INDUCTION OF PS II ACTIVITY AND INDUCTION OF A VARIABLE PART OF THE FLUORESCENCE EMISSION BY WEAK GREEN LIGHT IN FLASHED BEAN LEAVES

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1. Introduction

Primary bean leaves grown under a flash regime accumulate chlorophyll and they form chloroplasts having lamellae but devoided of grana [5, 6]. The absence of some PS II properties was reported in these flashed leaves [1]. Similarly some PS I activities (e.g. PMS catalyzed photophosphorylation), but no PS II activity, have been measured in flashed barley chloroplasts [4]. We have recently shown that at the first illumination of flashed primary bean leaves with continuous or fast chopped light, an induction of the ability to produce oxygen in a short time took place. Under this continuous light such leaves show an increasing apparent oxygen production, a maximum rate being reached within 6 min, although the quantity of total chlorophyll did not apparently change within this time [7–9]. This induction of oxygen production does not seem to be correlated with any actual photosynthetic activity since it occurs as rapidly under low light-intensity as under strong light [10].

In this paper we show that a variable part of the fluorescence emission and an oxygen production activity may be induced in flashed primary bean leaves within a few minutes (less than 8 min) under a weak green light.

2. Methods

The plant material and the experimental conditions were as described before [9] but there was no green safe light at all, at any stage of the manipulations. The induction experiments were as follows: A fresh disc of flashed bean leaf (8 mm diameter) was put in total darkness in the measuring cuvette. It was thereafter illuminated for 8 min with a green light (550 nm of a Bausch and Lomb monochromator, half band width: less than 10 nm; intensity: 100 $ergs \cdot cm^{-2} \cdot sec^{-1}$). This light is called below an "inducing-light" and the period of 8 min is called a "preillumination period". At the end of the preillumination a blue light (called below test-light) with an intensity of $5 \cdot 10^4$ $ergs \cdot cm^{-2} \cdot sec^{-1}$ was turned on. The blue "test-light" consisted of the broad band obtained by passing light of a Xenon Lamp through 10 cm of a saturated $CuSO_4$ solution. The time course of the oxygen consumption or production at the level of the platinum electrode in the cuvette and of the fluorescence emission of the piece of leaf at 680 nm (interference filter B10 Baird-Atomic, Inc. Cambridge) were continuously recorded during the experiments.

3. Results and discussion

In figs. 1 and 2, curves I show traces registered in the case of a control, a flashed bean leaf which did not get any preillumination with inducing light. Curves III show in the case of a flashed, bean leaf the corresponding traces when the preillumination with inducing light had occurred. It is clear that the preillumination induced a state in which the piece of flashed leaf appeared able to produce an oxygen

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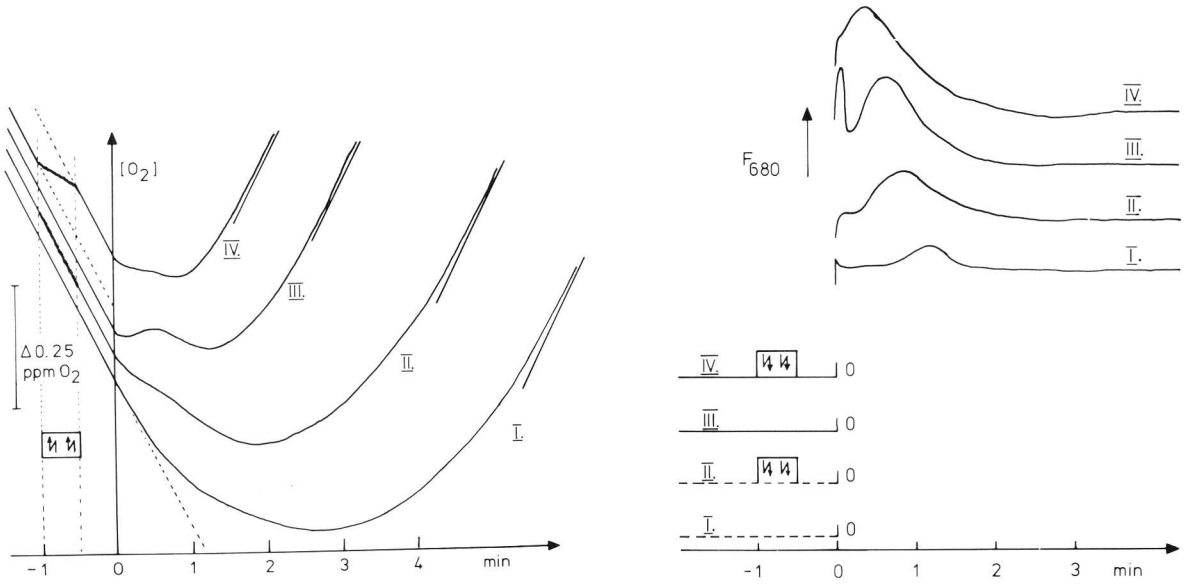

Fig. 1, 2. For the experiments no. I to IV we took 14 day-old flashed bean leaves (cultivated 7 days in darkness, then 7 days under a flash regime). In all cases 6 min of the same photosynthetic actinic light was used (broadband blue light of $5 \cdot 10^4$ ergs/cm$^2 \cdot$sec through a chopper with a light to dark period of 4 msec to 4 msec) to measure photosynthetic activities: in fig. 1 the oxygen exchange and in fig. 2 the simultaneous variable fluorescence at 680 nm of the same leaf are presented during the first minutes of illumination with actinic light. For each experiment a different pretreatment phase of 8 min was inserted between the cultivation and the photosynthetic actinic light period. The different pretreatments were:

Exp. I 8 min darkness;

III 8 min weak 550 nm light of 100 ergs/cm$^2 \cdot$sec;

II 8 min darkness plus 60 white flashes of 1/100 sec and 10^6 ergs/cm$^2 \cdot$sec during 30 sec one minute before the beginning of the actinic illumination;

IV 8 min weak 550 nm light as in Exp. III plus the same flash treatment as used for Exp. II.

All fluorescence curves are normalized to the steady state fluorescence intensity.

outburst and to show a variable part of the fluorescence emission as soon as the test-light was turned on. The experiments do not seem to contradict the view following which the oxygen outburst and the first fluorescence emission peak are correlated phenomena [2]. The occurrence of an oxygen outburst in curve III (fig. 1) may be understood admitting that the machinery which produces oxygen was more or less synchronized at the end of the preillumination period (considering views expressed in [3]). By inserting 60 white flashes with an intensity of 10^6 ergs$\cdot$cm$^{-2}\cdot$sec^{-1}, a duration of 10^{-2} sec, and a periodicity of 2 flashes per sec in the last portion of the preillumination period, i.e. 1 min before the test-light, we were able to suppress the oxygen outburst. Oxygen was released in this case by light from the 60 flashes (curves IV, fig. 1). An effect of these flashes was also seen in the fluorescence emission time course (curve IV, fig. 2). The 60 flashes given in the preillumination period prevented the first emission peak from appearing. The oxygen outburst and the first peak of the fluorescence emission are thus both suppressed by the same light treatment. We were not able to relate quantitatively both phenomena, because we were not able to place the illumination by the 60 white flashes immediately before the beginning of the illumination by the test-light.

Curves II, figs. 1 and 2 are controls to curves IV (no preillumination with inducing-light, but 60 white flashes). In this case, as expected, no oxygen production was observed during the 60 flashes. It is important to emphasize that the leaf disks with a diameter of 8 mm used in the reported experiments were taken from fresh flashed plants and that a surface with a

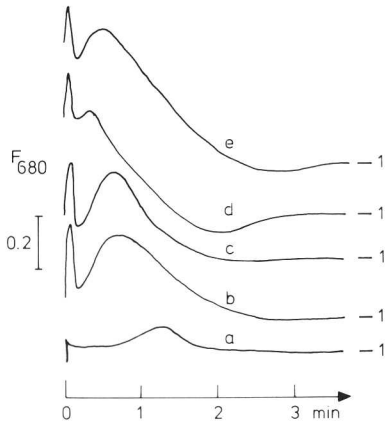

Fig. 3. Traces of the variable fluorescence at 680 nm of a) a flashed leaf and b), c), d), e) four different flashed leaves after 8 min preillumination with weak 550 nm light. Conditions as in Exp. III, figs. 1 and 2.

diameter of 4 mm only was illuminated. The time course of the fluorescence emission from this surface at the end of the preillumination with inducing-light was always qualitatively the same but there was some uncontrolled variation due to the sample from one leaf to another as seen in fig. 3. The time course of the emission showed the first peak more clearly detached when a little leaf surface was excited, than by exciting whole leaves.

In any case it is obvious from the reported results that both the induction of PS II activity and the induction of a variable part of the fluorescence emission occurred in flashed primary bean leaves when illuminated with a continuous green light of low intensity, although this light itself does not cause any measurable change of the oxygen concentration due to photosynthesis at the level of the platinum electrode.

We thus conclude:

i) There exists a light dependent induction mechanism which prepares the flashed leaf for producing an oxygen outburst as well as a variable part of the fluorescence emission when the leaf is transferred to the test-light.

ii) Since the inducing light may consist of a weak green light which does not produce any detectable photosynthetic oxygen, this induction mechanism seems independent of any actual photosynthetic activity. Detailed kinetics are under investigation.

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