Procedure for Inducing Curly Top Epidemics in Field Plots[1]

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For about 40 years, plots of sugarbeets have been grown in the field under conditions favorable for evaluating resistance to curly top virus. Selections from these plots have been used as parental material for nearly all cultivars of sugarbeets grown in the western states. In 1962 this work was moved from southern Idaho to northern Utah. During the next few years it became apparent that natural movement of leafhoppers would not provide satisfactory disease development each year and might seldom be sufficient to evaluate the more resistant selections. Therefore, procedures were developed for producing curly top epidemics artificially.

Procedures

In 1952 Murphy (1)[3] outlined several methods of inducing curly top epidemics in the field. Using the method of releasing viruliferous beet leafhoppers, *Circulifer tenellus* (Baker), procedures were developed that appear to assure successful curly top epidemics in the field nearly every year. Procedures used the past 2 years have resulted in very favorable disease levels for variety evaluation and suggest that the results can be reproduced in succeeding years. Table 1 outlines the schedule of events that was followed to induce curly top epidemics in field plots.

Preparations began December 1 to have 40,000 leafhoppers reared and 150 virus-source plants with severe symptoms available by June 24. About 250 sq. ft. of greenhouse bench space was required. Experience has shown that close adherence to the schedule and having conditions favorable for both plants and insects were important to the success of the procedure.

The plots were deliberately planted late so that weather conditions were most favorable for survival of leafhoppers. The warm dry weather near June 1 made it essential to have sprinkler irrigation available during the emergence period. With such irrigation, emergence was excellent and early growth was rapid. Each plot was planted as a 20-foot row and thinned to 20 plants per row. Routinely, two replications of each entry are included. Thinning was done while the beets were small, so leafhoppers could be released before the seedlings became resistant with age.

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[3]Numbers in parentheses refer to literature cited.

Table 1.—Schedule of events for inducing curly top epidemics in field plots.*

December 1	Plant† to obtain 15 seedlings.
February 1	Start 15 reproduction cages, each with 50 adult leafhoppers. Plant to obtain 120 seedlings.
April 1	Start 110 reproduction cages, each with 50 adult leafhoppers obtained from cages started on February 1.
	Plant to obtain 200 seedlings.
	Inoculate 10 plants with virus to use as source plants.
May 15	Put 1,200 leafhoppers on 10 virus-source plants.
May 22	Inoculate 200 plants, using 5 viruliferous leafhoppers per plant.
June 1	Plant plots—sprinkler-irrigate for good emergence.
June 24	Put 40,000 leafhoppers on the 200 virus-source plants at the rate of 100 leafhoppers in each of 400 leaf-cages.
June 26-30	Cultivate and thin plots to 20 plants per 20-ft. row.
July 1-2	Irrigate plots.
July 5	Release 40,000 viruliferous leafhoppers (100 leafhoppers per leaf-cage) uniformly over plots.
July 5-8	Disperse leafhoppers in plots twice daily.
August 1	Spray plots thoroughly with malathion or parathion. Repeat if necessary.
August 10-15	Record curly top grade for each plot.
September 10-15	Record curly top grade for each plot.

*This schedule is adapted to a 3-acre field containing about 2,000 20-foot plots.
†Sugarbeet cultivar US 33 was used for leafhopper reproduction and as virus-source plants.

Methods of leafhopper release and subsequent movement were important factors in uniform development of symptoms throughout the plots. For this reason, the leafhoppers were divided into groups of 100 for virus acquisition. Each group of 100 leafhoppers was caged on the leaf of an infected sugarbeet plant for one week. These groups of 100 leafhoppers were released at two locations, about 6 feet in from each end, of each 20-foot row. This was accomplished by walking across the rows at a right angle to row length and uniformly releasing leafhoppers from each leaf-cage over a predetermined distance. For 3 successive days after leafhopper release, a 12-foot length of aluminum tubing with heavy rag strips hanging from it was carried over the rows in such a way that the rag strips contacted the plants and moved the leafhoppers to new plants. Two such trips were made throughout the plots each day.

Observation indicates that the leafhoppers move very short distances during the 3 to 4 weeks they are in the plot. Before the abovementioned methods of releasing and scattering the leafhoppers were employed, areas 10 to 20 feet in diameter where a large group of leafhoppers were accidentally released would have unusually severe symptoms distinct from those in the remainder of the plot. This suggested that the leafhoppers fed on and inoculated plants primarily in the immediate area of release.

When disease symptoms were well developed, each plot was assigned a grade based on a scale of zero to nine (Fig. 1), with zero being no visible symptoms, and nine being a dead plant. The grade was determined by the severity of leaf curling, pimpling on the under surface of the leaf, and stunting. The correlation coefficient between entry grades of the two replications was $r = 0.80$ for the 1972 plots. The LSD at $p = 0.05$ between entry means (average of 2 replications) was 1.1. Since entry means were rounded to the nearest half grade, any two entry means that differed by 1.5 or more grades were considered significantly different.

To check on uniformity of infection, every 10th row was a check row. A relatively susceptible cultivar, US 33, and a relatively resistant one, US 41, were alternated as check rows. These checks also served as a guide when evaluations were being made and as a standard of comparison with different entries from year to year. In the 1972 curly top plots, 54 of the 83 plots of US 33 throughout the field received a grade of 6 on a 0-9 scale. Of the remaining 29 plots, 28 received either grade 5 or 7. This indicates the good uniformity of infection over the entire field.

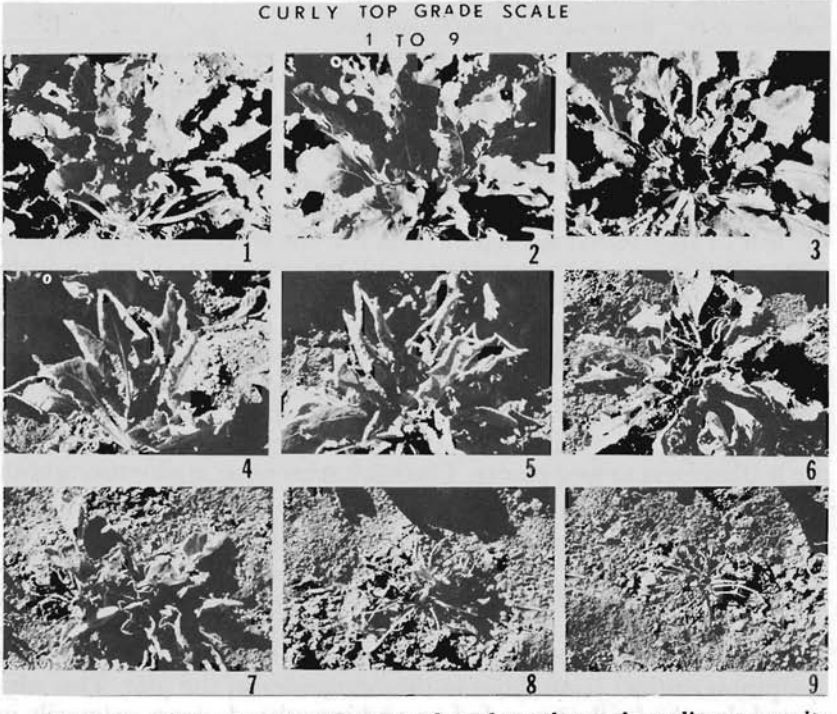

Figure 1.—Illustration of curly top grade scale used to evaluate disease severity. Grade 0, which indicates no symptoms, is not shown.

Figure 2 illustrates the differences between resistant and very susceptible entries observable in the 1972 disease plots. Differences as consistent as these not only increase the reliability of the evaluations, but reduce the possibility of selecting plants that have merely escaped infection when individual plant selections were made from a particular row.

Discussion

There are several advantages in using the described method of inducing curly top epidemics, instead of depending on natural leafhopper movements. The location of the plots is not restricted to areas near the desert; the virus strain used for inoculation can be controlled; and the period of time during which infection occurs is reduced. This last advantage is of considerable importance when evaluations for resistance are made. The time of infection influences greatly the severity of symptoms that the plants express. Therefore, if nearly all plants can be infected during a 1-2 week period, as is probable with these procedures, then comparative evaluations are more accurate than they would be if plants became infected throughout the growing season.

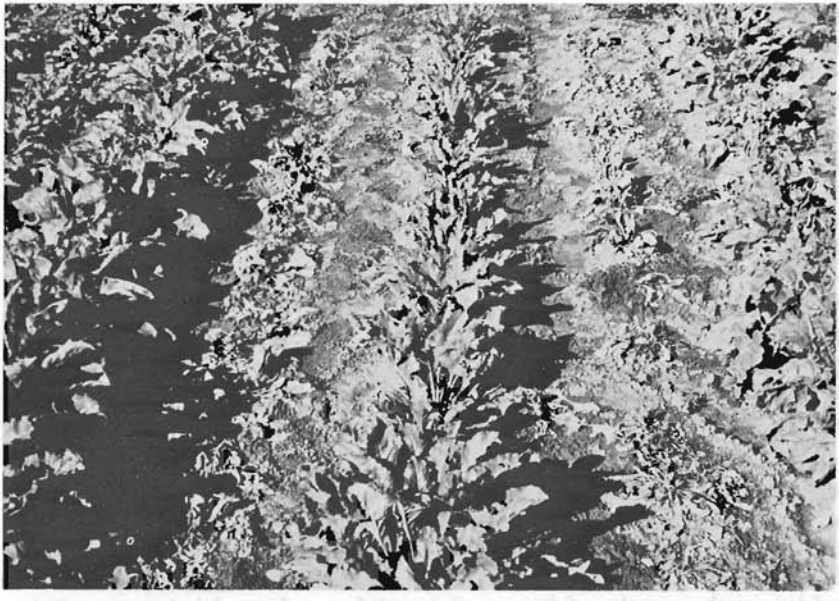

Figure 2.—Resistant and susceptible entries in 1972 curly top field. Nearly all plants are dead in the two rows on either side of the center row. Rows next to these susceptible rows show different degrees of resistance. The row to the far right is US 33.

Literature Cited

(1) MURPHY, ALBERT M. 1942. Production of heavy curly-top exposures in sugar-beet breeding fields. Proc. Am. Soc. Sugar Beet Technol. 3:459-462.