The Effect of Darkness and Moisture on Sporulation of Pseudoperonospora cubensis in Cucumbers

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Supported by USDA Grant No. FG-IS-231.

ABSTRACT

Part of the moist and dark period needed for the formation of sporangia of *Pseudoperonospora cubensis* on cucumbers can be replaced by a dark but dry period of the same duration. Phytopathology 61: 594-595.

Additional key words: host-parasite relationships.

Sporulation of most, if not all, downy mildew fungi is conditioned by alteration of light and dark cycles (4, 5, 6). Presence of light is a prerequisite for sporulation, and affects sporulation through the photosynthesis of the host plant (2). In tissues with a good supply of assimilates, the actual formation of spores occurs in the dark under moist conditions (2, 4, 6), referred to herein as "wet darkness" (WD).

Only traces of sporulation were found over cucumber (*Cucumis sativus* L. 'Bet-Alpha') plants infected with *Pseudoperonospora cubensis* (Berk. & Curt.) Rostow kept at 20 C in WD for 6 hr, while after 12 hr of WD sporangia were produced in quantity (1). In the field in Israel, however, numerous sporangia are found after moist and dark period as brief as 6 hr (*unpublished data*). The fact that dew often forms a few hr after the onset of darkness may be partly responsible for the differences in sporulation observed in laboratory and field. As a result, a moist dark period in the field is preceded by a dark but comparatively dry period. To determine the effect of such a "dry darkness" (DD) on the subsequent sporulation of *P. cubensis,* part of the wet and dark period needed for sporulation in the laboratory was replaced by a dark, but dry, period of the same duration. This was done with cucumbers in their two-leaf stage and with seedlings in their cotyledon stage. The test plants were quantitatively inoculated and kept at 20 C throughout the tests. Description of these procedures, as well as of the methods by which the produced sporangia were removed and counted, has been given previously (1, 2, 3). In all tests, the average value of two leaves or cotyledons of one plant was considered as a replicate, and eight replicates were made of each treatment.

Before being placed in darkness for sporulation, the test plants were exposed to a 12-hr light period (1,560 ft-c). They were then kept for 0 to 24 hr in DD (55-65% relative humidity), after which they were exposed to a 6-hr period of WD (leaves covered by a fine film of water). Plants exposed for various periods of time to WD without the preceding periods of DD were considered as controls.

Figure 1 shows that when plants in either the two-leaf or cotyledonary stage were immediately transferred, at the conclusion of the light period, to a 6-hr period of WD (0 and 6 on the abscissa of Fig. 1-A,B, respectively), the number of subsequently produced sporangia was minimal. When the 6-hr WD period was preceded by 6 hr of DD in the case of true leaves, and 12 hr in the case of cotyledons, maximal sporulation resulted (Fig. 1-A). Sporulation over plants exposed to WD only reached the level of the maximum sporulation of "dry + wet darkness" treatment only after a 12-hr exposure to wetness.

We do not know the biochemical process involved in the effects of "dry" and of "wet" darkness. To speculate on their supposed effects we must consider the following facts: (i) DD can substitute for a part of the total WD period needed for sporulation, but cannot bring about the actual formation of sporangia; and (ii) WD fulfills all the effects exerted by DD, and finally brings about the actual formation of sporangia.

These facts indicate that the effect of darkness on sporulation can be divided into two stages. We suggest that in the conditioning stage, metabolites previously accumulated in the process of photosynthesis have to pass through some as yet undetermined changes, after which they are available in the actual formation of sporangia. These changes can occur only in darkness, but it is immaterial whether moisture is present or absent. Once this conditioning stage is reached, the second stage begins, in which sporangia are actually formed. This stage too is bound up with darkness, but the presence of moisture here is necessary.

The described phenomenon explains why comparatively brief periods of moisture in the field (probably only during the second half of the night) result in the production of considerable amounts of sporangia. The described phenomenon may not be limited to *P. cubensis*. This means that in determining forecasting and

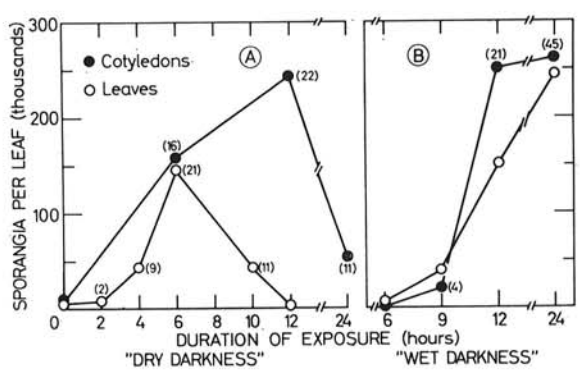

Fig. 1. The effect of dryness and wetness during the dark period on sporulation of *Pseudoperonospora cubensis* in cucumbers (averages; figures in parentheses indicate standard errors). **A)** Sporulation over true leaves and cotyledons kept for various periods under dry conditions and then for 6 hr under wet conditions. **B)** Sporulation over true leaves (after Cohen & Rotem, 1) and over cotyledons kept for various periods under wet conditions only.

simulation criteria, the possible effect of DD should be considered when using laboratory data concerning periods of wetness for sporulation.

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