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## **OUTBREAK OF WESTERN CUCUMBER MOSAIC ON SUGAR BEETS**

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## **SYMPTOMS OF ADDITIONAL CUCUMBER-MOSAIC VIRUSES ON SUGAR BEETS**

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## SYMPTOMS OF ADDITIONAL CUCUMBER-MOSAIC VIRUSES

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# SYMPTOMS OF ADDITIONAL CUCUMBER-MOSAIC VIRUSES ON SUGAR BEETS<sup>1</sup>

HENRY H. P. SEVERIN<sup>2</sup>

## SUMMARY

Celery calico occurs on celery and on some other host plants in the interior regions and in the fog belt of California; but has not yet been found on sugar beets here. In mechanically inoculated sugar beets, the type of infection is local.

The virus of common cucumber mosaic is not known to occur naturally in California. In mechanically inoculated sugar beets, the type of infection is local.

Symptoms of these two diseases on mechanically inoculated sugar beets resemble those of western cucumber mosaic, which does occur on this host plant in California. In all three, chlorotic areas, veinbanding, and necrosis occur. The first symptom of celery calico—large, irregular, pale-green areas on the leaves—serves to distinguish it from common cucumber mosaic. Common cucumber mosaic can be distinguished from both celery calico and western cucumber mosaic by the first symptom—small, white dots with pinpoint necrotic centers; later by small, rust-colored necrotic centers in circular, chlorotic areas; still later by holes in some leaves caused by the dropping out of the necrotic centers. Neither celery calico nor common cucumber mosaic show, in mechanically inoculated beets, the blisterlike elevations that characterize systemic infection with western cucumber mosaic.

## INTRODUCTION

The symptoms of celery calico and common cucumber mosaic closely resemble those of western cucumber mosaic. To facilitate distinguishing them, studies were made of the symptoms of all three diseases in experimentally infected sugar beets. This paper describes celery-calico and common-cucumber-mosaic symptoms on that host plant. Symptoms of western cucumber mosaic on experimentally and naturally infected sugar beets are described in the first paper of this issue (Severin and Freitag, 1948).

A number of references appear in the literature concerning the transmission of common cucumber mosaic or strains of this virus to beets (*Beta vulgaris*). Johnson (1930)<sup>3</sup> inoculated Crosby's Egyptian garden beet with common cucumber mosaic types 1 and 2, and necrotic rings  $\frac{1}{8}$  inch in diameter developed on the rubbed leaves 10 days after inoculation. These rings increased to  $\frac{1}{4}$  inch in diameter, at which time they were composed of alternate bands of necrotic and red tissues.

<sup>1</sup> Received for publication December 5, 1947.

<sup>2</sup> Entomologist in the Experiment Station.

<sup>3</sup> See "Literature Cited" for citations, referred to in the text by author and date.

Hoggan (1933) demonstrated that local symptoms resulted from mechanical inoculation of sugar-beet leaves with the common-cucumber-mosaic virus, but systemic infection was not secured. When the green peach aphid (*Myzus persicae*) and the potato aphid (*Macrosiphum solanifolii*) were confined to a single sugar-beet leaf, local lesions developed. The virus appears unable to pass from a single infected leaf of this host to other parts of the plant. When the infective aphids were allowed to feed freely on the foliage of young sugar beets, systemic infection was readily obtained; she suggests that this may possibly have resulted from a direct introduction of virus at or near the growing point of the shoot, the virus perhaps multiplying at this point and forming a source of infection for all subsequent growth.

Price (1940), in his table on species of plants tested for susceptibility to six viruses, lists *Beta vulgaris* as susceptible to the cucumber-mosaic virus (*Marmor cucumeris* H. var. *vulgare* H., *judicis* H., and *vignae* H.; mosts tests with the ordinary strain, *vulgare*).

### MATERIALS AND METHODS

The common-cucumber-mosaic virus was kindly sent to me by James Johnson, University of Wisconsin. The original source of the celery-calico virus was naturally infected celery obtained near Milpitas in the Santa Clara Valley. The viruses were maintained by repeated mechanical inoculation of various host plants; and also the virus extract was kept overwinter in cold storage at  $-18^{\circ}$  C.

The method of mechanical inoculation used is that described by Rawlins and Tompkins (1936). Shortly after inoculation, the carborundum and the inoculum were washed from the leaves with water. No tests of insect transmission were included in these experiments.

### CELERY CALICO

Celery calico has been found on celery in all of the large celery districts in California (Severin and Freitag, 1938). The disease occurs in the interior regions and in the fog belt of the state. The distribution of celery calico on naturally infected perennial delphiniums has been reported in a previous paper (Severin, 1942a). Other naturally infected host plants include larkspurs (Severin, 1942b) and pansies and violas (Severin, 1947). Up to the present time, no attempt has been made to find sugar beets naturally infected with this disease. It could easily pass unnoticed because the symptoms appear only on the inoculated leaves.

**Symptoms.** The first symptom of celery calico on the leaves of sugar-beet seedlings, 3 to 9 days after inoculation (4 to 15 days on large beets), is large, irregular, pale-green areas (fig. 1, *A*), which diffuse into the green tissue. (This symptom serves to distinguish this disease from common cucumber mosaic.) Later, these become circular yellow areas, 11 to 15 mm in diameter, each with a pale chlorotic center (fig. 1, *B*). Chlorotic veinbanding of a portion of the midrib and some of the veins may occur (fig. 1, *B*). Chlorosis spreads gradually over the entire leaf. Irregular green, later chlorotic, rings surround the circular yellow areas (fig. 1, *C*); these enlarge, coalesce, and become irregular in shape (fig. 1, *D*). The fused rings become necrotic (fig. 2, *A*), usually

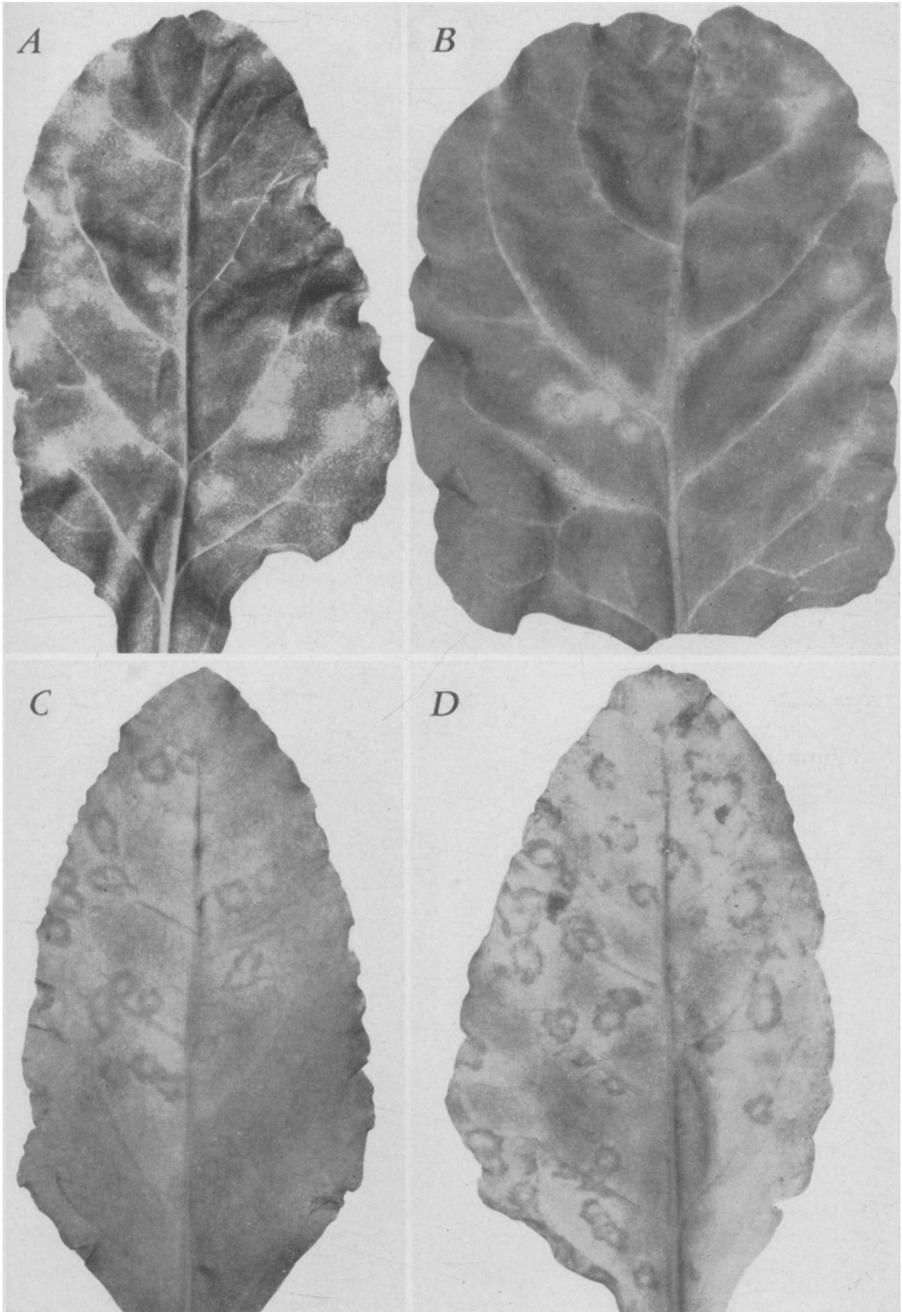


Fig. 1. Symptoms of celery calico on experimentally infected sugar beets: *A*, circular, chlorotic areas with margins diffusing in green areas; *B*, circular, chlorotic areas, some showing pale, circular center, veinbanding of portion of midrib and some of the veins; *C*, irregular, green, later yellow, rings surrounding pale-green areas which become chlorotic; *D*, yellow rings coalescing.

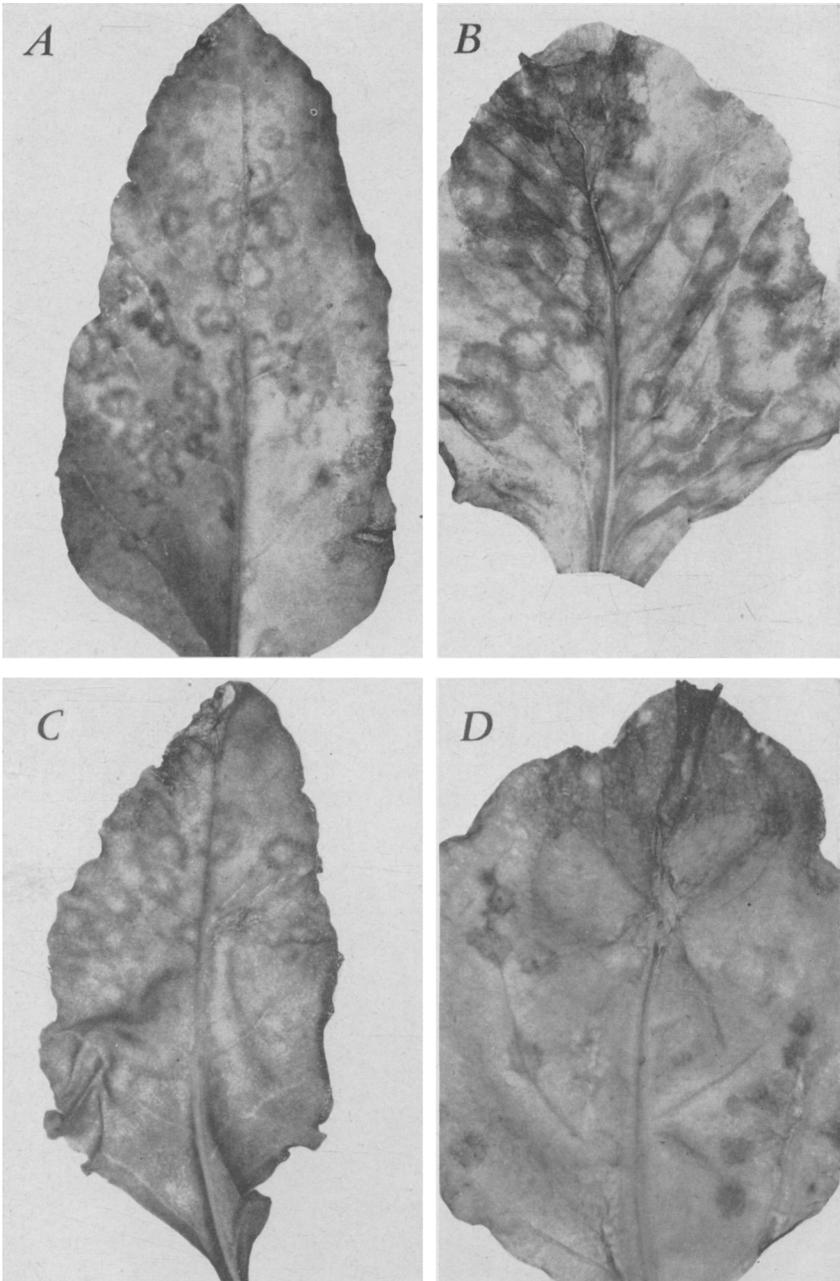


Fig. 2. Symptoms of celery calico on leaves of experimentally infected sugar beets: *A*, fused, necrotic rings; *B*, necrosis of apical portion of leaf, midrib, and veins, and necrotic rings still evident in dried portion of leaf; *C*, yellowing of upper half of leaf showing necrotic rings; *D*, necrosis of rings and enclosure. Note that the chlorotic areas in this disease lack the small rust-colored centers that are often present in common cucumber mosaic (see fig. 5, *A*).

after the leaf becomes yellow (fig. 2, *B*, *C*); and finally the entire circular areas become necrotic (fig. 2, *D*) and are still evident on the dried leaves (fig. 2, *B*).

**Recovery of the Virus.** The type of infection by mechanical inoculation, was local, not systemic. The virus was recovered only from the inoculated leaves and transferred to healthy sugar beets, cucumbers, celery, and Turkish tobacco (*Nicotiana tabacum*) by mechanical inoculation.

### COMMON CUCUMBER MOSAIC

Common cucumber mosaic is not known to occur on any host plant in California.

**Symptoms.** The first symptom of common cucumber mosaic on sugar-beet leaves, 4 to 9 days after inoculation, is numerous, white dots (fig. 3, *A*), each with a pinpoint, necrotic center. These dots gradually enlarge (fig. 3, *B*) and each retains the pinpoint, necrotic center. The white, circular areas fuse (fig. 4, *A*). Green rings, 3 to 8 mm in diameter, surround pale, chlorotic areas, with a small, circular central area (fig. 4, *B*) and a necrotic center. Within the next 2 or 3 days the green rings become yellow, enclosing chlorotic areas, each with a small central, circular area with a necrotic center (fig. 5). Sometimes concentric green and yellow rings surround chlorotic areas, each with a rust-colored, necrotic center. Frequently the rings coalesce (fig. 5, *C*, *D*). The chlorotic areas surrounded by rings may become brown, drop out, and leave

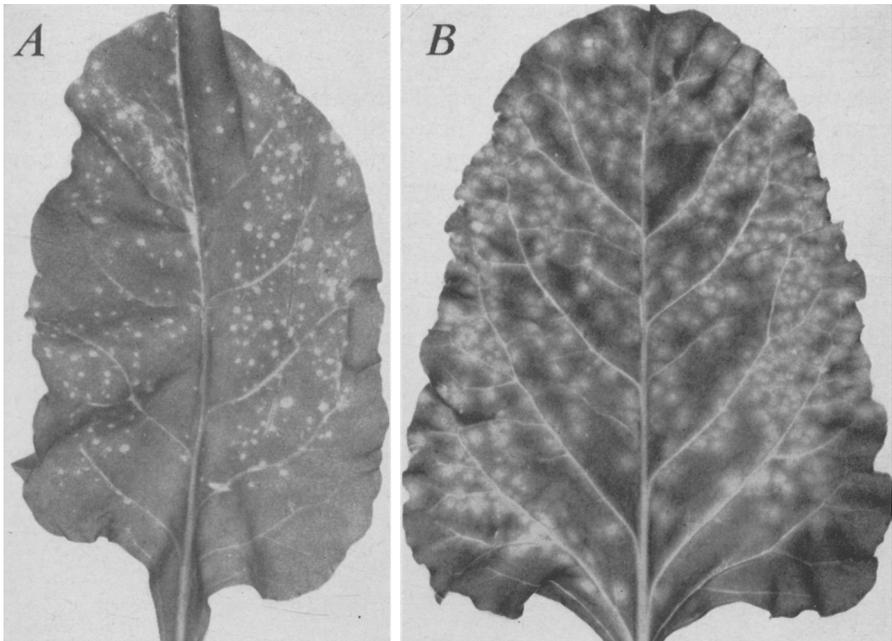


Fig. 3. Symptoms of common cucumber mosaic on leaves of experimentally infected sugar beets: *A*, numerous white dots; *B*, dots enlarged to form white, circular areas. These dots, the first symptom to appear in this disease, do not occur in celery calico or in western cucumber mosaic.

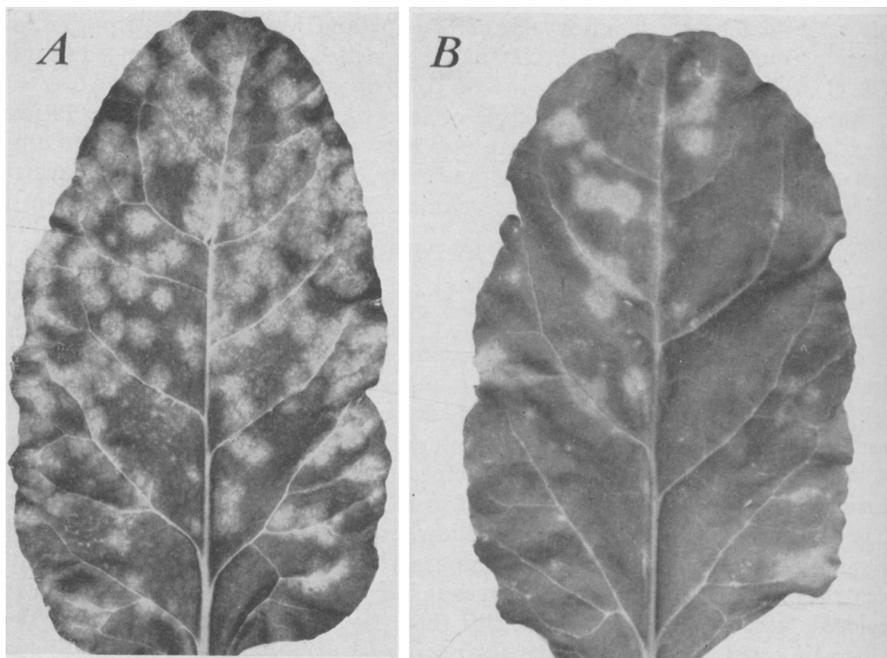


Fig. 4. Symptoms of common cucumber mosaic on leaves of experimentally infected sugar beets: *A*, fusion of white circular areas; *B*, green rings surrounding chlorotic areas, each with a small, central, circular spot.

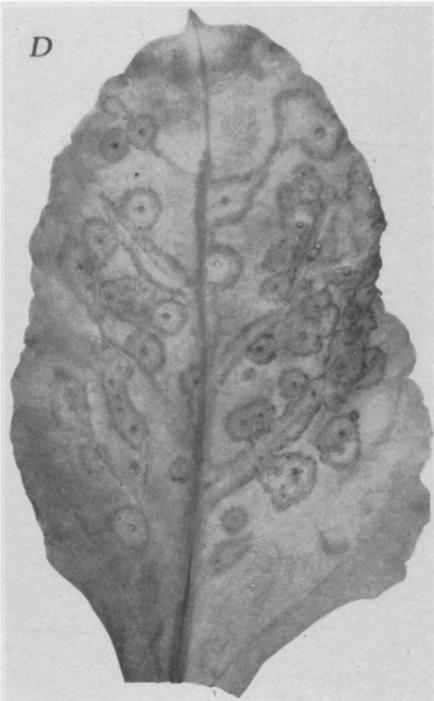
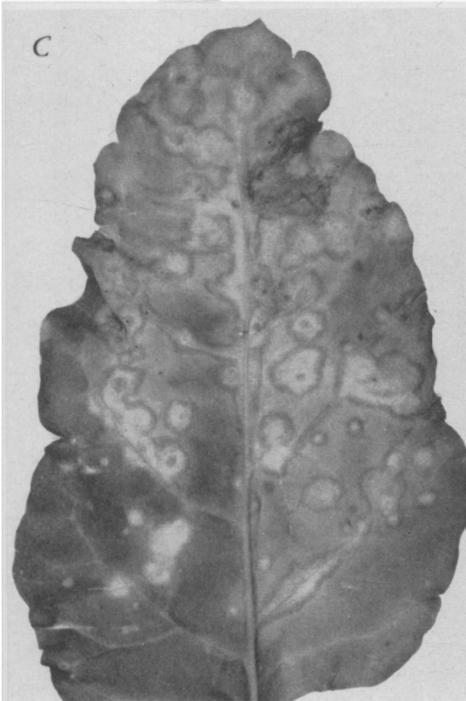
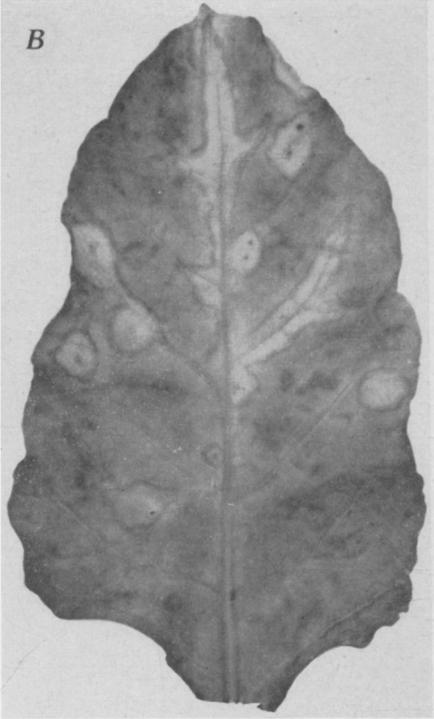
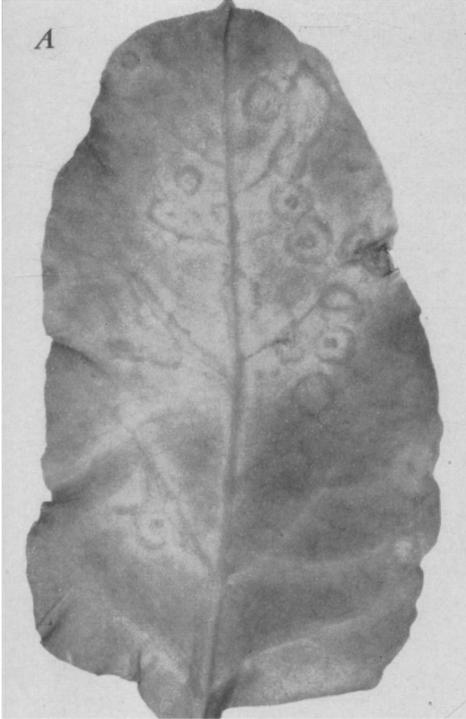
holes in the leaf. Yellow veinbanding along part of the midrib and lateral veins develops (fig. 5). Sometimes forked chlorotic tissue extends from the rings (fig. 5, *A*, *B*). In the later stage of the disease, necrosis of the rings occurs, and the rings are still evident on the dried leaves.

The symptoms that are useful in distinguishing this disease from celery calico and western cucumber mosaic are the small white dots with pinpoint necrotic centers (fig. 3, *A*)—the first symptom to appear; in a somewhat later stage, the small rust-colored necrotic centers of some chlorotic areas (fig. 5, *C*); and still later the holes in some leaves caused by the dropping out of the necrotic centers.

**Recovery of the Virus.** The virus was recovered only from the inoculated leaves and transferred to healthy sugar beets, cucumbers, and celery by mechanical inoculation. The type of infection was local and not systemic, agreeing with the results Hoggan (1933) obtained with mechanical inoculation of this virus.

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Fig. 5. Symptoms of common cucumber mosaic on leaves of experimentally infected sugar beets: *A*, yellow rings with large, necrotic, rust-colored centers and yellow veinbanding; *B*, fusion of rings, some with two necrotic centers, and yellow veinbanding of midrib and lateral veins; *C*, *D*, fusion of many necrotic rings with 1 to 5 necrotic centers, and veinbanding.



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