Fluorescent indices of bean seedlings leaves during de-etiolation

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INTRODUCTION

Etiolation is the process by which plants develop under conditions of insufficient light, leading to elongated stems and weakened leaves. Once etiolated plants receive adequate light, their recovery begins. Etiolation increases the chances of plant survival, while subsequent de-etiolation of leaves leads to chlorophyll synthesis and the formation of an efficiently functioning photosynthetic apparatus. The tasks related to studying the restorative and adaptive processes in plants are of scientific interest to biophysics and ecology. The method of Pulse-Amplitude-Modulation (PAM) fluorometry is used to monitor these processes, allowing for the assessment of changes in the fluorescent indices of plant leaves. The aim of this work is to study the changes in the fluorescent indices and pigment composition of etiolated leaves of *Vicia faba* L. The study presents data on the dynamics of adaptation of etiolated plants to high light conditions.

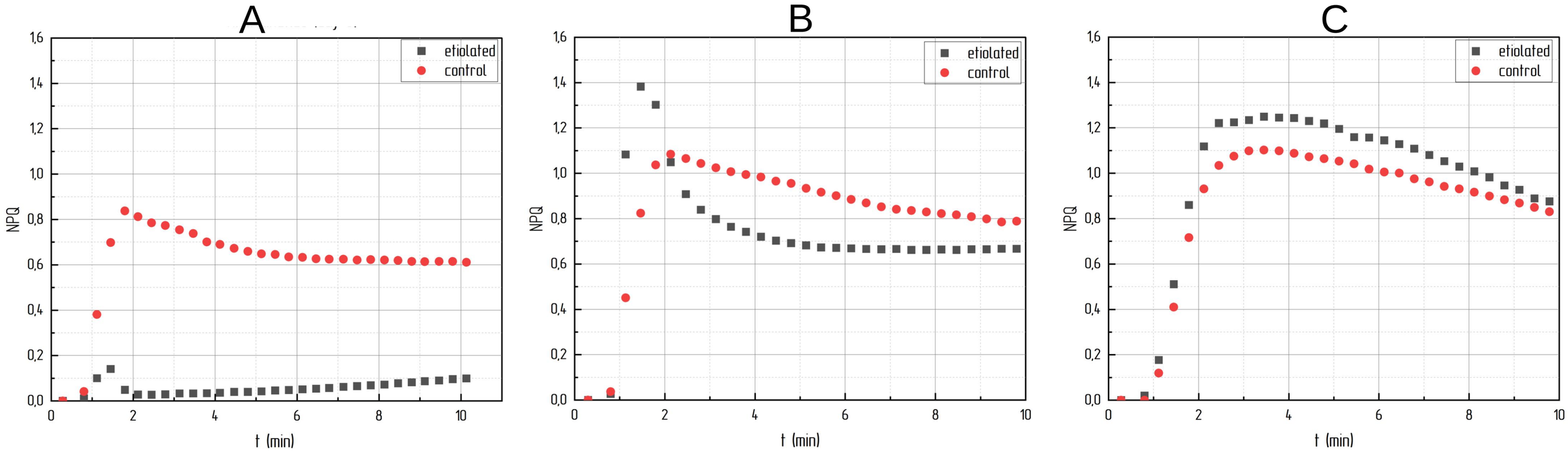

Fig. 1. Typical NPQ kinetics on 1 (A)*, 3* (B) *and 8* (C) *days of seedlings exposure to natural light*

MATERIALS AND METHODS

- Bean seeds were germinated for 2 weeks under different light conditions. Plants grown in conditions of insufficient light, so-called etiolated, were the object of this research. Plants grown under natural light conditions were used as a control. After the appearance of the third leaf tier, the etiolated seedlings were placed together with the control ones, and fluorescent indices and chlorophyll content were recorded daily.
- The kinetics of fluorescent indices in the leaves (fig. 1) was measured using a PAM-2500 pulse fluorometer (Walz, Germany). The PAM-fluorescence technique provides a number of indicators characterizing the efficiency of various processes taking place in the photosynthetic apparatus. One of these indices is F_v/F_m characterizing the potential activity of photosystem 2. The coefficient of the nonphotochemical quenching NPQ characterizes regulated thermal energy dissipation involving ΔpH- and zeaxanthin-dependent photoprotective mechanisms.

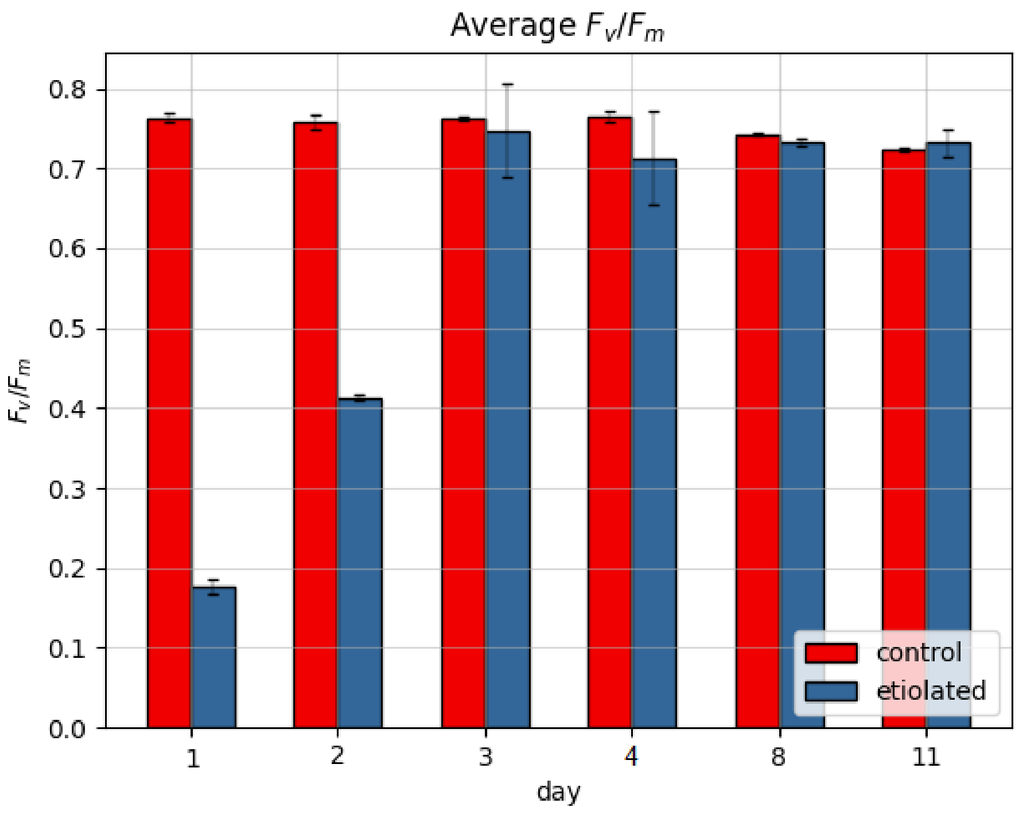

Fig. 2. Average value of F_v/F_m index

RESULTS AND DISCUSSION

During de-etiolation, plants grown under low light showed a rapid increase in initially low values of Fv/Fm (fig. 2), Φ_{PSII}, and NPQ (data not shown). The equalization of these indices with those of control plants occurred within two days after placing the etiolated seedlings in natural light conditions. Healthy plants showed a slight decrease in the NPQ index at 2-3 minutes after turning on actinic light due to the activation of the Calvin-Benson cycle. However, this parameter remained high at actinic light with PAR = 500 μmol photons/(m^2s) in our experiment (fig.1). The sharp peak in the kinetics of the NPQ index observed in etiolated samples can be explained by the uneven development of various components of the plant's photosynthetic apparatus. This peak disappeared by the 8th day of measurements, and the kinetics became indistinguishable from those of control samples.

The data obtained on the dynamics of adaptation of etiolated plants to high light conditions may indicate different rates of development of complexes responsible for the light and dark stages of photosynthesis.

CONCLUSION

The observed dynamics of the changes in the fluorescent indices of etiolated plants' leaves demonstrated a gradual recovery of the samples after growth under low light conditions. The increase in the NPQ coefficient characterizes the development of protective mechanisms of fluorescence quenching. The disappearance of the peak in the kinetics of this coefficient indicates an equalization in the development levels of the plant's photosynthetic apparatus components. The signs of underdevelopment of the photosynthetic apparatus and mechanisms of non-photochemical quenching were observed in etiolated plants.