Testing Sugar Beet Varieties for Their Resistance to Aphanomyces, Rhizoctonia and Fusarium Root Rots[1]

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The relation of various varieties of sugar beets to several soil-bourne diseases of beets was studied in this investigation, which is a part of an overall project involving the study of many qualities of different varieties of sugar beets.

This work is headed by the Sugar Beet Breeders Forum, composed of research workers of various sugar companies and those employed by different government and state institutions and agencies.

During the period of 1950-1953, 240 different varieties of sugar beets obtained from various sources and some raised in Montana were tested for their resistance to the three following diseases:

1. Aphanomyces root rot, caused by *Aphanomyces cochlioides* Drechs.
2. Rhizoctonia root rot, caused by *Rhizoctonia solani (Pellicu-laria filamentosa* (Pat.) (Rogers) .
3. Fusarium root rot (yellows) , caused by *Fusarium oxysporum* f. *betae* (D. Stewart) Snyder and Hansen.

Twenty-four of these varieties were supplied by the Great Western Sugar Company, Longmont, Colorado; 48 by the Holly Sugar Corporation, Sheridan, Wyoming; 53 by the U. S. Sugar Plant Field Laboratory, Salt Lake City, Utah; 76 by G. W. Deming, U.S.D.A., Fort Collins, Colorado; 15 by H. L. Kohls, Michigan State College, East Lansing, Michigan; I by the American Crystal Sugar Company, Rocky Ford, Colorado; and 1 by J. S. McFarlan, U.S.D.A., Salinas, California, while 22 were raised in Montana.

Tests were conducted under field and greenhouse conditions if a sufficient amount of seed was available; otherwise only greenhouse tests were made. Only limited field tests were conducted during 1950. Intensive greenhouse and field work was started in 1951.

Field work was conducted at the Huntley Branch Station, Huntley, Montana, in heavily infested soil. Usually several replications of each variety were planted. Stand counts and disease readings were made in these plots several times during the growing season. At harvest beets were dug and detailed readings were taken on the occurrence of disease. Under field conditions beets were tested only for their resistance to rhizoctonia and fusarium root rots.

Greenhouse tests were conducted at Bozeman, Montana, in soils brought from the Huntley Station. At first, attempts were made to conduct these tests in soil flats sterilized with chloropicrin and inoculated with the respective organisms. This method was discontinued because of the incon-

[1] Contribution from Montana State College, Agricultural Experiment Station, Bozeman, Montana. Paper No. 523, Journal Series.

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venience of using chloropicrin in the greenhouse where other plants were growing.

Later an attempt was made to test these varieties in nonsterilized soil *in* greenhouse benches. Before planting beets the soil was inoculated with the specific organism, and in addition beets infected with the respective organism were finely chopped and mixed into the specific soil. Although results were good with this method, still there were a few objections to it. Each tested soil was predominantly infested with a specific organism, but other pathogenic organisms were also present in it, and it was difficult to differentiate on the basis of symptoms the causal factor of the disease. It was also found that pathogenicity of the organisms gradually decreased in nonsterilized soil. It appears that certain conditions occurred in the non-sterilized inoculated soil which led to a decrease in number or virulence of the pathogenic organisms.

All these considerations led to the conclusion that, in further tests, sterilized inoculated soil should be used. This proved a more satisfactory standard testing technic and allowed a better comparison between individual tests.

The following standard procedure was adapted in all greenhouse tests:

Each variety of beets was tested for each disease in three 7-inch pots filled with Huntley soil. Prior to each planting, pots filled with soil, and saucers, were steam sterilized for four hours at 15 pounds pressure in the autoclave. Using this method, each of the pots can be considered as a separate replication. Usually 20 whole sugar beet seeds were planted in each pot.

It was also found that disinfection of seeds with New Improved Ceresan will eliminate possible seed-borne infection; for example, one which is caused by *Phorna betae.* Disinfection of seed was usually done about one month prior to planting. After emergence beets were allowed to grow for about 5-6 weeks and then they were harvested. Regular readings of healthy and diseased beets were taken during the glowing period and also at harvest. Inoculum used in the soil was composed of several cultures of the pathogenic organisms, whose pathogenicity was previously tested. During the 1951-53 period four cultures of *Aphanomyces cochlioides,* six cultures of *Rhizoctonia .solani* and three cultures of *Fusarium oxysporum* f. *betae* were used as inoculum.

In comparing the results of field and greenhouse tests, it appears that the greenhouse tests were more uniform and reliable. There are too many factors in field testing which make it impossible to control the disease factor. One year rhizoctonia root rot may be the predominant disease in a certain field, but the next year there may be another pathogen which makes an inroad in this field.

The plan is to submit all available varieties of beets to the greenhouse test. Field tests will be used to supplement the greenhouse tests. Later those varieties which showed the best possibilities will be rechecked under greenhouse conditions. Selection of individual beets from the varieties showing the highest degree of resistance will be made. These beets will be used for seed production and the progeny will be tested.

No attempt will be made to give the relative degree of resistance to the root rots of each of the tested varieties in this report. Only those varieties will be mentioned which showed a comparatively high degree of resistance to these diseases.

Those varieties of beets which showed the highest degree of resistance to the diseases among 240 varieties of beets tested under greenhouse conditions are listed in Table 1. All those beet varieties which are reported in this table as being used in three replications (3 pots) , including Deming 1952-333, were tested *in* sterilized soil. The remaining varieties were tested in iionsterilized, inoculated soil in benches when only two replications were used.

Table 1.—Percent of Healthy Sugar Beet Seedlings in Tests of Beet Varieties for Their Resistance to Aphanomyces, Rhizoctonia, and Fusarium Root Rots. Greenhouse, 1951-52, Bozeman, Montana.

Varieties Tested	Replications 1	2	3	Varieties Tested	Replications 1	2	3	Varieties Tested	Replications 1	2	3
Aphanomyces Root Rot											
H[2] 1123-0	25	12	7	D 1950-351	73	71	..	D 1951-517	18	17	10
SL 1-504-2	6	7	15	D 1950-540	91	73	..				
Rhizoctonia Root Rot											
GW 359	71	55	56	D 1950-387	59	55	....	D 1950-479	65	67	....
GW I-3	68	70	58	D 1950-392	59	77	....	D 1950-480	64	75	.
GW I-5	60	54	67	D 1950-395	56	80	..	D 1950-540	86	77	....
H 0117-0	55	53	. .	D 1950-406	80	82	..	D 1950-581	81	60	
H 1119-0	61	52	....	D 1950-413	78	62	....	D 1950-628	79	53	
H M W 391	77	69	74	D 1950-415	85	68	....	D 1951-500	100	100	86
SL 1019	71	70	....	D 1950-422	77	64	....	D 1951-622	68	80	100
SL 9092	77	70	58	D 1950-444	74	63	....	K 310; 851702	57	59	53
D 1950-351	94	71		D 1950-464	66	60		K 310; 851909	68	89	66
D 1950-357	55	54	....	D 1950-465	62	94	. ..	K 328; 234901-10	69	62	50
D 1950-361	71	54	....	D 1950-467	82	74	....	M-11	54	60	
D 1950-370	55	71	....	D 1950-471	69	73	....	Am Cr 9-406-0	80	80	67
D 1950-385	89	57	...								
Fusarium Root Rot											
GW 359	92	88	89	D 1951-370	57	61	79	D 1952-350	91	92	94
GW I-2	92	100	95	D 1951-391	85	82	77	D 1952-359	85	100	80
GW I-3	80	85	93	D 1951-399	94	100	78	D 1952-369	73	58	89
GW I-4	79	74	66	D 1951-402	95	100	100	K 32; 57302	75	85	100
GW I-5	100	96	94	D 1951-412	55	52	80	K 32; 57305	56	55	63
H 0122-0	79	94	78	D 1951-448	60	88	82	K 35; 410503	100	94	77
H 1120-0	84	73	100	D 1951-480	89	84	89	K 35; 410701	96	100	86
H 1123-0	100	100	100	D 1951-500	83	100	100	K 297; 624710	64	57	60
H 1124-0	84	73	77	D 1951-622	86	91	91	K 310; 851702	75	60	79
H 51-51	89	100	98	D 1952-305	59	79	86	K 310; 851909	98	94	73
H MW 391	94	100	98	D 1952-307	95	90	93	K 321; BL01-02	85	96	73
H US 22/3	71	86	85	D 1952-324	96	85	73	K 328; 234801-41	79	93	68
SL 509	92	100	100	D 1952-333	67	.	75	K 328; 234801-30	72	79	77
D 1950-558	72	72		D 1952-334	77	83	82	K 328; 234901-10	54	80	63
D 1951-319	60	73	85	D 1952-336	93	89	84	K 346; 219901	93	95	82
D 1951-335	70	66	82	D 1952-340	74	67	93	[4]Am Cr 9-406-0	78	96	77
D 1951-338	83	84	86	D 1952-347	67	77	77	McF S C 0502	53	52	94
D 1951-356	73	61	52	D 1952-349	95	100	93				

[1] Deming 1952, Kohls Accession 35 and higher, and American Crystal 9-406-0 need additional testing, as degree of pathogenicity was low during this test.

[2] H-Holly Sugar Corporation; GW-Great Western Sugar Company; Am Cr-American Crystal Sugar Company; SL-Salt Lake USDA; D-Deming USDA; McF-McFarlan USDA; K-Kohls, Michigan; M-Montana.

Five varieties of beets showed the highest degree of resistance to aphanomyces root rot, 37 varieties to rhizoctonia root rot and 53 varieties to fusarium root rot (Table 1). Only those varieties of beets which had in all replications more than 50 percent of healthy beets are included (Table 1) . There was only one exception to this rule, which is given *in* the Aphanomyces test. Three varieties of beets are included which, although they showed a lower percentage of healthy beets, had healthy beets present in all three replications. The degree of pathogenicity of aphanomyces cultures was very high and often 100 percent infection occurred *in* all replications. For this reason the three varieties showing the highest degree of resistance when beets were tested in sterilized soil are included in this list.

The degree of pathogenicity of rhizoctonia cultures was also high throughout the duration of all tests. Fusarium cultures for the most part showed a high degree of pathogenicity with the exception of the tests conducted during the fall and winter of 1953 when the degree of pathogenicity was low. Twenty-three varieties of beets of this last group reported in Table 1 will again be tested for fusarium root rot. Not a single variety of beets showed a high degree of resistance to all three diseases (Table 1) . However, a number of varieties showed a high degree of resistance to two out of three types of root rots.

Only 12 varieties of beets, reported in Table 1, for greenhouse tests were used in the field test. These varieties and their relative resistance to rhizoctonia and fusarium root rots under field conditions are summarized in Table 2. All varieties showed a high degree of resistance to both rhizoctonia and fusarium root rots with the exception of SL9092, which was low in resistance toward fusarium.

Table 2.—Percent of Healthy Sugar Beets in Tests of Beet Varieties for Their Resistance to Rhizoctonia and Fusarium Root Rots Under Field Conditions. Huntley Branch Station, Huntley, Montana. 1951-52.

	Root Rots				Root Rots		
	1951	1952			1951	1952	
Varieties Tested	Rhizoc-tonia	Rhizoc-tonia	Fusar-**ium**	Varieties Tested	Rhizoc tonia	- Rhizoc-tonia	Fusar-**ium**
GW 359	87	73	77	Holly 1124-0		76	80
Holly 0117-0		82	73	Holly 51-51		72	75
Holly 0122-0		75	87	Holly MW-39I		66	77
Holly 1119 0		83	88	SL 509		57	91
Holly 1120-0		76	82	SL 1019		69	70
Holly 1123-0		70	92	SL 9092		78	0

Summary

In the present investigation, resistance to 240 varieties of beets was studied under greenhouse conditions in regard to aphanomyces, rhizoctonia and fusarium root rot diseases. Among these varieties of beets, five varieties showed the highest degree of resistance to aphanomyces root rot, 37 varieties to rhizoctonia root rot and 53 varieties to fusarium root rot. Additional tests will be conducted to further evaluate the resistance of these varieties of beets to those root rots.