Short Communication

Phycomyces: An Increase in Mechanical Extensibility during the Avoidance Growth Response

JOSEPH K. E. ORTEGA
Department of Aerospace Engineering Sciences, University of Colorado, Boulder, Colorado 80309

R. IGOR GAMOW
Department of Chemical Engineering, University of Colorado, Boulder, Colorado 80309

ABSTRACT

The sporangiophore of Phycomyces shows a transient response to a double barrier, the avoidance growth response. Tensile tests conducted on the stage IV sporangiophore demonstrate that an increase in mechanical extensibility occurs about a minute after a double barrier stimulus. This change in mechanical extensibility is similar to the one that occurs after a light stimulus. We have concluded that the avoidance stimulus occurs somewhere on the same pathway between the photoreceptor mechanism and the final growth response.

Recently it has been shown that an increase occurs in mechanical extensibility of the growing zone after a light stimulus (10). Additionally, the increase in the mechanical extensibility was found to begin approximately 2 min after the light stimulus and continues until approximately the 15th min after the light stimulus (9). This result supports the hypothesis that the transient light growth response results from a transient increase in cell wall mechanical extensibility that occurs as a direct result of the light stimulus. In the present report, we have asked the following questions: does a double barrier stimulus result in a change in cell wall mechanical extensibility and if so, does this change also show the transient kinetics of the avoidance response?

In measuring the changes in mechanical extensibility, we have used the same procedure as previously reported (9) except that we have substituted a double barrier stimulus for the light stimulus. The procedure used to determine the mechanical extensibility of the sporangiophore was as follows. The sporangiophore was loaded and unloaded 12 to 15 times to 240 mg in room light to achieve a “strain-hardened” state, allowed to relax for either 1, 2, 3, 5, or 10 min, and then strain-hardened once more and allowed to relax once more. At the beginning of the second relaxation period, the double barrier stimulus was slipped in around the sporangiophore. The difference in the increase in cell wall mechanical extensibility that occurred after the first relaxation period, $E_s$, and after the second relaxation period plus the double barrier stimulus, $E_d$, is called the change in mechanical extensibility, $\Delta E = E_d - E_s$. In Figure 1, the points (x) represent the change in mechanical extensibility in the absence of the double barrier stimulus. The ×s (×) represent the change in mechanical extensibility after a double barrier stimulus. The double barrier stimulus was given by enclosing the entire sporangiophore within a pair of glass microscope coverslips that were 2 mm apart. After the insertion of the double barrier at the beginning of the second relaxation period, the double barrier remained around the sporangiophore for the remainder of the experiment. Figure 1 shows that the time kinetics of the increase in cell wall mechanical extensibility is similar to the time kinetics of the avoidance growth response. The relatively large standard deviations of the mean values are attributed to the fact that the magnitude of the avoidance growth response varies considerably from sporangiophore to sporangiophore. Each point without a number represents an average of 10 individual experiments, each conducted with a different sporangiophore. The numbers next to some of the points represent the number of experiments performed to obtain that particular mean value. The vertical bars indicate the standard deviation of the mean values.

We conclude from these experiments that the double barrier

1 This work was supported by National Science Foundation Grants GB-31039 and GB-35597.
Fig. 1. Change in extensibility, $\Delta E$, plotted against time after initiation of double barrier stimulus given at zero time. ($\times$): Change in extensibility that results from avoidance stimulus at different times after initiation of stimulus; (·): change in extensibility that results when the same experiments are repeated but without avoidance stimulus. All points ($\times$) and (·) represent the mean value of 10 experiments, except for those points with numbers next to them which indicate the number of experiments used to determine the mean value. Vertical bars indicate standard deviation of the mean value.

stimulus results in an increase in cell wall mechanical extensibility which in turn results in an increase in growth rate. This increase in cell wall mechanical extensibility may be the result of an increase in some cell wall-loosening enzyme(s) activity. Chitinase has been isolated from Phycomyces sporangiophores by Cohen (2). We have concluded that the avoidance stimulus occurs somewhere on the same pathway between the photoreceptor mechanism and the final growth response.

Acknowledgment – We would like to thank D. E. Clough for his fruitful discussions on the statistics.

LITERATURE CITED

3. COHEN RJ 1976 The avoidance behavior of Phycomyces blakesleeanus; is mediation by natural convection significant? J Theor Biol 58: 207-217
5. ELVING F 1881 En obeaktad känslighet hos Phycomyces. Bot Notiser 4: 105-107