Comparison of the Effect on Beet Seed Production of Spring and Fall Infestations of Beet Leafhoppers Carrying Curly Top Virus[1]

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Introduction

The beet leafhopper, *Circulifer tenellus* (Baker), and the curly top virus that it transmits have been a major problem to producers of sugarbeet seed since the crop was first grown in the southwestern United States in the early 1930's. Observers have usually considered that the virus reduced yield. Also, since the crop is planted in late August and early September and is harvested the following June, some investigators have speculated about the comparative damage done by the fall and spring migrations of the insect. For example, in 1943, Romney (3)[3] described the injury to the crop in Arizona and New Mexico caused by the fall migrations from the surrounding semidesert areas, and stated that "Beet leafhopper populations often increase in Arizona seed beet fields during April and May, as a result of spring movement from winter annuals in the surrounding semidesert areas." He also stated that "These leafhoppers cause some damage, but not so much as that caused by an equal infestation in the fall when the beets are small." Hills et al, in 1948 (1), also reported that the major losses from curly top virus were attributable to fall movements of the beet leafhopper from desert breeding areas to seed beet fields and were manifested as reductions in seed yield; their further experiments (2) in 1960-61 showed that early spring (March 20-23) infestations of infective beet leafhoppers did not reduce yield or germination. Nevertheless, observers in the field continued to report a reduction in germination and yield due to the spring migrations of infective leafhoppers. Experiments were therefore made in the Salt River Valley of Arizona from 1964 to 1967 to determine the comparative effects of the fall and spring infestations of curly top infective beet leafhoppers.

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[1] In cooperation with the University of Arizona Agricultural Experiment Station.

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[3] Numbers in parentheses refer to literature cited.

Materials and Methods

The field test plots[4] were 20 ft long and 2 rows wide (1 bed) with a 2-row buffer strip of untreated beets on each side and a 5-ft cleared alley at each end. Soon after the plants had bolted, the seed stalks in the buffer rows were cut off to prevent tangling with the plot rows; later, wires were stretched to prevent lodging. A monogerm curly top susceptible variety (GW-806) was used, and curly top inoculations were made by placing muslin cages over each plot and introducing infective beet leafhoppers from greenhouse colonies. Cages were of sufficient size to cover the plots (Figure 1). Thus when the plants were smaller, the cages were 24 in wide, 20 in tall and 20 ft long. Later, they were 30 in × 30 in × 20 ft. Finally, with the larger plants in April 1967, they were 36 in × 48 in × 20 ft.

The beet leafhoppers used to inoculate the test plots were either reared in the greenhouse on sugarbeets or gathered from weed hosts in the field. From 5 to 7 days before they were introduced into the field cages, they were caged on curly top infected sugarbeets. It was planned to use more leafhoppers per plot on larger plants in the spring than on smaller plants in the fall. However, numbers introduced were sometimes limited by the supply. The curly top inoculum was obtained by transplanting curly top infective beet plants from the field to the greenhouse. Virus strains used in 1964-65 were unknown, but the inoculum used in 1966-67 was identified by Dr. C. W. Bennett[5] as strain 11.

Each of the 3 years, the plots were arranged in a 6 × 6 Latin square. The test design called for two introductions of infective leafhoppers in the fall and three in the spring; one series of six plots was to remain uninfested as a check. However, because of inclement weather, irrigation, rapid plant growth, or a shortage of leafhoppers, it was not always possible to complete the full complement of infestations.

In 1964-65, the infective leafhoppers were introduced into the field cages by taking the colonies to the field, aspirating them from the colony cages, and blowing them through three small holes evenly spaced along the tops of the muslin covers. This same procedure was followed in October 1965, but infestations in April and March 1966 and all introductions of 1966-67 were made by anesthetizing the leafhoppers with CO_2,

[4] Field plots were provided by the Western Seed Production Corporation, Phoenix, Arizona.

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Figure 1.—Plots of sugarbeets covered with muslin to confine curly top infective beet leafhoppers. October 24-31, 1966.

turning back the cage covers, sprinkling the anesthetized leafhoppers along the rows and quickly replacing the covers. After the desired exposure, the plants within the cages were dusted with 2% parathion by inserting the duster tube through the ends of the cages; after which the covers were removed.

At maturity the seed from each plot was harvested and cleaned in accordance with commercial practice. Criteria of damage was seed yield (pounds per acre) and quality (percentage germination). Also, in 1965-66, the number of seed balls per ounce was determined. Reduction in yield or germination was calculated against the means for all control plots for each year.

Results

1964-65 tests

Two fall and two spring infestations were made; thus 12 plots were uninfested. Table 1 shows a 16% reduction in yield in the plots infested in February. However, these insects were left on the plants 7 instead of 4 days because it was assumed that cold weather would partially inactivate the leafhoppers. This longer exposure may have been responsible for the greater reduction in yield. Also, the infestations in November caused a 6% reduction in yield. The reductions computed against the mean yield of the 12 untreated plots amounted to a loss of 513 and 198 pounds per acre, respectively, for the February and

Table I.—Yield and germination of beet seed from experimental plots infested at various dates with curly top infective beet leafhoppers (Phoenix, Arizona).

Date of infestation	Plant development at time of infestation	Leafhoppers introduced	Seed yield (lb/acre[1])	Percentage germination[1]	Percentage reduction in yield	Percentage reduction in germination
1964-65 tests						
Uninfested			3179 ab	63.8		
October 9-12	4-8 leaf stage	200-300	3108 ab	66.2		
November 27-30	Plants 20 in tall; complete coverage	300	2981 b	62.8	6	
February 5-12	Spring growth just starting	300	2666 c	60.8	16	
March 5-9	Vegetative growth; no bolting	250	3220 ab	58.3		
1965-66 tests						
Uninfested			4133 a	69.5 a		
October 14-18	4-6 leaf stage	175	3997 a	66.3 ab		
March 1-14	Plants topped 2/15; new growth by 3/1	350	2427 c	62.3	41	10
April 5-11	Bolting; seed stalks 20-30 in tall	586	3037 b	51.8 c	27	25
1966-67 tests						
Uninfested			2465 a	53.5 a		
October 24-31	6-9 leaf stage	400	1763 c	40.8 b	29	24
November 7-14	10-12 in tall; 70% coverage	800	1376 e	41.2 b	44	23
Feb. 24-March 2	Spring growth just starting	400	2206 b	56.3 a	11	
March 20-27	16-20 in tall	600	1471 de	42.2 b	40	21
April 13-20	Seed stalks 4 ft tall; flower bud	900	1663 cd	29.2 c	33	45

[1] Values not followed by the same letter are significantly different at the 5% level of confidence by Duncan's multiple range test; 1964-65 germinations not significant by the F test.

November infestations. No significant differences in germination due to treatment occurred, but the plots infested in March had a tendency toward a lower percentage of germination.

1965-66 tests

Only one fall and two spring infestations were made because of shortage of leafhoppers; thus 18 plots were uninfested. Also, the numbers introduced were not as large as desired. However, Table 1 shows that March infestations reduced yield 41% (1,706 pounds per acre) and germination 10%, and the April infestations reduced yield 27% (1,096 pounds per acre) and germination 25%. The percentage reductions in yield were calculated against the mean of all 18 uninfested plots; however, percentage germination was obtained for only one series of six uninfested plots. In April, the plots were exposed to 586 leafhoppers for 6 days compared with 350 leafhoppers for 13 days in March. (Because of cold, rainy weather during the first half of March, the period of infestation was extended).

In February 1966, foliage on the plots was unusually heavy. Therefore, the beets in all plots were topped on February 15, a common practice among many growers at that time. By the time of the March 1 infestation, new growth had started, but it was lower than at the time of the April infestation. This difference and the longer infestation period should have and apparently did provide adequate exposure to the leaphoppers even though the actual number introduced was less than in April.

Also, during these tests, any possible effect of curly top virus on the size of the seed was checked by determining the number of seeds per ounce for each plot. The mean number per treatment ranged from 3,689 to 4,334, but the differences were not significant.

1966-67 tests

All five infestations were made as planned, and one series of six uninfested plots was the control. A more severe exposure was attempted by the use of more infective leafhoppers and a longer time. In October, the beets were comparatively small, and the 400 leafhoppers probably gave a good exposure. However, in February the foliage was heavy, and more leafhoppers would have been desirable but were not available.

The results are shown in Table 1. All infestations reduced yield, and all except the February infestation also reduced the percentage of germinating seed. Also, the infestation just before blooming (April 13-20) reduced the percentage of germinating seed significantly more than other treatments. Losses in yield ranged from 259 pounds per acre for the February infestation to 1,089 pounds per acre for the November infestation. However, both yield and germination were much lower even in the uninfested plots than for the 2 previous years. Perhaps the native beet leafhoppers that were seen in the plots during the spring may account for at least some of this reduction.

Discussion and Conclusions

The heavy infestations of curly top infective beet leafhoppers in sugarbeets grown for seed caused reductions in yield that were sometimes accompanied by a lower percentage of germinating seed. Despite earlier reports that the early fall infestations cause the greatest reductions in yield, our test results did not consistently support this view. Sugarbeets grown for seed in southern Arizona are unthinned, and usually the test plots had more than 12 plants per foot of row. Many plants in the plots infested in the fall were so severely affected by curly top that they did not contribute to the seed yield, but the comparatively short exposure left enough healthy plants to produce a satisfactory yield. Under field conditions if leafhoppers are allowed to remain in the field for a longer time, many more plants become infected and much greater loss can be expected.

The effect of curly top virus on the yield of sugarbeet seed has been known for some time, but the effect on the viability of the seed was not proved. The data presented here show that the greatest reduction in the percentage of germinating seed occurs when curly top infective beet leafhoppers invade the fields just as the plants are approaching the bloom stage. Since the symptoms of the disease resulting from these late inoculations are not always easy to see, late season migrations of leafhoppers into the beet fields have been considered of comparatively little importance. However, results of these tests indicate that fields of seed beets should be watched for spring beet leafhopper infestations and control measures applied if necessary.

Summary

The effect of fall and spring infestations of curly top infective beet leafhoppers on sugarbeets grown for seed were compared in artificially infested field plots.

Infestation was accomplished by caging entire plots during the exposure period. Both fall and spring infestations reduced seed yields, and sometimes the germination of the seed was also affected. The greatest reductions in germination resulted from infestations that occurred just before the plants bloomed. Seed size was apparently unaffected by the virus.

Literature Cited

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