Cercospora Leaf Spot as a Predisposing Factor in Storage Rot of Sugar Beet Roots

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ABSTRACT

In two F_2 populations segregating for *Cercospora* leaf-spot resistance, selection of sugar beet plants for high as compared to low leaf-spot resistance resulted in a 50% reduction in storage rot of harvested roots. Also, the degree of field leaf-spot infection closely paralleled the number of harvested roots that rotted in storage. Phytopathology 61: 1485-1487.

Additional key words: Cercospora beticola, Beta vulgaris, keeping quality.

The effects of leaf spot, incited by *Cercospora beticola* Sacc., on the yield and sucrose content of sugar beet (*Beta vulgaris* L.) are well documented (8, 9, 12). However, no data have been reported concerning the effect of severe leaf spot in the field on the incidence of subsequent rots of sugar beet roots during storage. Observations made by us in a study on the inheritance of resistance to *Cercospora* suggested an association between degree of *Cercospora* infection and the keeping quality of harvested roots. The objectives of this study were to first determine if leaf-spot infection in the field affected subsequent keeping quality of harvested roots, then to determine if differences in degree of leaf-spot infection were paralleled by a change in keeping quality of harvested roots.

MATERIALS AND METHODS.—Segregating F_2 populations of resistant by susceptible crosses were grown in the field under an artificially induced leaf-spot epidemic. The sugar beet populations in the study were US 201 x 52-334 and US 201 x 51-319. US 201, a heterogeneous cultivar, is homozygous for leaf-spot resistance. The other parents, 52-334 and 51-319, are susceptible inbred lines.

The technique used to initiate a uniform leaf-spot epidemic was described previously (10). At the peak of the epidemic, individual plants were given a leaf-spot disease rating based on a scale of 0 to 10, where 0 = no apparent infection and 10 = complete defoliation (10). In this study, only disease classes of 1 to 8 were seen. A random sample of 310 plants was rated within each F_2 population. In addition, 74-76 plants from each population were selected for high leaf-spot resistance (rating = 1 to 3), and 81-83 were selected for low resistance (rating = 5 to 8).

All leaf-spot rated plants were harvested and the leaves removed to the crown. Roots were washed, numbered (tagged), and placed in crates in a root storage room at 4 to 6 C and 100% relative humidity. At this time, roots from plants having high leaf-spot ratings appeared as healthy as roots from plants having low leaf-spot readings. Roots were examined for rot after 141 days of storage. Roots were classified as rotted when they contained sufficient rotted tissue to prevent successful seed production.

RESULTS.—Fungi observed on rotted beets included *Botrytis, Fusarium, Penicillium,* and *Phoma* spp. These are common storage rot pathogens of sugar beet (1, 6).

The number of rotted beets in samples selected for low leaf-spot resistance in both crosses was 2 or 3 times larger than the number of rotted beets in the samples selected for high resistance (Table 1). The average leaf-spot rating of the rotted beets in the low selection groups (6.1 and 6.0) was twice that of the rotted beets in the high selection groups (2.5 and 3.0). Data in Table 1 were arranged in a 2 x 2 contingency table, and the null hypothesis of "No difference in percentage rotted beets between plants selected for high leaf-spot resistance and those selected for low resistance" was tested by the X^2 test (11). A X^2 value of 2.40 with a probability of $P = .120$ was obtained. This value and the consistent pattern we observed indicates that the percentage of beets rotted in storage following selection of plants for high leaf-spot resistance was less than those plants selected for low leaf-spot resistance.

In those samples selected for high resistance, 4.6% of the stored beets rotted, whereas 10.3% of the beets rotted in the samples selected for low resistance (Table 1). Differences in percentage of rotted beets between the two F_2 populations also were found under selection for high and low leaf-spot resistance. But in both populations, selection for high resistance, compared to selection for low resistance, resulted in a 50% reduction of rotted beets in storage (Table 1). A reduction in rotted beets in storage was also seen in a comparison of beets selected for high leaf-spot resistance (Table 1) with those selected at random (Table 2). The latter included beets with high and low leaf-spot ratings.

In the sample where randomly selected plants were rated for resistance, the total number of beets that rotted was about 13% for both F_2 populations (Table 2). The average field leaf-spot ratings for these samples was 3.2 and 4.3 In the leaf-spot classes 1

TABLE 1. Ratio of rotted sugar beet roots to total roots in two F_2 populations selected for high and low leaf-spot resistance from field-grown plants inoculated with *Cercospora beticola*

F_2	Leaf-spot disease rating[a] 1	2	3	4	5	6	7	8	% Rotted beets
Selection for high resistance									
US 201 x 52-334	0/4[b]	3/33	3/37						8.1
US 201 x 51-319	0/2	0/30	1/44						1.3
Selection for low resistance									
US 201 x 52-334					5/26	4/40	4/16	1/1	16.8
US 201 x 51-319					1/28	1/31	1/20	0/2	3.7

[a] Leaf-spot rating based on scale of 0 to 10, where 0 = no infection and 10 = complete defoliation; only ratings of 1 through 8 were seen in this study.

[b] Number of beets rotted per number selected in each leaf-spot disease class.

TABLE 2. Ratio of storage rotted sugar beet roots to total roots from randomly selected plants rated for *Cercospora* leaf-spot severity in the field in two F_2 populations

F_2	Leaf-spot disease rating[a] 1	2	3	4	5	6	7	8	% Rotted beets
US 201 x 52-334	0/5[b]	3/40	16/128	14/81	4/22	4/24	1/7	1/3	13.9
US 201 x 51-319	0/6	1/29	10/108	14/93	7/36	3/22	3/13	0/3	12.3

[a] Leaf-spot rating based on scale of 0 to 10, where 0 = no apparent infection and 10 = complete defoliation; only ratings of 1 through 8 were seen in this study.

[b] Number of roots rotted per number selected in each leaf-spot disease class.

through 4, 11.8% of the stored beets rotted, whereas in classes 5 through 8, 17.7% of the beets rotted. When only the beets in classes 1 through 3 are considered as resistant, and those in classes 4 through 8 as susceptible, only 9.8% of the resistant beets rotted, whereas 16.8% of susceptible beets rotted (Table 2). Data in Table 2 were arranged in a 2 x 8 contingency table, and the null hypothesis of "No relationship between degree of leaf-spot infection and storage rot of beets" was tested by the X^2 test (11). A X^2 value of 9.99 with a probability of $P = .189$ was obtained. Even though a significant X^2 value was not obtained, the deviations from the expected showed a systematic pattern. In the rotted beet class, the observed numbers were lower than the expected numbers for leaf-spot classes 1 through 3, and the observed number of rotted beets in classes 4 through 8 were higher than the expected numbers. Contrary to the null hypothesis, the deviations from the expected suggest that more rot developed in stored beets that had high field leaf-spot ratings than in those with lower leaf-spot ratings.

DISCUSSION.—Storage of sugar beets in piles at receiving stations between harvest and processing is a common practice. Storage may range from several days to several months. Serious losses of sugar occur in these piles through natural respiration and from rotting caused by microorganisms.

Rotting of sugar beet roots during storage is influenced by many factors (2, 3, 4, 5, 7). Our study strongly indicated that *Cercospora* leaf spot may be another factor that predisposes beets to storage rot. The exact reasons for this predisposition have not been established. It is generally believed that beet roots with a low sucrose content do not store as well as those with a high sucrose content. Since infection of sugar beet plants by *Cercospora* reduces the sucrose content of the roots, the keeping quality of these roots also should be expected to be impaired.

The storage conditions in our study were considered less favorable for storage rot development than the conditions under which commercial sugar beet roots are stored. Our results emphasize the need for further studies on the nature of predisposal to storage rot of sugar beets infected with *C. beticola* during their growth and development.

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