



Chlorophyll fluorescent induction in plants treated with physiologically active compounds

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INTRODUCTION

Luminescent indices of photosynthesizing species depend on various biotic and abiotic factors and seem to be very attractive for monitoring the state of photosynthetic apparatus and for assessment of their functional activity. In this work, we have summarized the results of our experiments concerning the so-called slow fluorescence induction of the leaves. This fluorescence induction consists in a gradually decrease of the fluorescence intensity from maximal value F_M to stationary value F_T (Fig.1). It is supposed that this decrease is caused by some regulatory processes directed to the achievement of the optimal functioning of the light and dark stages of photosynthesis.

MATERIALS AND METHODS

- Bean seeds were soaked in epibrassinolide solution for 2-6 hours. The epibrassinolide content was 0.025 mg/L (approximately consistent with the manufacturer's recommendation). The treated seeds were germinated for 2 weeks and then the $(F_M - F_T)/F_T$ ratio for the leaves of the second tier was measured.
- The second experiment used barley seedlings of the Mikhailovsky variety and preparations of epin, gibberellin and zircon. In the vegetation experiment plants were sprayed with aqueous solutions of preparations in the "beginning of tillering" phase. The active compounds were used at a concentration of 0.01% (based on the active substance).

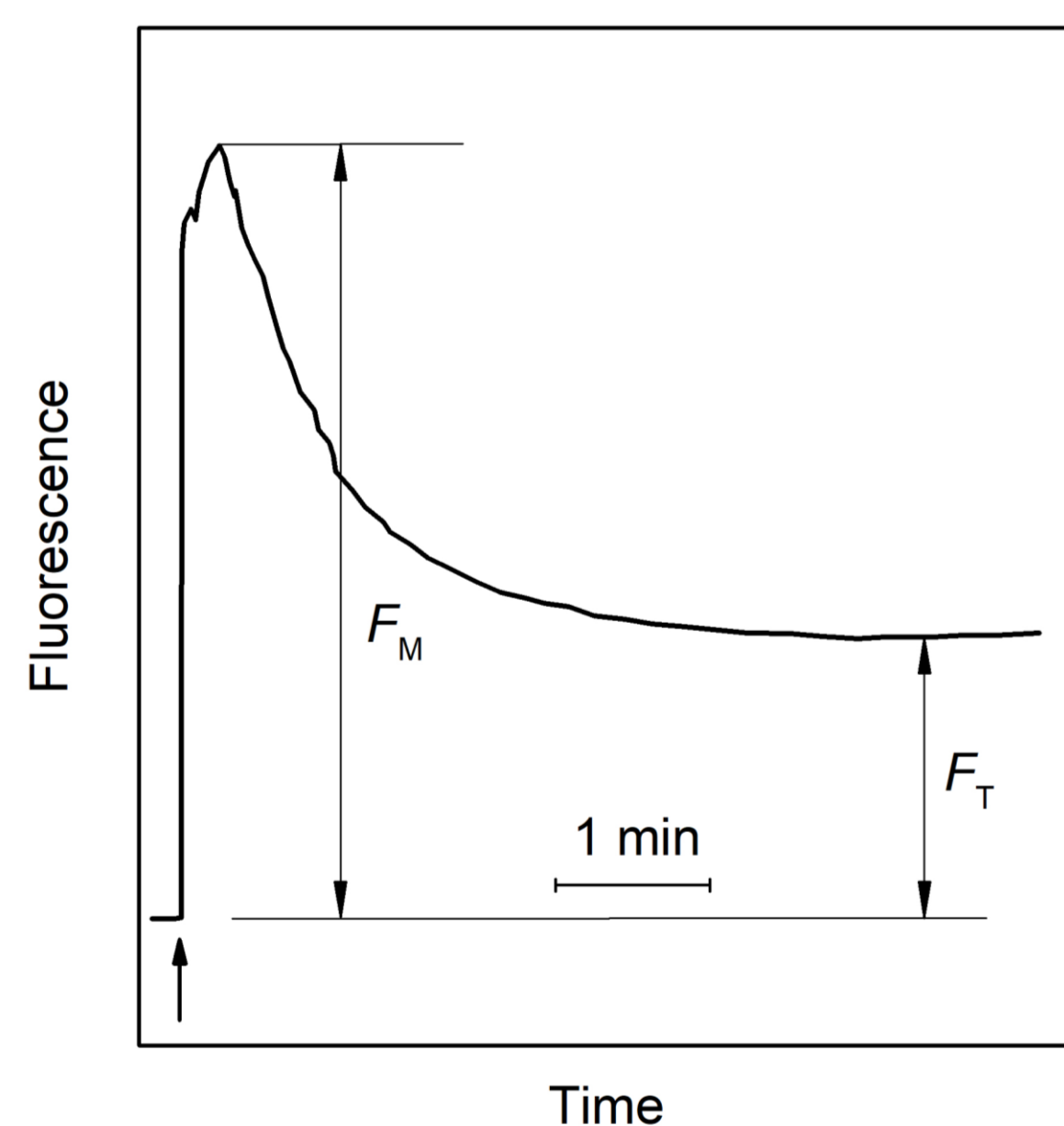


Fig. 1. Typical slow fluorescence induction (SFI) in green leaf

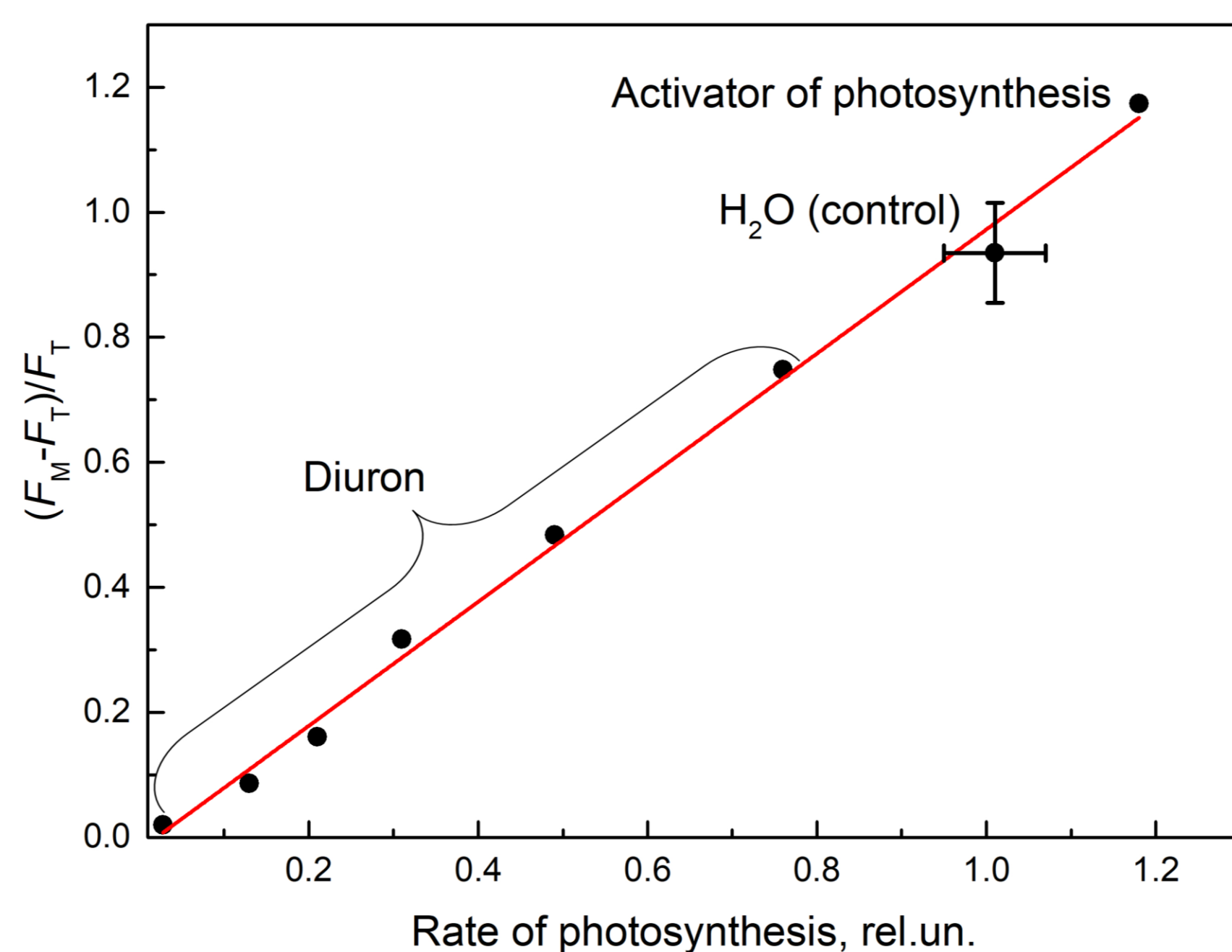


Fig. 2. Positive correlation between the photosynthetic activity and the ratio $(F_M - F_T)/F_T$ of SFI

RESULTS AND DISCUSSION

In the experiments with bean plants treated with the inhibitor of electron transport diuron and also with specific activator of photosynthesis, we have established that the relative changes in $(F_M - F_T)/F_T$ ratio correspond to the relative changes in photosynthetic activity estimated as a rate of O_2 evolution per chlorophyll (Fig.2). Further, in experiments with beans grown in aqueous solutions of heavy metals salts, we established an important and universal compensatory effect: a decrease in the chlorophyll content in plant leaves is accompanied by a corresponding increase in photosynthetic activity per chlorophyll (fata not shown).

Soaking the beans in a solution of epin led to an increase in values $(F_M - F_T)/F_T$ compared to control (Table 1) indicating on the increase in photosynthetic activity of the plants. With an increase in the time of soaking, the values $(F_M - F_T)/F_T$ also increased, and the growth of plants accelerated. It should be noted that the increase in the ratio $(F_M - F_T)/F_T$ was due to an increase in the values of F_M compared to F_T . This effect can be interpreted as a partial "removal" of nonphotochemical quenching due, for example, to a more active synthesis of ATP in the first seconds of illumination and, as a result, a decrease in the proton gradient on the thylakoid membrane.

Under the conditions of a growing experiment with barley plants, an increase in value of $(F_M - F_T)/F_T$ was observed already 2 days after treatment compared to the control. Over time after treatment, the stimulating effect of growth regulators on photosynthetic activity increased (Table 2).

Tab. 1. Luminescent and biometric indices of bean seedlings depending on the time of soaking the seeds in epin solution, $c = 0.025$ mg/l

Time after treatment	$(F_M - F_T)/F_T$		Height of seedlings, mm	
	Control	Epin	Control	Epin
2 hours	0.40 ± 0.03	0.77 ± 0.05	79.5 ± 1.5	86.5 ± 2.0
4 hours	0.48 ± 0.03	0.88 ± 0.05	91.0 ± 2.0	99.0 ± 2.0
6 hours	0.75 ± 0.05	0.97 ± 0.07	130.0 ± 2.5	165.0 ± 3.5

Tab. 2. $(F_M - F_T)/F_T$ ratio of slow fluorescence induction for barley leaves after treatment with growth regulators. Vegetation experiment.

Variant of treatment	Selection period after treatment	
	2 days	16 days
Control	0.58 (100%)	0.57 (100%)
"Epin-Extra"	0.71 (122%)	0.81 (142%)
"Zirkon"	0.67 (116%)	0.74 (129%)
"Gibberellin"	0.70 (121%)	0.75 (131%)

CONCLUSION

All the studied compounds had a stimulating effect on the photosynthetic apparatus of plants, which depended on the type of compounds, method of treatment and duration of exposure. The results obtained should be taken into account when developing intensive technologies for cultivating agricultural crops.

The results of the studies allow to conclude that the use of fluorescent research methods give the opportunity to evaluate the structural and functional organization of the photosynthetic apparatus of plants in various physiological conditions.

