

Studies on the mechanism of light-dependent germination of akinetes of blue-green algae

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Abstract

This paper deals with the role of light in the germination of akinetes of *Anabaena azollae*. The two maxima action spectra are situated at 385 and 615 nm and the stimulation of the germination process by photosynthate was confirmed. The photoreceptor absorbing at 385 nm was identified as a flavin and that at 615 nm as a phytochrome. A model is suggested for the mode of action of light in the germination of akinetes of blue-green algae.

Introduction

It has long been known that light is essential for the germination of akinetes of blue-green algae (Braune, 1979), but the role of light still remains obscure. Reddy & Talpasayi (1981) provided evidence to prove it is a photochromic process. However, Chauvat *et al.* (1982) emphasized the energetic action of the light. This paper reports results obtained in a study on the akinetes of *Anabaena azollae*.

Materials and methods

The Braune's method of akinete germination tests was adapted (Braune, 1979). A group of interference filters with half-band width 2.5–4 nm and transmittances of 40–60% were used to obtain monochromatic lights.

Results and discussion

Figure 1 shows the effects of light of different wavelengths under uniform light flux rate (2 000 erg

cm⁻² S⁻¹) on the germination of akinetes, the effects of 615 nm and 385 nm light irradiations being stronger. Figure 2 shows the relative efficiency of light with wavelengths 615 nm and 385 nm in an atmosphere with or without CO₂ on the germination of akinetes. The results demonstrate that the photosynthate formed during germination facilitates germination. Furthermore, it shows that after deducting the contribution of photosynthesis, the 615 nm and 385 nm irradiation had almost the same efficiency on a flux basis.

In order to ascertain whether the pigment absorbing at 615 nm is phytochrome, the red/far red reversibility experiment was carried out. The results of Table 1 show a typical phytochrome reaction.

According to Mohr (1980), the crucial test for the existence of functional phytochrome is a dichromatic irradiation experiment. Figure 3 shows the results of simultaneous dichromatic irradiation with red/far red and blue-UV/far red lights. The morphogenetic effect of red light is clearly abolished by far red light. This result indicates that the photoreceptor absorbing at 615 nm may be phytochrome while that at 385 nm is a pigment different from phytochrome.

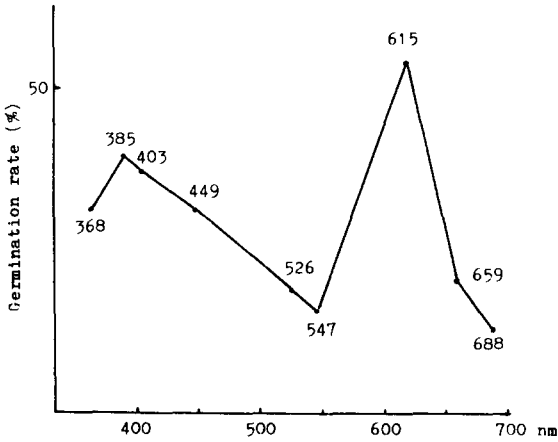


Fig. 1. Efficiency of different wavelengths for the germination of akinetes of *A. azollae*.

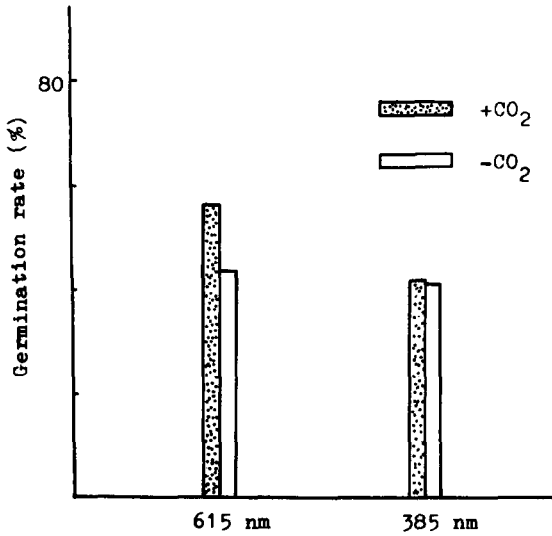


Fig. 2. The influence of carbon dioxide in the atmosphere on the germination rate of akinetes of *A. azollae*.

Table 1. The reversible red far-red control on the akinete germination of *Anabaena azollae*.

Treatments	germination rate (%)
48 h Dark (control)	0
24 h R	17.6
24 h R, 3.5 h FR	8.8
24 h R, 3.5 h FR, 3 h R	17.8
24 h R, 3.5 h FR, 3 h R, 3.5 h FR	7.2
24 h R, 3.5 h FR, 3 h R, 3.5 h FR, 3 h R	18.7

R = 615 nm, 600 erg cm⁻² S⁻¹; FR = 743 nm, 5500 erg cm⁻² S⁻¹.

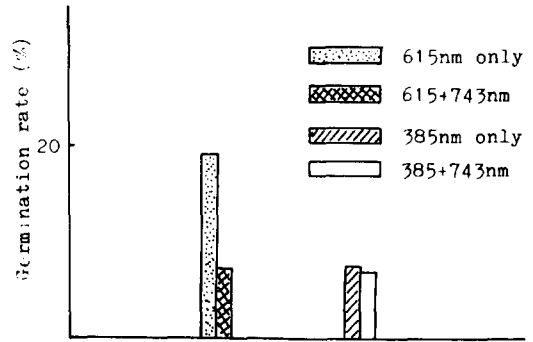


Fig. 3. Results of experiment with dichromatic irradiation.

Cis-4-cyclohexene-1,2-dicarboximide (CHDC), an endogenous inhibitor of seed germination in higher plants isolated from sugar beet seeds, has been shown to inhibit the action of phytochrome in photoblastic seeds (Bewley & Oaks, 1980). Our studies showed that CHDC (10⁻³ mol) inhibits markedly 615 nm promoted akinete germination but has no influence on the 385 nm promoted one. This is additional evidence for the existence of functional phytochrome in akinetes of *Anabaena azollae*.

Schmidt (1977) has reported that low concentration of NaN₃ (10⁻⁴ mol) has specific inhibitory action on flavin in higher plants. If this is true, the result of Figure 4 would imply that the blue-UV photoreceptor is probably a flavin.

It is not surprising to find a blue-UV photoreceptor in the akinetes of blue-green algae, though it has not been described in the literature, since this pho-

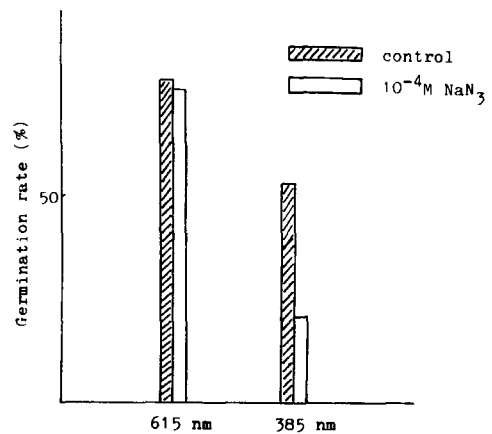


Fig. 4. The inhibitory action of NaN₃ on the photoreceptors.

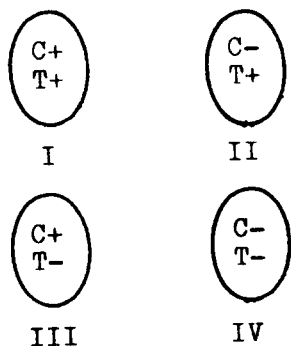


Fig. 5. Four subpopulations of akinetes of blue-green algae according to their different situations of carbohydrate storage (C) and light trigger action (T).

toreceptor is detectable in different plants and is acting as a sensor pigment in a number of responses. Numerous photochromic pigments in blue-green algae have been recorded (Bjorn & Bjorn, 1980; Reddy & Talpasayi, 1982). Our results provide more evidence supporting the view that the red/far red reversible pigment is probably phytochrome or one of its analogues.

The results reported here confirm that both the photosynthetic activity which supplies energy for akinete germination and the trigger action of red and/or blue-UV light are involved in the germination process. A hypothetical model as shown in Figure 5 is proposed to represent the relation between the two factors in a akinete population, which consists of four subpopulations differing in

carbohydrate storage (C) and/or trigger action (T). For instance, the akinetes of subpopulation III could germinate under blue-UV light, while the akinetes of subpopulation IV must be irradiated by red or white light to provide the carbohydrate supply and to elicit a trigger action. Using this model all of the conflicting results so far reported can be explained satisfactorily.

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