Effect of Soil Deposition in Crowns on Development of Rhizoctonia Root Rot in Sugar Beet

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ABSTRACT

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Our greenhouse and field experiments showed that soil deposition in and around sugar beet crowns (hilling) aggravated root rot in soils infested with *Rhizoctonia solani*. In the greenhouse, hilled plants had root rot sooner and more severely than unhilled plants. In field plots at two locations, in two of three experiments, hilling significantly increased root rot incidence and severity in resistant and in susceptible cultivars.

Root rot, caused by *Rhizoctonia solani* Kuehn, is one of the most important diseases of sugar beet (*Beta vulgaris* L.) in the United States. There are indications that the disease has been gradually increasing in incidence and severity (2). Recently, cultivars resistant to *Rhizoctonia* have been developed in the United States but are not yet widely grown. Among suggested control measures, modification of cultural practices can be readily adopted by most growers at the present time.

It has long been suspected that cultivating operations known as ditching-out and hilling aggravate Rhizoctonia root rot of sugar beet. In the final cultivation of the season, some growers deposit soil in and around crowns by moving equipment at relatively high speeds of 6.4–12.8 km/hr (4–8 mph). Growers may "ditch-out" to provide channels for irrigation water, to help control weeds, and to provide guides for harvesting equipment. In nonirrigated areas, growers may use hilling to control weeds with soil and to provide soil support to high-crowned beets in order to ensure more uniform topping at harvest.

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Aboveground parts of several crops readily become infected by the pathogen when in contact with *Rhizoctonia*-infested soil (1). Soil in contact with petioles contributes to the crown phase of dry-rot canker of sugar beet caused by *R. solani* (4).

In an Ohio experiment, hilled and nonhilled plots infested with *R. solani* showed no significant difference in sugar beet survival (3). On the other hand, in a Japanese study, hilling resulted in increased root rot (7). In the present study, we sought evidence concerning the effect of hilling on Rhizoctonia root rot development and the effect of host genotype (resistant or susceptible) on disease development after hilling.

MATERIALS AND METHODS

Our experiments were conducted at two widely separated locations. Preliminary greenhouse and field studies were conducted at East Lansing, MI, whereas field tests simulating commercial cropping methods were subsequently conducted at Fort Collins, CO.

Greenhouse test. Sugar beet cultivar US401, susceptible to root rot, was grown in beds of steam-pasteurized soil. Plants about 8 wk old were inoculated by the method of Schuster et al (6); a *Rhizoctonia*-infested toothpick was inserted into each crown, then 150 cm^3 of sterile soil was deposited in and around half of the plants. Plants were arranged in 14 blocks, each block comprising two hilled and two nonhilled plants. The number of days from inoculation until appearance of first root rot symptoms (presymptom period) was noted for individual plants.

Plants were examined 80 days after inoculation and graded according to the degree of root rot: 1 (none to light); 2 (moderate); 3 (severe to dead).

East Lansing field test. Two breeding lines, one susceptible and the other resistant to *Rhizoctonia*, were grown in adjacent one-row plots 5.2 m long in three randomized blocks. Dried barley grain inoculum was applied as a side dressing in early June at 14 kg/ha and along the plant rows and into the crowns in mid-July at 25 kg/ha as previously described (5).

In mid-August, plots were cultivated between the rows. In half of each block the soil was manually hoed along the rows and into the crowns to simulate the hilling operation. The other half of each block served as a nonhilled control. Incidence and severity of root rot were determined at crop maturity in October.

Fort Collins field tests. The tests were conducted in a field that contained the previous year's Rhizoctonia nursery and was highly infested with the pathogen. In addition, barley grain inoculum was broadcast and incorporated into the soil at 56 kg/ha.

In 1978, a *Rhizoctonia*-susceptible commercial hybrid (Mono Hy A-1) and a

Table 1. Effect of soil deposition in crowns on root rot development in sugar beet line US401 inoculated with *Rhizoctonia solani* in the greenhouse

Soil treatment	No. of plants in index class: 1	2	3	Index mean[x]
		Presymptom period[y]		
Hilled	5	7	16	2.4 b
Nonhilled	15	6	7	1.7 a
		Disease index[z]		
Hilled	4	8	16	2.4 b
Nonhilled	15	5	8	1.8 a

[x] Treatments with different letters differed significantly according to the chi-square test for independence ($P = 0.05$).

[y] Presymptom period index = 1 (>30 days), 2 (15–30 days), 3 (<15 days).

[z] DI (disease index) = 1 (none to light), 2 (moderate), 3 (severe to dead).

Rhizoctonia-resistant breeding line (FC703) were grown in four-row plots each 6.1 m long. Cultivars and treatments were arranged as a 2 × 2 factorial experiment with eight replications. At the final cultivation, ditching operation was done to force soil into and around the beet crowns by operating the tractor at approximately 13 km/hr (8 mph). Beets in control plots were cultivated similarly but were shielded from the dislodged soil. In 1979, essentially the same experiment was repeated with three replications.

RESULTS

In the greenhouse test, disease symptoms developed sooner and root rot was more severe in plants with soil-covered crowns than in control plants (Table 1). Similarly, in the East Lansing field test, hilling resulted in more root rot in the susceptible line and also in the *Rhizoctonia*-resistant line (Table 2).

In the 1978 Fort Collins field tests, incidence and severity of root rot were significantly greater in the hilled plots of susceptible cultivars and resistant lines (Table 3, Fig. 1). The percentage of healthy and harvestable roots of both host types was significantly decreased in the hilled series. In the 1979 Fort Collins field tests, there was a tendency toward higher disease indices and fewer harvestable roots in both host types in hilled plots, but differences between treatments were not statistically significant.

Table 2. Effect of soil deposition in crowns on root rot development in two sugar beet cultivars in field plots inoculated with *Rhizoctonia solani* at East Lansing, MI

Cultivar	Soil treatment	No. of plants in each DI class[y] 1	2	3	Index mean[z]
Susceptible					
SP6822-0	Hilled	1	14	36	2.7 d
	Nonhilled	7	30	12	2.1 c
Resistant					
FC701/1	Hilled	29	21	6	1.6 b
	Nonhilled	42	6	4	1.3 a

[y]DI (disease index) = 1 (none to light), 2 (moderate), 3 (severe to dead).
[z]Treatments with different letters differed significantly according to the chi-square test for independence ($P = 0.05$).

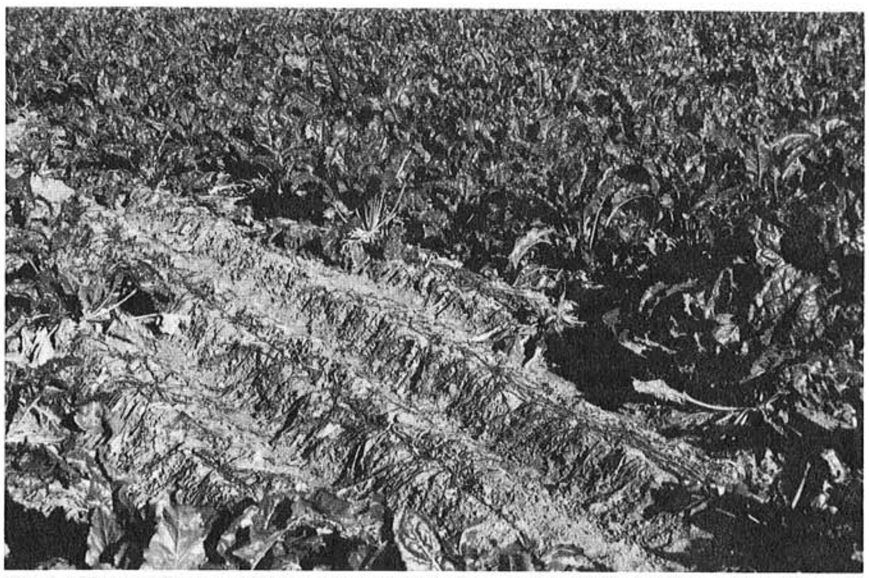

Fig. 1. Effect of hilling on Rhizoctonia root rot in four-row plots of sugar beet cultivar Mono Hy A-1 at Fort Collins, CO: hilled **(lower left)** and nonhilled **(upper right)**.

DISCUSSION

Our greenhouse test and two of our three field tests demonstrated increases in root rot severity when sugar beet crowns were covered by cultivation soil. The effect of hilling was noted in the *Rhizoctonia*-resistant lines as well as in the susceptible cultivars. Hilling in itself does not appear to be harmful, however. In preliminary greenhouse experiments, no rot or deleterious effects were noted in plants hilled with *Rhizoctonia*-free soil.

The lack of significant results in the 1979 Fort Collins tests suggests that factors other than hilling may have affected disease intensity. Environmental factors and variation in inoculum potential have been considered as possible contributing influences.

The following cultural practices are suggested as means of preventing excessive soil deposition in and around sugar beet crowns: furrow at speeds that do not exceed 3.2–4.8 km/hr (2–3 mph); plant in preshaped beds and/or in wider rows; and use cultivator shoes with shields to reduce the amount of soil reaching beet crowns.

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Table 3. Effect of soil deposition in sugar beet crowns on incidence and severity of root rot caused by *Rhizoctonia solani* in field plots at Fort Collins, CO

Cultivar	Soil treatment	DI[w,x] 1978	DI[w,x] 1979	Healthy roots (%)[x,y] 1978	Healthy roots (%)[x,y] 1979	Harvestable roots (%)[x,z] 1978	Harvestable roots (%)[x,z] 1979
Susceptible							
Mono Hy A-1	Hilled	6.6 d	5.4 b	2.3 d	14.9 a	7.3 d	21.9 a
Mono Hy A-1	Nonhilled	5.2 c	5.1 b	17.7 c	14.8 a	29.8 c	25.4 a
Resistant							
FC703	Hilled	2.9 b	3.2 a	44.6 d	36.4 b	72.2 b	60.7 b
FC703	Nonhilled	2.4 a	3.1 a	59.0 a	37.0 b	79.7 a	65.1 b
CV (%)		8.5		19.0		9.0	

[w]DI (disease index) = 0 (no symptoms)–7 (roots completely rotted, plants dead).
[x]Means of eight replications in 1978 and three in 1979. Means in each column followed by the same letter do not differ significantly ($P = 0.05$) by Duncan's multiple range test.
[y]Disease index classes 0 and 1 combined; disease class 1 consists of roots having very small, superficial, arrested lesions.
[z]Roots in classes 0–3 are considered harvestable and would be processed at the sugar factory.

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