Performance of *Lolium multiflorum/Festuca arundinacea* introgression forms under abiotic and biotic stress conditions

A. Augustyniak [1], D. Perlikowski [1], E. Pociecha [2], M. Dziurka [3], A. Płażek [2], M. Rapacz [2], A. Kosmala [1]

[1]Institute of Plant Genetics, Polish Academy of Sciences, Strzeszynska 34, 60-479 Poznan, Poland.

[2]University of Agriculture in Cracow, Department of Plant Physiology, Podluzna 3, 30-239 Cracow, Poland.

[3]The Franciszek Górski Institute of Plant Physiology, Polish Academy of Sciences, Niezapominajek 21, 30-239 Cracow, Poland.

Introduction

Lolium multiflorum (Italian ryegrass) possesses high forage quality but low tolerance to abiotic and biotic stresses. *Festuca arundinacea* (tall fescue) expresses higher winter-hardiness, drought tolerance and resistance to diseases. The hybrids of both species and their introgression derivatives combine their complementary attributes. In the research presented here the BC5 *L. multiflorum/F. arundinacea* introgression forms were evaluated with respect to the level of winter-hardiness, drought tolerance, frost tolerance, resistance to diseases, including *Microdochium nivale*, and physiological parameters during cold acclimation.

Methods

The selection of plants tolerant to drought was performed in the simulated field conditions under 'rain-out' shelters (2014) and for winter-hardiness in the natural field conditions (2014/2015) at Danko Plant Breeding Ltd., in Szelejewo, Poland (Perlikowski et al. 2014). The plant frost tolerance and changes in physiological parameters (electrolyte leakage, chlorophyll fluorescence, gas exchange) during cold acclimation were evaluated according to Larsen (1978) and Kosmala (2012), respectively. The plant resistance to diseases (e.g. *Puccinia coronata*, *Bipolaris sorokiniana*, *Erysiphe graminis*, *M. nivale*) was estimated as described by Prończuk and Prończuk (1987).

Results

Among the analyzed BC5 introgression forms a wide range of diversity with respect to their drought tolerance, was observed. The forms with a relatively high tolerance to water deficit conditions and high re-growth ability after re-watering, were selected. A majority of these plants revealed also high levels of resistance to fungal diseases in the field conditions. Twenty selected BC5 forms were further analyzed with respect to their resistance to *M. nivale*, after inoculation. A wide range of diversity with respect to this trait was observed among the analyzed plants (Fig. 1) and four introgression forms with a distinct level of resistance were selected for further molecular research to evaluate the physiological indicators of resistance. These were as follows: 180/30/19 and 180/30/75 with a relatively high level of resistance and 180/30/138 and 180/30/84 with no resistance. The plants (234 forms) selected as the introgression forms with a relatively high level of drought tolerance were also further selected with respect to their winter-hardiness in the natural field conditions. Although, the environmental conditions during winter-time (2014/2015) were not too severe (especially according to low temperature, including frost), clear differences in winter-hardiness level were visible among the plants. Four introgression forms with a distinct level of winter-survival were selected for further molecular research to evaluate the physiological indicators of frost tolerance. Interestingly, these were exactly the same genotypes, which were selected earlier following *M. nivale* inoculation. The forms 180/30/19 and 180/30/75 were shown to be high winter-hardy and the forms 180/30/138 and 180/30/84 – low winter-hardy. After further evaluation of those plants with respect to their re-growth ability after freezing in laboratory conditions, two introgression forms with distinct levels of frost tolerance were selected – the 180/30/19 – as a low frost tolerant and the 180/30/138 as a high frost tolerant genotype. These two genotypes were analyzed in detail according to the physiological parameters, including an electrolyte leakage (Fig. 2). The clear differences between the analyzed plants were revealed, suggesting a different physiological performance of selected forms during cold acclimation.

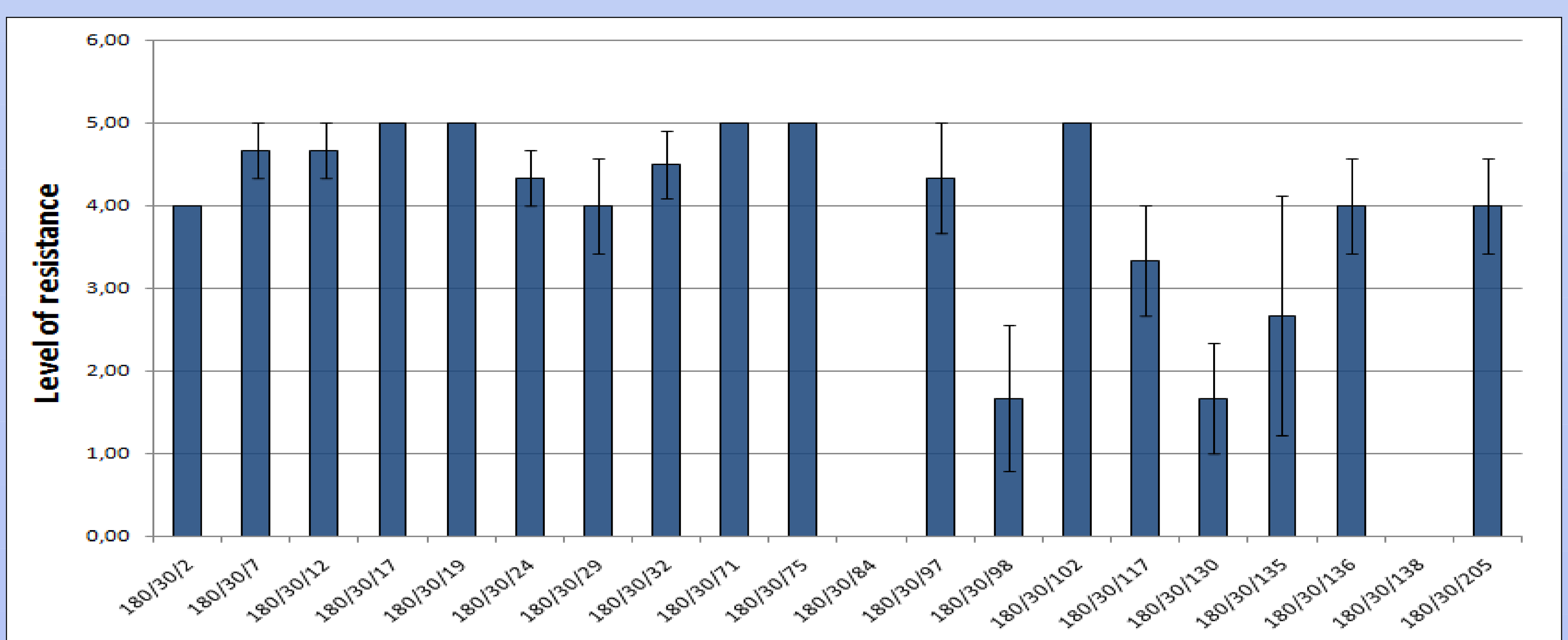

Fig. 1. The level of *L. multiflorum /F. arundinacea* introgression forms resistance to *Microdochium nivale* after inoculation [scale 0-5; 5 – the highest level of resistance]. Standard errors are indicated.

Fig. 2. A relative electrolyte leakage (EL) observed during 21 days of cold acclimation in *L. multiflorum /F. arundinacea* introgression forms. Standard deviations are indicated.

Conclusions

It was demonstrated that the *L. multiflorum/F. arundinacea* introgression forms were excellent plant materials to perform the research on molecular mechanisms of stress resistance in forage grasses and to dissect this complex trait into its different components in different genotypes. The obtained results indicated that the selected BC5 introgression forms with distinct levels of frost tolerance were also characterized by differences in a cellular membrane stability and in a photosynthetic capacity (CO2 assimilation) after full time of cold acclimation, and in a functioning of photosystems during the whole process of acclimation. To recognize the molecular background of these differences further research is required.

References

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