The Effect of Sterile Cytoplasm on Curly Top Disease Resistance[1]

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The discovery of cytoplasmic male sterility has made possible the large-scale, commercial production of hybrid varieties of many crops. In sugarbeets (*Beta vulgaris* L.), cytoplasmic male sterility provides the economically soundest means of developing superior varieties. Over 90% of the sugarbeet seed produced in the United States today is hybrid. It is produced with the aid of one source of cytoplasmic male sterility, discovered by Owen in 1945 (7).[3] Cytoplasmic male sterility has been found in several open-pollinated varieties of sugarbeets, but no substantial evidence exists that these sources are significantly different (3).

The outbreak of southern corn leaf blight in 1970, its significance, and the fact that susceptibility to this disease was associated with T-type sterile cytoplasm focused attention on the genetic vulnerability of major crops. Corn (*Zea mays* L.) became a victm of the epidemic because T-type sterile cytoplasm had been used universally in hybrids and a new, more virulent strain of the pathogen *Helminthosporium maydis* suddenly emerged. As early as 1961, Mercado and Lantican (4) noted that in the Philippines corn hybrids with T cytoplasm were more susceptible to *H. maydis* than other hybrids. However, research workers in the United States failed to note this association (3).

Sugarbeet breeders are concerned not only about the vulnerability of a single source of sterile cytoplasm, but also about the existence of a narrow genetic base for resistance to curly top, a virus disease spread by the sugarbeet leafhopper, *Circulifer tenellus* Baker. Curly top devastated sugarbeet yields in the early 1920's and almost became an insurmountable barrier to the beet-sugar industry in the western United States (2). New, more virulent strains have been reported in recent years (1, 6). This demonstrates the ever-present potential for evolution of a more virulent strain of curly top.

This genetic vulnerability of sugarbeets suggested an investigation into the possible relationship of sterile cytoplasm and the curly top

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disease in sugarbeets. The results of greenhouse and field tests at Logan, Utah are reported here.

Materials and Methods

Seed of eight pollinators and their cytoplasmic male sterile equivalent inbreds were germinated in vermiculite in the greenhouse. Seedlings in the cotyledon stage of development were transplanted to 15-cm pots of soil. Five replicates of four plants each were planted for each variety. Viruliferous leaf hoppers were placed in small cages on each plant, and standard inoculation techniques and evaluation procedures described by Schneider et al. (8) were followed. Isolate 66-10, more virulent than any other known strain of the curly top virus (6), was used as inoculum in this test. Each plant was classified visually on a 0-9 scale in which 0 represented a plant showing no curly top symptoms and 9, a dead plant.

Replicated field tests of 12 sugarbeet inbreds and their cytoplasmic male sterile equivalents were also conducted in 1971 and 1972. The method used for evaluation of curly top in the field has been previously described by Mumford (5).

Normal and sterile cytoplasm equivalents were compared by use of the standard t statistic.

Results and Discussion

In the greenhouse, three fertile lines were slightly more susceptible to curly top than their male sterile equivalent, and four other inbreds showed the opposite relationship (Table 1). The differences, however, were not significant.

Table 1. — Means of curly top reading (0 = no symptoms - 9 = dead plant) for cytoplasmic male sterile vs. normal fertile sugarbeet inbreds.

	Greenhouse 1971		Field 1971		Field 1972	
Inbred	Fertile	Sterile	Fertile	Sterile	Fertile	Sterile
L3	6.0	6.4	—	—	—	—
L-53	4.4	4.4	—	—	5.3	5.3
L28	—	—	—	—	4.6	4.3
L29	—	—	7.5	7.0	4.0	3.6
L33	3.0	3.6	—	—	3.0	3.0
EL31	—	—	—	—	8.0	8.0
EL32	6.8	6.3	—	—	7.0	7.0
A1-10	4.1	3.3	5.5	5.0	4.3	3.6
A1-12	—	—	6.5	5.5	5.6	5.3
NB-1	3.1	2.7	5.0	5.5	4.0	3.6
F.C.504	4.6	5.1	—	—	5.6	6.0
F.C.506	—	—	7.5	7.5	—	—
F.C.601	2.2	1.7	6.5	6.5	5.6	5.0
Mean	4.25	4.19	6.42	6.17	5.18	4.97
Calculated t	.43		.55		.21	

Two readings were made on the field tests for each year, one in August and the other in September. The varieties were similarly ranked for each reading, and only data for the September reading are given in Table 1. Fertile and sterile equivalents did not differ in curly top scores in 1971. In 1972 field tests, four sterile inbreds had identical curly top scores with their fertile counterparts. The other seven comparisons showed a slight but nonsignificant difference. In every case except one, the sterile equivalent had a lower score than the fertile counterpart. This trend, however, was probably due to chance, because no general consistency among the varieties was noted in the three tests.

The varieties were originally selected for wide differences in curly top resistance. Differences between varieties in all three tests were significant. These data demonstrate that apparently no association exists between the single source of sterile cytoplasm in sugarbeet and the curly top disease incited by isolate 66-10.

Sugarbeet breeders should not become complacent with the apparent negative association between sterile cytoplasm and curly top disease. Corn breeders in the United States failed to note any association between cytoplasms and *H. maydis* until the corn blight epidemic of the 70's (3). Sugarbeet researchers should be alert for new sources of sterile cytoplasm and for new, more virulent strains of curly top, and they should continue to test them for any association that could cause problems similar to corn leaf blight.

Abstract

The outbreak of southern corn leaf blight in 1970 and the association of disease susceptibility with T-type sterile cytoplasm focused attention on the genetic vulnerability of major crops.

Thirteen cytoplasmic male sterile and equivalent pollinator inbreds of sugarbeet (*Beta vulgaris* L.) were compared to determine any association between the single source of sterile cytoplasm in sugarbeets and susceptibility to the curly top virus disease. Field and greenhouse tests in 1971 and 1972 with 66-10, the most virulent strain of the virus known to date, indicated no difference between the equivalent normal and sterile genotypes in their susceptibility to curly top.

Key words — Sugarbeet disease, cytoplasmic male sterility, genetic vulnerability, virus disease

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