Progress Report on Breeding for Storage-Rot Resistance in Sugar Beets[1]

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In an earlier report by the author (1)[3] strains of sugar beets, *Beta vulgaris* L., were shown to differ greatly in resistance to rotting under controlled storage conditions, and individual roots within certain strains also differed considerably in rate of rotting following artificial inoculation. A composite-inoculation technique applied to approximately 400 mother beets[4] of the wide-base, commercial, leaf-spot-resistant variety, U. S. 226, was described and illustrated. One hundred nine of the more resistant-appearing roots of U. S. 226 were transplanted in the field in the spring of 1949 and allowed to interpollinate. Approximately two-thirds of the total number survived and produced mature seed, the surviving plants varying widely in vigor and in quantity of seed produced. The seed was harvested separately from each plant. In the spring of 1950 the 20 largest seed lots were planted in replicated field plots together with two lots of the parent variety and several other varieties or strains. The plantings were made at three locations, as follows:

1. U. S. Sugar Plant Field Station, Fort Collins, Colorado: plots 2 rows x 16 ft.; 2 plots of each strain plus a systematically placed standard for visual comparisons.

2. Harry Clark farm, near Ault, Colorado: plots 2 rows x 33 ft.: 4 randomized, complete blocks.

3. J. E. Alford farm, Fort Collins: plots 2 rows x 33 ft.; 4 randomized, complete blocks.

The crop was given ordinary care in each field, with the exception of inoculation and frequent sprinkling in Field 1 for the purpose of developing an epidemic of leaf spot *(Cercospora beticola).* Leaf spot was negligible in fields 2 and 3.

Harvest results were obtained in October in Fields 2 and 3, using all roots from a carefully measured section of row (approximately 14 ft.) in each plot for weight and sucrose determinations. A representative sample of approximately 15 to 18 roots from each plot in those fields was topped, washed, stored at 65° F. for 13 weeks, and the percentage of rotted tissue determined. A duplicate set of samples was held at 45° for 20 weeks. Storage conditions and the method of rot determination used have been described previously (2). Logarithmic transformation was applied to the percentage-

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[3] Numbers in parentheses refer to literature cited.

[4] Full-sized roots with crowns; suitable for growing seed.

Table 1.—Field and Storage Comparisons Between U. S. 226 and Progenies of Roots Selected from that Variety for Storage-rot Resistance.

		Field results					Storage rot[3] (field 2-65° F., field 2-45°, and field 3-65°)	
			Fields 2 and 3[2]					
Description	S.P.I. strain No.	Leaf[1] spot (field 1)	Stand (bills per 100 ft. of row)	Roots per ft. of row	Sucrose	Gross sucr. per ft. of row	Log. mean	Geom. mean
		Pct.	No.	Lb.	Pct.	Lb.		Pct.
U. S. 226 (steckling increase)	471004-0	103	93	1.47	17.66	.257	2.7829	5.41
U. S. 226 (commerical increase)	Acc. 1147	94	97	1.44	18.12	.259	2.6677	4.65
Mean, U.S.226							2.7003	5.02
Progeny of 471004-0	491024-17	105	96	1.38	17.05	.234	2.2918[4]	1.96
Progeny of 471004-0	-22	96	99	1.38	18.51	.254	2.8720	7.45
Progeny of 471004-0	-26	115	96	1.52	16.95	.257	2.2643[4]	1.84
Progeny of 471004-0	-30	95	99	1.59	16.92	.267	2.7924	6.20
Progeny of 471004-0	-52	103	99	1.46	17.26	.251	2.2649[4]	1.84
Progeny of 471004-0	-56	106	99	1.37	17.65	.241	2.4547	2.85
Progeny of 471004-0	-58	108	101	1.59	17.40	.277	2.5538	3.58
Progeny of 471004-0	-61	98	91	1.39	18.25	.252	2.8060	6.40
Progeny of 471004-0	-68	78	100	1.37	17.78	.241	2.6135	4.11
Progeny of 471004-0	-70	90	98	1.33	17.63	.232	2.5843	3.84
Progeny of 471004-0	-71	55	95	1.56	17.10	.265	2.4688	2.94
Progeny of 471004-0	-75	40	94	1.57	17.41	.270	2.6676	4.65
Progeny of 471004-0	-83	89	97	1.37	17.60	.240	2.5641	3.67
Progeny of 471004-0	-86	83	101	1.41	17.66	.248	2.2217[4]	1.67
Progeny of 471004-0	-89	96	97	1.49	17.41	.257	2.5761	3.77
Progeny of 471004-0	-92	93	98	1.65	16.77	.279	2.5377	3.45
Progeny of 471004-0	-96	108	95	1.31	18.25	.237	2.4543	2.85
Progeny of 471004-0	-100	123	89	1.53	17.56	.266	2.3921[4]	2.47
Progeny of 471004-0	-104	115	96	1.39	17.99	.250	2.3926[4]	2.47
U. S. 225 (storage-rot susceptible inbred)	Acc. 1148	142	98	1.42	17.55	.248	3.2733	18.76
R. & G. Old Type (commercial check)	Acc. 1139	197	100	1.51	18.21	.275	2.9454	8.82
L.S.D. (5 percent point):								
For comparing individual strains							.5449	
For comparing any one strain with the mean for U. S. 226							.3008	

[1] Leaf-spot readings (two-plot averages) expressed as percent of standard; low percentage indicates high resistance.

[2] Each strain occurred in four plots in each of the two fields.

[3] Storage: 65° F., 13 weeks; 45° F., 20 weeks; rotted tissue in each sample determined as percentage, by weight.

[4] Mean for the indicated progeny is significantly below the mean for the parent variety, U. S. 226.

rot data for summarization and variance analyses in accordance with accepted practice (3). The plots in Field 1 were used for leaf-spot readings, no harvest or storage samples being taken. One of the progenies of U. S. 226 was dropped from the experiment before storage because of undesirable agronomic characters.

Results

The highlights of the storage results for Field 2 may be summarized as follows: 1. The overall average percentage of rot for the 19 progenies of U. S. 226 was significantly lower than the average for the parent variety; and

2. four progenies, individually, were significantly below U. S. 226, none being significantly higher. Pooling of results in this way was based on nonsignificant interaction of strains x temperatures and nonsignificant difference between the two lots of U. S. 226.

The general level of rot for each temperature, among samples taken from Field 3, was much lower than that obtained for the corresponding temperature for Field 2. This occurrence was attributed to various factors which are considered irrelevant insofar as this study is concerned. The average percentage of rot for the Field 3 roots stored at 45° F. was less than one-half of one percent, and differences between individual progenies and between parent variety and progenies were negligible. These results, representing negligible disease exposure, were disregarded. Rot among the Field 3 roots stored at 65° was higher, and the average tended to substantiate the results obtained for Field 2.

A general summary of results obtained for the 19 progenies and the parent variety is given in Table 1, together with results for a susceptible inbred and a European commercial variety which are of particular interest because of the fact that they were included in the earlier report on breeding for storage-rot resistance (1) discussed at the beginning of this paper. Since the two lots of U. S. 226 did not differ significantly in percentage of rot, the average for that variety is used as a basis for evaluating the storage-rot resistance of the progenies. Sixteen of the 19 progenies were below the parent average in percentage of rot, that is, they kept better, and, as shown in the column of logarithmic means, six of them had significantly less rotted tissue than the parent variety. None were significantly higher in amount of rotted tissue. These results confirm an earlier tentative conclusion that storage-rot resistance of sugar beets can be improved through breeding (1) and indicate one applicable method of screening mother beets for resistance. It is worthy of note that the data in Table 1 do not reveal consistent association between improved storage-rot resistance and low sucrose, low root yield, or leaf-spot susceptibility.

Summary

Nineteen progenies resulting from open pollination among sugar-beet roots which had been selected for storage-rot resistance in the spring of 1949 by means of a composite-inoculation technique were grown in replicated plots in two fields in 1950 and subsequently tested for storage-rot resistance in comparison with the parent variety, U. S. 226. Samples of topped roots from the field plots were stored under controlled conditions at 65° and 45° F. for 13 weeks and 20 weeks, respectively, and the percentage of rotted tissue in each sample then was determined on a weight basis. The amount of rot which developed in samples taken from one of the fields and stored at 45° was extremely low, and differences between strains were negligible. Consequently, those results were disregarded. In a general summary of all other storage data, 16 of the 19 progenies were below the parent variety in average percentage of rotted tissue, six of them being significantly lower. None was significantly higher. These results confirm an earlier tentative conclusion that storage-rot resistance of sugar beets can be improved through breeding.

Literature Cited

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