Cooperative Field Testing of Strains of Sugar Beets for Resistance to Several Root Rotting Organisms

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The task of breeding for resistance to root rot is not a simple one. There are many factors and interactions of factors which add to the difficulties involved. The problem of securing an artificial epidemic of a root rotting organism in a particular soil does not always meet with success. At the present, at least, it appears that resistance to root rotting organisms might be obtained by the adding of small increments and not in one single selection. It is, therefore, quite possible to lose what little resistance that might be present early in the process of selection. Also, the selection of "escapes" may quite often complicate the program, especially if the soil complex is at all unsuitable for the creation of an artificial epidemic.

Materials and Methods

The problem of obtaining artificial field epidemics for the four different root rotting organisms would be quite difficult at any one location. Fortunately the American Crystal Sugar Company had access to three Aphanomyces-infested field areas in Minnesota and Iowa and also to sclerotium-infested fields in California. The Great Western Sugar Company located a fusarium-infested field at Sterling, Colorado. The University of Nebraska, at the Scottsbluff Experiment Station, had a plot series which had grown sugar beets continuously for the past 40 years and the soil was badly infested with rhizoctonia. These locations served admirably for the testing of the various beet strains.

Table 1.—Results of Testing Beet Strains in Rhizoctonia-infested soil at Scottsbluff Field Station, Mitchell, Nebraska—1950.

Beet Strain	Germ. Stand Seedlings per ft. of row[1]	Final Stand in % of post-thinning stand[1]	Wt. of Beets 125 Ft. of row Unfertilized[2]	Wt. of Beets 125 Ft. of row Fertilized[2]
Nebr. 525	13.5	56.1	51.6	133.3
G.W. B526	8.5	38.8	39.0	87.3
G.W. 304	7.0	51.2	45.6	129.1
G.W. 208	7.0	36.8	51.2	94.0
G.W. B116	5.0	52.9	37.8	130.2
A.C.S. 7-609-X	10.5	55.3	44.2	131.3

[1] Six replications, three unfertilized and three fertilized.
[2] Three replications.

Rhizoctonia Root Rot—1950

A test was made at the Scottsbluff Station in 1950 in which six beet strains were planted. The strains were G.W. 304, G.W. B526, G.W. 208, G.W. B116, A.C.S. 7-609-X and Nebraska 525. The latter was a selection for rhizoctonia resistance by Dr. M. L. Schuster out of the Great Western variety G.W. 526. The American Crystal strain 7-609-X was a selection for resistance to aphanomyces. The stand counts and the yields for this test are presented in Table 1.

The results of this test indicate that the Nebraska 525 selection was definitely superior to the parent strain G.W. B526. This superiority is the result of selecting over a period of two years. Also, it may be noted that

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the G.W. 304, which is a commercial variety, also ranked fairly close to the top as did G.W. B116 and A.C.S. 7-609-X.

Aphanomyces Root Rot Tests—1951

This cooperative effort was expanded in 1951 and tests were made using representative varieties for resistance to *Aphanomyces cochlioides*, Drechsler; *Rhizoctonia solani, Fusarium conglutinans* Wr. var. betae Stewart, and for *Sclerotium rolfsii* Sacc.

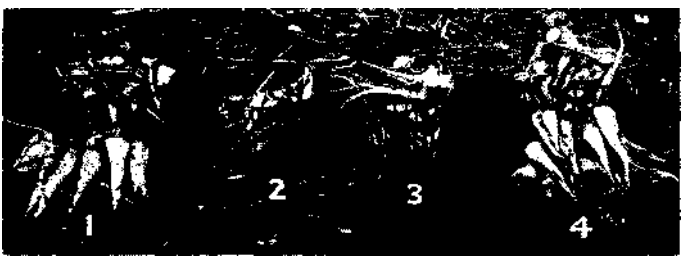

Figure 1. - Representative yields of four sugar beet strains grown in soil infested with Rhizoctonia at Scottsbluff in 1950. 1. A.C.S. 7-609-X. 2. Susceptible Strain. 3. G.W. B526. 4. Nebraska 525.

The tests for resistance to aphanomyces root rot were made at three places. The data for these tests are given in Table 2.

Table 2.—Yields of Beet Strains Selected for Resistance to Rhizoctonia, Sclerotium and Aphanomyces When Grown on Aphanomyces-infested Soil at Moorhead and at Waseca, Minnesota, and at Mason City, Iowa—1951.

Beet Strain	Originally Selected for resistance to:	Yield in Tons per A.			
		Moorhead	Waseca	Mason City	Ave.
A.C.S. 9-406-0	Aphanomyces root rot	11.41	12.16	8.66	10.74
A.C.S. 9-604-0	Aphanomyces root rot	9.75	8.61	7.76	8.71
Nebr. 525	Rhizoctonia root rot	6.30	4.46	5.44	5.40
A.C.S. 0-404	Rhizoctonia root rot	7.18	7.13	4.46	6.99
A.C.S. 0-403	Sclerotium root rot	6.37	5.52	4.95	5.61
Amer. No. 3 LSR	Commercial Variety	7.85	3.39	6.52	5.92
USDA 1-9-00	Very susceptible to Aphanomyces	3.62	1.52	3.86	3.00

The tests at Waseca and at Mason City were three replicate-randomized blocks while the test at Moorhead had six replications. In general, the beet strains behaved quite similarly at the three locations. The strains selected for aphanomyces resistance were highest in yield, while the strains selected for rhizoctonia and sclerotium pretty much fell in the same yield class as the commercial variety. The beet strain 1-9-00, which is the susceptible check, was the lowest in yield.

Rhizoctonia Root Rot Test—1951

A test similar to that which was made in 1950 was conducted on the

Table 3.—Yields and Stands of Beet Strains Grown on Rhizoctonia-infcsted Soil at Scottsbluff Field Station, Mitchell, Nebraska—1951.

Beet Strain	Originally Selected for resistance to:	Beet containing inches per 100 inches of row	Final stand in % of post thinning stand	Yield in tons per Acre
A.C.S. 9-604-0	Aphanomyces root rot	65	60.7	8.9
Nebr. 525	Rhizoctonia root rot	67	66.8	11.1
A.C.S. 0-404	Rhizoctonia root rot	53	54.7	6.7
A.C.S. 0-403	Sclerotium root rot	66	41.9	6.1
G.W. B526	Parent of Nebr. 525	57	38.0	5.7
G.W. 304	Commercial Variety	63	64.5	8.3

same rhizoctonia-infested, continuous beet plots, at the Scottsbluff Station in 1951. The results for this test are given in Table 3.

Comparison of the results obtained in 1950 and 1951 at Scottsbluff indicate that the beet strains behaved quite similarly in both years. The three beet strains which gave the highest yields in 1950 also gave the highest yields in the 1951 test. It is interesting to note in Table 3 that Nebraska 525 was almost twice as high in yield as its parent.

Sclerotium Root Rot Test—1951

The failure to obtain a good epidemic of this disease in 1950 not only made individual selections for resistance practically impossible, but also made it impossible to compare strains as to their resistance. The test in 1951 was much more conducive of results. The stand losses and the percent survival are presented in Table 4.

Table 4.—Performance of Sugar Beet Strains Grown in Field Soil Naturally Infested with *Sclerotium Rolfsii,* Clarksburg, California—1951.

		% Loss[1]			% Survivors
Beet Strain	Originally Selected for Resistance to:	Aug. 1	Sept. 1	Sept. 24	Sept. 24
9-604-0	Aphanomyces root rot	11.6	28.4	39.3	60.7
0-201	Sclerotium root rot	20.9	38.4	51.5	48.5
0-202	Sclerotium root rot	26.8	41.6	53.9	46.1
Am. No. 5	Commercial Variety	21.9	40.8	54.3	45.7
9-203	Sclerotium root rot	23.2	40.4	54.8	45.2
0-403	Sclerotium root rot	21.3	39.2	56.7	43.3
8-204	Sclerotium root rot	21.6	42.9	58.2	41.8
U.S. No. 15	Commercial Variety	30.8	50.0	66.4	33.6

[1] Percent loss based on comparison of thinned count of approximately 144 beets per 100 feet of row.

Beet strains 0-201 and 0-202 are selections of the mother lines obtained from beet strain 8-204 which is described by Lawlor and Doxtator (3)[2]. Beet strain 9-203 is a selection for Sclerotium resistance from U. S. No. 15.

The performance of the beet strain 9-604-0 is very surprising. This selection has never been exposed to sclerotium root rot since it is definitely a selection from a long line of varieties which have been found adapted to eastern areas where this disease has not been found. Also, it is of interest to note that the apparent resistance found in 8-204 has been transmitted to its selections. This same indication of the possibility of selecting resist-

[2] Numbers in parentheses refer to literature cited.

ant material was mentioned by Coons (1) and some selection work had been done on this problem. As far as the writers have been able to determine, the project was dropped.

Fusarium Yellows—1951

The test for resistance to fusarium yellows was made in a farmer's field at Sterling, Colorado. This field had been very badly infested in 1950 and was known to be extremely low in fertility. The test consisted of single rows of each beet strain running the entire length of the field. Each beet strain was replicated twice through the field. The results of this test were complicated by the occurrence of a fairly severe epidemic of rhizoctonia root rot in the west end of the field. The data as presented in Table 5 were obtained from the east end of the field where rhizoctonia root rot was not an important factor.

Table 5.—The Performance of a Group of Sugar Beet Strains Grown in Soil Naturally Infested with Fusarium at Sterling, Colorado—1951.

Beet Strain	Originally Selected for resistance to:	% Loss in Stand 7/19-9/21	% Healthy beets 9/21	Ft.	Roots	T per A.	% Suc.	S. per A.
G.W. 359	Commercial Variety	3.6	58.5	200	147	10.0	14.9	3,070
Nebr. 525	Rhizoctonia-resistant	9.1	21.6	200	157	9.9	11.9	2,349
C 404	Supposedly resistant to Fusarium yellows	11.4	18.0	100	68	6.8	12.4	1,673
G.W. 304	Commercial Variety	11.6	36.8	100	76	9.0	13.8	2,488
C 474	High Sugar selection from 304	18.4	44.6	200	136	8.6	14.5	2,477
A 123	USDA Aphanomyces res.	26.2	4.1		61			

Visible symptoms of fusarium yellows did not appear until about August 15. During September differences in varietal reaction were evident. The data on percentage of healthy beets taken September 21 are based on the foliage symptoms.

The strains G.W. 359, G.W. 304 and C 474 were the most resistant to fusarium. At harvest time, on the basis of presence or absence of vascular necrosis, it was apparent that selections from G.W. 359 had the lesser amount of actual infection. Since sugar beets infected with this organism are likely to be lower in sugar percent than healthy beets (4), the relatively higher sucrose content of this variety further substantiates this finding. Also, under disease-free conditions Nebraska 525 and G.W. 359 usually have about equal sucrose content. This was certainly not true in this experiment.

Discussion

One of the remarkable features apparent in these tests is the tolerance of some beet strains to more than one root-rotting organism. The beet strain 9-604-0 shows considerable tolerance to aphanomyces, rhizoctonia and sclerotium. The beet strain was originally selected for resistance to aphanomyces. It is plausible that in selecting for aphanomyces resistance there was enough rhizoctonia present in the soil so that an automatic selection was made for resistance to this organism. However, it can be categorically stated that rhizoctonia certainly was not an important factor in losses of beets when

selections were made for aphanomyces resistance. There is no such probability that *Sclerotium rolfsii* might have been present in the soil at the time when selections were being made for aphanomyces resistance. This organism, which causes southern root rot, has never been reported from the areas where the aphanomyces selections were made.

From the foregoing, it might be deduced that selections with resistance to aphanomyces might also be resistant to rhizoctonia and sclerotium. Likewise, selections resistant to rhizoctonia are not resistant to aphanomyces. It is the belief of the writers that such conclusions may be a little too premature. Until more data is obtained or until the nature of resistance to the various root rots has been determined the above suppositions are not valid.

Another interesting feature is the apparent resistance of G.W. 304 to both rhizoctonia and fusarium. If this continues to hold true it certainly will lighten the load of breeding for resistance to these diseases, since this beet strain has done exceptionally well as a commercial variety and should be a desirable parent.

Summary

1. Various strains of sugar beets were tested on soils naturally infested with the fungi causing the following diseases: Aphanomyces root rot, rhizoctonia root rot, southern root rot and fusarium yellows.

2. Beet strain A.C.S. 9-604-0 was found to have resistance or tolerance to aphanomyces, rhizoctonia and sclerotium under the conditions of the experiments.

3. G.W. 304 appeared to have resistance or tolerance to rhizoctonia and fusarium. Also, the performance of Nebr. 525 definitely indicates that it is more tolerant to rhizoctonia than is its parent.

4. The selection Nebr. 525, which was made for resistance to rhizoctonia, did seem to have much resistance to aphanomyces.

5. The results of these tests indicate that there may be sources of resistance for these diseases and it may be possible to combine resistance to more than one root-rotting organism in a single variety of beets.

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