

1948-1949 Progress in Breeding Sugar Beets for Resistance to *Aphanomyces* Root Rot

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During the past two years breeding sugar beets for resistance to *Aphanomyces cochloides* (Drechs) has been expanded to include the Red River valley in Minnesota and North Dakota, and areas in northwestern Montana. In general the experimental work was conducted along the same lines as in previous years (1), (2)².

This paper reports the progress made in developing resistance in adapted varieties for these areas, as well as the results from newer selections in the northern Iowa-southern Minnesota area.

MATERIALS AND METHODS

The selections tested in 1948 and 1949 at Mason City, Ia., and Waseca, Minn., were obtained from previous selections of the variety American 1, which variety has been the source of all resistance to this disease obtained by the American Crystal Sugar company in this area up to the present date. In the Red River valley, hybrids of American 3 Northern and American 1 resistant types were used for tests in 1948. Nineteen forty-nine tests in this area were from selections of the varieties American 3 Northern and American 3 Leaf Spot Resistant. At Missoula, Mont., in 1949 test plantings were made of individual plant seed lots obtained from U. S. 33, made the previous year. Further, since the test fields used in the Red River valley and northwestern Montana had only one year's record of root rot conditions, duplicate plantings of certain selections from the American 3 varieties and U. S. 33 were made at Mason City as insurance that reselections under disease conditions would be made in 1949. All seed lots tested in both years in the breeding nurseries of Montana, Minnesota and Iowa were individual plant progenies derived from open pollinated mother beets planted in the greenhouses at Rocky Ford, Colo. Selections of roots from the three above mentioned areas were shipped to Rocky Ford in time for winter seed production in both years. Check varieties used were U. S. 216, American 3 LSR, and the very susceptible variety S.P. 1-9-00, furnished by the U. S. Department of Agriculture.

In both 1948 and 1949 99 plant progenies of American 1 resistant were tested in 4 replications of plots. The 1948 test at East Grand Forks was of 33 plant lines in unreplicated plots and the 1949 test was of 55 plant lines in duplicate plantings. The Missoula test in 1949 was of 48 plant lines in 3 replications of plots. Plots in all nursery tests were 1 row wide by 20 feet

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² The numbers in parentheses refer to literature cited.

long. In addition to these tests, inbred seed lots and hybrids were planted at Mason City and at Rocky Ford in 1948, and at Waseca and Rocky Ford in 1949. All nursery plantings were used for selection of mother beets in 1948 and 1949.

Three replicated plot tests for yield were continued in 1949, one at Mason City, Ia., and two at Moorhead, Minn. The Mason City test was made up of 9 breeders' stocks of root rot resistant origin in six replications of plots 3 rows wide by 40 feet long. One Moorhead test was of 11 mother progenies of American 3 Resistant along with 5 check varieties in 6 replications of plots 1 row wide by 50 feet long. The second Moorhead test was of 3 varieties in six replications of plots 1 row wide by 20 feet long.

EXPERIMENTAL RESULTS

1948 Selections

In 1948 root rot conditions at Waseca were not as severe as in previous years, and less severe than at Mason City. Leaf spot appeared in the Mason City nursery and selections were made for resistance to this disease as well as for root rot resistance. Average stand counts and vigor notes for the 99 lines and the 3 check varieties compared with the lines selected are given in Table 1.

Table 1.—Average stands per 20 feet of row, and vigor indices for 99 lines and 3 check varieties compared with lines selected. Mason City, Ia., and Waseca, Minn., 1948.

	Ave. Stand	Vigor Index ¹
	Mason City	
99 lines	11.7	3.32
3 check varieties	4.2	3.32
26 selected lines	11.8	2.94
	Waseca	
99 lines	11.26	2.91
3 check varieties	7.52	4.41
26 selected lines	13.05	2.92

¹ 1 = vigorous; 5 = weak.

The best roots of all of the 26 Mason City lines were planted in the Rocky Ford greenhouses in late December for winter seed production, along with the best roots of 16 of the 25 lines selected at Waseca. These selections were placed in separate houses. In a third house, root selections made at Moorhead, Minn., and at Missoula, Mont., from American 3 and U.S. 33 respectively were planted. All plants were inbred, using one Kraft bag per plant; and crosses were made between beets from the Waseca selection of American 1 RR, and American 3 and U. S. 33. At harvest, open pollinated seed was harvested separately from all plants, the best seed lots being used for 1949 nursery plantings.

1949 Selections

Root rot conditions in the Mason City and Waseca areas in 1949 were the reverse of those prevailing in 1948. The extremely severe conditions prevailing at Waseca eliminated most of the stand in all 99 lines and checks. At harvest all beets in this test were harvested by line, after which only the best beets from the best lines were saved.

On the basis of percent stand and vigor notes taken as in the previous years, 15 lines at Mason City were judged to be superior to others, and 245 beets were selected out of these lines. At Waseca some 65 lines were used for selections, with only 12.2 percent of the beets in these lines being selected.

Line selections of beets were also made in remnants of the 6 replicate M-line test and the 55-line nursery test at Moorhead and the 48-line nursery test at Missoula. The best of these root selections, along with those from Mason City and Waseca, were shipped to Rocky Ford for greenhouse seed production in the 1949-50 winter season.

1949 Yield Results

In Table 3 are given the results obtained from the breeders' stock variety test conducted at Mason City in 1949.

Table 3.—Root rot resistance variety tests, Mason City, Ia., 1949

Variety	Description	Tons Beets per Acre	Percent Sucrose	Lbs. Sugar per Acre	Vigor Index ¹
8-706-X	1947 Amer. 1 RR Sel.	12.87	13.63	3,516	2.4
1949 G.H.	G.H. O.P. Amer. 1	13.32	13.13	3,491	2.0
7-609-X	1946 Amer. 1 RR Sel.	12.88	13.35	3,448	2.5
Amer. 3 I.S.R.	Com'l check	11.98	12.85	3,090	3.0
8-413	12 line Sel. M.C. '47	11.85	13.03	3,079	3.5
6-423-X	1st inc. Amer. 1 RR	11.03	13.18	2,935	3.5
7-606	1st Sel. 1945	11.25	12.87	2,908	4.1
8-705	M-line from 7-606	9.92	13.35	2,671	4.0
8-804	1st Sel., Amer. 3 N	8.88	11.50	2,036	4.2
Significant Difference (odds 19:1)		1.91	.95	547	
F Value		4.05*	3.29*	5.91*	

¹ 1 — vigorous; 5 = weak

* Significant beyond the 1% point

During the glowing season foliage was most vigorous on the American 1 resistant varieties, the order of rank being as follows: 1949 greenhouse OP (49 increase), 8-706-X (1948 increase), 7-609-X (1947 increase) and 6-423-X (1946 increase). The latest increase, 1949 greenhouse OP, was significantly higher in yield than the first root resistant increase, 6-423-X. Eight-eight

Table 4.—Results of mother line test, Moorhead, Minn., 1949

Variety	Description	Tons Beets per Acre	% Sucrose	Lbs. Sugar per Acre
7-609-X	Amer. 1 RR, '48 inc. check	6.09	22.51	2,732
M 19	8-804-9	6.92	21.62	2,727
25	-26	6.05	21.68	2,613
16	-3	5.81	22.03	2,544
26	-38	5.99	21.20	2,518
24	-33	5.58	22.02	2,461
25	-34	5.15	22.01	2,260
21	-16	4.87	21.49	2,062
6-423-X	Amer. 1 RR, '46 inc. check	4.15	22.65	1,876
Amer. 3 I.S.R.	Commercial check	4.10	22.89	1,855
M 18	8-804-7	4.10	22.60	1,842
22	-24	4.14	21.96	1,819
20	-10	4.18	21.63	1,812
Amer. 3 N	Commercial check	3.43	22.53	1,536
M 17	8-804-5	2.79	22.00	1,229
S.P. 1-9-00	USDA Susceptible	2.44	22.17	1,082
General Mean		4.70	22.06	2,062
Significant Difference (19:1)		1.59	.78	683

hundred four, a first selection for resistance made in the East Grand Forks area, was lowest in yield, indicating that very little resistance had been obtained from that selection.

In Table 4 are given the yields obtained from the 6 replicate M-line test conducted at Moorhead, Minn., in 1949.

Due to a severe late season drought, yields of all varieties were low. However, highly significant differences between varieties were obtained for tonnage yield and pounds sugar per acre. 7-609-X, the 1947 American 1 RR Breeders Stock, was significantly higher in tonnage yield than the other 4 checks, 6-423-X, American 3 LSR, American 3 N and S.P. 1-9-00. Lowest in yield was S.P. 1-9-00, the USDA susceptible check.

For a further check on the performance of American 3 LSR, variety commercially used in the Moorhead area, all 6 plots of each of the 3 check varieties in the 55-line Moorhead root rot resistance nursery were harvested. The results of this comparison are given in Table 5.

Table 5.—Yields of root rot resistant variety checks in the 55-Line Moorhead test of 1949.

Variety	Tons Beets per Acre	% Sucrose	Lbs. Sugar per Acre
S.P. 1-9-00	2.16	19.57	842
Amer. 3 LSR	5.49	19.14	2,126
Waseca RR '49 (Amer. 1 RR)	14.01	19.35	5,289
General Mean	7.22	19.35	2,776
F value	39.51 ¹	.82	39.35 ¹
Significant Diff. (19:1)	2.75	.67	1,050

¹ Exceeds 99:1 odds (8.65)

Striking differences were found for yield in this comparison, with significant differences being obtained between the 3 varieties. Where *Aphanomyces* root rot occurs in the Red River valley beet growing area, it is evident that a variety as resistant as American 1 RR is needed.

SUMMARY

During the past two years selection for beets resistant to *Aphanomyces* root rot has been expanded to include the Red River valley beet growing area of Minnesota and North Dakota, and the Missoula, Mont., area.

Selections for these new areas, made in the two types of American 3, and in U. S. 33, although showing some resistance, are not resistant enough to withstand severe attacks of the disease. Hybrids of these selections, with highly resistant American 1 selections, are now being made.

A test conducted at Mason City in 1949 of elite stocks from selections made each year since 1946 showed that the 1949 selection under medium severe root rot conditions was significantly higher in yield than the 1946 (first) selection.

Under severe root rot conditions in the Red River valley, seed obtained from roots selected *in* American 1 RR at Waseca in 1948 yielded 14.01 tons beets per acre compared with a yield of 5.49 tons per acre for the commercial variety American 3 LSR.

Literature Cited

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