0.6	0.5
1952	217	46	0.087	10.4	45.0	12.0
1953	217	25	0.04	14.5	8.0	6.0

in 1952. In that year 46 percent of the 10-mile stops where plants were present showed that widespread distribution of hosts was common to the area. In northern Utah, 12 percent curly top damage to tomatoes was recorded, with 45 percent damage to tomatoes in western Colorado; sugar beets in southern Utah and western Colorado showed from 40 to 50 percent obvious curly top. In 1951, by contrast, the average leafhopper population in the desert was 0.015 per square foot and only 10 percent of the stops showed widespread distribution of host plants. Curly top damage to tomatoes that year was absent. Damage to sugar beets was also negligible.

Host plant conditions in the desert breeding area vary considerably over a period of years. Portions of the desert which produced good stands of host plants in the St. George-Littlefield-Las Vegas areas in the late 1920's and early 1930's have not been productive more recently. When favorable precipitation occurs, host plants are found in other portions of the desert and different species are present from those observed in earlier studies. Different host distribution also has been noted in the Phoenix-Blythe-Needles-Las Vegas areas than that recorded in the early 1930's. The time and quantity of precipitation apparently determine the species of host plants which may germinate.

The winter desert breeding area is divided by the Colorado River. The leafhopper movement from the east side of the river may be carried to the eastern part of Utah and western Colorado. On the other hand, leafhoppers which mature on the west side of the Colorado River may be carried to northern Utah up the Virgin and Sevier River basins. Wind directions at the time of the leafhopper movement probably influence the distribution to the different agricultural areas. The long distance movements (2) to the cultivated areas of northern Utah have been detected as early as late March, but in average years most of the movement in Utah and western Colorado has occurred by May 15.

Even though the source of leafhoppers which migrate to the cultivated areas of northern Utah and western Colorado is identical, the magnitude of the leafhopper migration to western Colorado may be greater. Large

populations often are produced in the portion of the breeding area east of the Colorado River, and the Colorado River basin provides an avenue for the leafhoppers to move to eastern Utah and western Colorado. In 1948, 20 percent curly top was recorded on tomatoes in western Colorado but only 3 percent in northern Utah. In 1952, the incidence of curly top on tomatoes in western Colorado was 45 percent, in contrast to 12 percent in northern Utah.

During some years in northern (4) and eastern Utah and western Colorado, local breeding areas produce leafhoppers which migrate to the adjacent cultivated districts. Precipitation in the fall which germinates such annuals as alfileria, *Erodium cicutarium;* African mustard, *Malcolmia africana* and blister cress, *Erysimum repandum,* is favorable for winter survival of this insect. If a large population of leafhoppers enters the winter under favorable host plant conditions, winter temperatures may reduce their numbers to insignificance. The leafhopper movement from these areas which occurs in June was in the past of some consequence, but in recent years has become less important because grasses have replaced the former weeds.

Some breeding areas in northern Utah adjacent to Great Salt Lake and Utah Lake, and areas in eastern Utah and western Colorado may be populated by the long distance migrants in the spring. Under favorable host plant conditions a brood of leafhoppers may be produced before movement to the adjacent cultivated areas. These movements usually occur in early June after beets have reached the 10- to 12-leaf stage; however, the leafhopper may infect susceptible crops such as tomatoes, cantaloupe and beans. The higher incidence of curly top on tomatoes in western Colorado in 1952 in comparison with northern Utah was in part the result of a local movement of leafhoppers from eastern Utah.

Resistant strains of sugar beets have provided major protection against the inroads of curly top transmitted by the beet leafhopper. Maximum resistance to curly top is reached after the sugar beets reach the 10- to 12-leaf stage of development (3). In 1940 (1), 1952 and 1953 beet leafhopper populations grreater than 1 per square foot of beet row occurred on sugar beets while in the cotyledon to 8-leaf stage of development. Under these circumstances, 40 to 80 percent obvious curly top was observed and the yield of sugar beets was considerably reduced.

Summary

The beet leafhopper, *Circulifer tenellus* (Baker), is a pest of sugar beets, tomatoes, beans and cantaloupe in the intermountain area. The leafhopper population varies in intensity from year to year, frequently causing sharp reduction in yields of susceptible crops. This pest migrates to the cultivated districts of Utah, western Colorado, southern Nevada, central Arizona and southestern California, from semi-desert breeding areas in southern Utah, southern Nevada, southeastern California, western Arizona and southern Arizona.

Studies of the leafhopper population in semi-desert breeding areas and its corresponding damage to susceptible crops in the cultivated districts

were initiated in the late 1920's and have been continued each year except during the period 1936-1942. The data collected in these studies and their evaluation have provided a basis from which the research worker can estimate the anticipated magnitude of the beet leafhopper migration and expected damage to cultivated crops each spring.

By using this information, the sugar beet industry may determine the selection of resistant strains of sugar beets which will give the best returns in line with the anticipated magnitude of the leafhopper movement.

Literature Cited

(1) DOUGLAS, J. R., DORST, H. E., and PEAY, W. E.
1946. Beet leafhopper population in southern Idaho and northern Utah during the seasons of 1940 and 1941. Amer. Soc. Sugar Beet Tech. Proc. pp. 289-297.

(2) DORST, H. E., and DAVIS, E. W.
1938. Tracing long-distance movements of beet leafhopper in the desert. Jour. of Econ. Ent. 30 (6) 948-954.

(3) GIDDINGS, N. J.
1942. Age of plants as a factor in resistance to curly top of sugar beets. Amer. Soc. Sugar Beet Tech. Proc. pp. 452-459.

(4) KNOWLTON, G. F.
1932. The beet leafhopper in northern Utah. Utah Agr. Exp. Bul. 234, 64 pp.

(5) ROMNEY, VAN E.
1943. The beet leafhopper and its control on beets grown for seed in Arizona and New Mexico. U. S. Dept. Agr. Tech. Bul. 855, 24 pp.