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DEHYDRATION EFFECT ON PARAMETERS OF CHLOROPHYLL FLUORESCENCE INDUCTION IN LEAVES OF SALAD

(Lactuca sativa L.*)*

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A portable, two-wavelength fluorometer based on recording chlorophyll fluorescence induction of agronomic plants is proposed.

The effect of water deficit can be explained by re-absorption of emitted chlorophyll fluorescence by the leaf chlorophyll.

A portable fluorometer is characterized by compactness, an independent power supply, high sensitivity and gives a non-destructive estimate of in vivo fluorescence parameters of agronomic plants.

Index Headings: Induction of fluorescence, chlorophyll, agronomic plants, stress

Photosynthetic activity of plant can be estimated through the measurement of *fluorescence induction kinetics* of dark-adapted green plant sample. The fact is that illumination of a pre-darkened during 15-20 minutes green leaf induces induction kinetics of the chlorophyll fluorescence. This temporal behaviour of the chlorophyll fluorescence intensity is known as “Kautsky effect” [Kautsky, Hirsch, 1931]. This induction kinetics consists of fast (100-500 ms) fluorescence rise to the maximum fluorescence level f_m and slow (usually 4 minutes) fluorescence decrease to the steady-state level f_s. The fluorescence kinetics reflects the sum total of processes which are linked with photosynthesis activity of a plant object.

The parameters of the fluorescence induction kinetics have been measured in the laboratory and field conditions with a portable two-wavelength fluorometer [7]. By fluorescence spectroscopy was used to study the influence of water stress on photosynthetic activity of leaves, total efficiency of photosynthesis, photosynthetic plants protection from intense light, gas exchange, chlorophyll content in different types of plants [4, 5, 6].

The main objective of this research is the demonstration of a portable, two-wavelength fluorometer used to record chlorophyll fluorescence induction as a way to quantify the agronomic state of plants under dehydration.

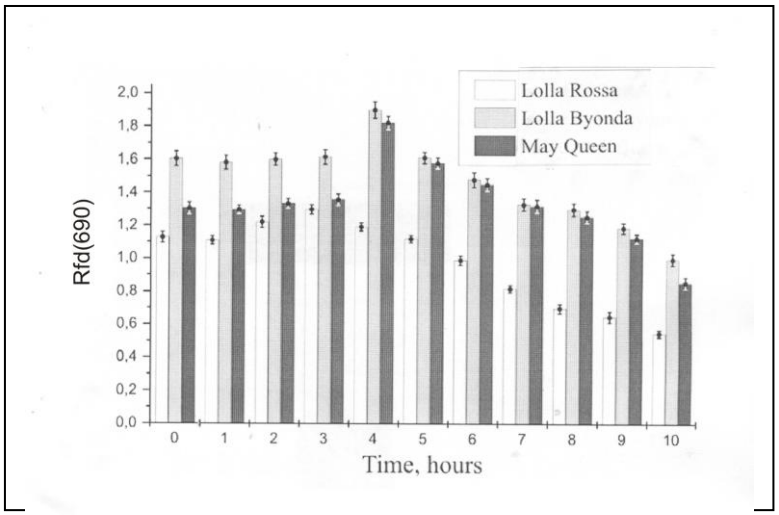
Materials and Methods

The chlorophyll fluorescence induction of lettuce (*Lactuca sativa*) (cvs *Lolla Bionda, Lolla Rossa* and *May Queen*) was investigated using a portable fluorymeter which consisted of light diode that was used as a source of fluorescence excitation; collimator and prism, beam splitter, sample (green leaf), interference filters with transmittance maxima at 690 nm and 740 nm, photodetectors, amplifier and readout system. Two last units were connected with power supply (accumulator). The device was equipped with display where fluorescence indices are indicated, and acoustic signalisation that controls the 4-minutes period of recording chlorophyll fluorescence.

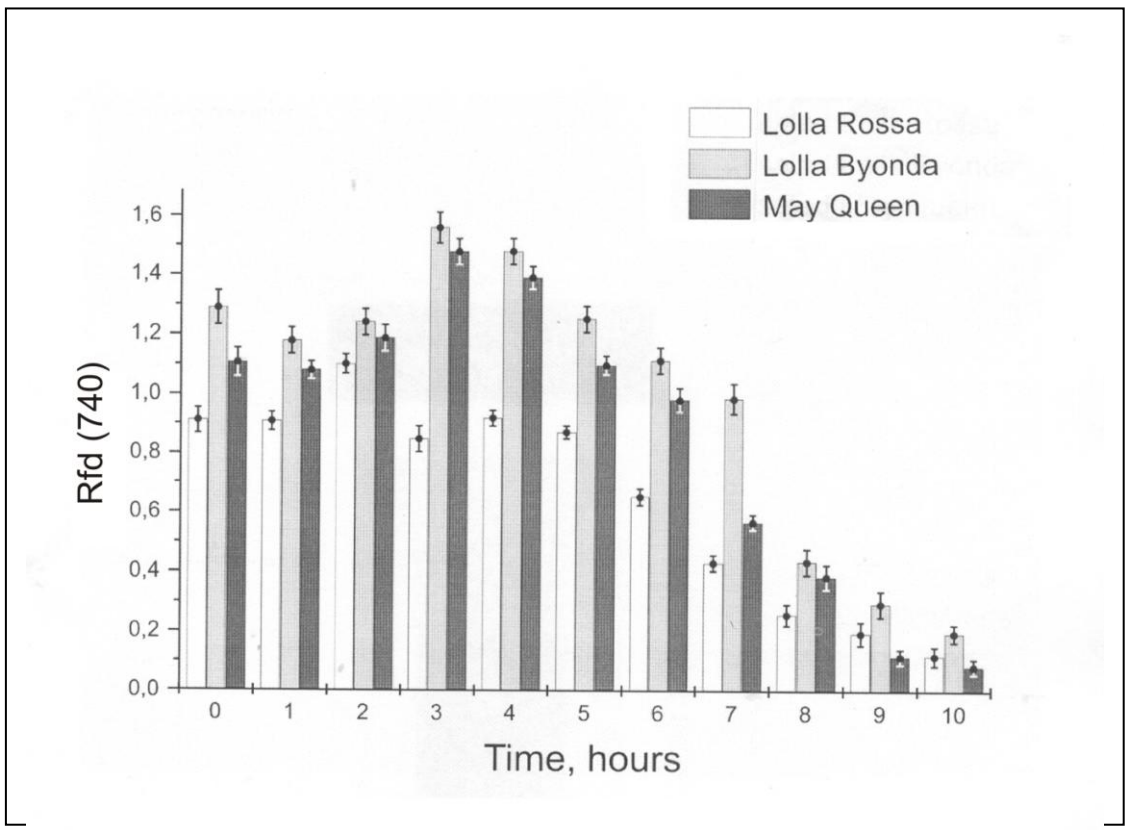
We have compared the fluorescence kinetics in green leaves with normal water supply and with increasing water stress and dehydration of detached leaves from plants 10 hours after leaf abscission. In detached leaves of salads the water deficit develops faster and therefore it is accompanied with a decline of the fluorescence indices.

The vitality indices *Rfd(690)* and *Rfd(740)* and the stress adaptation index $A_p = 1 - [Rfd(740)+1]/[Rfd(690)+1]$ were determined with the portable fluorometer. Here $Rfd = f_d/f_s$, where $f_d = f_m - f_s$ is the fluorescence decrease; f_m – maximal fluorescence; f_s − steady-state fluorescence. The *Rfd* values were measured in the 690-nm [*Rfd(690)*] and in the 740-nm [*Rfd(740)*] regions.

Results. *Water Deficit.* The dependence of fluorescence indices of three types of lettuce (cvs *Lolla Bionda, Lolla Rossa* and *May Queen*) on water deficit was studied in these experiments (Fig.1,2).



Fi ree types of lettuce on water



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The results of this investigation demonstrated the increasing the fluorescence kinetics at the first stages (3-4 hours); the same behavior of fluorescence kinetics was registered also by Lichtenthaler and Rinderle [3]. The decrease of the

fluorescence induction kinetics was observed: in cv *Lolla Rossa* − from 1.15 to 0.55 for *Rfd* (690) and from 0.85 to 0.1 for *Rfd* (740) and; in cv *Lolla Byonda* − from 1.9 to 1.0 for *Rfd* (690) and from 1.55 to 0.15 for *Rfd*(740); and in cv *May Queen* − from 1.8 to 0.8 for *Rfd* (690 and from 1.45 to 0.05 for *Rfd* (740). Values of the *Rfd* (690) index exceed values of the *Rfd* (740) index. This can be explained by re-absorption of the shorter wavelength fluorescence by the leaf chlorophyll [6]. Essential role in the plant response to abscisic acid dehydration plays [7]. The peculiarity of this material is its rapid accumulation during water shortages, causing partial closing of stomata by dehydration of the cytoplasm and chloroplast stroma, dry cytoplasm and chloroplasts are packed tightly, resulting in suppression wavelength (690 nm) due to reabsorption of fluorescence of chlorophyll fluorescence (maximum chlorophyll absorption is at 660 nm).

Conclusions. Thus, using the proposed method can obtain information on possible changes or destruction of the photosynthetic apparatus under the influence of stress; to quantify this effect should be used fluorescent indexes Rfd '(690) and Rfd "(740).

The method of registration induction of chlorophyll fluorescence is a promising diagnostic for age and morphological changes during its development of lettuce and under the influence of dehydration. Fluorescent indices are sensitive to changes of the photosynthetic apparatus of plants that can be used in the field.

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Запропоновано метод реєстрації індукції флуоресценції хлорофілу для дослідження стану рослин салату під впливом зневоднення. Вимірювання параметрів флуоресценції хлорофілу, зокрема індексів життєдіяльності Rfd' при 740 нм та Rfd'' при 690 нм, дає можливість отримати корисну інформацію щодо стану рослини протягом розвитку та залежності від стресових умов.

Флуоресценція, індукція флуоресценції, салат.

Предложен метод регистрации индукции флуоресценции хлорофилла для исследования состояния салата под влиянием обезвоживания. Измерение параметров флуоресценции хлорофилла, в частности индексов жизнедеятельности Rfd' при 740 нм и Rfd'' при 690 нм, дает возможность получить полезную информацию относительно состояния растения в течение развития и в зависимости от стрессовых условий.

Флуоресценция, индукция флуоресценции, салат.