STUDIES ON CURLY TOP EPIDEMIOLOGY IN SUGAR BEET FIELDS

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Epidemiology was studied in connection with agronomic evaluation of a series of curly top resistant sugar beet varieties. Randomized arrangement of many times replicated plots was used. Dates of planting and dates of thinning were varied and on half of the field curly top virus was introduced by extensive release of viruliferous leafhoppers in advance of the natural infestation.

Studies were also made on the relation of 8" and 20" spacing to the rate of curly top infection, yield and sucrose percentage with varieties varying in resistance as follows: a susceptible European brand; a variety of intermediate resistance, U.S. 33; and a highly resistant variety, No. 619. Under the conditions of the tests the wider spacing was relatively unfavorable for the susceptible variety; the wider spacing gave poorer results with the variety of intermediate resistance; but with the highly resistant variety the wider spacing was advantageous.

A GENERAL DISCUSSION OF THE BEET LEAFHOPPER

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The beef leafhopper, or "white fly" is a tiny insect, somewhat less than ⅛ inch long, varying from gray to greenish yellow in color. So far as we know, this insect is native to the western part of the United States and northern Mexico, where it is found breeding upon many desert weeds.

Most of the desert breeding plants of the beet leafhopper are short-lived spring annuals living in areas where the heaviest rains fall during winter and early spring. These plants mature and dry rather early, and the leafhoppers are forced to move to other green vegetation. The dispersal areas are usually cultivated and irrigated regions, where green food is available during the summer. The larger known breeding and dispersal areas are:

(1) The Central Columbia Area.
(2) The Southern Idaho Area.
(3) Utah, Nevada, and Northwestern Arizona.
(4) California.
(5) Southern Arizona.
(6) Western Texas and Southern New Mexico.

In all except the last two of these areas, the chief breeding plant is Russian Thistle. Other plants are involved to a limited extent, but extended studies and experimental control work have demonstrated that Russian thistle is a key plant.

The principal spring hosts vary widely in the different breeding grounds. Filaree is important in Oregon and Washington; native mustards in Idaho; while filaree, native plantains, and peppergrasses make possible the

breeding of spring migrants in the other areas.

The introduction of strains of sugar beets that are resistant to curly-top has gone a long way toward solving the curly-top problem so far as it relates to sugar beets. However, this is the only susceptible crop for which resistant strains are available, and curly-top attacks many other crops, including tomatoes, any varieties of beans, most curcubitaceous crops, and a large variety of ornamental plants. The resistant strains of sugar beets have proved so successful that sugar beets are now being grown in many areas where the older varieties were not able to grow successfully. This has resulted in an increase of available favorable summer hosts for the beet leafhopper, and in increased populations of leafhoppers. Further, a larger percentage of the leafhoppers bred on beets quite often carry virus than of those bred on other summer hosts. This results in the introduction of more, and probably more virulent, virus into the desert breeding grounds. This more abundant supply of virus is picked up by the leafhoppers and carried with them on their migrations, so the damage to crops other than beets may become intensified by the growing of resistant beets. For this reason the Bureau of Entomology and Plant Quarantine is carrying on control studies more intensively than before the introduction of resistant varieties of beets.

Control measures are most readily considered if divided into immediate control measure, such as crop spraying, leafhopper spraying, and the control of host plants by cultural methods, and indirect or long-time control of host plants by cultural methods, and indirect or long-time control measures which depend upon community action over a period of time for their effectiveness.

Immediate Control Measures

Although resistant varieties of sugar beets are much more resistant to curly top than are the older varieties, they are not immune, and under certain conditions it seems possible that the crop might be increased through spraying.

In California, the leafhoppers leave the cultivated areas during October and November, and fly to the desert foothills. At that time there is rarely any freshly sprouted annual vegetation available and the leafhoppers must exist upon perennial shrubs like desert sage until the fall rains occur. In many parts of the breeding grounds these shrubs are limited in their distribution to the bottoms of desert washes, and the leafhoppers swarm upon them in enormous numbers. Under these conditions it is feasible to spray these patches of perennials and thus reduce greatly the number of leafhoppers entering the winter. Further, owing to climatic conditions and to the conformation of the breeding grounds, the leafhoppers lay their eggs in the spring upon relatively small patches of annual range weeds on canyon slopes. It is also feasible to spray many of these patches just at the time of egg-laying and destroy the females before they lay their eggs.

The average yield of beets for the period 1932-1935 inclusive was nearly 14 tons per acre, as against 12 tons per acre for the four highest seasons preceding the spray operations.

Control of Host Plants. Considerable experimental work has been done in California, Idaho and Utah on the control of Russian thistle. The seeds do not loosen until rains have soaked the plant after it dries. Campaigns for burning the dry thistle in the fall were carried out in several places in

California in 1933 and 1934, and the results showed nearly a 50% decrease in thistle following the first year's operations, and a further reduction of around 40% following the second year's operations.

Some experimental work was done with hoeing by hand, dragging with rails, and disking, and all of these operations are feasible under certain conditions. 1937 three sugar companies contracted nearly 15,000 acres of beets in the central part of the San Joaquin Valley, close to the breeding grounds.

Direct control of Russian thistle is feasible wherever the area of thistle is comparable with that of beets being grown, and where the thistle areas are not too scattered.

In all of the breeding areas, the leafhoppers breed in the spring upon range annuals. Most of these annuals are range weeds, and their presence in large amounts is due to overgrazing.

PLANT ECOLOGY IN RELATION TO THE CURLY TOP DISEASE

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The curly-top disease is carried by the beet leafhopper. The worst curly-top years are those when leafhopper populations are high. These high populations are produced on weedy areas where the insect breeds on wild mustards and Russian thistle. A grass cover or one of sagebrush and grass produces few or no leafhoppers and is a desirable cover as compared to the undesirable weedy type. Up to the 80's sagebrush and grass formed an almost unbroken cover over southern Idaho. After 1900 large areas were plowed and later some were abandoned.

Russian thistle and wild mustards were introduced and covered the abandoned lands, forming breeding areas for the leafhopper. Also the remaining sagebrush areas were used more intensively by stock; the grasses began to disappear and weeds, including a native wild mustard, appeared to form another type of breeding area. By applying the methods of plant ecology it has been found that there are changes in the weedy cover of the abandoned lands; that the changes form a series in development and that under certain conditions (proper farming and grazing of the lands) the weedy areas may change to the more desirable grass or sagebrush and grass cover.

EXPERIMENTS FOR THE CONTROL OF THE BEET LEAFHOPPER IN IDAHO, 1936-37

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Idaho appropriated $50,000 in 1935 as a beet leafhopper extermination fund. On April 28, 1936 the Governor requested the University of Idaho Agri-

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2 Idaho Agricultural Experiment Station