Comparative study of frost-tolerant *Arabis alpina* populations from the region of “The Seven Rila Lakes” and the French Alps

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Arabis alpina (Brassicaceae) is a new model plant used in cold stress research. Its populations can be found across the high mountain parts of Europe, as well as in north Africa and parts of the Middle East. Being an alpine plant, it can survive low temperatures. We have used three populations of *A. alpina*, found in the French Alps, based on their resistance to chilling (4oC) and freezing stress (-6oC). These populations included T-plants (tolerant to frost, collected in the higher French Alps, Col du Galibier), NT-pants (non-tolerant, growing in the mountain of Vercors) and SH-plants (short hypocotyl phenotype), the latter considered as an adaptive feature to snow cover. *A. alpina* is also present in Bulgaria, in the highest mountain areas of Rila and Pirin, as well in the Central Balkan. An expedition for studying populations of *A. alpina* was carried out in the area of “The Seven Rila Lakes” in 2013. Populations of *A. alpina* were detected in the area between the lakes “Bliznaka” and “Trilistnika” and fully developed seeds were collected thereafter.

Experimental scheme

Growing of T, NT and SH plants at 22°C (control), followed by acclimation to chilling stress (4°C) for 4 days and exposure to freezing stress (-7°C, 12h, darkness)

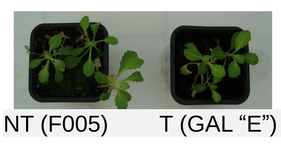
	22°C	4°C	-7°C
T	**T22**	**T4**	**T-7**
NT	**NT22**	**NT4**	**NT-7**
SH	**SH22**	**SH4**	**SH-7**

Materials and methods

A. alpina plants from France, as well as seeds from French populations (T, NT, and SH) were used. Plants from the area of the “Seven Rila Lakes” were transferred for laboratory analysis and seed from siliques were collected. The chlorophyll fluorescence was measured by the means of PEA fluorometer (Hansatech, Germany).
The content of photosynthetic pigments (chl a, chl b, carotenoids and tocopherol) was estimated using HPLC analysis (LECA, Grenoble, France).

A. alpina plants from the “Seven Rila Lakes”

A. alpina plants in controlled conditions

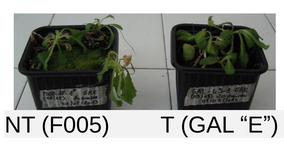


NT (F005) T (GAL “E”)

Plants from seed of NT and T grown at 22oC

NT (F005) T (GAL “E”)

Chilling stress at 4oC for 4 days



NT (F005) T (GAL “E”)

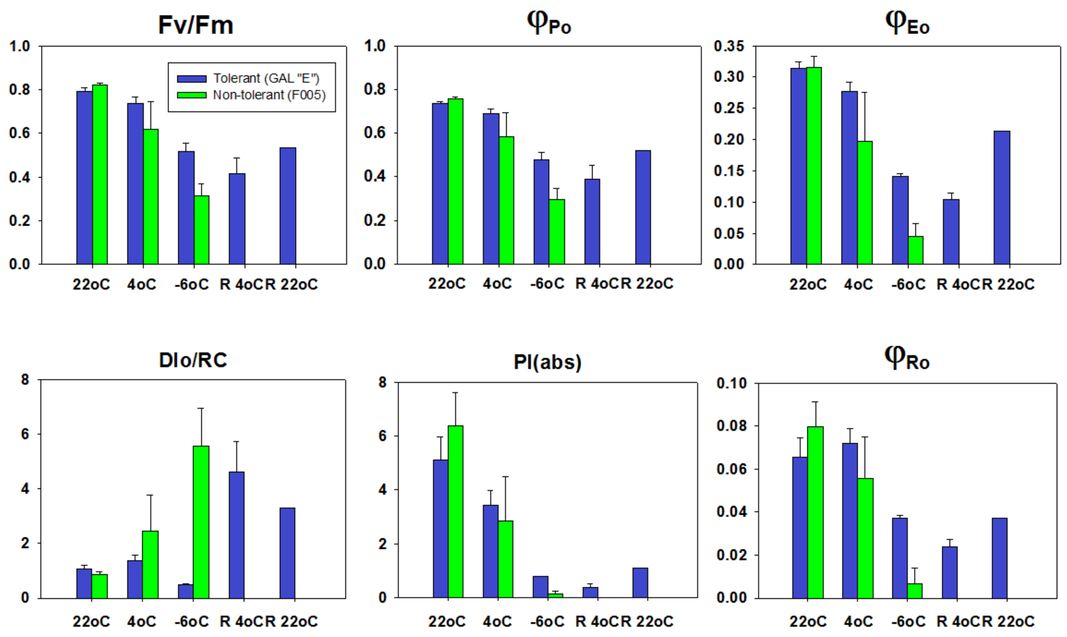
Freezing stress at -6oC, 12h in the dark

Arabis seedlings, developed from wild silique seeds (30d)

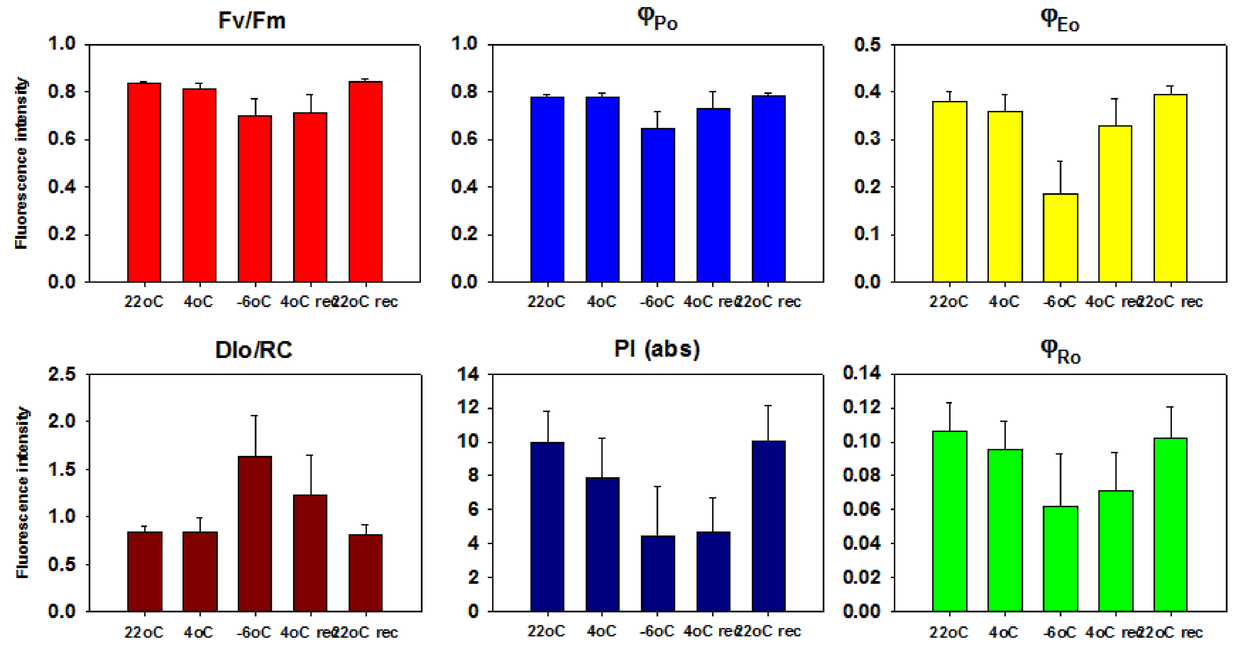
Intact wild Arabis plants after transfer from natural tuffs from Rila and rooted in control conditions, for three weeks

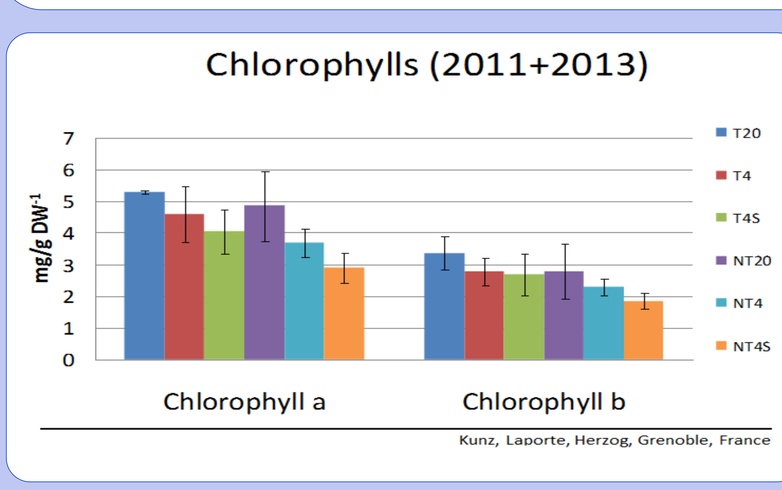
photoperiod 12/12h (220 µmol), 22-23°C, age 2½ months

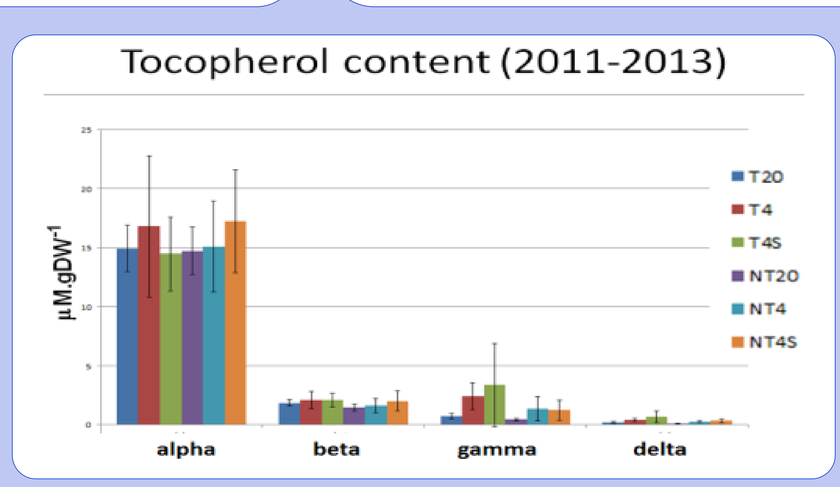
Chlorophyll fluorescence after chilling and freezing stress in *A. alpina* from the French Alps

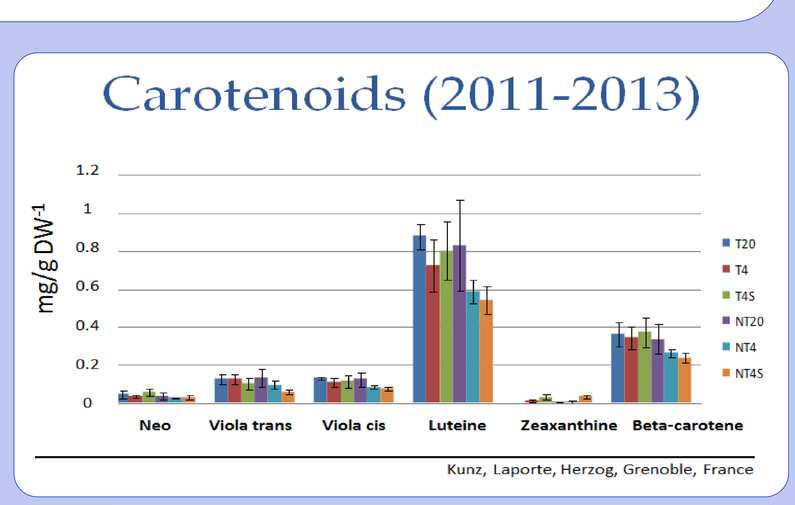


Chlorophyll fluorescence after chilling, freezing stress and recovery of *A. alpina* from Rila









Conclusions

Our results showed no significant loss of photosytem II (PSII) function at chilling stress with the three French populations in contrast to a considerable decrease in PSII activity and electron transport at freezing temperatures. Concerning the Bulgarian *A. alpina* wild population from the region of “The Seven Rila Lakes”, no significant changes in PSII activity at both chilling and freezing stresses were detected. The obtained tolerance of Bulgarian *A. alpina* population to chilling and freezing stress could be due to genetic determinants, as well as to the effect of acclimation induced by the conditions in the high mountain. Investigations to distinguish between these two possibilities are now in progress.

Seven Rila Lakes