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LIGHT INHIBITION OF UREDOSPORE GERMINATION IN PUCCINIA RECONDITA

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LIGHT INHIBITION OF UREDOSPORE GERMINATION IN *PUCCINIA RECONDITA*

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ABSTRACT

Nonhydrated, hydrated, and hydrated-redried uredospores of Puccinia recondita were germinated on one per cent water agar at 10° and 20°C under several light intensities. Intensities above 165 foot-candles inhibited short-period (two-hour) germination of hydrated and hydrated-redried spores. As in other species of Puccinia studied previously, this was not a permanent inhibition, but only a depression of the initial germination rate, since per cent germination for longer incubation periods (six to eight hours) was virtually the same for spores germinating in light and in darkness. Light inhibition is temperature-sensitive, though not so markedly as in P. graminis var. tritici. At the lower intensities investigated, inhibition was greater at 10° than at 20°C. Higher intensities (450 f.c.) almost completely inhibited two-hour germination at both 10° and 20°C. Inhibition was never observed in nonhydrated spores but only in hydrated and hydrated-redried spores, suggesting that the uptake of water sensitizes them to light, the sensitivity remaining even after spores have been dried to a low moisture level following hydration.

I. INTRODUCTION

The literature concerning the effects of visible light on uredospore germination in various rusts has recently been reviewed elsewhere.[1] Stock[2] and Sharp et al[3] reported depression of uredospore germination in P. graminis var tritici. Dillon Weston[4] observed inhibition in P. triticina (=P. recondita), P. graminis avenae, and P. coronata, as well as in P. graminis var. tritici. Rayner[5,6] and Nutman and Roberts[7] found that light inhibited uredospore germination in Hemileia vastatrix, and that the inhibition was greater at suboptimal germination temperatures than at optimal or supra-optimal temperatures. Inhibition has also been observed in P. glumarum f. sp. tritici (=P. striiformis)[8] and in Phragmidium mucronatum.[9] McCracken and Burleigh[10] reported that light promoted uredospore germination in P. striiformis.

Stock[2] had detected no depression of uredospore germination by light in P. triticina (=P. recondita), but Dillon Weston[4] observed that light inhibited germination of uredospores of the same species. For this reason it seemed worth while to conduct further studies into the effects of light upon spore germination in P. recondita in order to gain a clearer understanding of the problem, and if possible to resolve the discrepancy in the earlier observations. Since temperature and light intensity had previously been found particularly important in determining the degree of inhibition in P. graminis var. tritici,[1,3] these factors were given special attention in the present study. The relationship of light inhibition to spore moisture content was also investigated.

II. MATERIALS AND METHODS

Uredospores of Puccinia recondita, race 12,* grown on M1 (C.I. 13398) or Baart (C.I. 1697) wheat in a greenhouse at 20° to 30°C, were harvested with a cyclone collecting device. They were subsequently stored at room temperature (15° to 20°C) for a period not exceeding 72 hours. Prior to the germination tests, the spores were either hydrated (placed overnight in an atmosphere of 100% relative humidity), hydrated and redried (placed overnight in a desiccator jar following hydration), or were given no hydration treatment whatsoever (nonhydrated). The spores were then incubated for two hours on one per cent water agar in darkness and in light of known intensity. Intensities employed were approximately 165, 275, and 450 foot-candles (f.c.) as measured with a Weston Illumination Meter; temperatures were 10° and 20°C.

The light source consisted of a bank of twenty fluorescent tubes (General Electric, Standard Warm White) at a distance of 40 to 100 centimeters from the spores, depending upon the intensity. All experiments were repeated on several different days, and each day's experiment was done in quadruplicate, 200 spores on each of four plates being counted for each light or dark treatment.

III. RESULTS

Tables I and II show typical results. Light had no detectable effect on the germination of nonhydrated spores in any of the experiments. Short-period germination of hydrated and hydrated-redried spores, however, was strongly inhibited by light, although for longer incubation periods (six to eight hours) the germination percentages of illunimated and nonilluminated spores were nearly equal. Clearly, light retards germination but effects no permanent inhibition. At 20°C, an intensity of 450 f.c. almost completely inhibited germination during the two-hour incubation period. An intensity of 275 f.c. depressed germination by roughly 50 per cent, whereas 165 f.c. had virtually no effect. At 10°C, the light effects were essentially the same as at the higher temperature, but inhibition was somewhat more marked. This was scarcely evident at 450 f.c., where inhibition was pronounced at both temperatures, but was quite noticeable at the lowest intensity used (165 f.c.). The latter intensity, although essentially without effect at 20°C, caused approximately 30 per cent inhibition at 10°C.

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* Identification by Dr. C.O. Johnston gratefully acknowledged.

TABLE I. GERMINATION OF HYDRATED, HYDRATED-REDRIED, AND NONHYDRATED UREDOSPORES IN DARKNESS AND IN LIGHT (450 f.c.) AT 10° AND 20°C.

Per Cent Germination at 2 Hours			
10°C		20°C	
Light	Dark	Light	Dark
Nonhydrated Spores			
24	28	67	65
70	70		
Hydrated Spores			
5	81	12	81
1	59	6	87
Hydrated-Redried Spores			
4	14	6	42
3	14		
8	45		

TABLE II. GERMINATION OF HYDRATED UREDOSPORES IN DARKNESS AND IN LIGHT (165 f.c.) AT 10° AND 20°C

Per Cent Germination at 2 Hours			
10°C		20°C	
Light	Dark	Light	Dark
44	67	84	79
41	68	79	78

IV. DISCUSSION

Light inhibition of uredospore germination in P. recondita resembles that of other rusts in being temperature-sensitive[1,7,8] and in being temporary rather than permanent.[1,2,7,8] Interpretations concerning the mechanism of the phenomenon, taking into account the observed temperature-sensitivity and recovery with long incubation periods, have been discussed in an earlier paper[1] in connection with P. graminis var. tritici and will not be repeated at length. Temperature sensitivity seems to indicate the participation of enzymatic reactions in the light response, whereas the recovery of a normal germination rate following the initial inhibition suggests that light may produce a metabolic inhibitor that initially prevents germination but subsequently breaks down, allowing germination to proceed.

The most striking feature of light inhibition in this organism is that it apparently is restricted to spores that have been hydrated, and never occurs in nonhydrated spores (at least not in the light intensity range investigated here). Sensitivity to light does not depend simply on moisture content, however, since hydrated-redried spores show roughly the same response as hydrated spores. Evidently hydration initiates a series of reactions rendering the spores light-sensitive; subsequent drying causes no reversal of these reactions, so that sensitivity is retained. The exact mechanism by which hydration induces light-sensitivity is obscure, and at present the phenomenon can be reported only as an observation. Nonetheless, the differing responses of hydrated and nonhydrated spores may well provide the explanation for the conflicting observations of Stock[2] and Dillon Weston[4] although the discrepancy may also have resulted from differences in light intensities used (neither worker reported intensity) or from racial differences in the spores.

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