Effect of Dew Period and Temperature on Infection of Seedling Maize Plants by *Puccinia polysora*

C. A. HOLLIER, Former Graduate Research Assistant, Department of Plant Pathology and Weed Science, Mississippi State University, Mississippi State 39762, and S. B. KING, Research Plant Pathologist, Agricultural Research Service, U.S. Department of Agriculture, P.O. Drawer PG, Mississippi State, MS 39762

ABSTRACT

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The effect of dew period (0–16 hr at 4-hr increments) and temperature (8–40 C) on infection of maize (*Zea mays*) seedlings by *Puccinia polysora* was determined. Dew was always necessary for infection, and no infection occurred at temperatures of 8, 12, 36, or 40 C, regardless of length of dew period. A 16-hr dew period at 26 C was the optimum environment for infection and resulted in more than double the pustule density obtained with a 12-hr dew period. Lower temperature limits for infection were 16 C for the 12- and 16-hr dew periods and 18 C for the 4- and 8-hr dew periods. Upper temperature limits for infection were 22, 28, 32, and 32 C for the 4-, 8-, 12-, and 16-hr dew periods, respectively.

Puccinia polysora Underw., the incitant of southern rust of maize (*Zea mays* L.), was first reported by Underwood (6) in 1896 on a herbarium specimen of *Tripsacum dactiloides* collected in Alabama in 1891. The destructiveness of *P. polysora* was first realized when southern rust swept across Africa in the late 1940s and early 1950s, causing yield losses as high as 50–60% in some areas (1). The epiphytotic in Africa spurred interest in the epidemiology of *P. polysora*. During the 1950s, studies were conducted on the relationships between the incidence of rust and West African environmental conditions (1) and factors influencing gradients from a point source (2).

Although southern rust has not been a major problem in the United States, its destructive potential has been present for many years. During the early 1970s, interest in southern rust was renewed in the United States when the disease advanced northward to the southern part of the corn belt before unfavorable environmental conditions halted its advance in late June (3). Studies of urediniospore germination, penetration, establishment and disease development after penetration (4,5), and the optimum environments in which each of these events occur were conducted (4). The purpose of this study was to investigate, under controlled conditions, the dew period and temperature requirements for infection of maize by *P. polysora*.

MATERIALS AND METHODS

The susceptible maize hybrid Pioneer Brand 3369A was used throughout this study. Urediniospores of *P. polysora* were collected from maize plants with a cyclone spore collector within 3 days of pustule rupture, air-dried in open petri dishes at 22–24 C for 24 hr, and used for inoculum within 24 hr. Urediniospore germination always exceeded 95% on 2% water agar.

Immediately before inoculation, an artist's airbrush was used to cover leaf surfaces with fine droplets of water containing 1 drop of Tween 20 surfactant per 50 ml of water. The adaxial leaf surface was inoculated by releasing 0.1 g of spores into a spore settling tower, then seedlings were placed in a dew chamber at 100% RH for 0, 4, 8, 12, or 16 hr at each of 13 selected temperatures from 8 to 40 C. A timer turned the humidifier on and off at predetermined intervals to prevent the

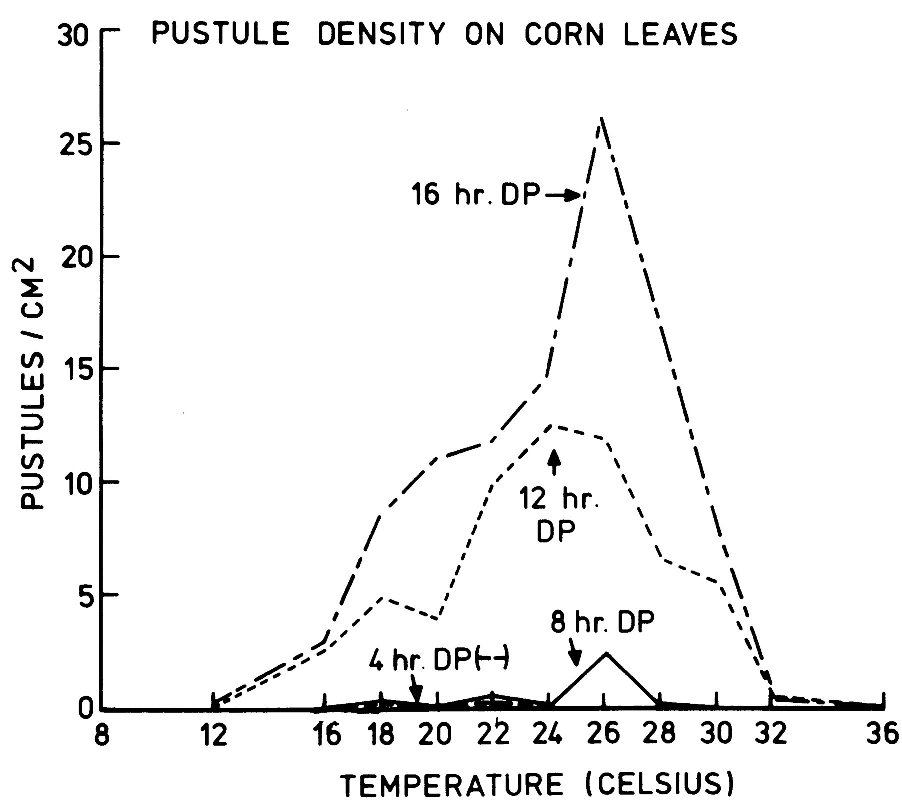

Fig. 1. Infection expressed as pustule density on maize by *Puccinia polysora* at temperatures of 8–36 C and dew periods of 4, 8, 12, and 16 hr.

Present address of first author: Louisiana Cooperative Extension Service, Louisiana State University, Baton Rouge 70803.

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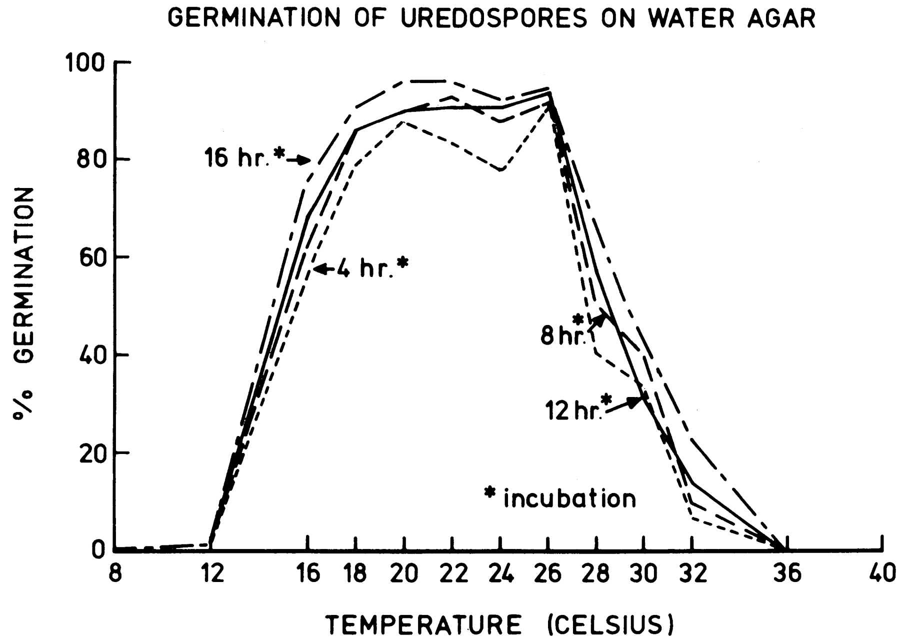

Fig. 2. Percent germination of *Puccinia polysora* urediniospores at temperatures of 8–40 C and incubation periods of 4, 8, 12, and 16 hr on water agar.

small water droplets applied before inoculation from evaporating during any dew period.

After each dew period, seedlings were removed from the dew chamber and placed on laboratory benches under a light bank with a 14-hr day/10-hr night regime at 23–27 C. Fourteen days after inoculation, all pustules were counted within a measured 5-cm^2 area on the third leaf of each plant in each of four replications. These counts were converted to pustules per square centimeter.

Urediniospore germination was determined on 2% water agar in petri dishes placed in the dew chamber for the same length of time as inoculated seedlings.

RESULTS

Using pustule development to indicate infection, no infection occurred without dew or at temperatures below 12 or above 36 C, regardless of length of dew period. The optimum environment for infection, based on pustule density, was a 16-hr dew period at 26 C (Fig. 1). The temperature range for infection was above 12 and through 32 C for the 12- and 16-hr dew periods. Limited infection occurred at 18 and 22–28 C for the 8-hr dew period and at 18 and 22 C for the 4-hr dew period. Infection at 4- and 8-hr dew periods was considerably less than at 12 and 16 hr. The small increase in pustule density with 8 hr of dew at 26 C was not significantly different ($P = 0.05$) from other densities obtained with 8 hr of dew, regardless of temperature.

The increase in pustule density at 12- and 16-hr dew periods was significant over that of 4- and 8-hr dew periods (Fig. 1). With 12 hr of dew, a peak in pustule density was obtained at 24 C, but this was not significantly different from densities obtained at 22 and 26 C. The general pattern of infection with 12 or 16 hr of dew was similar except for the peak of density of uredia with 16 hr of dew at 26 C. After this peak, infection dropped rapidly as temperature increased.

Germination of urediniospores on water agar was similar for the 4-, 8-, 12-, and 16-hr incubation periods (Fig. 2). Percentage germination increased sharply between 12 and 16 C and decreased sharply at temperatures higher than 26 C. No germination occurred at 36 C.

DISCUSSION

Infection data expressed as pustule density revealed that a 16-hr dew period at 26 C was necessary for optimum infection. This treatment significantly increased infection over any other treatment. This agrees very closely with the optimum of 27 C reported by Melching (4).

Urediniospore germination was tested on 2% water agar at temperatures and incubation periods identical with the temperatures and dew periods used to study infection. The range of temperatures in which infection occurred was narrower than that for germination. This agreed with Melching's results (4). No infection occurred with the 0-hr dew period, which affirms earlier beliefs that free water on the leaf is necessary for rust establishment in compatible host plants.

Germination was not affected by incubation periods longer than 4 hr (Fig. 2). Longer dew periods apparently increased the number of germ tubes that successfully completed penetration and, eventually, pustule formation (Fig. 1).

Laboratory results have been similar to field results in successive summers in Mississippi. In 1979, environmental conditions for infection were good; dew periods were long and night temperatures "moderate." The result was heavy infection by *P. polysora* in artificially inoculated plots. In contrast, very little infection was evident even in artificially inoculated plots in 1980 or 1981. During these years, dew periods were short or nonexistent and night temperatures were extremely high.

Environmental conditions conducive to southern rust epiphytotics occur in most years in much of the maize-growing area of the United States. Furthermore, most commercially available hybrids show little or no resistance to southern rust. Hence maize culture in the United States at present is extremely vulnerable to the type of epiphytotics that occurred on the African continent in the late 1940s and early 1950s. This and other similar studies provide information necessary to evaluate resistance in maize genotypes.

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