# Selection for Resistance and Chemical Control of Rhizoctonia Root Rot Disease of Sugarbeets[1]

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Most sugarbeets in Montana are grown under irrigation in heavy clay soils and are very often affected by *Rhizoctonia* root rot disease which causes considerable losses. Usually this disease becomes evident in the middle of the summer and gradually increases toward fall. Beets which become infected early with *Rhizoctonia* usually die quite rapidly. Beets infected later in the season may survive until harvest, however, their quality is poor and most of them become culls. It has been observed that infection of sugarbeets by *Rhizoctonia* in the seedling stage is not important in Montana. It is possible that cool temperatures early in the season are not conducive for the development of this disease (1,2,3)[3].

It appears that more *Rhizoctonia* root rot occurs in sub-irrigated or heavily watered soils than other soils. Short rotations with sugar beets also contribute to an accumulation of this disease. Introduction of longer rotations with cereals, corn and alfalfa are encouraged to help reduce the incidence of this disease.

In an attempt to control this disease various lines of sugarbeets were tested for resistance to this root rot. Numerous Montana selections of beets and selections supplied by various sugar beet companies and by agencies of the United States Department of Agriculture were tested. In addition, various chemical soil treatments were investigated in the field and in the greenhouse for control.

## Testing Different Varieties of Beets for their Resistance to *Rhizoctonia* Root Rot Disease.

In recent years, four Montana selections of sugarbeets (A-339-1, 2, 3, 4) and lines received from Dr. R. K. Oldemeyer, Plant Breeder for the Great Western Sugar Company were tested for resistance to *Rhizoctonia* root rot disease. Originally Dr. Oldemeyer supplied us in 1962 with 48 varieties of beets to be

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[3] Numbers in parentheses refer to literature cited.

tested against this disease. Some of these lines were eliminated during 1963-65 tests because of their extreme susceptibility to *Rhizoctonia* or because of scarcity of seed. Only the following six varieties were tested during the 1966-67 period: 62108-8,10,16,26,27 and 39. In the spring of 1966, Dr. Oldemeyer supplied us with an additional 62 lines of beets for these tests. All 72 lines were tested for resistance to *Rhizoctonia* disease in highly infested soil at the Huntley Branch Station in 1966. The results of this test were rather disappointing because the degree of infection was rather low. It is possible, that cool temperatures of this summer prevented full development of this disease. Because of these circumstances it was decided to conduct further pathogenicity tests in the greenhouse in Bozeman.

In all these tests beets were planted in the greenhouse benches in steamed clay loam soil which was inoculated with several cultures of *Rhizoctonia* grown on steamed barley kernels. All seeds were disinfected with New Improved Ceresan. One row of beets 3½ feet long was planted either with 40 whole or 80 segmented seeds which represented one replication of this test. In these tests Great Western Company variety GW 359 was used as a check. Beets were usually grown for 45-49 days and several readings were taken of healthy and diseased beets. At harvest time a final reading was made when each beet was examined for the presence of infection.

It was decided to submit the above mentioned 62 lines of beets which were received in 1966 to a screening test, and to test later more intensively those lines which showed a best resistance in the screening test. Each of these lines was planted in one row. The variation in percentage of healthy beets in these lines was considerable, and it varied from 1.1 to 68.1%. The check beets averaged 45.4% healthy beets. After analyzing these results it was decided to save for further tests only the 14 lines which had more than 50% of healthy beets in the screening test. These 14 lines of beets and also the above mentioned six Oldemeyer's and four Montana lines were submitted to an intensive pathogenicity test in which all these beets were planted in four replications. The results of these tests are presented in Table 1.

The results of this test show that there was some variation in the degree of resistance of these lines of beets to *Rhizoctonia* root rot disease. None of these lines showed an exceptionally high degree of resistance. However, the following seven lines 65102: 17-6, 27-3, 31-4, 31-5, 646: 9-1, 9-3 and 38-3 distinctly showed a higher degree of resistance to this disease than the remaining lines of beets. All lines except A339-1, had a higher percentage of healthy beets than the check (GW 359).

Table 1.—Testing sugar beet lines for resistance to *Rhizoctonia* root rot disease. Greenhouse 1967.

| Sugarbeet lines | Sugarbeet plants | |
|---|---|---|
| Original No. | Healthy % | Diseased % |
| A 339-1 | 10.2 | 89.8 |
| 2 | 25.4 | 74.6 |
| 3 | 24.4 | 75.6 |
| 4 | 21.6 | 78.4 |
| 62108-8 | 24.6 | 75.4 |
| 10 | 22.4 | 77.6 |
| 16 | 21.0 | 79.0 |
| 26 | 22.5 | 77.5 |
| 27 | 27.2 | 72.8 |
| 39 | 31.6 | 68.4 |
| 6510217-6 | 43.7 | 56.3 |
| 27-1 | 35.4 | 64.6 |
| 27-3 | 40.8 | 59.2 |
| 31-4 | 41.8 | 58.2 |
| 31-5 | 38.8 | 61.2 |
| 646 0-4 | 34.4 | 65.6 |
| 9-1 | 39.9 | 60.1 |
| 9-3 | 39.6 | 60.4 |
| 17-4 | 30.2 | 69.8 |
| 38-2 | 32.3 | 67.7 |
| 38-3 | 43.2 | 56.8 |
| 39-3 | 30.3 | 69.7 |
| 41-2 | 32.8 | 67.2 |
| 41-3 | 26.4 | 73.6 |
| GW 359 | 18.8 | 81.2 |

## Control of *Rhizoctonia* Disease of Sugarbeets with Vitavax Treatments

It has been reported that Vitavax material (oxathiins) is especially effective against certain diseases of plants caused by *Basidiomycetous* fungi (4,5,6). This material was also suggested for treating sugarbeet seeds in controlling disease of young beets caused by *Rhizoctonia*. To investigate the effect of Vitavax on *Rhizoctonia* disease of sugarbeets, several tests were conducted in the greenhouse in Bozeman in which Vitavax was used for seed and soil treatment, and also as a spray.

These tests were conducted in greenhouse benches filled with clay-loam soil. The soil was steamed and inoculated with several strains of *Rhizoctonia* culture grown on autoclaved barley kernels. Each treatment was planted in three replications and each replication was represented by a 3.5 ft row of beets planted with 80 segmented sugarbeet seeds of GW 359.

First the maximum of adherence of Vitavax to sugarbeet seeds was established. It was found that 0.4 g of Vitavax would adhere to 240 segmented beet seeds which weighed 2.6 g. This proportion was used in establishing various rates of seed treatments.

### First Test

In this test the following treatments were used:

1. Seeds were treated with 1/4 of the maximum of adherence of Vitavax (0.1 g of Vitavax to 2.6 g of beet seeds or 62 oz for 100 lb of seed).

2. Seeds were treated with 1/8 of the maximum of adherence of Vitavax (0.05 g of Vitavax to 2.6 g of beet seeds or 31 oz for 100 lb of seed).

3. Beet plants were sprayed three times with a solution of 250 ppm of Vitavax. The first spray was applied when beets had 2-4 leaves, the second time when they had 4-6 leaves, and the third time when they had 6-8 leaves.

4. Soil of each beet row (3.5 ft) was treated with 0.25 g of Vitavax. On the basis of row application, one acre of beets would receive 4.12 lb of 75% (or 3.09 of actual) Vitavax.

5. Check rows.

Beets were grown for 52 days. During this period readings of healthy and diseased plants were taken and the final readings were made at harvest time.

The results of this test are presented in Table 2. The number of healthy beets in both seed treatment tests was about the same and was equal to one fifth of the total number of beets. Beet plants showed some toxic effect from Vitavax which manifested itself in the form of a slight burning of leaves. Beets sprayed with Vitavax showed a slightly higher percentage of healthy beets than those where seeds were treated. In the soil treatment test practically no healthy beets survived. This was mainly due to toxicity of Vitavax and not because of the disease factor. Check beets showed only 14% healthy beets.

Table 2.—Seed and soil treatments and spraying of beet plants with Vitavex for controlling *Rhizoctonia* disease of sugarbeets.

| Treatments applied | Percent of healthy and diseased plants | | | |
|---|---|---|---|---|
| | First Test | | Second Test | |
| | Healthy % | Diseased % | Healthy % | Diseased % |
| 1. Seed treatment 1/4 of the maximum of adherence | 21.0 | 79.0 | — | — |
| 2. Seed treatment 1/8 of the maximum of adherence | 21.9 | 78.1 | 28.8 | 71.2 |
| 3. Seed treatment 1/16 of the maximum of adherence | | | 30.6 | 69.4 |
| 4. Spraying 250 ppm | 28.4 | 71.6 | 13.0 | 87.0 |
| 5. Check | 14.4 | 85.6 | 12.4 | 87.6 |

### Second Test

Because of some toxicity to beets of Vitavax when it was used as a seed treatment and an extreme toxicity in the form of soil treatment, it was decided to conduct another test using lower amounts of Vitavax.

In this test seeds were treated with 1/8 and 1/16 of the maximum of adherence of Vitavax to seeds (equivalent to 31 and 15.5 oz of Vitavax respectively per 100 lb of seed). In the soil treatment only 0.125 g was used per 3.5 ft row of beets (about 2 lb of 75% Vitavax on an acre basis applied in rows). The same concentration of Vitavax was used for spraying plants in this test as in the first one. The same procedure was used here for planting, taking readings and harvesting beets as in the first test. Beets were grown for 33 days. The percent of healthy beets in both seed treatment tests was equal to about 30%. (Table 2). Plants in these tests again showed a slight toxicity from Vitavax. Beets sprayed with Vitavax and the check beets had about the same percentage of healthy beets (about 13%). Beets planted in treated soil again suffered a high degree of toxicity from Vitavax in spite of the fact that the amount of the chemical was reduced to half as compared with the first test. Because of this toxicity it was difficult to differentiate between symptoms of the disease and toxicity. For this reason no further discussion of soil treatments will be made in this paper.

### Control of *Rhizoctonia* Disease with Terraclor and Potassium Azide Treatments

Field experiments were conducted in 1967 in an attempt to control *Rhizoctonia* root rot disease of sugarbeets by treatment of soil with Terraclor (PCNB) and potassium azide ($KN_3$) materials. The location of this test was near the town of Pompeys Pillar in South Central Montana. The sugarbeets were planted in 1967 in a field where beets were grown in 1966 and were severely infected with *Rhizoctonia* root rot. This grower usually follows a two-year rotation of beans and beets so in 1965 this field had been planted to beans.

The following materials were used as soil treatments. Terraclor granular 10%, Terraclor E. C. (emulsifiable concentrate), containing 2 lb of active per gallon and Terraclor Super X, E.C., containing 2 lb of active plus 0.5 lb of Terrazole (Olin compound 2424) per gallon. All the above materials were supplied by the Olin Company. Potassium azide (100% active) was furnished by the Pittsburg Glass Company.

Terraclor 10% granular was applied at the rate of 250, 500 and 1000 lb per acre (25, 50 and 100 lb of actual, respectively).

Terraclor Super X, E.C. was used at a rate of 2, 4 and 6 gallons per acre and Terraclor E.C. in amounts of 4 and 8 gallons per acre. Potassium azide was used in amounts of 80 and 160 lb per acre. Granular Terraclor was broadcast and the azide, Terraclor Super X., E.C. and Terraclor E.C. were diluted with water and sprayed on the surface of the ground at the rate of 100 gallons of solution per acre. Chemicals were applied and the soil was rototilled, harrowed and planted on April 28, 1967. Unless otherwise stated, all treatments and the check plots were used in four replications. The size of Terraclor plots were 11 × 40 ft and azide plots 11 × 20 ft. Six rows of beets were planted in all these plots. Disease readings of beets were made twice during the summer and final readings were made at harvest time (September 19-20). At this time all beets in the four central rows of plots were pulled from the soil and examined for infection with *Rhizoctonia* root rot disease. The results of these tests are presented in Table 3. This table presents the average results on a percentage basis for four replications of all these treatments.

The greatest reduction in infection with *Rhizoctonia* was obtained in beets grown in plots treated with 1000 lb of granular Terraclor. The percentage of severely infected beets in this treatment was only about 1/3 of that found in the check beets. Reduction of disease of beets grown in plots treated with 500 lb of Terraclor was quite comparable to the 1000 lb treatment.

**Table 3.—Control of *Rhizoctonia* disease of sugarbeets with terracolor and potassium azide treatments.**

| Materials used | Per acre lb or gal | Healthy Beets % | with slight % | Degree of infection *Rhizoctonia* severe % |
|---|---|---|---|---|
| Terraclor 10% Gr. | 250 lb | 55.7 | 18.2 | 26.1 |
| Terraclor 10% Gr. | 500 lb | 63.9 | 14.5 | 21.6 |
| Terraclor 10% Gr. | 1000 lb | 66.0 | 15.1 | 18.9 |
| Terraclor Super X, E.C. | | | | |
| (2# + 0.5#/gal) | 2 gal | 45.2 | 16.7 | 38.1 |
| (2# + 0.5#/gal) | 4 gal | 50.5 | 15.7 | 33.9 |
| (2# + 0.5#/gal) | 6 gal | 45.4 | 17.8 | 36.8 |
| Terraclor E.C.(2#/gal) | 4 gal | 55.0 | 22.1 | 22.9 |
| Terraclor E.C.(2#/gal) | 8 gal | 56.4 | 15.6 | 28.0 |
| Check | | 38.4 | 14.5 | 47.1 |
| Potassium azide | 80 lb | 23.0 | 13.9 | 63.1 |
| Potassium azide | 160 lb | 23.3 | 11.4 | 62.3 |
| Check (only 2 rpl) | | 24.6 | 13.6 | 61.8 |

Beets with a silght degree of disease were considered to be those which had only a few superficial *Rhizoctonia* lesions. Severly infected beets were badly diseased and decayed and usually would not be accepted at the beet dumps.

Diseased beets in plots treated with 250 lb of Terraclor, 4 and 8 gallons of Terraclor E. C. ranged from 43.6 to 45.0% This amount of disease was slightly higher than for those treated with 500 and 1000 lb of Terraclor. Beets grown in plots treated with Terraclor X, E.C. had much more disease than beets grown in all the above mentioned plots. Check plots had the greatest amount of disease and about half of the beets in these plots were so decayed that they were of no commercial value.

The azide test was located in a different area of the field where the disease was very severe. For this reason a separate set of checks was arranged for this test. The results show that treatments with azide apparently did not have any effect on the control of *Rhizoctonia* root rot.

## Conclusion

It is evident that some of the varieties of sugarbeets tested for resistance to *Rhizoctonia* root rot disease showed greater degree of resistance than the check beets, although none of them showed really an outstanding degree of resistance. Some inherent resistance apparently exists in sugarbeets for *Rhizoctonia* root rot, although multigenic inheritance probably decreases the possibility of obtaining highly resistant varieties among *Beta vulgaris* lines.

It appears that further development of sugarbeet varieties with resistance to this disease should be attempted either by concentrating resistant genes by recurrent mass selection or by searching for resistance to *Rhizoctonia* among wild species of *Beta* and incorporating this resistance into the commercial varieties of beets. This might result in the development of beet varieties with a higher degree of resistance to this root rot.

Existence of numerous pathogenic races in *Pellicularia filamentosa* greatly complicates breeding and selection work for resistance to *Rhizoctonia* disease of sugarbeets.

In an attempt to control the disease through the use of various chemicals which would suppress or destroy the causal organism, several materials were investigated in this study.

Experiments with Vitavax showed it to be generally ineffective in controlling *Rhizoctonia* disease of sugarbeets and to be toxic to the beets. It produced only a slight beneficial effect when it was used as a seed treatment and practically no effect when used as a spray. Vitavax was extremely toxic when used in the form of soil treatment.

Field test with Terraclor showed that PCNB used in amounts of 50 and 100 lb of actual material per acre produced a distinct beneficial effect in controlling *Rhizoctonia* disease of sugarbeets.

Other formulations of Terraclor alone or in combinations with Terrazole produced less beneficial effects probably because they contained smaller amounts of PCNB.

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