EVALUATION OF FROST RESISTANCE CHANGES OF RAPE USING LUMINESCENCE MEASUREMENTS

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Introduction

Complex influence of low temperature onto plants is connected with changes in the structure and functioning of chloroplasts /Levitt 1980, Griffith et al. 1982, Oquist 1983, Havaux et al. 1984/. It can lead to the injuries in the photosynthetic apparatus, and to the disturbances in the electron transport in particular /Heber 1967, Oquist and Martin 1980/.

Closely related to the initial photosynthetic reactions /particularly in photosystem II/ is the delayed luminescence /Artuhr and Strehler 1957, Lavorel 1975, Amesz 1983/. Consequently the stress temperature elicites certain changes in the intensity of the delayed luminescence of the photosynthetic apparatus /Murkowski 1974, Melcarek and Brown 1977, Tarusov and Veselovskij 1978/.

Successful attempts of the application of low temperature measurements of delayed luminescence in the evaluation of frost resistance of cereals and the observation of the process of its acquirement /Brzóstowicz et al. 1981, Brzóstowicz and Prokowski 1984, Brzóstowicz et al. 1985/ encouraged the similar investigations on rape.

This work presents results of the investigations of the influence of low temperature on delayed luminescence

of rape and an attempt of the evaluation of its frost resistance on such basis.

Material and measurement methods

Investigations of the influence of low temperature on the intensity of delayed luminescence /IDL/ were coducted on leaves of two varieties of rape /Brassica napus - "Siberian" and "Asparagus Kale"/ with different frost resistance.

Seeds were sown into containers dug into ground on the experimental field. On day before the measurements were taken, the containers with the plants were placed in the thermoluminostat /fluorescent lighting 20 Wm^{-2}, temperature equal the air temperature on the day of sample taking/. After an hour the temperature was changed at the speed of $1^{o}C/h$ until the value of $+5^{o}C$ was achieved. After 24 hours 3 discs of 15 mm in diameter of each variety cut out from the oldest healthy leaves were taken for the investigation. Investigated discs were placed in a measurement chamber /Brzóstowicz et al. 1985/ and their temperature was lowered from $0^{o}C$ to $-20^{o}C$ with the rate $1^{o}C/60$ s. Simultaneosly every 60 s the IDL was recorded during 2 s /2 s after switching off the 2 s - photoactivation/. These investigations were done in 4 replications for each variety in November and February. Erros in measurement graphically marked on the diagrams were calculated by the Student-Fisher method for the confidence level 0.95.

Results and discussion

Thermograms of the relative IDL values for "Siberian" were presented on figure 1, and those for "Asparagus Kale" on figure 2. The curves of IDL/t/ show that IDL decreases initially, achieves the shallow minimum /IDL_{min} - - assumed as 100%/ at the temperature $-5^{o}C$, $-6^{o}C$, and increases afterwards. Having achieved the maximum value /IDL_{max}/ the intensity decreases anew.

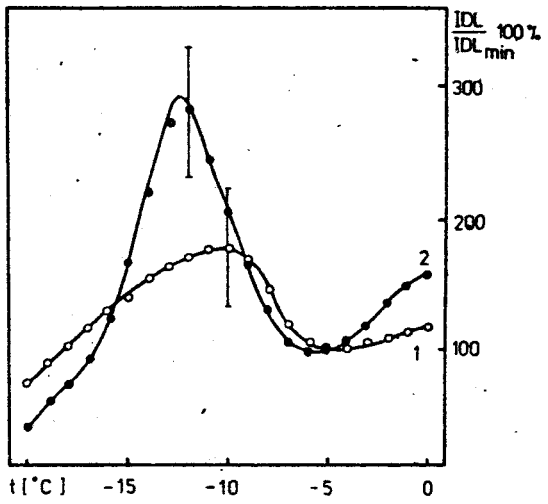

Fig. 1. Thermograms of relative values of delayed luminescence intensity during the temperature lowering /0°C to -20°C/ of leaves' fragments of "Siberian" rape taken from the field in November /curve 1/ and February /curve 2/.

The shapes of the curves for both investigated varieties of rape /fig. 1 and fig. 2/ taken from the field in November /curve 1/ and for those taken in February /curve 2/ differ considerably. The values of IDL_{max} were higher in February as compared to those in November and appeared at a lower temperature. It constitutes the evidence of the influence of frost hardening on the temperature dependence of IDL, and this in turn can prove the achievement of frost resistance by the photosynthetic apparatus.

Comparison of figures 1 and 2 shows that the appropriate values of IDL_{max} are higher for "Siberian" and that

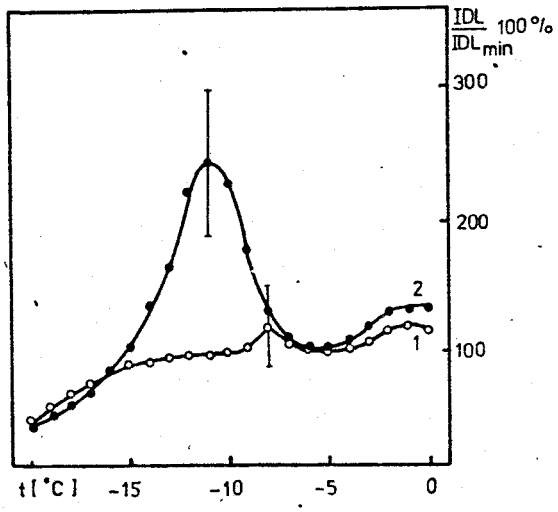

Fig. 2. Thermograms of relative values of delayed luminescence intensity during the temperature lowering /0°C to -20°C/ of leaves' fragments of "Asparagus Kale" rape taken from the field in November /curve 1/ and February /curve 2/.

they appear at a lower temperature. This meets the expectations since /according to written data/ "Asparagus Kale" is less frost resistant than "Siberian".

Conclusions

1. Delayed luminescence intensity of rape leaves at a low temperature /within the range 0°C ÷ -20°C/ depends on frost hardening of the plant.
2. Maximum value of the delayed luminescence intensity and the temperature at which it appears can/most probably/ constitute a useful indicator for an evaluation

of the actual sensitivity of rape to low temperature.

Investigation financed within CPBP 05.02.

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