An Alternaria Leaf Spot of the Sugar Beet

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A hitherto unreported disease of the sugar beet, Beta vulgaris L., incited by a parasitic species of Alternaria was found on a sugar beet inbred line at Salinas, California, in January, 1950. The disease has continued to reappear on one or more inbred lines grown at the same location in the Salinas Valley during the past 3 seasons. Although the occurrence of secondary or saprophytic Alternarias, usually Alternaria tenuis Auct., has been reported $(1, 5)^2$ on both sugar beet and table beet, this is the first occurrence in the writers' knowledge of a pathogenic form on this host. This paper reports studies made on the Alternaria disease, and its incitant.

Symptoms

The disease first appears on the older leaves as dark brown, circular to irregular spots measuring 2 to 5 mm. The spots enlarge as they become older and may reach a diameter of 10 mm. The centers turn gray with age and may become slightly zonate (Figure 1), giving a target spot effect to the lesion. The dead centers may later tear and partially drop out. A reddish coloration may or may not occur around the edges of the older spots, depending on the variety of sugar beet inbred involved.

The spots are frequently delimited by the veins of the leaf, but infections which occur on the veins extend beyond them, on either side. Spotted leaves turn yellow and die prematurely. Under favorable environmental conditions, infection centers are numerous, and the spots coalesce (Figure 1), resulting in a rapid necrosis of the leaf. This necrosis may continue until the leaf blades of the entire plant are almost completely destroyed.

Infection also may occur on the petioles. These are similar to those found on the leaf blade except that they tend to be long and narrow. When cool, wet conditions have continued after the initiation of bolting, lesions have been found on the seed stalks. It seems probable that other organs of the plant may prove to be susceptible also.

During periods of continued high humidity the Alternaria may be seen sporulating sparsely to moderately in the center of the spot. In the case of the leaf infections, sporulation, when it occurs, is usually on the under surface of the leaf.

Environmental Relations

Infection and disease development occurred at Salinas, California, during the winter months when the mean temperature was 7° to 10° C, and the humidity was high. The earliest observed infection occurred in middle November following a week of cool, rainy weather. The disease was not evident during the rain-free summer months when the mean tempera-

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Figure 1A. Progressive stages of infection with Alternaria brassicae on leaves of the C0532 sugar-beet inbred. B. Closeup (natural size) of spots resulting from infection with A. brassicae. C. Conidia of A. brassicae from beet leaf.

ture was above 16° C, and the humidity was relatively low. Plants which had been defoliated during the winter produced new growth during the late spring and summer free from infection.

The Pathogen

The sporulation of the fungus in nature, on the sugar beet and other hosts, is typical of those species treated by Neergaard (2) under the section *Noncatenatae*. The spores are borne singly over the surface of the necrotic portion of the spot, and have long, gradually tapering beaks (Figure 1C). In culture, occasionally short chains of 2 or 3 conidia may occur, or secondary conidia may arise from the sides of the primary ones.

The spore color, septation, approximate size of the spore body and beak and the manner of spore formation agree well with the description given by Neergaard for *Alternaria brassicae* (Berk.) Sacc. and the sugar beet fungus, accordingly, is identified as belonging to that species. Since the species has been well described by Neergaard, no further description of the fungus is required here.

It may be added, however, that *A. brassicae* on sugar beet is readily distinguishable from the ubiquitous *A. tenuis* which abounds on dead or dying plant parts. The spores of the latter fungus occur in long chains (section *Longicatenatae*), and the individual spore is essentially beakless, much smaller in size, the length being one-fourth to one-tenth that of a spore of *A. brassicae*, and dark in color. These several differences are sufficiently distinct to be recognized in the field by means of a hand lens.

A. brassicae may be isolated easily from infected tissues by placing the material on straw-water-agar plates (4). When such plates are incubated out-of-doors under conditions similar to those favoring the disease, abundant conidia have been produced with relatively little aerial mycelium, within a week's time.

Pathogenicity and Host Range

The disease was first observed in 1950 on a sugar beet inbred line designated C0532. During the past three years, two other inbred lines were found to be highly susceptible to A. brassicae under field conditions. One of these was a derivative of the U. S. 56 variety and the second was a monogerm inbred line which was developed from a cross between the U. S. 22 variety and the original S. L. C. 101 monogerm inbred described by Savitsky (3).

Artificial inoculations were conducted in the greenhouse to determine the host range of the pathogen. A group of cultivated plants belonging to *B. vulgaris* and a group of plants known to be susceptible to various Alternaria species were included. Inoculation was accomplished by spraying the test plants with a spore suspension from a single spore culture of *A. brassicae* isolated from a leaf of the inbred, C0532. The plants were placed in a humid inoculating chamber maintained at a temperature of 7° to 16° C, for 48 hours. They were then removed and placed in a cool, humid section of the greenhouse to await disease development. Results with susceptible plants are shown in Table 1.

Plan	Severity of Infection	
	Greenhouse	Field
Eckendorf Red mangel		None
Golden Tankard mangel	L†	Not tested
Detroit Dark Red beet	+	None
Green Top Bunching beet	+	None
Large Ribbed Dark Green Swiss chard	lr	None
U. S. 56/2 sugar beet	tr	tr
CO532 inbred	+++	+++
Copenhagen Marker cabbage	+	tr
Scarlet Globe radish	+++	· + +
Wild radish	+++	++

Table 1.--Pathogenicty of Alternaria Brassicae to Various Plants When Artificially Inoculated in the Greenhouse and Naturally Infected in the Field.

tr—Trace +— Slight + +—Moderate +++—Severe

When artificially inoculated under favorable greenhouse conditions, the host range was found to include Eckendorf Red mangel, Golden Tankard mangel, Detroit Dark Red beet, Green Top Bunching beet, Large Ribbed Dark Green Swiss chard, and the U. S. 56 sugar beet variety, all of which belong to *B. vulgaris*. Infection was classed as only a trace or slight on these hosts. Scarlet Globe radish and wild radish, *Raphanus sativus* L., were found to be highly susceptible in the greenhouse. Cabbage (Copenhagen Market) proved to be moderately susceptible. Sporulation occurred on all of these host plants. Carrot spinach, tomato, potato, flax, and zinnia were also inoculated, but no infection occurred.

Plant species which proved susceptible in the greenhouse were also tested in the field. The field planting was made in September, 1953, and infection occurred through natural means. Results are shown in Table 1. Infection took place on fewer plant species in the field than in the greenhouse. The C0532 inbred and Scarlet Globe radish proved most susceptible in this test. Abundant infection occurred on the wild radish but it developed more slowly than on the cultivated radish. A trace of infection was found on the U. S. 56/2 sugar beet variety and on the cabbage.

Wild radish is a common weed in the Salinas area and was found to be severely infected in its native habitat during the late fall and winter months. A culture of *A. brassicae* isolated from wild radish which was growing in the vicinity of the sugar beet trials proved pathogenic on the C0532 inbred and the resulting leaf spot was identical to that produced by inoculation with a culture isolated from a naturally infected leaf of the inbred. An isolate of the fungus obtained from wild radish grown in another part of the Salinas Valley where the susceptible sugar beet inbreds had not been grown also showed the same pathogenicity for C0532.

Discussion

The regular occurrence of the Alternaria leaf spot on susceptible inbred lines during the past three winters suggests that the fungus is either seedborne or is carried over on other hosts in the area. Attempts to isolate the pathogen from the seed of susceptible inbreds have been unsuccessful although the disease might potentially be expected to be seedborne if conditions were favorable for infection at seeding time. It is probable that the pathogen is carried over for the most part on crucifers, such as wild radish, which may grow under relatively cool, sometimes foggy conditions in the Salinas area during the summer months.

The host range and pathogenicity studies indicate that the appearance of an Alternaria leaf spot of sugar beets is the result of bringing susceptible inbred lines into contact with an existing pathogen already established on other hosts in the particular area in question. Our present commercial sugar beet varieties as well as several other cultivated crops belonging to the *B. vulgaris* species proved to be resistant or only slightly susceptible in the field. With this disease, the plant breeder needs only to avoid the selection of susceptible varieties rather than to search for resistance, which is the normal procedure in disease-resistance breeding.

The host range as established in the greenhouse included more members of the *B. vulgaris* species than were found susceptible in the field. In the greenhouse the humidity was maintained at a high level at all times and the leaf tissue became water soaked on most plants in the test. This condition may have tended to predispose the greenhouse-tested plants to infection. In the field, conditions favorable for Alternaria infection are also favorable for Ramularia leaf spot and rust infection. The presence of these diseases, together with associated saprophytes made it difficult to identify local infections from *A brassicae*. It is, therefore, possible that plants which showed only slight infection in the field were overlooked as hosts.

Three different sugar beet inbred lines which were not closely related were found to be highly susceptible. This suggests that genes for susceptibility are widespread within our sugar beet breeding stocks and that the breeder who is developing varieties for fall and winter plantings in the coastal area of California should keep the disease in mind. The inheritance of resistance is under study.

Summary

An unreported disease of sugar beets caused by Alternaria brassicae (Berk.) Sacc, was found on three different sugar beet inbred lines at Salinas. California. During cool, humid weather the disease caused a severe leaf spotting which eventually resulted in the defoliation of the susceptible inbred lines during three successive winters. The host range as determined in both the greenhouse and field is reported. Both wild radish and cultivated radish were found to be preferred hosts. Susceptible crucifers are thought to be the hosts on which the pathogen is carred over from one season to another.

Although our present commercial sugar beet varieties are resistant, the disease does offer a potential danger in that genes for susceptibility exist in some sugar beet germ plasm being used by the breeders.

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