Beet" Varietal and Species Reactions to the 1953 Curly Top Exposure at Jerome, Idaho

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Introduction

It is well known that the curly top disease caused almost complete abandonment of the sugar beet industry in several western states from 1916 to 1934. This disease still causes severe injury to tomatoes, some bean varieties, and a number of other crops. Curly top is characterized by sporadic and destructive outbreaks, but farmers can now plant resistant sugar beet varieties with confidence that the crop will yield reasonably well, despite some loss in the worst years. However, it cannot be said that curly top has vanished, nor has the curly top problem completely disappeared. Some lines of sugar beets possess outstanding characters and yet are susceptible to curly top, which restricts their utilization. Notable in this respect were the *new* monogerm races discovered by Dr. V. F. Savitsky in 1948.

The sugar beet breeding program has its complications. Not only is curly top sporadic so that natural conditions cannot be depended upon to give the desired exposure every year, but curly top is also made up of numerous strains which produce different symptoms and effects (4) [2]. Added to the difficulty with symptoms is the discovery by Bennett (1) concerning vein clearing which is usually one of the earliest curly top symptoms noted on young leaves of sugar beets. He has shown that certain non-viruliferous beet leafhoppers from stock cultures or field collections, when fed on seedling sugar beet plants, occasionally induce a *vein* clearing similar to that produced by curly-top virus but which is not curly top. Thus, many factors must be considered when evaluating new breeding material.

Methods

For the past sixteen years of breeding, the natural exposure to curly top in the experimental fields has been augmented to a certain extent by artificial means. A previous paper (5) reports some of the methods devised to bring about the desired curly top exposure for test purposes.

In 1953, crosswise strips of the susceptible Klein E variety from Germany (also known as R. and G. Old Type) were planted May 6. These strips were 15 feet wide and 100 feet apart (Figure 1). In addition to these crosswise strips, Klein E seed was also used for planting the buffers on each end of the field. These buffer strips varied in width from 15 to 50 feet. In every other row in these crosswise strips, a diseased beet from the previous season was transplanted. Beet leafhopper developed abundantly on the susceptible variety. Test material was planted June 15 and July 16 at right angles to the crosswise strips planted May 6. When beets from these plantings emerged the leafhoppers moved in on the small seedlings in great numbers from the crosswise-planted sugar beets. This brought about very severe curly top injury and a very high mortality.

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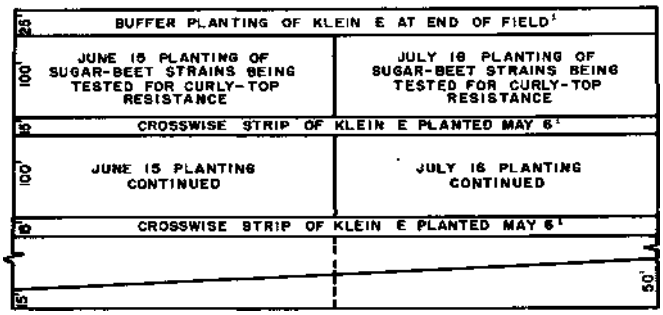

Figure 1.—Diagram of part of 1953 experiment field showing Klein E planted in crosswise strips and as a buffer at end of field.

[1] Diseased beet roots from previous season transplanted in single row 44 inches apart in crosswise and buffer strips.

Results

Table 1 shows results of the reaction of some well known varieties to a moderate and a drastic curly top exposure.

Table 1.—Reaction of Some Sugar Beet Varieties Under a Moderate and a Drastic Curly Top Exposure.

Variety	Moderate exposure 1952 Planted July 1 Curly top grade[1] in Sept.	Drastic exposure 1953 Planted June 15 Curly top grade in Sept.
Klein E. (SL 1300)	8	10
U. S. 33 (SL 939)	6	9
U. S. 22/3 (SL 96)	4	7
Beta trigyna	0	Definite symptoms
Beta patellaris	0	do.

[1] Curly top grades 1 to 10 represent successive degrees of injury; 0 represents no injury and no obvious infection.

In 1953 there was almost perfect timing in bringing together factors natural to the area and the experimental procedure which produced the most drastic curly top exposure ever observed by workers on the curly top problem. The disease exposure was so severe that it swept the field clear of all but the most highly resistant forms. For this reason it was not possible to make any selections in any but the most highly resistant varieties.

By use of specially treated seed (6) furnished by Dr. Helen Savitsky, excellent stands of beets from two wild species, *Beta trigyna* and *Beta patellaris* were obtained in the June 15 planting. As far as can be determined, this is the first report of these two highly resistant *Beta* species taking curly top under field conditions. *Beta patellaris* has been reported immune to curly top (2). The 1953 exposure was so severe that many plants in these

two species showed what appeared to be curly top symptoms. By use of non-viruliferous leafhoppers fed on leaves of these plants, test inoculations were made to new healthy sugar beets under careful control at the Riverside, California, laboratory. These tests definitely established that *Beta trigna* and *Beta patellaris* plants exposed to curly top under the severe disease exposure at Jerome, Idaho, were infected with curly top.

Some *Beta patellaris* plants were dwarfed in August and by September the vascular tissue in the stems turned black but there was no leaf distortion. It was of interest to note that these *Beta patellaris* plants were excellent leafhopper hosts and hundreds of leafhoppers were observed feeding on the relatively large single plants.

Beta trigyna plants showed vein clearing in August and some vein swelling in September. By October *Beta trigyna* gained remarkably and showed little injury, whereas the large *Beta patellaris* plants became badly injured. After the middle of October further comparison between these two species was impossible, because *Beta patellaris,* which is very susceptible to frost injury, was frozen and killed. *Beta trigyna,* on the other hand, is very resistant to frost injury and it continued to grow and made still further lccovery. By November 1 the *Beta trigyna* plants had recovered so well that they showed only a trace of curly top injury.

Discussion

Spring temperatures in 1953 were abnormally low. Average temperatures compared to normal were —2.0° F. for April, —4.4° F. for May and —1.6° F. for June. The precipitation in May and June was above normal. These conditions were very unfavorable for the development of curly top and, consequently, the epidemic in the crosswise strips planted May 6 was slow getting under way. On the other hand, temperatures for the rest of the year were abnormally high, with not more than a trace of precipitation in July, August and September. Both the low precipitation and high temperatures of July, August and September were very favorable for the rapid development of curly top.

Data on leafhopper migrations were supplied through the courtesy of }. R. Douglass (3). These data, obtained from sugar beet fields similarly located to the experimental field *(i.e.,* close to the desert breeding area) , showed that the 1953 beet leafhopper *(Circulifer tenellus,* Bak.) population ranged from three leafhoppers per 100 plants on May 4 to 791 per 100 plants on July 3 when the peak was reached. Combinations of factors favorable for the development of a drastic curly top epidemic in these plantings were: abnormally high temperatures, low humidity and an average beet leafhopper population plus virulent forms of virus from adjacent earlier crosswise-planted beets. By the end of July it was quite obvious that the 1953 epidemic was going to be the most severe yet produced in our experimental fields.

For improvement of curly-top-resistant sugar beets, there are reasons for making outcrosses to curly-top-susceptible varieties for incorporation of other desired characters, such as increased yield, sucrose content, greater adaptation to a range of environmental conditions, resistance to other dis-

eases, and incorporation of the monogcrm character. It has been observed that, in making hybrids to be grown in curly top areas, if one parent is susceptible, the higher the curly top resistance in the other parent the greater the probability of success.

In the development of higher resistant varieties from hybrids between susceptible and resistant types, it has been found that the selection process needs to be several short steps rather than one big step, because even if a few roots do survive a severe expo ure it may be impossible to produce seed from them. It takes about four successive selections for recovery of satisfactory resistance, depending upon the method used and the degree of resistance sought. The curly top exposure for the first selection should be moderate, the second relatively heavy, the third severe, while the fourth should be a drastic exposure. This drastic exposure is required to bring out small differences in curly top reaction between individual beets and to show differences between different highly resistant varieties.

Summary

In 1953 the artificial curly top epidemic in the experimental beet breeding field was so extremely severe that it completely annihilated all but the most highly resistant sugar beet material. On the other hand, the" yield of the commercial crop in southern Idaho was the highest on record. This seemingly paradoxical situation came about by the almost perfect synchronization of factors favorable to growth of beets in early, normal, commercial plants on the one hand, and to unfavorable conditions for survival and growth of beets under the artificial conditions set up in the experimental field.

This experience emphasizes the advisability of sugar beet breeders maintaining the highest possible degree of curly top resistance and combining this with other desirable characters, because: 1. the curly top disease may suddenly make its appearance in areas where normally it does not occur; and 2. it may appear under conditions very favorable for the development of the disease, but at the same time unfavorable for the best development of the sugar beet crop. Under either of these extreme conditions, curly top will still take some toll, even from varieties relatively resistant to curly top.

Literature Cited

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