Testing of Inbred Lines of Sugar Beets for Resistance to Aphanomyces, Rhizoctonia and Fusarium Root Rots[1]

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A large number of open pollinated and inbred lines of sugar beets have been tested for their resistance to Aphanomyces, Rhizoctonia and Fusarium root rots since 1950 (4, 5, 6)[3].

In earlier work in this laboratory, many open pollinated lines of beets were tested for their resistance to these diseases. Later on, studies were conducted mainly with inbred lines of beets since they represent a population of greater genetic uniformity. Seeds of such open pollinated lines of beets were received, mainly from various commercial sugar beet companies. Seeds of inbred lines of beets were supplied through the Beet Sugar Development Foundation.

In all tests a mixture of inoculum was used for each of the following pathogenic organisms: *Aphanomyces cochlioides* Drechs.; *Pellicularia filamentosa* (Pat.) Rogers, (*Rhizoctonia solani);* and *Fusarium oxysporum* f. *betae* (D. Stewart) Snyder and Hansen. Pure cultures of these organisms were isolated from infected sugar beets. The virulence of these cultures was determined regularly in separate tests.

The inocula for these tests usually were prepared by growing the fungi in petri dishes containing potato dextrose or oatmeal agar. After a sufficient amount of growth developed, it was scraped off the agar, homogenized in a blender and added to steam-sterilized soil in pots immediately after beet seeds were planted. Usually one petri dish of inoculum was used per seven- or eight-inch pot of soil.

In most of the testing, the following technique was used: All beet lines were submitted first to a screening test for three root rots (6). Those lines which showed a good degree of resistance to any of these diseases in the screening test were retained for further testing. After the first cycle of selection, five apparently resistant beets from each line which showed resistance were either selfed or sib-mated depending on whether they were self fertile or self sterile. The seeds produced from these beets were tested again for resistance to the same disease for which the line

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[3] Numbers in parentheses refer to literature cited.

was selected and only those lines of beets were retained which showed an outstanding degree of resistance.

After the second cycle, resistant beets from self-fertile lines were selfed while resistant beets from self-sterile lines were grouped according to which disease they were resistant to and cross pollinated. An attempt was made to produce a large amount of seed from these beets in order to perform large-scale tests either in the field or in the greenhouse. Prior to large-scale testing, all lines of beets obtained through cross pollination were again tested in the greenhouse and all susceptible entries were discarded.

In the first two cycles of testing, resistance of beets to each respective root rot disease was tested in the seedling stage and beets were harvested usually about six weeks after emergence. During the last test, when they were tested on a large scale, they were allowed to grow for several months in order to test for resistance at an older plant stage. Readings of healthy and diseased beets were always taken during the growing season and at harvest. Table 1 gives coding identification and source for various sugar beet entries reported in this paper.

Table 1.—Coding system and sources for the various sugar beet entries.

Code	Source
US	USDA, Beltsville, Maryland
SP	USDA, Beltsville, Maryland
SL	U.S. Sugar Plant Field Laboratory, Salt Lake City, Utah
SLC	U.S. Sugar Plant Field Laboratory, Salt Lake City, Utah
D	USDA, Fort Collins, Colorado
FC	USDA, Fort Collins, Colorado
GW	The Great Western Sugar Company, Denver, Colorado
ACS	American Crystal Sugar Company, Denver, Colorado
HSC	Holly Sugar Corporation, Colorado Springs, Colorado
TASCO	The Amalgamated Sugar Company, Ogden, Utah
AC	Michigan State University, East Lansing, Michigan

Aphanomyces Root Rot

None of the tested lines of sugar beets consistently showed a high degree of resistance to Aphanomyces root rot in the greenhouse tests. Greater differences in disease resistance between lines may have been detected at a lower concentration of inoculum. Even though there does not appear to be a specific resistance among these lines of beets to the disease, some beet lines were more resistant than others and beets may become infected and still recover sufficiently to give a satisfactory stand. There was

some variation between tests in disease ratings for the inbred lines and their progenies. These variations may have been due to some differences in the growing conditions and in the concentration of inoculum.

The following eight lines of beets showed a higher degree of resistance to Aphanomyces root rot than the others:

US acc - 1241	SP5270-0
D1952-359	GWI-42
D1952-441	GWI-44
SP5263-0	HSC5126-0

Under field conditions, beet lines were infected considerably less than in the greenhouse. This difference may have been due to lower inoculum concentrations in the field or to a difference in other environmental factors. It is quite possible that by exposing beets to a lower standardized inoculum in the greenhouse, similar to the method used by Schneider (7), one may be able to obtain a closer correlation between greenhouse and field tests. More work is required to clarify this situation.

In early work with Aphanomyces root rot it was shown that the seedling phase of this disease can be controlled fairly well in the field by improving the physical conditions of the soil and by providing sufficient and balanced fertilization (1, 2, 3). It is possible that this disease can be controlled satisfactorily by planting beet lines with a moderate degree of resistance to Aphanomyces root rot in soil well supplied with organic matter and fertilizers.

At the present time the supply of seed of the eight abovementioned beet lines, is being increased so that further tests can be conducted.

Rhizoctonia Root Rot

Most of the following 16 lines of beets showed only a moderate degree of resistance to Rhizoctonia root rot. The concentration of inoculum was undoubtedly an important factor in the performance of these tests. It appears that these lines of beets also do not have a specific resistance to this disease. Variation in disease ratings between tests was similar to that observed for Aphanomyces root rot:

AC9-406-0	SLC238	D1954-600	ACS-I_1
SL2-501-1-4	D1941-164	FC55-8055	ACS-I_8
SL028	D1950-351	SP5478-0	HSC5152-0
SLC207	D1950-540	GWI-5	TASCO 6-284

Fusarium Root Rot

A rather large number of beet lines showed a moderate to high degree of resistance to Fusarium root rot. When the original

seed or their progenies was tested, less variation in degree of resistance occurred for this disease than for Aphanomyces or Rhizoctonia root rots. It appears that resistance of these lines of beets to Fusarium root rot may be more specific in nature.

The following twenty-five lines of beets showed a fairly high degree of resistance to Fusarium root rot:

SL509	D1951-500	D1953-337	FC55-8022
SLC238	D1952-388	D1954-315	FC55-8034
D1950-444	D1952-393	D1954-593	AC32;57302
D1950-558	D1952-443	D1954-467	AC310;851909
D1951-319	D1952-444	FC55-8027	GWI-8-55L
D1951-356	D1953-328	FC55-8057	GWI-43
			ACS-14

Further tests will be conducted with those lines which showed the highest degree of resistance to each of the three root rots discussed.

It appears that the use of a standard concentration of inoculum is an important factor in the evaluation of the resistance of beet lines. Evidently the concentration of the inoculum used in these tests was considerably higher than in the disease exposure which beets encountered under ordinary field conditions. In further tests, standardization of inoculum will be made and especially in regard to testing beets for resistance to Aphanomyces root rot.

Screening of beet lines and selection within varieties has been most successful for Fusarium root rot, followed by Rhizoctonia and Aphanomyces. However, the development of a Rhizoctonia resistant varieties of beets would be most desirable since this disease causes the greatest loss in the Western sugar beet areas. Some inherent resistance apparently exists for Rhizoctonia and Aphanomyces root rots, but multigenic inheritance probably decreases the possibility of obtaining highly resistant varieties. Concentration of resistance genes by recurrent mass selection might result in development of beet varieties with higher degree of resistance to these root rots than the varieties presently grown.

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