The Damages Induced by a Severe Epidemic of Cercospora Leafspot on Susceptible and Resistant Varieties of Sugar Beets

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DURING THE SUMMER of 1947 a test was conducted on the Plant Industry Station to evaluate susceptible and resistant varieties of sugar beets under extreme conditions of leafspot exposure, with and without fungicidal treatment. The varieties U. S. 15, Line J, U. S. 215x216/2 and Improved U. S. 216 were included in the test. According to disease readings from tests conducted in sugar beet-growing regions over a period of several years the non-bolting variety U. S. 15 is leafspot susceptible, Line J and the 2nd release of U. S. 215x216 are resistant and Improved U. S. 216 is highly resistant. These varieties as well as others conform with reasonable constancy to previous classification as to disease reaction when grown in territories where climatic conditions restrict the growth of the pathogen *Cercospora beticola* or on the Plant Industry Station during the onset of the disease epidemic. However, after prolonged exposure to intense epidemics which occur most seasons on the Station it has been observed that varieties in the resistant categories do not perform as expected. Late in the season they show considerable blighting of the foliage due to an accumulation of spots on senescent leaves. Under comparable conditions the susceptible varieties react more violently to the disease and suffer a tremendous loss of foliage long before the leaves have served their useful span of life. Thus the susceptible and resistant varieties differ quantitatively, the resistant ones being characterized by smaller spots and fewer spots per unit of leaf area as well as a delay in the appearance of blight. It was the purpose of the test to appraise the extent to which varieties with this type of resistance are adequate to cope with a prolonged and unusually severe epidemic of the disease.

During the growth of the beets, methods were followed which favor the intensification of leafspot. The land had grown a crop of sugar beets the previous season and the infested tops were left on the ground. The climatic conditions which are usually hot and humid during late spring and summer were supplemented when needed by a sprinkler system. An occasional leafspot could be found in the seedling stands and this slight infestation was augmented by inoculation shortly after singling. Leaves of an overwintered crop of beets on which the pathogen was sporulating profusely were used as a source of inoculum. A suspension containing 5-10 spores per drop was applied on June 23 to each plant except those of the control plots. On July 25 the disease was considered to have reached epidemic proportions

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when an abundance of leaf blight was observed in plots of U. S. 15. The disease condition worsened and soon all plants of the susceptible variety and the less tolerant phase of the resistant varieties were defoliated except for the few young leaves in the central buds.

With slight fluctuations in intensity, the disease epidemic continued until about October 10 when the growth of the pathogen was halted by a light frost and a period of cool nights. The period of disease exposure was approximately one half of the growing season from seedling emergence (April 28) to harvest, November 4. For a period of 75 days there was an appreciable loss of leaves due to blight. The disease injury was recorded using a scale of 0 to 10. On the scale 10 represented maximum injury and 1 designated severe spottings but essentially no blighting of the leaves. U. S. 15 received a score of 5.0 to 9.0 for the period of the epidemic while the highly resistant strain of U. S. 216 scored 0.5 to 3.0. The other varieties were intermediate in scores.

The Latin-square design with split plots was used for the test. The plots of the varieties were 8 rows wide and 20 feet long. The rows were 24 inches apart and the plants were spaced approximately 24 inches within the row. One half of each varietal plot received 8 applications of Bordeaux mixture at intervals of 8 to 10 days beginning July 11 to control the disease. The other half was exposed to the ravages of the disease. There were 2 Latin squares giving 8 plots of each of the 4 varieties which were divided into subplots for spray and no spray treatments. The results from the 2 squares have been combined into one summary as given in table 1.

In this test the differences between the sums of varietal performances are of minor concern whereas the comparison between spray treatments are of special interest. Each of the four varieties gave a highly significant gain for fungicidal treatment in acre yield of gross sugar and roots and in sucrose percentage. The spectacular difference for the susceptible variety U. S. 15 is thought to represent an extreme record of *cercospora* leafspot damage to sugar beets. If the differences between subplot means for acre yield of gross sugar as recorded in the table for each of the varieties are converted into percentages of the unsprayed half of the plot there are indicated gains of 127 percent, 126 percent, 122 percent, and 225 percent for Improved U. S. 216, U. S. 215x216/2, Line J, and U. S. 15, respectively. In like manner for acre yield of roots calculated gains of 87 percent, 68 percent, 79 percent, and 130 percent are obtained for the varieties in the order as given for gross sugar. The sucrose percentage was strikingly reduced for all varieties as a result of the disease. With the possible exception of the highly resistant Improved U. S. 216 which is a high-sucrose type, the quality of the roots from the unsprayed beets was below acceptable standards for factory use. In regions subject to less severe epidemics it should be possible to produce roots of acceptable quality if the most disease tolerant, high-sucrose varieties are planted. However, with the varieties available, such crops would be produced at a considerable sacrifice of acre yield of roots.

Table 1. Summary[1] of 1947 field test conducted under conditions of severe leafspot disease exposure. Plant Industry Station, Beltsville, Maryland.

Variety	Treatment[2]	Acre yield[3]		Sucrose	Stand[4]
		Gross sugar	Roots		
		(pounds	(tons)	(percent)	(percent)
Improved U.S. 216[5]	Spray	3033	10.61	14.30	91.7
	No Spray	1337	5.68	11.83	83.3
	Difference	1696	4.93	2.47	8.4
U.S. 215 x 216/2[5]	Spray	3524	14.81	11.80	75.0
	No Spray	1561	8.80	8.90	65.7
	Difference	1963	6.01	2.90	9.3
Line J[5]	Spray	3407	13.31	12.83	62.0
	No Spray	1532	7.43	10.36	50.5
	Difference	1875	5.88	2.47	11.5
U.S. 15[5]	Spray	2744	13.22	10.56	66.2
	No Spray	845	5.74	7.24	42.1
	Difference	1899	7.48	3.32	24.1
Significant difference between spray and no spray treatments for a variety					
	odds 19:1	467	1.44	0.80	9.3
	odds 99:1	630	1.94	1.08	12.6

[1]Results given as averages of 8 subplots.
[2]One half of each plot of a variety received 8 applications of Bordeaux mixture.
[3]Calculated from average weight per root and a complete stand of 10,890 plants per acre.
[4]For the 3 rows harvested, a full stand would consist of 27 plants per plot.
[5]On a scale of 0 for no injury and 10 for maximum, the disease readings recorded for the no-spray treatment for period of the epidemic were as follows:

Improved U.S. 216	0.5 to 3.0
U.S. 215 x 216/2	2.0 to 5.0
Line J	1.0 to 4.0
U.S. 15	5.0 to 9.0

In comparison of stands, attention is directed to differences between subplot means rather than to varietal differences. U. S. 15 suffered the greatest injury from the disease and also this variety gave the greatest difference in stand for treatments. Evidently, plants which have been defoliated by *cercospora* leafspot over a long period are more likely to be lost as a result of root rot.

Summary

Leafspot resistant varieties have been introduced which afford essential control of the disease under epidemics as ordinarily experienced in regions where sugar beets are grown commercially. Nevertheless, representatives of resistant types showed a highly significant reduction in yield and quality under the extreme conditions of this test. These drastic exposures serve to indicate the need of further improvement in disease resistance before a feeling of security can prevail. Obviously varieties that would give crops completely free from *cercospora* leafspots would be more desirable than the tolerant types that have been introduced. However, such a goal seems to be far from attainable at the present time. The tendency for smaller spots and fewer spots per unit of leaf area associated with a delay in tissue breakdown will have to remain the basis for breeding for leafspot resistance until factors for immunity have been found and can possibly be incorporated into the genetical composition of the cultivated forms.