Selecting Sugar Beet Seedlings for Resistance to Aphanomyces Cochlioides

GERALD E. COE AND C. L. SCHNEIDER[1]

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Aphanomyces cochlioides Drechs. is a major pathogen of the black root disease of sugar beets in the Great Lakes region, but serious losses from this pathogen are prevented by using resistant varieties. In 1940, Coons, *et al.* (1)[2] observed that some varieties differed in resistance to the chronic phase of the disease. Later, A. R. Downie and J. O. Culbertson, and records taken by J. H. Torrie, confirmed these observations. Soon after that, Henderson and Bockstahler (3) and Doxtator and Downie (2) began field selections for resistance and reported some success. These early efforts resulted in the production of US 400, US 401, and American Crystal No. 3, commercial multigerm varieties with reasonably good yields under moderate epidemics of black root. However, many sugar beet districts of the Great Lakes region need a higher level of resistance.

Frequently, field testing and field selecting are unsatisfactory because of low disease intensity or lack of uniformity of exposure in the testing plot and the masking effect of environmental and nutritional factors. Methods have been developed (4,5,6) to test seedlings in the greenhouse for resistance to *A. cochlioides*. The greenhouse test has several advantages over the field tests: a) adequate disease epidemics can be attained in every test; b) the desired disease severity can be established according to the tolerance of the population; and c) pathogenic organisms other than *A. cochlioides* are excluded.

By inoculating 7- to 10-day-old sugar beet seedlings (grown in 6-inch saucers) with zoospores of the pathogen, breeding lines can be screened to eliminate those with least resistance. Approximately one-third of the breeding material tested in the greenhouse is placed in the nursery trials; the remaining two-thirds is discarded.

In the greenhouse tests, some plants are relatively vigorous, suffer little, and recover rapidly; other plants weaken and die. The healthiest, most vigorous seedlings were selected to determine whether they had more resistance or had simply escaped

[1] Geneticist and Pathologist, respectively, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland, and Logan, Utah, respectively.

[2] Numbers in parentheses refer to literature cited.

the disease. The selected plants were transplanted from the saucers to 6-inch pots. After they were established, up to 10 million zoospores were added to each pot to confirm resistance. Only a few of the primary selections suffered severe damage. In the spring, the surviving plants were planted in the nursery plot

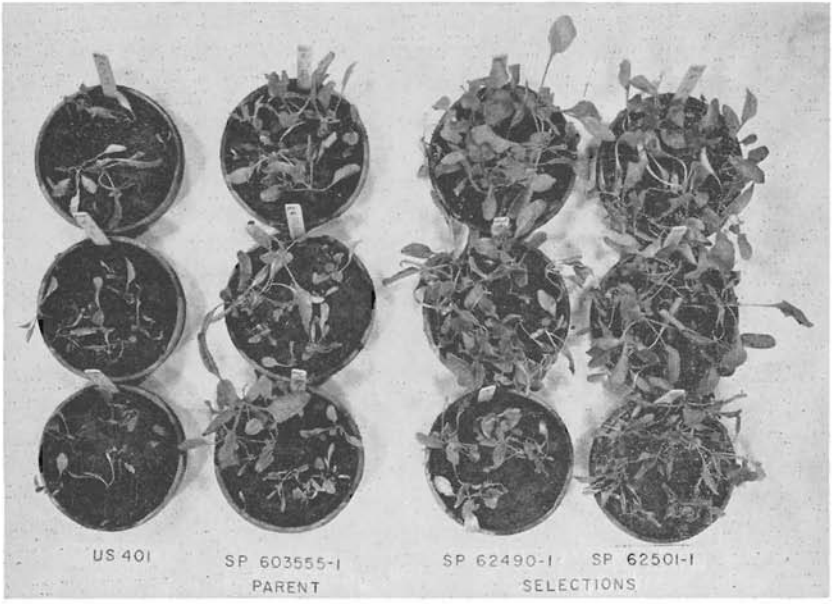

Figure 1.—Varieties of sugar beet showing different degrees of tolerance after testing for resistance to black root. Left to right: US 401, SP 603555-1, SP 62490-1, and SP 62501-1. SP 62490-1 and SP 62501-1 are progenies of plants selected from SP 603555-1.

Table 1.—Comparison between populations of parental lines and progenies of sugar beet seedlings selected for resistance to *Aphanomyces cochlioides*.

Parental material	No. of plants selected	Progenies more resistant	Progenies as resistant	Progenies less resistant
		Percent	Percent	Percent
1959 Selection:				
Open-pollinated monogerm progenies	113	69.9	13.3	16.8
F_1 hybrids monogerm-multigerm	35	54.3	14.3	31.4
1961 Selection:				
Open-pollinated multigerm progenies	39	44.8	24.2	31.0
Open-pollinated monogerm progenies	125	51.2	25.6	23.2
F_1 hybrids monogerm-multigerm	45	22.2	40.0	37.8

for further growth; in the fall, they were harvested and placed in storage for the winter. The following spring they were transplanted in groups to isolation plots for seed production, according to the type of breeding material from which they were selected—monogerm, multigerm, and F_1 hybrids between monogerm and multigerm lines. Seed was harvested separately from each plant. These progenies and the parental varieties were then exposed simultaneously to the pathogen in greenhouse tests for direct comparisons.

Disease resistance was evaluated by two methods. First, a mean disease severity index of each entry was computed by assigning a numerical rating to each surviving plant according to severity of symptoms, totaling the individual plant scores, and dividing by the number of plants inoculated. In the second method, a numerical rating expressing the foliage vigor of the surviving plants was assigned to each entry. Scores obtained by the two methods generally agreed.

Two progenies which were more resistant in the greenhouse test than the parental stock from which they came are shown in Figure 1. Both parent and progenies were more resistant than US 401—the resistant check variety in the three saucers on the left.

Results of experiments on selections made in 1959 and 1961 are shown in Table 1. About 50 percent of the selected plants produced progenies more resistant to black root than the parental lines. About 25 percent produced less resistant progenies. The remainder equaled their respective parents. The percentage of selected plants that produced progenies with increased resistance to black root was less from F_1 hybrid lines than from open-pollinated lines.

Discussion and Conclusions

There is no indication that tolerance to black root is conditioned by a single Mendelian gene. The evidence indicates that resistance is influenced by many genetic factors. It has not been possible to select, from a susceptible variety, plants capable of producing progenies with a very high degree of resistance. On the other hand, a higher degree of resistance has been attained by selecting for several generations. Various degrees of tolerance were observed among plants within a single progeny. However, this might be attributed to micro-environmental factors. Since some plants selected for apparent resistance to Aphanomyces do not produce progenies with improved resistance, it is assumed that they partially escape the disease, that the inheritance of resistance is complex, or that both conditions occur.

The seedling selection technique is being utilized to improve resistance to black root by obtaining seed increases from selected plants whose progenies appear more resistant than the parental line from which selections were made.

From the results of the experiments we conclude that:

a). It is necessary to test progenies of selected plants to determine which selections better resist black root than their respective parent lines.

b). Seedling vigor resulting from heterosis may contribute to apparent resistance in the F_1 plants, because in each of the 2 years in which selections were made, the percentage of selected plants with better resistance was less from F_1 hybrid lines than from open-pollinated lines.

c). A better standard of selection is needed to increase the percentage of selected seedlings with improved resistance. The various characteristics upon which judgment is based are being studied to develop a more effective criterion for selection.

Summary

The healthiest, most vigorous sugar beet seedlings were selected from greenhouse tests for resistance to the root rotting disease caused by *Aphanomyces cochlioides*. Of the selected plants, 53 percent produced progenies having more resistance than the parent lines from which selections were made, and 24 percent produced progenies having less resistance. Although the existing method of sugar beet seedling selection may be used to improve resistance to black root, a more effective selection criterion is needed.

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