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Drought tolerance and winter-hardiness in *Lolium perenne* × *Festuca pratensis* hybrids

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INTRODUCTION

The *Lolium-Festuca* complex involves numerous species and hybrids crucial for grassland production in temperate regions. Some of them, have been also successfully applied as excellent plant models into the research to decipher mechanisms of tolerance to a wide range of environmental stress conditions in forage grasses [1, 2]. Here, *L. perenne* (perennial ryegrass) × *F. pratensis* (meadow fescue) hybrids distinct in the levels of drought tolerance and/or winter-hardiness were analyzed to identify crucial cellular components associated with their tolerance to water deficit or winter stresses.

PLANT MATERIAL

Drought tolerance and ability to regenerate after stress cessation in *L. perenne*/*F. pratensis* introgression forms were examined under 'rain-out' shelters in the field conditions. Plant material included diploids (2x) - population PB and BC2 and tetraploids (4x) - population PA1, PA2, BC3. The ability of plant to survive under drought and control conditions was examined in each population. After drought treatment, the plants remained in the field and were subsequently selected for winter-hardiness, according to their potential for overwintering.

Furthermore, based on drought selection in the field, two introgression forms, from each population, significantly differing in their potential of drought tolerance: high drought tolerant (HDT) and low drought tolerant (LDT) (Table 1), were used for further analysis. Physiological measurements: relative water content (RWC), electrolyte leakage (EL), and gas exchange, were examined in the water deficit conditions in a greenhouse at the selected time-points: control (C), drought (D) and after re-hydration (RH).

Table 1. Introgression forms used for physiological measurements.

	DIPLOID (2X) INTROGRESSION FORMS	TETRAPLOID (4X) INTROGRESSION FORMS
HIGH DROUGHT TOLERANT	PB-HDT BC2-HDT	PA-HDT BC3-HDT
LOW DROUGHT TOLERANT	PB-LDT BC2-LDT	PA-LDT BC3-LDT

RESULTS

Table 2. Average plant survival in PB, BC2, PA1, PA2 and BC3 populations under drought treatment and control conditions in the field.

AVERAGE PLANT SURVIVAL

POPULATION	DROUGHT [%]	CONTROL CONDITIONS [%]
(2x) PB	76.5	94.1
(2x) BC2	60.0	100.0
(4x) PA1	17.7	47.0
(4x) PA2	75.0	100.0
(4x) BC3	79.6	80.7

RESULTS

PHYSIOLOGICAL PERFORMANCE UNDER DROUGHT AND RE-WATERING CONDITIONS

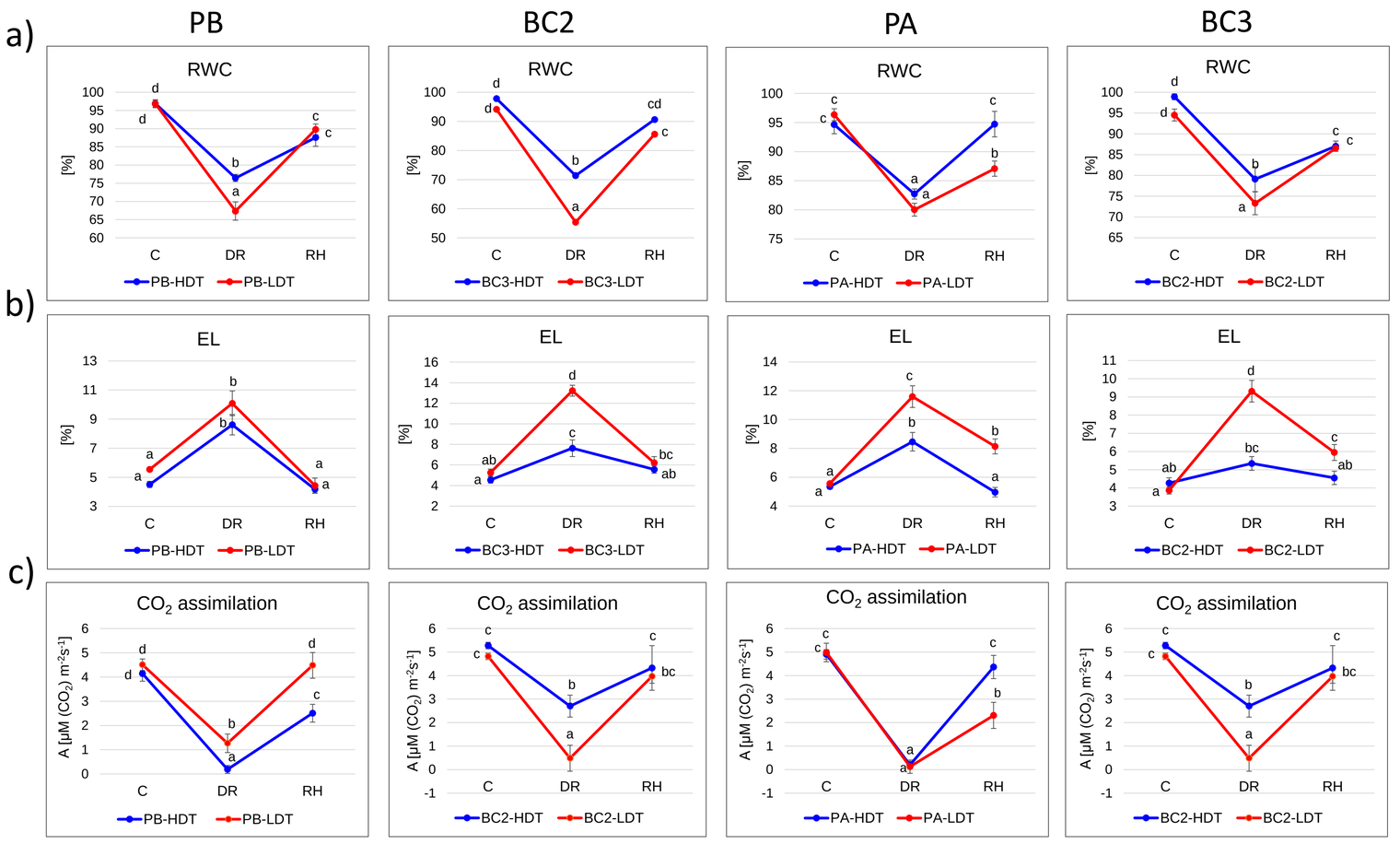

Figure 1. Physiological parameters: a) relative water content (RWC), b) electrolyte leakage (EL) and c) CO_2 assimilation (A) in high drought tolerant (HDT) and low drought tolerant (LDT) introgression forms of PB, BC2, PA and BC3 populations at control conditions (C), drought (D) and after re-hydration (RH) in a greenhouse.

WINTER-HARDINESS

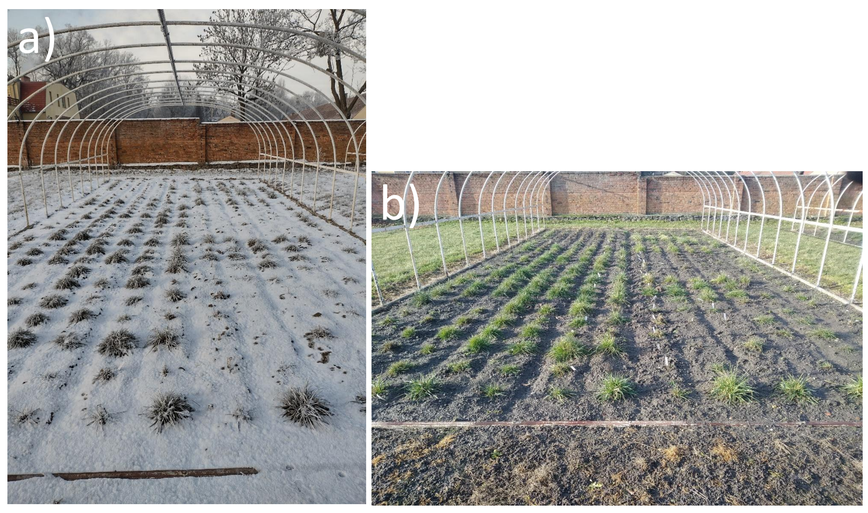

Figure 2. Selection of introgression forms for winter-hardiness at DANKO Plant Breeding Ltd., in Szelejewo, Poland, January 2022. Conditions a) with and b) without snow cover.

OVERWINTERING

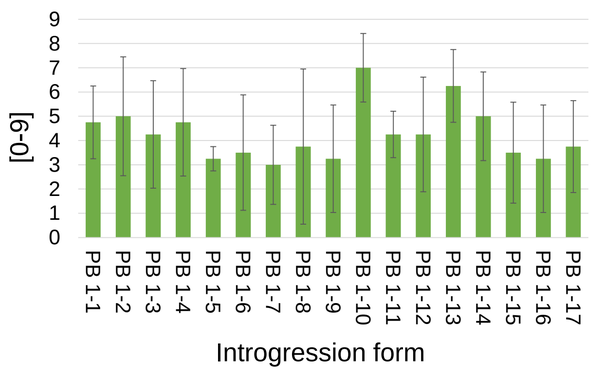

Figure 3. Example of overwintering for each introgression form from the PB population. Bars represent standard deviations of four replicates.

SUMMARY AND CONCLUSIONS

- High variability in plant survival under drought conditions was observed within all populations of *L. perenne*/*F. pratensis* introgression forms. Particularly, plants of tetraploid populations showed the highest variability.
- In all introgression forms, reduction of RWC and CO_2 assimilation under drought was observed, while EL increased during stress treatment. Most of the selected introgression forms showed a high capacity of regeneration after stress cessation. The dynamics of physiological parameters under drought clearly indicated differences with respect to the level of stress tolerance observed between the analysed introgression forms.
- The overwintering parameter associated with plant winter-hardiness revealed that the introgression forms showed the ability to survive stress of low temperatures. An important component of winter-hardiness in the selected introgression forms was frost tolerance. It cannot be ruled out that at least some of these introgression forms were also tolerant to de-acclimation and/or indicated an ability to re-hardening.

REFERENCES

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