Pathogenicity of Curly Top Virus Isolates from Utah and Idaho on Several Hosts[1]

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Introduction

Curly top virus comprises a number of strains differing in their ability to infect and incite disease symptoms on several plant hosts. In 1944 Giddings described 10 strains which he differentiated according to their pathogenicity on sugarbeet (*Beta vulgaris* L.) varieties SL742 and SL68, Turkish tobacco (*Nicotiana tabacum* L.) and field bean (*Phaseolus vulgaris* L.) variety Red Mexican (4)[3]. Giddings (5) and Bennett (1) subsequently reported virus strains with greater virulence on sugarbeet varieties designated as resistant. Striking differences in reaction of two curly top resistant tomato (*Lycopersicon esculentum* Mill.) lines and *Lycopersicon pimpinellifolium* Mill, to curly top in different areas of the western United States suggest the existence of curly top strains differing in ability to attack these hosts (6,7). Bennett (2) reported curly top strains incapable of attacking *Capsella bursa-pastoris* (L.) Medik. in contrast to many strains that readily do. Thomas (8) differentiated five distinct strains of curly top virus according to severity of symptoms on *Nicotiana glutinosoa,* sugarbeet and tomato.

This paper reports on the inoculation of several plant species with over 30 curly top virus isolates collected by the author in northern Utah and southern Idaho in 1962 and 1963. The objectives of the study were to determine the extent of pathogenic variation among the isolates on the test hosts, to identify the strain or strains that the isolates comprised, and to determine if the relative degree of virulence of an isolate on one sugarbeet variety is indicative of its relative degree of virulence on other sugarbeet varieties.

Materials and Methods

Thirty-one of the virus cultures tested were derived from sugarbeet plants with curly top symptoms collected in Box Elder, Utah, Salt Lake and Cache Counties in Utah and Jerome

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[3] Numbers in parentheses refer to literature cited.

County, Idaho. Ten of the cultures were derived from greenhouse-grown sugarbeet plants that had developed curly top after exposure to beet leafhoppers *(Circulifer tenellus* Baker), collected in a desert area in Box Elder County, Utah.

Subcultures of the virus were made in a manner designed to screen out the less virulent strains and to decrease the likelihood of the occurrence of strain mixtures. Non-viruliferous leafhoppers were caged on the curly top plants for 7 days, to acquire the virus. The insects were then placed individually in small glass cages (3) on seedling cotyledons of curly top-resistant sugarbeet variety SL68 for relatively short feeding periods of 8 to 12 hours. From among the comparatively few plants that subsequently developed curly top symptoms (approximately 16%), those that showed severe disease symptoms were selected as sources of the subcultures.

The pathogenicity of the curly top isolates on seedlings of the following hosts was then determined by greenhouse inoculations: sugarbeet varieties SL68, US75, SL742 tomato Line 193; Turkish tobacco variety Samsoun; and *Capsella bursa-pastoris.* Leafhoppers from a non-viruliferous colony were confined on the virus source plants for 7 days then were transferred to the test seedlings for a like period. On all hosts except tobacco, two insects—each in a small glass cage—were placed on each plant. One cage was attached to each cotyledon of seedlings that were planted four per 6-inch pot. Ten insects were placed in a lamp chimney cage covering each young tobacco plant in a 4-inch pot. Twenty plants of each test host except tobacco were inoculated with each isolate. In each test, five to 10 tobacco plants were exposed to each isolate, and most isolates were tested at least twice.

Six weeks after inoculation, each test plant was assigned a numerical rating according to severity of disease symptoms and an average disease severity rating was computed. A rating of 0 indicates no symptoms. Ratings of 1 to 3 inclusive, indicate mild symptoms, including vein clearing, protuberances and slight leaf curling. Ratings from 4 to 6 inclusive, indicate moderate symptoms, including slight stunting. A rating of 7 indicates pronounced stunting and leaf curling, 8 indicates a moribund plant and 9 indicates a dead plant. Plants that were rated 0 were usually not included in the computations of average disease ratings because of the difficulty in distinguishing between inoculated plants that show no symptoms, and those that may have escaped infection. In exceptional instances where all of the inoculated plants showed no symptoms an average rating of 0 was assigned.

Among the 41 virus isolates tested on the sugarbeet varieties, 28 were tested twice and 13 were tested once. Most of the inoculation tests on Turkish tobacco were repeated, in some cases three or four times. On other hosts inoculations were conducted once with each isolate.

Results and Discussion

On sugarbeet varieties SL68 and US75, tomato, *L. pimpinellifolium* and *C. bursa-pastoris,* the curly top isolates incited disease reactions ranging from moderate (numerical ratings of 3.1-6.0) to severe (ratings of 6.1-9.0) in intensity (Table 1). All isolates incited a severe reaction on SL742 sugarbeet variety. None of the isolates incited a mild reaction on any host.

Table 1.—Distribution of curly top virus isolates from Utah and Idaho according to severity of disease incited on seven plant hosts.

Plant species and variety	Number of isolates in indicated disease severity classes[1]							Total no. of isolates tested
	0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0	7.1-8.0	8.1-9.0	
Sugarbeet, var. SL68	—	4	25	12	1	—	—	42
Sugarbeet, var. US75	—	—	10	21	8	—	—	39
Sugarbeet, var. SL742	—	—	—	—	10	27	5	42
Turkish tobacco var. Samsoun	2[2]	1	4	9	11	13	2	42
Tomato, Line 193	—	—	. .	9	15	7	1	32
Lycopersicon pimpinellifolium	—	—	4	14	9	5	. .	32
Capsella bursa-pastoris	—	—	1	3	9	15	. .	32

[1] Disease severity classes based on an index ranging from 0 (no symptoms) to 9 (plant dead).

[2] Results based on exposure of 22 plants to one isolate and 24 plants to the other.

Two isolates, both subcultures from the same virus source plant, failed to incite symptoms on Turkish tobacco in several inoculation tests but were pathogenic on all of the other test hosts. Sugarbeet varieties SL68, US75 and SL742 inoculated with one of the isolates (B6A) showed disease severity ratings of 3.9, 5.3 and 7.5 and inoculated with the other isolate (B6D) showed disease ratings of 4.7, 5.6 and 7.2, respectively.

On the basis of the reactions of the test species—with the exception of Turkish tobacco—the isolates did not separate into distinct pathogenic strains. Instead, they were distributed into three or four contiguous disease severity classes according to the reactions of each host. Additional testing would be required to determine if the differences in virulence noted in this study are consistent enough and of sufficient magnitude to separate the isolates into pathogenic strains.

Most of the isolates appeared similar to Strain 1, the only strain in Giddings' classification described as moderately severe

on variety SL68 and pathogenic on tobacco. One isolate incited a severe reaction (rating of 6.1) on SL68, indicating a similarity to Strain 11, which incites severe symptoms on sugarbeet varieties that had been designated as highly resistant to curly top, including SL68 (5).

The two isolates that failed to incite symptoms on Turkish tobacco did not fit any descriptions in Giddings' key. Of the three strains described by Giddings that are non-pathogenic on tobacco, two are non-pathogenic on tomato and one is non-pathogenic on SL68. Since the two isolates in question were pathogenic on both of these hosts it is likely that they represent an isolate that hitherto has not been reported in the literature.

Correlation coefficients between disease severity ratings of the 28 curly top isolates tested twice on each of the three sugarbeet varieties were calculated. The correlation coefficients between ratings on SL68 and SL75, SL68 and SL742, and US75 and SL742 equal .54**, .42* and .58**, respectively. This means that the isolates tended to occur in the same order of virulence on each of the three varieties. No isolate in this study showed relatively low virulence on one variety and relatively high virulence on another. Should isolates ever be found that show such selective virulence on sugarbeet varieties designated as curly top resistant, they would have to be taken into account in curly top resistance breeding programs.

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