Abscisic acid level and osmotic adjustment of sorghum roots under chilling conditions

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Introduction

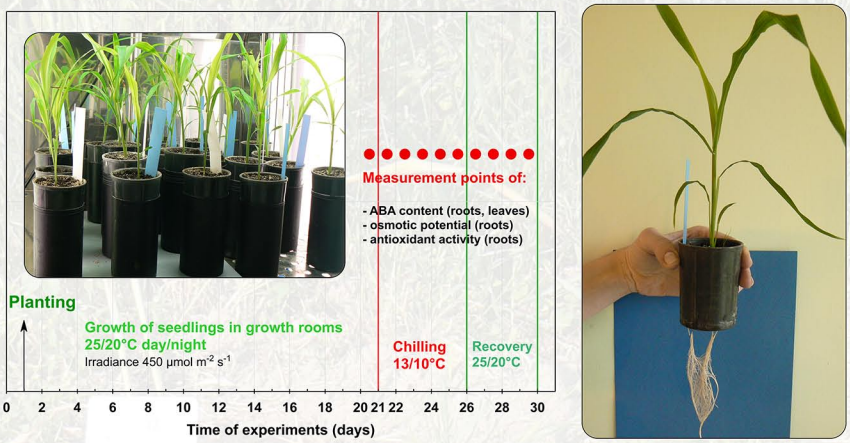
In view of the effects of global climate changes on plant growth conditions in Europe, specific traits of sorghum (*Sorghum bicolor* (L.) Moench) make some of its cultivars (sweet sorghum) a promising candidate for a future bioenergy crop in this region. The main limiting factor seems to be low tolerance of sorghum seedlings to low temperature and possible seedling damage caused by chilling spells occurring in April and May.

The aim of the presented research was to clarify the physiological mechanisms underlying the potential adaptation of sorghum roots to chilling conditions.

Materials and methods

Seedlings of two sorghum parental lines M71 (chilling tolerant) and SS79 (susceptible) grew in a special two-pot system with soil in the upper pot and half-strength Hoagland nutrient solution in the lower one, where the roots were available for measurements (Scheme 1).

At the third-leaf stage seedlings were exposed to 5-day chilling (13/10°C, day/night) and then recovered for 4 days at control temperature (25/20°C). Before and during the chilling treatment as well as during recovery, the following measurements were performed on the roots: osmotic potential (OP) with osmometer, abscisic acid (ABA) level with ELISA and total antioxidant activity with DPPH method. Additionally, the following were measured for the first three leaves: stomata status by porometer AP4 Delta T and ABA level with ELISA.



Scheme 1. Scheme of the experiments. Seedlings were grown in growth chambers in a special two-pot system with soil in the upper pot and half-strength Hoagland nutrient solution in the lower one. Before the chilling treatment the seedlings grew for ca. 20 days until the third leaf was fully developed. The seedlings were then subjected to 5-day chilling (13/10°C, day/night) treatment and afterwards recovered for 4 days at control temperature (25/20°C).

Results

As early as after 8 h of chilling ABA level of roots dropped significantly and remained low during the first three days of chilling, going back to the control level towards the end of the chilling treatment (Fig. 1A). Meanwhile, ABA level in the first three leaves increased significantly on the first day of chilling and remained high throughout the chilling treatment, going back down to the control level on the first day of recovery (Fig. 1B). This suggests intensive root-to-shoot ABA transport via xylem sap. The ABA increase in leaves caused stomata – which had opened drastically at the beginning of chilling – to close back to the control level.

OP dropped in both lines during the first hours of chilling and decreased further over the following days of the chilling treatment (Fig. 1C). This decrease was quicker and more pronounced in the susceptible line (SS79) than in the tolerant one (M71). During recovery OP returned to the control level in both lines.

Antioxidant activity in roots dropped temporarily during the first hours of chilling but then increased significantly during further treatment and remained above the control level till the end of chilling, especially in the sensitive line (Fig. 1D).

Conclusions

- **In sorghum seedlings under chilling conditions ABA is intensively transported from roots to leaves and causes stomata closure back to the control level.**
- **In both investigated lines there occurs an osmotic adjustment of roots under chilling conditions but it is more pronounced in the susceptible line than in the tolerant one.**
- **Roots of the susceptible line suffer from higher oxidative stress than the tolerant one during the whole chilling treatment.**

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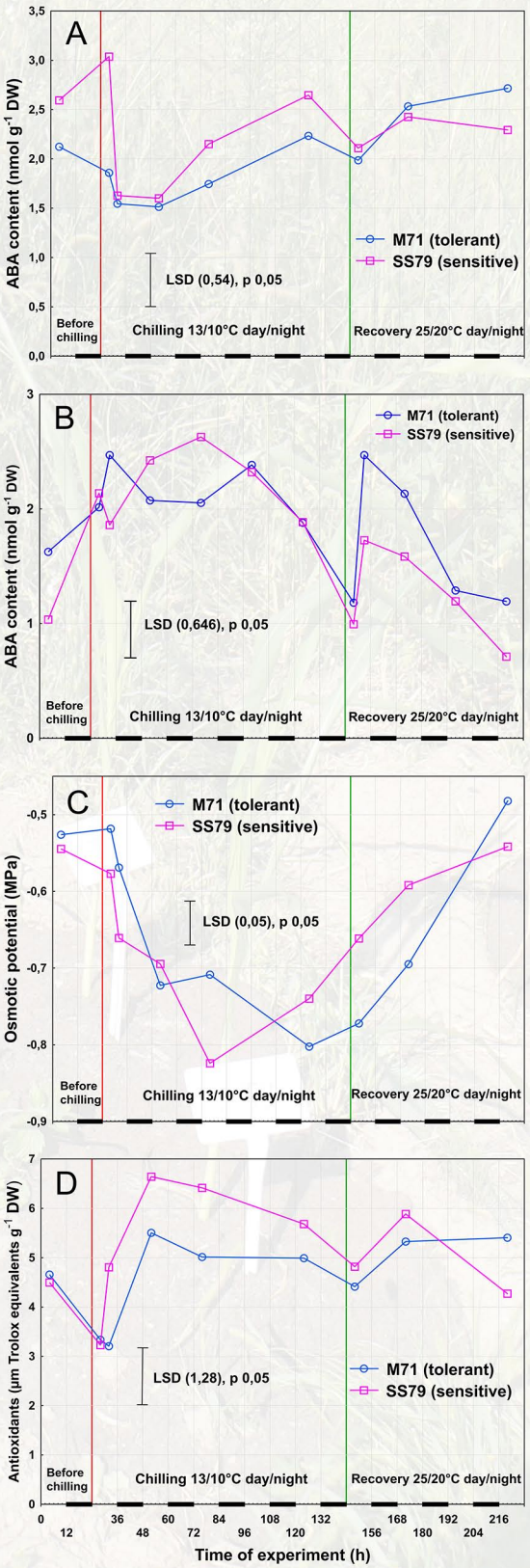

Fig. 1. Abscisic acid (ABA) levels in roots (A) and in the first three leaves (B), osmotic potential (C) and antioxidant activity (D) in roots of two sorghum parental lines M71 (chilling tolerant) and SS79 (susceptible) before and during 5-day chilling (13/10°C, day/night) treatment and 4-day recovery. n=6. Black boxes on the x-axis indicate dark periods.