

A PRELIMINARY REPORT ON THE INHERITANCE  
OF RHIZOCTONIA RESISTANCE IN SUGARBEET <sup>1/</sup>  
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In ten years research at Fort Collins, Colorado, substantial improvement in resistance to Rhizoctonia root and crown rot (R. solani Kuehn) has been achieved by selection in various sugarbeet populations. (3)<sup>3/</sup>. Two Rhizoctonia resistant sugarbeet lines, resulting from this research, were officially released in 1968. Those lines are not suitable for use as commercial varieties and are considered of value primarily as sources of genes for Rhizoctonia resistance. Their usefulness for this purpose will depend in part on the relative ease with which the resistance can be transferred to other sugarbeet lines or varieties. This article is intended as a preliminary report on this subject.

Material and Methods

On April 27, 1965, plantings of seed of two parental sugarbeet lines were made in the greenhouse as the first step in the production of two successive hybrid generations - the F<sub>1</sub> and the F<sub>2</sub>. One of the parental lines (FC 901) is quite susceptible to Rhizoctonia, and the other (SP 631001-0) has slight to moderate resistance. Seed of both the F<sub>1</sub> and F<sub>2</sub> generations was produced in the greenhouse, using the seedling induction technique (1,2) to hasten reproductive development. The time required for the two complete life cycles - i.e., from the date when the seed of the parental lines was planted until the seed of the F<sub>2</sub> generation was harvested - was less than 50 weeks. Bolting (with normal flowering) was essentially 100 percent, and consequently the F<sub>2</sub> generation was considered representative of the parental lines.

Seed of the F<sub>2</sub> generation was planted in a Rhizoctonia infested field in the spring of 1966. Twenty-five plants were selected for resistance from that population in the fall and planted in an isolated group in 1967 where they were allowed to interpollinate. The seed lots produced by the respective plants were harvested separately and assigned the numbers, SP 671010-1 through SP 671010-25. Eighteen of these F<sub>3</sub> lines were included in a Rhizoctonia resistance test (Experiment R-3) in 1968 together with other material listed in Table 1. Most of that material has been described in an earlier report (3). However, some explanatory comments at this point may be of interest. FC 701 is a product of four cycles of selection for Rhizoctonia resistance. It was derived from the susceptible variety, GW 674-56C. The same description applied to FC 702, except that the

<sup>1/</sup> Report of research conducted by the Crops Research Division, Agriculture Research Service, U. S. Dept. of Agriculture, in cooperation with the Colorado Agricultural Experiment Station and the Beet Sugar Development Foundation, at Fort Collins, Colorado. Publication approved by the Director, Colorado Agricultural Exp. Station, as Scientific Series Paper No. 1406.

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<sup>3/</sup> Numbers in parentheses refer to Literature Cited.

latter was derived from another Rhizoctonia susceptible variety, C 817. GW 674-56C is a Great Western Sugar Company commercial variety, and C 817 is a derivative from another Great Western commercial variety, GW 359. SP 631001-0, was derived from GW 674-56C, but with only two cycles of Rhizoctonia resistance selection. The resistance of SP 631001-0 is not as high as that of FC 701 and FC 702. FC 901, the Rhizoctonia susceptible line referred to above, has some resistance to both Cercospora leaf spot (C. beticola Sacc.) and curly top.

Experiment R-3 consisted of 1-row plots, 25 feet long, with a randomized complete block design and four replications. The experiment was planted on May 10, 1968, thinned by hand in the usual manner, and harvested October 10-11. A 16-foot section in each plot was inoculated with a highly pathogenic isolate (B-6) of Rhizoctonia on July 16, using the rosette method previously described (3). Irrigation was performed by sprinkler as needed. Harvest results were based on plants classed as healthy - i.e., plants in which both crowns and roots were essentially free of Rhizoctonia injury.

### Results

As expected, the performance of FC 701, FC 702, and the respective selections from those two lines contrasted sharply with that of the two lines that were classed as Rhizoctonia susceptible when the experiment was designed - i.e., GW 674-56C and FC 901 - (Table 1).

The results (Table 1 and Figure 1) indicated a rather strong tendency towards dominance of resistance in the F<sub>1</sub>, FC 901 aa ♀ x FC 702 selection (i.e., entry No. 876). The expression of resistance in the other F<sub>1</sub>, FC 901 aa ♀ x FC 701 selection (i.e., entry No. 874), may be characterized, loosely, as intermediate.

In considering the results for the F<sub>3</sub> lines - entries 879 through 896 - (Table 1 and Figure 2), it should be noted that the resistant parent (SP 631001-0) is not as high in Rhizoctonia resistance as FC 701 or FC 702. In view of this fact, it is quite encouraging to observe that several of the F<sub>3</sub> lines apparently were about as resistant as FC 701 and FC 702 under the conditions of Experiment R-3. The occurrence of highly susceptible entries among the F<sub>3</sub> lines was to be expected.

### Summary

A replicated field experiment was conducted at Fort Collins, Colorado, in 1968 as a part of a preliminary study of inheritance of resistance to Rhizoctonia root and crown rot in sugarbeet.

The results for one F<sub>1</sub> hybrid (resistant x susceptible lines) indicated partial dominance for resistance. The resistance of a similar F<sub>1</sub> hybrid was loosely classed as intermediate.

The results for a series of F<sub>3</sub> lines indicated, tentatively, that resistance can be transferred from resistant to susceptible material with relative ease.

Literature Cited

- (1) Gaskill, John O. 1952. Induction of reproductive development in sugarbeets by photothermal treatment of young seedlings. Proc. Am. Soc. Sugar Beet Technol. 7:112-120.
- (2) Gaskill, John O. 1963. Comparison of fluorescent and incandescent lamps for promotion of flowering in sugarbeet seedlings. J. Am. Soc. Sugar Beet Technol. 12(7):623-634.
- (3) Gaskill, John O. 1968. Breeding for Rhizoctonia resistance in sugarbeet. J. Am. Soc. Sugar Beet Technol. 15(2):107-119.



Figure 1. Rhizoctonia resistance of an  $F_1$  sugarbeet hybrid and its parental lines, Fort Collins, Colorado, October 4, 1968. The inoculated portion of each of the following 1-row plots is delimited by a short white stake (facing camera) in foreground and a tall white stake in background (from left to right): (a) FC 901 (susceptible parent); (b)  $F_1$ , FC 901 aa♀ x FC 702 selection; and (c) FC 702 selection (resistant parent).



Figure 2. Comparison of Rhizoctonia resistance of six  $F_3$  sugarbeet lines, Fort Collins, Colorado, October 4, 1968. Each  $F_3$  line was derived from the cross, FC 901 (susceptible) aa♀ x SP 631001-0 (slightly or moderately resistant). The inoculated portion of the six 1-row plots to be compared is indicated by stakes.

**Table 1.** Comparison of sugarbeet lines and hybrids for Rhizoctonia resistance, Fort Collins, Colorado, 1968; results presented as 4-plot averages (Experiment R-3)

Description and/or Source	Seed No.	No.	Stand	Inoc. <sup>a/</sup>		Grade	Harvest Results <sup>d/</sup>	
				Survival	%		(Healthy Plants)	Wt.
				No.	%		%	Lb.
FC 701; LSR, Rhiz.res., MM; derived from GW 674-56C	SP 671005-0	871	17.3	17.3	85.1	5.25	31.5	10.05
FC 702; " " " " " " " C 817	" 671006-0	872	17.3	17.3	79.7	5.25	37.8	12.28
FC 701 sel. (Rhizoc.res.sel.from FC 701)	" 671181HO	873	18.0	18.0	94.7	3.75	47.3	17.30
F <sub>1</sub> , FC 901 aa ♀ x FC 701 sel.	" " HO1	874	18.3	18.3	71.1	6.00	11.2	5.00
FC 702 sel. (Rhizoc.res.sel.from FC 702)	" 671182HO	875	17.8	17.8	96.9	2.75	50.3	13.40
F <sub>1</sub> , FC 901 aa ♀ x FC 702 sel.	" " HO1	876	17.0	17.0	93.0	2.50	47.0	18.95
FC 901; LSR-CTR, MM; Rhizoc. sus.	" 661203HOB	877	16.8	16.8	35.0	8.50	5.7*	1.98*
GW 674-56C; LSR, MM, com.var.; Rhizoc. sus.	Acc. 2168	878	18.8	18.8	50.8	7.25	13.5	6.78
F <sub>3</sub> , FC 901 (Rh.sus) aa ♀ x SP 631001-0 (Rh.res.†)	SP 671010-1	879	18.0	18.0	45.8	7.50	1.5*	0.20*
do.	" " -3	880	18.0	18.0	67.1	5.75	26.2	6.15
do.	" " -6	881	17.5	17.5	87.2	5.00	25.7	9.10
do.	" " -7	882	18.0	18.0	76.1	5.00	18.1	6.50
do.	" " -9	883	17.3	17.3	65.6	6.25	16.1	4.43
do.	" " -12	884	16.3	16.3	80.3	5.50	24.7	11.25
do.	" " -13	885	18.3	18.3	72.0	5.25	18.5	8.13
do.	" " -14	886	18.3	18.3	76.4	6.25	15.5	6.38
do.	" " -15	887	19.8	19.8	67.5	6.75	10.2	4.65
do.	" " -16	888	16.8	16.8	53.2	7.25	6.6*	3.43*
do.	" " -17	889	18.0	18.0	27.6	8.50	1.2*	0.15*
do.	" " -18	890	16.5	16.5	13.0	9.25	0.0*	0.00*

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Table 1. Continued from previous page

Description and/or Source	Fort Collins Seed No.	Entry No.	Inoc <sup>a/</sup> Stand	b/		c/		Harvest Results <sup>d/</sup> (Healthy Plants)	
				Survival	Grade	%	Wt.		
			No.	%					Lb.
F <sub>3</sub> , FC 901(Rh.sus.) aa ♀ x SP 631001-0(Rh.res.†)	SP 671010-19	891	19.3	70.8	6.75	11.3	5.88		
do.	" "	-20 892	18.8	62.7	7.25	12.7	4.88		
do.	" "	-21 893	17.8	21.2	8.75	2.8*	1.35*		
do	" "	-22 894	18.5	87.8	4.25	32.4	13.20		
do.	" "	-23 895	18.3	76.9	5.75	23.4	10.40		
do.	" "	-25 896	18.0	97.2	3.00	56.9	12.60		
General mean (In harvest results, entries marked "*" are disregarded)				67.4798	5.9712	26.4988	9.3638		
LSD (.05)				18.59	1.45	15.97	5.68		
LSD (.01)				24.66	1.93	21.26	7.57		
Calculated F <sup>e/</sup>				12.48	12.50	6.61	4.49		

<sup>a/</sup> Counts of inoculated stand (plants per 16' of row) made on 7/26, 10 days after inoculation (before any loss in stand had occurred as a result of inoculation).

<sup>b/</sup> Living plants on 9/24, expressed as percent of inoculated stand.

<sup>c/</sup> Visual, preharvest estimate of Rhizoctonia injury based on depression of both stand and foliage vigor: 0 = healthy; 10 = all plants dead. Date grades were recorded, 9/28.

<sup>d/</sup> Harvest results (10/10-10/11) based on plants classed as essentially healthy. The number of such plants (per 16' of row) is expressed as percent of inoculated stand. The weight shown is total weight of beets (roots plus crowns) of such plants per 16' of row.

<sup>e/</sup> Each F value shown is substantially greater than the 1-percent point.

\* Each entry number indicated was disregarded in variance analyses of harvest results because of the occurrence of more than one plot with no healthy plants at harvest. LSD values are not applicable to comparisons involving any average marked with an asterisk (\*).