

Exposure of Fungus Organisms to Ultraviolet Rays

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Introduction.—The stimulating effect of the violet portion of the spectrum on growth has been definitely proved for higher green plants. Since fungi lack chlorophyll, their needs as to various wave lengths are not associated with photosynthesis; nevertheless, light in its various forms and intensities is important as an environmental factor. The purpose of this study is to determine the effect of ultraviolet light (which represents very short wave lengths) on the rate of growth, the advancing hyphal tip, and fructification. Results from previous investigations on this phase of light study have been found to be inconclusive on some points. This may be because of numerous factors such as variation in wave-length, intensity of source, nature of any absorbing media interposed, composition of media, age of culture and hydrogen-ion concentration.

Porter and Bockstahler (1929), in their studies concerning the reaction of fungi to various wave lengths, found that ultraviolet inhibited growth and the aerial hyphae collapsed with resultant death. In regard to spore formation, they found sharp inhibition with *Cephalothecium* but slight acceleration in the case of *Colletotrichum*. Stevens (1930), Hutchinson and Ashton (1930), and Ramsay and Bailey (1930) also report a stimulation of spore production. Weston (1932) and Smith (1935) report a stimulation of vegetative growth preceded by a previous retardation. The fungicidal action of ultraviolet has been reported by Fulton and Coblenz (1929) in which he killed the spores of twenty-seven miscellaneous species of fungi by comparatively short exposure.

In my study concerning ultraviolet irradiation, I noted particularly the stimulation of aerial mycelium after a slight retardation. The lethal effect on the aerial hyphae and the stimulation of fructification (especially sclerotial formation of *Sclerotia rolfsii*) was also evident.

Investigation.—The present work is concerned primarily with the effect of ultraviolet irradiation on hyphal development and fructification. In all experiments, a Hanover quartz-mercury arc vapor lamp was used, operated on A.C. current. All exposures were made at a distance of 25 cm. from the arc.

Sclerotium rolfsii and *Macrosporium solani* were cultured on potato dextrose agar by means of 5 mm. discs cut from the edge of a normal growing colony. When these colonies had attained a diameter of approximately 2 cm., the lids of the plates were removed and the plates covered aseptically with cellophane. These preparations were then irradiated, three plates of each being exposed 10 sec., 30 sec., 1 min., 5 min. After full strength exposure without filters, the plates were covered with their lids and the colonies incubated at room temperature in darkness. The effect of the irradiation on the hyphal tips was studied one half hour after exposure by cutting out a section of the colony and

placing it in a Van Tiegham cell. The rate of growth was followed and any unusual behavior of the hyphae noted. Increase in diameter of the colonies was recorded after a 10-hour incubation period, and the hyphal tips again studied. The colonies were later studied with respect to effect on fructification.

Data.—The data from this report support the conclusion of Weston (1932) and Smith (1935) concerning stimulation of vegetative growth preceded by a previous period of retardation. *Macrosporium solani*, after ten hours of incubation, showed an average increase of 3 mm. in the control, whereas the plates exposed 5 min. increased only 1 mm., those exposed 1 min. increased 2 mm., and those exposed 10 sec. increased 2.5 mm. *Sclerotium rolfsii* control showed an average increase of 7.5 mm., while the plates exposed 5 min. increased only 1.5 mm., those exposed 1 min. increased 4.5 mm., those exposed 30 sec. increased 6.5 mm., and those exposed 10 sec. showed an average increase of 6.5 mm.

Although the colonies increased in diameter, this increase was due to the hyphae below the surface of the agar, the surface hyphae being killed. This was particularly evident with *Sclerotium rolfsii*, the edge of the colony being distinctly delimited even with a 10 sec. exposure. As shown by the increase in diameter, even the hyphae below the surface of the agar were affected, especially those irradiated 5 min.

An examination of the hyphal tips about one half hour after exposure indicated a tendency toward branching at the tips. Approximately 60% of the tips were forked, many tips were bulbous, and others showed evidence of plasmolysis. Along numerous hyphal strands there appeared small refractive globules. After a 10-hour incubation, tips appeared normal, apex ellipsoidal, and the cytoplasm uniform. In some cases, as many as six branches arose from the same bulbous tip previously mentioned, presenting a broom-like appearance. The rate of growth of numerous hyphal tips after exposure presented no outstanding difference from that of the control.

The effect of irradiation on fructification was outstanding on *Sclerotium rolfsii*. In this organism sclerotial formation follows vegetative development. In the control plates the sclerotial formation was rather uniformly distributed, whereas those exposed showed a tendency toward the formation of sclerotia in the central exposed area, especially those exposed for 5 minutes.

Both *Sclerotium rolfsii* and *Macrosporium solani* showed a decided stimulation of aerial mycelium. After 60 hours of incubation, the colonies of *Macrosporium* showed this stimulation as a raised cottony circle around the colony originally exposed. This area was considerably darker than a comparative area in the control. *Sclerotium rolfsii* showed a similar white fluffy circle around the original exposed area.

Discussion.—Stimulation of vegetative growth as shown by the raised cottony circle surrounding the area exposed is further substantiated by the branching of the hyphal tips. This retardation of the diameter has been interpreted not only as a checking of the hyphae but also as a branching of the tips already present. Subsequent growth following the initial retardation seems to be greatly accelerated. Previ-

ous workers have suggested that, when growth is retarded, labile products may be stored in the plant and that growth acceleration is brought about immediately following retardation because of this accumulated supply of labile products. Another theory which may be advanced is that certain growth-promoting hormones may accumulate at the bulbous apex of the hyphae and not only cause considerable branching but also accelerated growth of these branched hyphae.

Although the media seem to have a protective influence on the submerged hyphae, increasing the length of exposure was relative in its retarding effectiveness as shown by growth increments. The lethal effect to aerial hyphae was particularly apparent in the case of *Sclerotium rolfsii* colonies, in which even a 10-second exposure sharply delimited the colony, the edges appearing as though trimmed. On the basis of these observations, I feel that the following statements are justified: (1) Fungi are extremely sensitive to ultraviolet irradiation. (2) The hyphal tip is first retarded, then branched, and is finally stimulated in the production of aerial mycelium. (3) Fructification is materially altered, not only in quantity but also in location on the plate, as shown by the ringing effect and massing of sclerotia in the area exposed. (4) The media are partially effective in screening out the rays according to the length of exposure; however, sufficient rays seem to filter through to produce subsequent stimulating effect. (5) Irradiation is lethal to individual aerial hyphae but not to the entire colony.