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Effect Of Solar Radiation On The Fluorescence Of Green Plants

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Abstract- ***In nature, high light conditions are those exposed to full sunlight such as the leaves of trees and plants grown in the sun, while low light conditions are those of the leaves of trees and plants grown in the shade. The red fluorescence band of chlorophyll emitted by leaves is called the F690 band. Partial reabsorption of the shortest wavelength band of fluorescence of leaf chlorophylls at room temperature was first postulated by Murata and Satoh (1986). The shape of the fluorescence emission spectrum of chlorophylls and the relative height of the red fluorescence band F690 and the infrared band of fluorescence F740, approximately at 730-740 nm, depends on the chlorophyll content of the leaves on the one hand and on the other hand the wavelength of the excitation radiation. The objective of the study is the presentation of fluorescence spectra for two pear varieties Santa Maria and Abbas, in the period of May, in the presence of water.***
Also the presentation of the results regarding the concentration of chlorophylls.

Keywords—Fluorescence spectra; Chla; Chlb; Ch l (a+b); F690/F73.

I. INTRODUCTION

In terms of light absorption, there are two types of chloroplasts: sun type with high illumination and shade type with low illumination. Both types show considerable variation in the frequency or density of their thylakoids, the level of light-harvesting protein-pigment complexes, and chloroplast properties such as the rate of electron transport and the rate of photosynthetic CO2 fixation [3], [5], [6], [7]. The development of chloroplasts of each type is also controlled by

the quality of light where: blue light promotes the formation of sun-type chloroplasts and red light promotes the formation of shade-type chloroplasts.The concentration of pigments Chl (a+b) in the leaves of the sun appears higher compared to the leaves of the shade type, but high values of the Chl a/b ratio correlate with low values of the x/c ratio. The leaves of trees exposed on the north side, which mainly receive the blue light of the sky, present a content of pigments and their ratios with values intermediate to those of leaves in the sun and in the shade. So these are often called "leaves of the north in the shade". Also, the CO2 fixation rate of their photosynthesis has intermediate values with those of sun and shade leaves [11], [9].
The emitted fluorescence spectra depend on the structure of the fluorophore, the solvent molecules and the interactions between them. Fluorescence spectrometry is based on the emission of radiation from fluorophores that, after absorbing visible VIS (400-700 nm), ultraviolet UV (200-400 nm) or near-red NIR (700-1100 nm) radiation, pass into a state of electronically excited [10].

II. MATERIAL AND METHODS

A. PLANTS

Measurements were made with leaves selected in three types of positions (sun - southern part of the crown, blue shade - northern part and semi-shade/shade - inside a tree crown) for the varieties: Santa Maria (pear) and Abbas (pear), part of a group of Pyrus Communis L pear species and the rose family. The study for two varieties was done in an area near water, called area 1.

B. PIGMENT DETERMINATION

Leaf pigments were extracted with 100% acetone in the one circular piece of 9mm in diameter cut from the leaves using a mortar. The pigment extracts were centrifuged for 5 min at 500 X g in glass tubes to obtain the fully transparent extract. The pigment contents, Chl a, Chl b and total carotenoids, were determined spectrophotometrically from acetone extract using the extinction coefficients and equations re-determined by Lichtenthaler [1], [2]. The represented values are the mean of six determinations from six leaves.

C. FLUORESCENCE SPECTRA

To perform the measurements, the option can be selected: Emission (emission) - to obtain an emission or fluorescence emission spectrum. During this scan the excitation monochromator is fixed at a specific wavelength while the emission monochromator is shifted over a wide range of wavelengths. The resulting spectrum is referred to as the fluorescence emission (or emitted fluorescence) spectrum. During this scan the excitation monochromator is fixed at the

wavelength of 632 nm (red light), while the emission monochromator is shifted from the wavelength of 660 nm- 800 nm with 2nm steps. The resulting spectrum is referred to as the leaf fluorescence spectrum. In the measurement, the selected signal amplifier is "Gain" x 300 and slits 2 nm.

III. RESULTS

A. PHOTOSYNTHETIC PIGMENTS.

The highest value of the chlorophyll content Chl (a+b) is presented by the variety Abbas (pear) compared to the variety Santa Maria (pear). It is also observed that the content of chlorophylls Chl (a+b) decreases in both varieties from sun leaves to blue-shade and shade leaves (Tab. 1). The ratios of the photosynthetic pigments, Chl a/b and (a+b)/(x+c), reflecting the light adaptation of the photosynthetic apparatus showed different values in the three leaf types. The mean values of the ratio Chl a/b are higher in sun leaves as compared to blue-shade and shade leaves (Tab. 1).

Table 1. Content of Chl (a+b) and total carotenoids (x+c) per leaf area unit as well as the pigment ratios Chl a/b and chlorophylls (a+b) to carotenoids (a+b)/(x+c) between sun, blue-shade, shade leaves of *Santa Maria* and *Abbas* varieties of pear trees. Mean values of 6 determinations per leaf-type.

Leaf-type	*Chl a+b (mg dm^{-2})*	*Chl a/b*	*(a+b)/(x+c)*
Santa Maria			
Sun	6.30±0.01	2.67	4.28
Blue-shade	5.44±0.01	2.49	4.26
Shade	4.83 ± 0.02	2.15	4.48
Abbas			
Sun	7.24 ±0.05	2.58	5.67
Blue-shade	4.46 ±0.01	2.49	5.60
Shade	4.09 ± 0.01	2.42	5.82

B. FLUORESCENCE SPECTRA.

Fluorescence spectra were constructed for an excitation (excitation) wavelength of 632 nm (Fig.1). In the May period, the highest value of the ratio F690/F735 is represented by the variety Abbas (pear), shade position, while the lowest values are represented by the variety Santa Maria (pear), south position (Tab. 2).

Table 2. Presentation of fluorescence ratio, F690/F735 in three positions, varieties: Santa Maria and Abbas, May period

Leaf-type	*F690/F735*
Santa Maria	
Sun	0.721
Blue-shade	0.732
Shade	0.768
Abbas	
Sun	0.823
Blue-shade	0.935
Shade	0.956

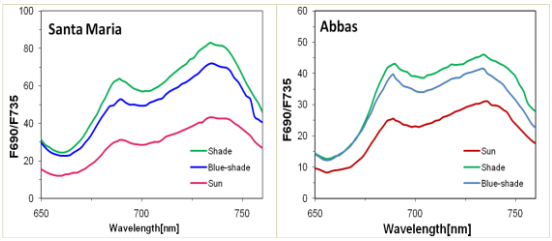

Fig. 1. Presentation of fluorescence spectra for Santa Maria (pear) and Abbas (pear) varieties.

The Abbas variety presents the highest value in the May period compared to the Santa Maria variety, the explanation is related to the geographical extent and adaptation to the climatic conditions of the environment in this area.

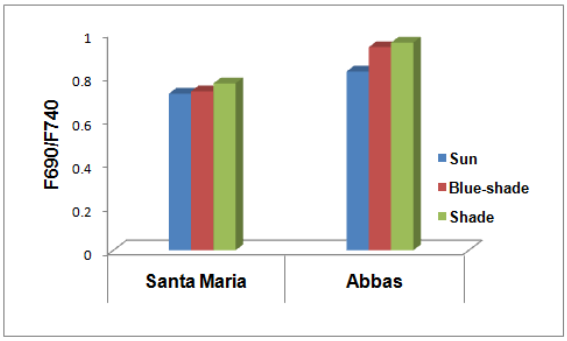

Fig. 2. Report of F690/F740, varieties: Santa Maria and Abbas (pears), May period.

The thickness of the leaves in the two varieties presents higher values in the sun position. The changes are very small due to the period with optimal conditions for the development of the photosynthetic apparatus (Tab. 3).

Table 3. Thickness of varieties, Santa Maria and Abbas, May period

Leaf-type	Thickness
Santa Maria	
Sun	0.300
Blue-shade	0.281
Shade	0.268
Abbas	
Sun	0.301
Blue-shade	0.280
Shade	0.254

IV. CONCLUSIONS

Shade and low light leaves are thinner and have a larger average surface area than sun or high light leaves. The total content of chlorophylls and their carotenoids per unit leaf area is significantly lower than in sun or high light leaves.

From the fluorescence spectral data, the F690/F735 ratio was determined.
The red/infrared fluorescence ratio of F690/F740 or F690/F735 decreases with increasing leaf chlorophyll content due to reabsorption of the red F690 fluorescence band by the different in vivo forms of Chl a.

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