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Short communication

An action spectrum for photoinduced conidiation in *Helminthosporium oryzae*

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An action spectrum for photoinduced conidiation in the fungus *Helminthosporium oryzae* was studied. A five-day dark-grown colony was irradiated with monochromatic radiation of known intensity for a short time, then the conidia produced were counted after a subsequent 24-hr dark period.

Peak effectiveness occurred at 298 nm with a shoulder at approximately 320 nm and a trough at 250 nm. Wavelengths longer than 336 nm were not at all effective.

A certain strain of *Helminthosporium oryzae* produces only vegetative hyphae when grown in total darkness. However, when a dark-grown colony is exposed to near ultraviolet radiation, conidiophore formation is induced in the narrow region of the mycelia produced just prior to illumination, and then conidia are formed in the subsequent darkness. It has been recently reported that the blue and near ultraviolet reversible photoreaction plays an important role in conidial development of the fungi, *Helminthosporium oryzae* (*1*), *Alternaria tomato* (*2–4*) and *Botrytis cinerea* (*9, 10*). However, effective wavelengths have yet to be studied in detail. The present study shows the action spectrum for photoinduction of conidia in *H. oryzae*.

Helminthosporium oryzae Breda de Haan (HA_2) was used in these experiments. Experimental cultures were grown on a medium of potato dextrose agar with an initial pH of 5.8. Tyston petri dishes (9 cm in diameter) were filled with 20 ml of the medium, and a few conidia were inoculated into the center of the agar plate. Experimental cultures were grown for five days in darkness at 26 ± 1°C. After this period, the cultures, with the dish covers removed, were exposed to various monochromatic radiation, and then cultured for 24 hr in darkness. Conidia were microscopically ($\times$ 100) counted at five areas (each 1.2 mm^2) per colony for each replication, and the results were averaged. Then the values of several replications were averaged.

A grating monochrometer (Model CRM-50, Japan Spectroscopic Co.) with a 2 KW xenon lamp (Ushio Co.) was used for monochromatic radiation. Irradiation was applied from 222 to 680 nm at 8–10 nm intervals. The radiation band width at all wavelengths was 5 nm. Radiation intensity at each wavelength was measured with a compensated thermopile (Model E-1, Kipp and Zonen) and

a micro-voltmeter (Model PM-16A, Toa Electronics). When necessary, radiation intensities were controlled by changing the monochrometer slit widths.

First, the length of exposure for conidiation was determined. As shown in Fig. 1, conidiation occurred linearly during the first 10 min at 298 nm with an intensity of 235 ergs·cm^{-2}·sec^{-1}. As the exposure time was lengthened, the rate of increase of conidia number per 1.2 mm^2 decreased markedly, e.g., after 10 min at 298 nm. Similar tendencies were obtained with other wavelengths. If the intensity was higher, the number of conidia increased linearly in proportion to the light intensity, e.g., until at least 500 ergs·cm^{-2}·sec^{-1} at 298 nm.

Thus, the relation between total dosages and conidiation at various wavelengths was determined using the light intensities and lengths of exposure shown in Table 1. Conidiation occurred linearly in proportion to the increase of total dosages at various wavelengths (Fig. 2). From this result, the total dose necessary for producing 100 conidia per 1.2 mm^2 was calculated as the standard effect to determine the action spectrum, since the relationships of conidia produced to the total dosages at various wavelengths were linear. The total number of incident quanta per cm^2 required to induce the standard effect at different wavelengths is shown in Table 2. The reciprocals of quanta per cm^2 are plotted in Fig. 3. The action spectrum showed the greatest effectiveness at 298 nm with a shoulder in the neighborhood of 320 nm and a trough at 250 nm. Wavelengths longer than 336 nm were not at all effective.

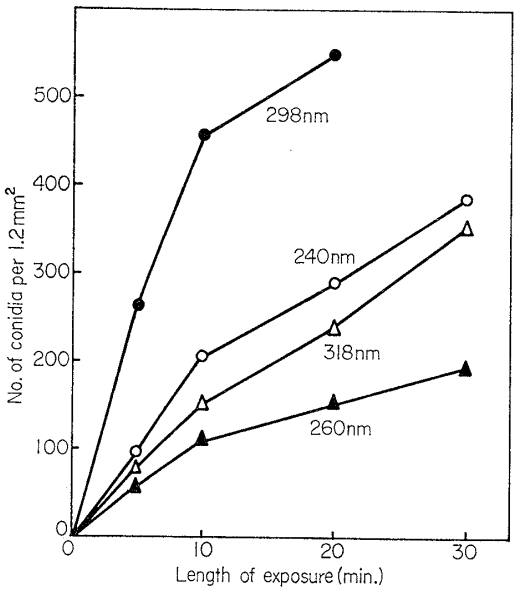

Fig. 1.

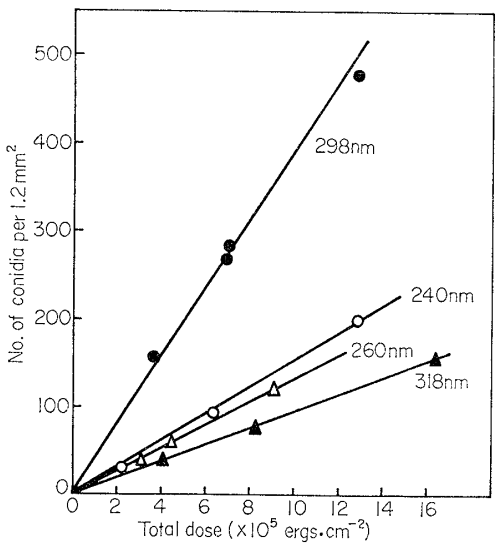

Fig. 2.

Fig. 1. *Relation of exposure length to number of conidia in* H. oryzae. A five-day dark-grown colony on a medium of potato dextrose agar was irradiated with monochromatic radiation of 240, 260, 298 nm and 318 nm at an intensity of 216, 152, 235 and 278 ergs·cm^{-2}·sec^{-1}, respectively. Conidia produced were microscopically counted after the subsequent 24-hr dark period.

Fig. 2. *Relation of the total dose to number of conidia in* H. oryzae. Total dose was obtained by multiplying the radiation intensity by the exposure time shown in Table 1.

Table 1 *Intensity and length of exposure to monochromatic radiation*

Wavelength (nm)	Intensity (ergs·cm^{-2}·sec^{-1})	Length of irradiation (sec)
222	70, 140	300, 600, 1200, 1800
232	92, 184	300, 600, 1200, 1800
240	110, 216	300, 600, 1200, 1800
250	130, 260	300, 600, 1200, 1800
260	76, 152	300, 600, 1200, 1800
270	87, 174	300, 600, 1200, 1800
280	98, 196	300, 600, 1200, 1800
288	106, 212	300, 600, 1200, 1800
298	120, 235	300, 600, 1200, 1800
308	128, 256	300, 600, 1200, 1800
318	139, 278	300, 600, 1200, 1800
328	150, 300	300, 600, 1200, 1800
336	159, 318	1800, 7200
346	162, 324	1800, 7200
356	170, 340	1800, 7200
384	158, 316	1800, 7200
432	160, 320	1800, 7200
480	147, 295	1800, 7200
528	264	1800, 7200
575	220	1800, 7200
629	320	1800, 7200
680	240	1800, 7200

Monochromatic radiation was applied from 222 to 680 nm at 8–10 nm intervals.

Table 2 *Total number of incident quanta necessary to induce the standard effect at various wavelengths in* H. oryzae

Wavelength (nm)	Standard effect (induction of 100 conidia per 1.2 mm^2)	
	Dose ($\times 10^3$ erg/cm^2)	No. of quanta per cm^2 ($\times 10^{12}$)
222	264.1	25.07
232	484.2	56.56
240	883.5	106.76
250	1039.9	130.89
260	911.3	119.28
270	652.5	88.70
280	542.8	76.52
288	423.9	61.47
298	261.1	39.18
308	379.2	58.80
318	940.2	150.53
328	1001.0	165.31
336～680	no conidiation	

The standard effect was determined by measuring the total dose necessary to produce 100 conidia per 1.2 mm^2.

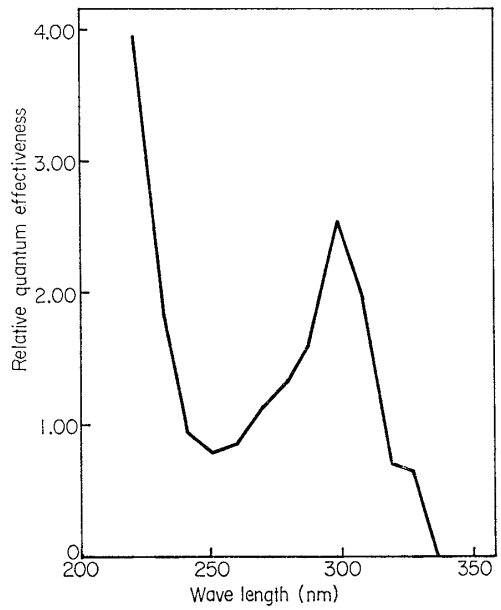

Fig. 3. *Action spectrum for photoinduced conidiation in* H. oryzae. Reciprocals of the number of quanta per cm^2 to induce the standard effect at each wavelength obtained from the results of Table 2 were plotted against the wavelength.

This action spectrum for photoinduced conidiation in *H. oryzae* (HA_2) is very similar to those of *Ascochyta pisi* (*5*), *Pleospora herbarum* (*6*), *Alternaria dauci* (*6*), *Leptosphaerulina trifolii* (*7*) and *Stemphylium solani* (*8*). Hence, we may be conclude that basically the same photoreceptor pigments are involved in the photoinduction of conidia in these fungi.

References

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