The trait ”persistence“ in perennial ryegrass – Analysis of allele compositions and development of selection methods

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Introduction

Lolium perenne L. (perennial ryegrass) is an out-crossing grass species of major agricultural importance and is cultivated in temperate regions world-wide. Perennial ryegrass can be utilized as a component in forage seed mixtures (cultivated only a few years, maximum yield). In addition, it can be sown for generation of persistent grassland also in rough regions, and it can be cultivated as amenity grass.

Plants surviving well under typical, locally varying environmental conditions like intensity and duration of snow coverage and low temperatures during winters are called “persistent”. From the view of grass breeding companies and farmers, “persistence” is a very important trait to have knowledge of and to optimize. Therefore, the Bavarian State Research Center for Agriculture (LfL) started an experiment on the improvement of persistence in perennial ryegrass in 1998 (Hartmann S., Mitteilungen Arbeitsgemeinschaft Grünland und Futterbau 5(2003), 163-165; cf. Fig. 1). The differences in persistence between *Lolium* cultivars (summary shown in Fig. 1) resulted in a differentiation into winter hard and less winter hard entries. As a follow-up, this study aims to develop a selection method for “persistence” via monitoring changes in the allele composition of different ryegrass varieties. For this means, SNP alleles were quantified using the Pyrosequencing method (PSQ), while the same set of cultivars was evaluated phenotypically in the field since 2004.

Figure 2: Map of Germany showing the five experimental sites (for numeration, cf. to ‘Material‘).

Material

- 19 forage and 4 lawn varieties
- within these varieties: winter hard and less winter hard entries
- five defined cultivation sites (Fig. 2; sites 1-4 sown in 2004; site 5 sown in 2005):

(1) Detern, Lower Saxony; moor;
(2) Schmalenbeck, Lower Saxony; moor;
(3) Spitalhof, Bavaria; mountainous;
(4) Hötzelsdorf, Bavaria; mountainous;
(5) Malchow/Poel, Mecklenburg Western Pomerania; maritime.

Status & Results

- currently, experiments with a total of 192 SNP markers are being conducted for genotyping the material before and after four years of cultivation
- field evaluations resulted in scores concerning the winter hardiness of the varieties (cf. Fig. 1) as a whole and of individual plants of them
- phenotypic data seem to result in showing genetic drift in one out of the four chosen varieties: being less winter hard before the start of the field experiments characterized, it is now phenotyped as winter hard.

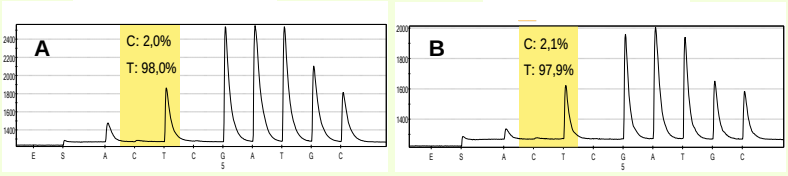

Figure 4: Pyrogram of the variety “Guru” at the sites Hötzelsdorf (A) and Spitalhof (B), respectively, after four years of cultivation, showing no shift in allele composition.

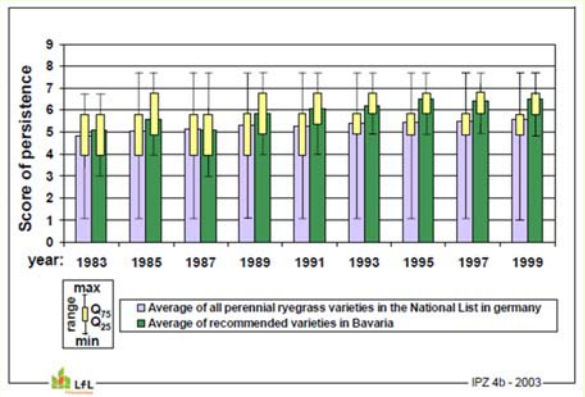

Figure 1: The differences in persistence between listed cultivars and varieties recommended for cultivation in Bavaria (Hartmann, 2003).

Strategy

The detection of possible changes in SNP allele compositions between original genotypes and genotypes in the trial field after four years of cultivation (starting material: two visually fittest varieties in trial locations vs. two visually least fit varieties) is performed via Pyrosequencing. The evaluation of phenotypic data (e.g. visible changes in variety appearance, Fig. 3) and the analysis of correlations to the PSQ results (Fig. 4) is used for investigating the “persistence” components. The knowledge of those interacting components leads to the development of selection methods for the trait “persistence”. Genetic drift, e.g. changes in the phenotypic scoring from “less winter hard” to “winter hard”, will be analyzed within and between the varieties at different sites, too.

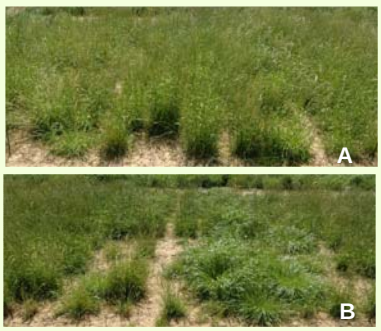

Figure 3: Mixtures of genotypes and winter survival of the variety “Guru“ from the sites Hötzelsdorf (A, mountainous) and Schmalenbeck (B, moor) after four years of cultivation, with drastic phenotypic changes being visible at Schmalenbeck.

Outlook

With the outlined strategy, we aim at providing breeders and farmers with recommendations for the selection and cultivation of the best, i.e. most persistent varieties for different environments.

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