FLUORESCENT INDICES OF BEAN AND TAGETES PLANTS TREATED WITH HEAVY METALS SALTS

O.A. Kalmackaya[1], E.I. Gunar[2], A.V. Malozemova[1], V.A. Karavaev[1]

[1] Lomonosov Moscow State University, Faculty of Physics, Leninskie Gory, 1, b.2, 119991, Moscow, Russia, kalmackaya@physics.msu.ru;

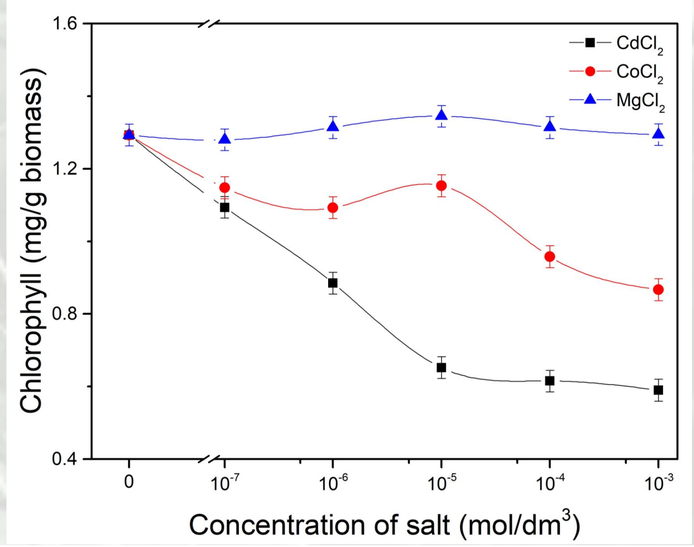
[2] Institute of Horticulture and Landscape Architecture, Russian State Agrarian University – Moscow Timiryazev Agricultural Academy, Timiryazevskaya street, 55, Moscow, 127550, Russia

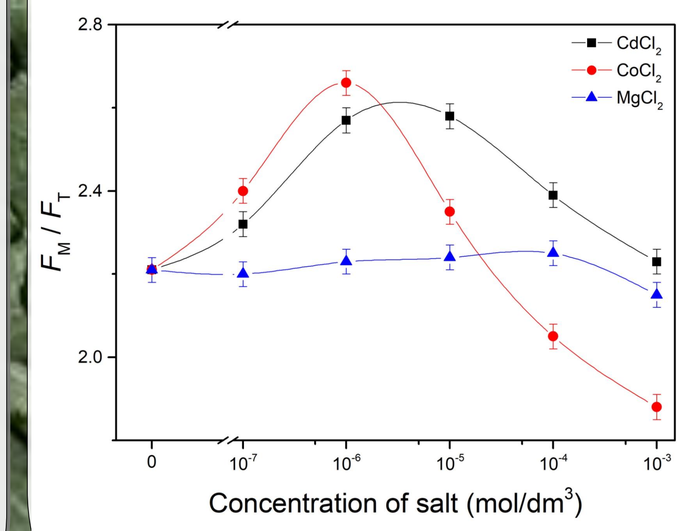
ITRODUCTION

An urgent task of modern biophysics is the study of changes occurring in the photosynthetic apparatus of plants under the influence of heavy metals (HMs). Fluorescent indices of photosynthesizing species depend on various biotic and abiotic factors and seem to be very attractive for monitoring the physiological state of the plants. In this work, we studied the fluorescent parameters of the leaves of *Vicia faba* and *Tagetes patula* treated with cobalt and cadmium chlorides, the most toxic HMs to higher plants. In the experiments, a single-beam scheme for recording fluorescence induction was used, as well as the PAM fluorometry technique. Rooted bean seedlings were planted in glasses with $CdCl_2$ and $CoCl_2$ solutions of various concentrations and further grown under hydroponic conditions. For comparison, we used the results obtained in similar experiments with $MgCl_2$.

Fluorescence of chlorophyll in the leaf was excited by wide-band blue light, and registered at 686 nm. The relative fluorescence decay, F_M/F_T, measured from the slow fluorescence induction curve was used to estimate the potential activity of photosynthetic apparatus. The regularities obtained in experiments with $CdCl_2$ and $CoCl_2$ (measurements using a single-beam scheme) were identical (Figs.1-3). The content of chlorophyll, calculated per unit of fresh biomass, gradually decreased down to 10^{-3} M (Fig.1). As regards the F_M/F_T parameter, it peaked at 10^{-6} M ($CoCl_2$) and 10^{-5} M ($CdCl_2$). At high concentrations of HMs salts, up to 10^{-3} M, the values of these parameters decreased significantly (Fig.2). Changes in F_M/F_T values in a wide range of concentrations positively correlated with changes in the rate of O_2 evolution calculated per chlorophyll unit (Fig.3). We assume that the increase in F_M is related to the decrease in so-called non-photochemical fluorescence quenching. The relaxation of non-photochemical quenching, in its turn, is assumed to be the result of the decrease in ΔpH across the thylacoid membrane in conditions of active ATP synthesis. Under these conditions, the rate of electron transport between the photosystems was also higher.

In the case of $MgCl_2$, no such changes occurred.





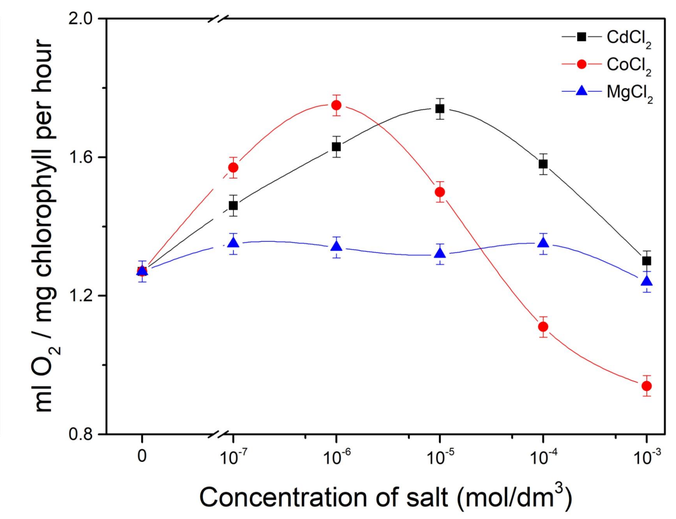


Figure 1-3. Physiological and fluorescent parameters of plant leaves treated with heavy metals salts.

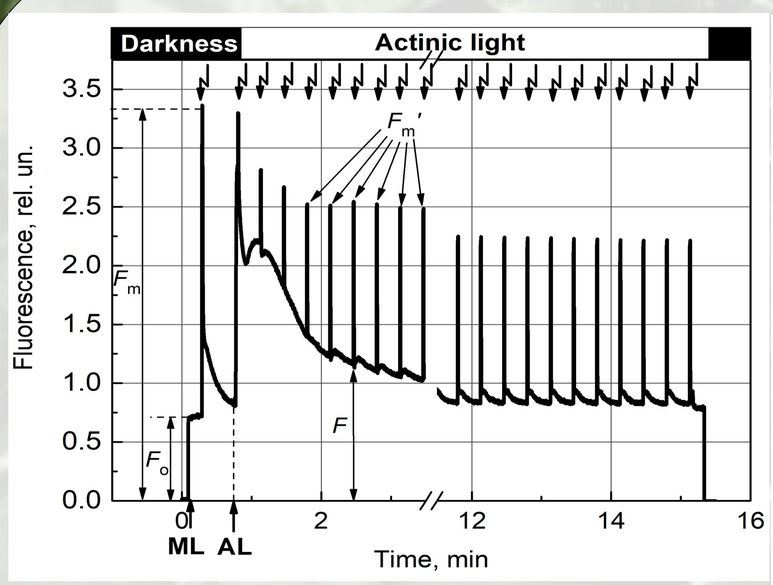


Figure 4. Typical protocol of fluorescence measurement with PAM-fluorometer. ML, measuring light; AL, actinic light. The moments of light flashes of saturation intensity are indicated by zigzag arrows.

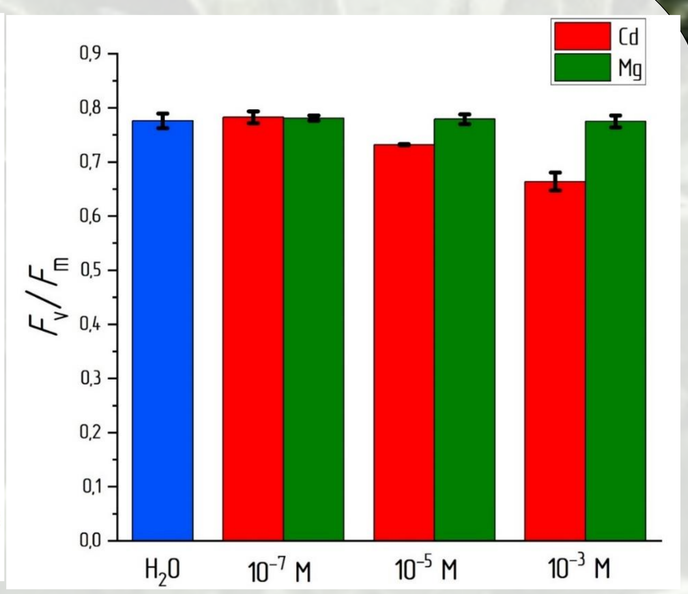


Figure 5. Average values of the maximum PS2 quantum yield for various samples. The control sample is marked in blue.

When registering fluorescence on a PAM-2500 pulsed fluorometer, it was found that with an increase in the concentration of $CdCl_2$ in the solution, the initial level of F_0 increased (Figs.4,5). At the same time, the values of the maximum and effective PS2 quantum yield, as well as the NPQ coefficient, gradually decreased with increasing salt concentration in the solution (in contrast to the samples grown on $MgCl_2$ solutions, Fig.5). Similar changes were established in experiments with *Tagetes patula*, which occupies one of the leading places among ornamental crops used in the structure of urban landscaping. The results obtained indicate a diversified effect of HMs on the functional activity of the photosynthetic apparatus of plants. Can any drugs reduce the negative effect of heavy metals is the task of our further research.