Relative Damage of Cercospora Leaf Spot in Sugarbeet Varieties

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In 1948, Stewart (2)[2] reported the results of a spraying experiment to control leaf spot caused by *Cercospora beticola* Sacc. Under severe and prolonged exposure, the productivity of sprayed populations of the most resistant sugarbeet variety, US 216, was over twice that of the unsprayed diseased population. In 1965, an experiment was undertaken at the Plant Industry Station, Beltsville, Maryland, to reappraise losses caused by leaf spot, particularly the production loss, in the current resistant variety. Summer temperature and humidity at this station are favorable for the disease. A sprinkler system was used to promote infection during periods of drought.

Materials and Methods

Three varieties differing in leaf spot resistance were used. The experimental design was a randomized-block split plot with 6 replications, spray treatments being the main plots and varieties being subplots. A border of SP 6322-0, a resistant multigerm variety, surrounded each plot to minimize border effects of drifting spray and splashed spores. Each variety subplot was 4-rows wide and 20 feet long. The rows were 24 inches apart, and the plants were spaced about 12 inches apart in the rows.

Sugarbeets in the sprayed plots received 11 mist spray applications of copper oxychloride in oil emulsion at the rate of ⅔ lb per acre to control the disease. In 1964, Schneider (1) found copper oxychloride effective in controlling *Cercospora* leaf spot. The applications were made at weekly intervals except for more frequent applications during periods of rainfall. The rate of application was limited to ⅔ lb because of the danger of leaf damage from numerous applications of the fungicide. No leaf damage occurred from the treatments.

On June 8, leaf spot inoculum was applied to sugarbeet plants in the unsprayed halves of the split plots. The first symptoms of disease appeared about 10 days later. Fungicidal treatment of uninoculated plots was started on July 5. Fungicidal treatments were not applied to the inoculated populations.

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[2] Numbers in parentheses refer to literature cited.

Five readings of leaf spot intensity were made on all plots between July 23 and September 4. The readings were based on a scale from 0 to 10—0 being no leaf spot and 10 being complete defoliation due to the disease. At the peak of the disease epidemic all mature leaves were blighted; only a few young immature center leaves of the foliar rosette remained free of spots in the susceptible variety. The disease epidemic continued until harvest, but declined in severity after August 31. Therefore, for a period of more than 60 days, the disease was severe and caused significant damage to the sugarbeets.

The center 2 rows of each subplot were harvested individually and weighed on October 6 and the beets taken for quality evaluation. Duplicate pulp samples were taken from each subplot, using all the beets in each individual row for sucrose analysis by polarization and for soluble substance determination by refractometer.

Results and Discussion

The fungicidal treatments were not fully effective in controlling the disease, as indicated by the leaf spot readings given in Table 1. Although oil emulsion of copper oxychloride is a standard fungicide for the control of Cercospora leaf spot of

Table 1.—Average leaf spot readings of sprayed and unsprayed populations of three sugarbeet varieties in 1965 fungicide spray test for Cercospora control.

Variety	Treatment	Average leaf spot reading				
		July 23	July 30	Aug. 6	Aug. 12	Sept. 4
SP 633269-0	No spray	4.50 a[1]	4.83 a	5.08 a	5.17 a	6.33 a
	Sprayed	1.42 d	2.00 cd	2.83 c	2.92 c	5.00 b
US 401	No spray	3.08 b	3.83 b	4.08 b	4.08 b	4.50 b
	Sprayed	1.00 e	1.83 d	1.92 d	2.17 d	3.75 c
SP 6322-0	No spray	2.08 c	2.25 c	3.00 c	3.00 c	3.42 c
	Sprayed	0.42 f	1.25 e	1.25 e	1.42 e	2.67 d
Average for both treatments:						
SP 633269-0		2.96 a	3.42 a	3.96 a	4.04 a	5.67 a
US 401		2.04 b	2.83 b	3.00 b	3.13 b	4.13 b
SP 6322-0		1.25 c	1.75 c	2.13 c	2.21 c	3.04 c
Average for 3 varieties:						
	No spray	3.22 a	3.64 a	4.06 a	4.08 a	4.75 a
	Sprayed	.94 b	1.69 b	2.00 b	2.17 b	3.81 b
Difference between treatments:						
SP 633269-0		3.08 a	2.83 a	2.25 a	2.25 a	1.33 a
US 401		2.08 b	2.00 b	2.16 a	1.91 ab	.75 a
SP 6322-0		1.66 b	1.00 c	1.75 a	1.58 b	.75 a

[1] Means in the same column which have the same letter are not significantly different at the 5% level.

sugarbeet, it was not as effective as desired in this experiment where disease development was intentionally intensified. However, the sprayed populations suffered strikingly less leaf damage through the middle of August and visibly less through the remainder of the growing season until harvest. This difference in treatments was highly significant each time leaf spot evaluations were made. After September 4, the difference in the amount of leaf spot between the treatments decreased considerably. The leaf spot readings of July 23, July 30 and August 12 indicate a significantly greater difference in the amount of disease between the sprayed and unsprayed populations of the more susceptible varieties, as compared to the differences between sprayed and unsprayed populations of the more resistant varieties. The differences between varieties in leaf spot readings were highly significant.

Harvest data are indicative only of productivity at different levels of disease intensity. The harvest results and laboratory analyses are presented in Table 2. Yields of beets and gross sugar for the sprayed populations undoubtedly would have been

Table 2.—Harvest data of three sugarbeet varieties in 1965 fungicide spray test for Cercospora control.

Variety	Treatment	Acre yield		Sucrose	Raw juice apparent purity
		Gross sugar	Roots		
		Pounds	Tons	Percent	Percent
SP 633269-0	Sprayed	4033 d[1]	17.86 c	11.29 c	75.25 c
	No spray	2395 e	12.63 d	9.48 d	72.59 d
U'S 401	Sprayed	6015 b	24.39 a	12.33 b	78.28 b
	No spray	4030 d	18.57 c	10.85 c	75.60 c
SP 6322-0	Sprayed	6620 a	25.21 a	13.13 a	80.18 a
	No spray	5444 c	21.67 b	12.56 b	79.36 ab
Average for both treatments:					
SP 633269-0		3214 c	15.25 c	10.39 c	73.92 c
U'S 401		5023 b	21.48 b	11.59 b	76.94 b
SP 6322-0		6032 a	23.44 a	12.85 a	79.77 a
Average for 3 varieties:					
	Sprayed	5556 a	22.49 a	12.25 a	77.90 a
	No spray	3956 b	17.62 b	10.96 b	75.85 b
Difference between treatments:					
SP 633269-0		1638 ab	5.23 a	1.81 a	2.66 a
US 401		1985 a	5.82 a	1.48 a	2.68 a
SP 6322-0		1176 b	3.54 a	.57 b	.82 a

[1] Means in the same column which have the same letter are not significantly different at the 5% level.

higher if leaf spot control had been more effective. Nevertheless many significant differences occurred.

SP 633269-0 was significantly lower than the other two varieties in root yield, and there were significant differences between treatments in root yields. However, there were no significant differences between varieties in the amount of loss of root yield caused by leaf spot.

Differences between varieties in percent sucrose were significant. The decrease in percent sucrose attributable to leaf spot in SP 6322-0 was significantly less than in the other two varieties.

Differences between varieties in gross sugar production were highly significant as were the differences between treatments. The decrease in gross sugar production attributable to leaf spot in SP 6322-0 was significantly less (1% level) than in US 401.

There were highly significant differences between varieties in raw juice apparent purity. There were highly significant differences between treatments in two of the varieties, SP 633269-0 and US 401, but no significant difference between treatments in raw juice apparent purity in the variety SP 6322-0. The difference between treatments in SP 6322-0 was smaller than in the other two varieties because of the greater leaf spot resistance of SP 6322-0.

There were no significant differences between varieties in the amount of decrease in raw juice apparent purity attributable to leaf spot.

There was essentially no difference between sprayed and unsprayed treatments in the amount of nonsucrose solutes in raw beet juice (Table 3). However, the differences between varieties in content of these nonsucrose solutes were significant and are the result of selection efforts.

It should be emphasized that even the resistant variety, SP 6322-0, suffered appreciable losses in tonnage and sugar percentage under the severe leaf spot conditions of this test and that more resistance is still to be desired. In trying to estimate whether application of fungicidal treatments to a variety with resistance equivalent to SP 6322-0 would be profitable on a commercial basis, two imponderables are present. First, in commercial sugarbeet districts, the intensity of leaf spot is almost never as severe as the epidemic induced in this test; consequently, the losses in commercial fields are not nearly so great as the losses under the conditions of this test. Second, the indicated losses realized in this test are not as great as they would have been if perfect leaf spot control had been achieved in the fungi-

Table 3.—Percentage nonsucrose solutes in press juice of sprayed and unsprayed populations of three varieties of sugarbeets in 1965 fungicide spray test for Cercospora control.

Variety	Treatment	Nonsucrose solutes
SP 633269-0	Sprayed	3.57 ab[1]
	No spray	3.70 a
US 401	Sprayed	3.50 b
	No spray	3.43 bc
SP 6322-0	Sprayed	3.27 c
	No spray	3.25 c
Average for both treatments:		
SP 633269-0		3.64 a
US 401		3.46 b
SP 6322-0		3.26 c
Average for 3 varieties:		
	Sprayed	3.45 a
	No spray	3.46 a
Difference between treatments:		
SP 633269-0		.13 a
US 401		.07 a
SP 6322-0		.02 a

[1] Means in the same column which have the same letter are not significantly different at the 5% level.

cide-treated populations. Hence, there is no exact measure of the loss caused by leaf spot at the degree of disease severity experienced in this experiment.

Summary

Fungicidal treatments of three sugarbeet varieties differing in Cercospora leaf spot tolerance enhanced gross sugar yields, root weights, sucrose percentages, and percent purities under severe disease exposure. The productivity of untreated populations was associated with varietal resistance to the pathogen. SP 6322-0, the most resistant entry, had less decrease in percent sucrose due to leaf spot than the other varieties. The beets of SP 6322-0 had less nonsucrose solutes in both sprayed and unsprayed populations than the other 2 varieties. This was not attributable to the better leaf spot tolerance of SP 6322-0 but is inherent in the variety as a result of selection for this characteristic. A commercial variety with leaf spot resistance comparable to SP 6322-0 affords reasonably good protection against field epidemics of leaf spot, but even more resistance is needed if disease losses are to be avoided without fungicidal protection when leaf spot is severe.

Literature Cited

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