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Research article

HIGH LIGHT INDUCED ALTERATIONS IN PHOTOSYNTHETIC ELECTRON TRANSPORT ACTIVITIES IN THE CYANOBACTERIUM *SYNECHOCOCCUS* 6301

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ABSTRACT: In this present study the effect of high light (300-900 Wm^2) on photosynthetic electron transport activities of *Synechococcus* 6301 was studied by exposing the cells for 15 min. Our results clearly indicated that photosystem II is more susceptible when compare to that of photosystem I. The possible reason for the inhibition of photosystem II could be alterations at the level of D_1 protein of photosystem II complex. Thus high light shows differential effects on photosystems in the cyanobacterium, *Synechococcus* 6301.
Key words: Electron transport, High light, Photoinhibition, Photosystem

INTRODUCTION

The source of energy, which helps in the maintenance of biosphere n the earth, is sunlight. This light is converted to chemical energy by the process of photosynthesis. Therefore light can also be bad when plants are exposed to high intensities of light under adverse environmental conditions [1]. There is an evidence that too much of light can affect plant growth leading to the reduction of plant productivity and crop yield. This stress condition is known as photoinhibition, which was reported as long ago [2,3]. Strong illuminations of light to oxygenic photosynthetic organisms results in decreased CO_2 fixation, inhibition of photosynthetic electron transport and oxygen evolution [4].

Photoinhibition causes mainly photoinactivation of photosystem (PS) II catalysed electron transport and irreversible damage to the reaction centres (RC) [5,6,7]. The 32 kDa, Q_B binding protein of the PS II RC is known as D_1 protein. It is involved in the early stages of damage caused by photoinhibition. The damage to the 32 kDa was thought to be the primary cause of photoinhibiiton. The possible reason for the damage of D_1 protein is the production of oxyradicals from molecular oxygen [8,9,10,11]. There is general argument that light induced impairement of electron transport is not consequence but rather the cause of protein damage and transfer of D_1 protein [12]. Therefore in this investigation an attempt has been made to characterize the effect of high light intensity photosynthetic electron transport by isolating the thylakoid membranes from cyanobacterium, *Synechococcus* 6301. The effect of high light intensity was studied using polarography in terms of partial electron transport measurements to identify the target site in photosynthetic apparatus in cyanobacterium, *Synechococcus* 6301.

MATERIALS AND METHODS

1gm fresh weight of *Synechococcus* 6301 cells were suspended in a fresh growth medium with a concentration of 20 µg of Chl/ml. The cells were placed in a glass tube, which is surrounded with borosil glass circulating water jacket to maintain constant temperature. This entire setup is exposed to different intensities of light (300-900 Wm^2) for 15 min. The cells were harvested by centrifuging the culture at 6000 xg for 10 min. The collected cells were suspended in 25 mM HEPES-NaOH buffer (pH 7.5) at a chlorophyll (Chl) concentration of 2 kg m^{-3}. After the treatment electron transport activities were analysed using an oxygen electrode at 25°C and saturating irradiance of 420 µmol (photon) m^{-2} s^{-1}. The assay mixture for the measurement of whole chain electron transport activity contained reaction buffer, 0.5 mM MV and 1 mM Na-azide. The assay mixture for the measurement of PS II mediated oxygen evolution activity contained 0.5 mM PBQ in three ml of the 25mM reaction buffer. For measurement of PS I activity, the reaction mixture contained 0.1 mM DCPIP, 5mM ascorbate , 1 mM azide, 0.010 mM DCMU and 0.5 mM MV. In all these assays chloroplasts equivalent to 30 µg was used. The whole chain electron transport activity (ETC) assay was done in intact cells using MV as an acceptor by following the procedure of Robinson *et al.* [13].

RESULTS AND DISCUSSION

In this present investigation an attempt has been made to analyse the effect of high light intensity on the photosynthetic electron transport activities of *Synechococcus* 6301 by exposing the cells for different intensities of light (300-900 Wm^2) for about 15 min. after giving the treatment initially whole chain electron transport has been measured by using methyl vilogen (MV) as an acceptor (Table 1). The control activity is equal to 235 µmol of O_2 consumed per mg/ Chl/hr. High light induced intensity dependent inhibition in whole chain electron transport and at 900 Wm^2 of treatment 55% loss was noticed. The possible reason for the inhibition of whole chain electron transport could be alterations at the level of PS II [14,15] or at the level of PS I [16,17]. To rule out the possibility regarding the susceptibility of photosystems PS II catalysed electron transport activity has been measured PBQ and Hill acceptor (Table 2). The control activity of PS II is equal to 423 µmol of O_2 evolved per mg/ Chl/hr. high light treatment caused gradual inhibition in Hill activity and at 900 Wm^2 only 55% loss was noticed. The observed inhibition in PS II activity at high light intensity could be either alterations at the level of D_1 protein or due to inactivation of water oxidation complex as suggested by earlier workers [18,19]. To rule out the possibility regarding the susceptibility to high light intensity PS I catalysed electron transport has been measured using reduced DCPIP a donar and MV as acceptor (Table 3). Control activity of PS I with *Synechococcus* cells is equal to 550 µmol of O_2 consumed per mg/ Chl/hr. Surprisingly our results indicated that PS I is less sensitive to high light intensity when compare to the PS II activity (only 11% loss in PS I). the observed inhibition in PS I catalysed electron transport could be due to the alterations at the level of either P700, the RC of PS I or at the level of Iron-Sulfur centres as earlier reported by Sonoike group [20,21]. Recently Rajagopal et al [17] reported that high light intensity induces more inhibition when the incubating temperature is chilling and causes damage to LHC I of PS. Thus high light intensity shows differential effect on PS II or PS I based on the temperature at which the exposure is made.

Table 1: Effect of High light intensities on whole chain electron transport activity ($H_2O \rightarrow MV$) in cyanobacterium *Synechococcus* 6301

High Light (Wm^2)	Whole chain electron transport activity ($H_2O \rightarrow MV$) µ moles of O_2 consumed mg Chl^{-1} h^{-1}	Percentage of loss
Control	235 ± 22	0
300	171 ± 17	27
600	122 ± 12	48
900	106 ± 10	55

Table 2: Effect of High light intensities on PS II electron transport activity ($H_2O \rightarrow PBQ$) in cyanobacterium *Synechococcus* 6301

High Light (Wm^2)	PS II electron transport activity ($H_2O \rightarrow PBQ$) µ moles of O_2 evolved mg Chl^{-1} h^{-1}	Percentage of loss
Control	423 ± 43	0
300	305 ± 31	28
600	245 ± 25	42
900	190 ± 20	55

Table 3: Effect of High light intensities on PS I electron transport activity (DCPIP $H_2 \rightarrow MV$) in cyanobacterium *Synechococcus* 6301

High Light (Wm^2)	PS I electron transport activity (DCPIP $H_2 \rightarrow MV$) µ moles of O_2 consumed mg Chl^{-1} h^{-1}	Percentage of loss
Control	550 ± 55	0
300	523 ± 53	5
600	501 ± 51	9
900	489 ± 50	11

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