CONTROL OF BLACK ROOT OF SUGAR BEETS BY USE OF RESISTANT VARIETIES

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Black root of sugar beets is a disease complex in which many organisms are involved. Control measures, such as seed treatment, that are effective against the acute phases of attack have not proved adequate to assure a crop. Certain organisms persist in their attack on the sugar beet plant throughout its entire life, causing death of the lateral feeding roots, and even of the tap root. The typical affected plant as seen in midsummer or later is a stunted sugar beet almost devoid of feeding roots. Frequently it is turnip-shaped from loss of the terminal portion of the tap root. It has been found that these chronic phases of black root are chiefly the result of attack on the sugar beet rootlets by the water mold, Aphanomyces cochlioides Drechs.

So long as control of black root was conceived as involving breeding against the entire group of pathogens capable of attacking in the seedling period and later, the outlook for obtaining blanket resistance to all pathogens seemed hopeless. No strains or varieties were found giving promise of such outstanding qualities.

Two findings have now clarified the situation: (1) the resolution of the black root problem into its components with attention focused on A. cochlioides as the worst offender; and (2) the discovery that some sugar beet strains and varieties show resistance to the attack of this fungus. There are now abundant grounds for the belief that breeding for black root resistance will make definite contribution toward control of the disease.

Observations made in 1940 and 1941 in Michigan, Ohio, and Minnesota, and confirmed by observations by Kotila and Torrie in Wisconsin and Downie and Culbertson in Minnesota, showed that U.S. 216, well known as an inbred variety resistant to leaf-spot, as well as F_1 hybrids of this inbred with other strains, possessed resistance to A. cochlioides. The resistance was manifested by its relatively better stand when planted in infested soil, and by its relative freedom from rotting of the terminal portion of the tap root in comparison with behavior of other varieties such as European check or U.S. 200 x 215 that showed poor stands and stunted, decayed roots. Conversely, it was also noted that another variety in the tests, SP 1-9-00, showed great susceptibility. This variety was produced by allowing two inbreds, U.S. 215 and 8-266-0, since proved not to possess any resistance to A. cochlioides, to intercross. Plots planted with 1-9-00 showed such depressed growth that they could be readily identified from all others in the test. Whereas, this variety showed excellent root yields in tests in western districts where attack by A. cochlioides was a minor factor, it fell significantly below other varieties in root yield and sugar production in the humid area where black root was severe. These findings, that certain beet strains possessed factors for resistance, and on the other hand certain strains showed high susceptibility, clearly indicated possibilities for control by utilization of the techniques of plant breeding.

As is to be expected, the resistance found in U.S. 216 and its hybrids is somewhat limited. Under severe exposures, U.S. 216 may yield only five tons per acre, but under such conditions commercial beet varieties fail almost completely. It is extremely reassuring to note that selections from U.S. 216 and from its hybrids, as well as selections from other inbred lines, appear to be superior in resistance to the parent variety. The inbred lines, the hybrids and the synthetic varieties utilized for breeding for black root resistance, are those obtained in the leaf-spot resistance breeding. U.S. 216 for example combines leaf-spot resistance, high sucrose, and black root resistance. Kodachrome views from the plantings in Minnesota in 1945 and 1946, and in Ohio in 1946, will illustrate the opportunity now offered to the plant breeder.

(3 or 4 field views showing evidences of black root resistance will be shown.)

Without depreciating in any way the excellent work done by Bockstahler, Henderson, Lohman, and others in obtaining the evidence that there is very definite promise for black root control through application of the techniques of plant breeding, it is necessary to call attention to the fact that at the same time that man breeds or manipulates the heritable factors of the sugar beet to produce a disease resistant type, nature also manipulates the heritable factors of the fungus parasite, thereby seriously complicating the problem. A. cochlioides is not one simple entity but is a congerie of biotypes, each differing from the other in some property or quality. From the point of view of breeding for disease resistance our interest is in the fact that the biotypes differ in their ability to attack the sugar beet. It is common experience in plant pathology that a variety resistant to a given species of fungus in one area may not show equal resistance in another. The explanation is that the biotypes that constitute the species differ from place to place.

In breeding for black root resistance, our plans are drawn to have the experimental work conducted with a broad base of exposures, in order to forestall so far as we can the apparent breakdown of resistance when the sugar beet varieties are planted under a wide range of disease exposures. That such can be achieved is shown by the leaf-spot resistant varieties of sugar beet that have been introduced. These perform as well in one state as another with respect to leaf-spot resistance. We attribute this to the fact that from the outset collections of infectious material from various locations were used to inoculate the plants. The selections therefore were limited to those plants that were resistant to the full gamut of biotypes present in the field.

One further caution must be expressed, namely, that the breeding work at present is to be confined to resistance against A. cochlioides. This is only one of the fungi causing black root. The direct and general measures that have been advocated for black root control still must be employed. We feel however, that as soon as we can introduce a black root resistant variety, one that will of itself put up something of a fight against the fungus enemy, then the grower will view the matter of black root control in an altogether different light. He will be so encouraged about sugar beet prospects that he will select the proper field, improve drainage, plow legumes in late summer or very early fall, will prepare the seed bed properly, will apply adequate amounts of phosphate and other fertilizers and will treat his seed. With such a start, the degree of resistance to chronic phases of black root that can be achieved by breeding may assure a dependable sugar beet crop in spite of unfavorable spring seasons.