The persistence of perennial ryegrass cultivars (*Lolium perenne* L.) in binary mixtures with white clover (*Trifolium repens* L.) under grazing

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Abstract

The persistence of highly productive forage species in pastures is essential to maximize economic returns from grazing livestock. However, most forage cultivars are neither selected nor evaluated under grazing. To test the persistence of ryegrass (*Lolium perenne* L.) cultivars under grazing, a five-year plot trial was conducted on commercial dairy farms located in different climatic conditions in Switzerland. Plots were arranged in a randomized, complete block design with three replicates and sown in autumn 2007 and spring 2008 in binary mixtures with white clover (*Trifolium repens* L). The relative frequency of the perennial ryegrass cultivars was evaluated in 2008, 2009 and 2012 to determine their long-term tolerance to grazing. Significant interactions between both site and cultivar and site and years were found, revealing the importance of the site and its management for the performance of the cultivars. The persistence, as determined by the relative frequencies of the ryegrass cultivars tested, corresponded in the short-term (second and third years) to the rankings of the official variety trials but differed for the long-term observation (in the fifth year). This suggests the need for additional long-term observations under grazing conditions as an extension of the official variety recommendations for cost-efficient, pasture-based livestock production.

Keywords: *Lolium perenne*, grazing tolerance, persistence, cultivar

Introduction

Its tolerance to grazing, its reproductive performance and its excellent nutritional value make perennial ryegrass (*Lolium perenne* L.) the principle grass plant for pasture-based dairy systems in temperate climates (Mosimann, 2002). Persistence is gaining an important role in minimizing costs through reducing the expenses for reseeding while maintaining good productivity of the grass sward. However, most forage cultivars are neither developed nor evaluated under grazing (Brummer and Moore, 2000). This is also the case for the official Swiss variety trials for perennial ryegrass conducted by Agroscope, the Swiss federal research institute for the agro-food industries, in which cultivars are evaluated under a cutting regime only. To simulate pasture conditions, plots for plant-density investigations were cut more frequently (Suter *et al.*, 2012). Specific factors, which may affect the performance of a cultivar under grazing such as trampling, fouling, and tiller pull-up, are not present or may not be as prevalent, as in a clipping situation (Hopkins, 2005). Nevertheless, persistence (evaluated after three years) and the ability to build dense plant populations (stand-density) as an indirect indicator of grazing tolerance are evaluated. To assess tolerance to grazing, we tested seven official recommended cultivars under grazing conditions over a period of five years to compare the correspondence between the official substituted pasture parameters (persistence and stand-density) and the effective performance under grazing pressure.

Materials and methods

Seven officially tested and recommended perennial ryegrass cultivars (Arara, Salamandra, Elgon, Soraya, Alligator, Arvicola, Artesia) (Suter *et al.*, 2012) were sown in field plots (3m × 7m) on five different dairy farms in Switzerland in autumn 2007 and spring 2008 in binary mixtures with white clover (*Trifolium repens* L.). The experimental sites covered a wide range

of climatic conditions and farm management practices (altitude (430 – 600 m a.s.l., precipitation (650 – 1100 mm/year), pasture type/pressure (continuous, rotational stocking), fertilizer use (80-190 kg N, 40-90 kg P, 100-150 kg K, 0-20 kg Mg/ha per year in the form of slurry and/or different mineral fertilizers) and sowing season (autumn 2007, spring 2008). The perennial ryegrass cultivars were sown at seed rates of 15 kg/ha (Arara) and 20 kg/ha (others) in binary mixtures with two white clover cultivars, differing in leaf size, and sown at a seed rate of 25 kg/ha and 15 kg/ha. At each site, the plots were repeated three times in a randomized complete block design. The relative frequency of the cultivars was measured in every plot in the autumn of 2008, 2009 and 2012 according to Daget and Poissonet (1969) by observing the plants at 50 points per plot at an equidistance of 10 cm.
To analyse the effects of the cultivars, sites and time, a Brunner-Langer F2-LD-F1 model for longitudinal data was fitted using the nparLD package in R (R Core Team, 2013).

Results and discussion

Generally, relative frequencies of all cultivars within the experiment strongly declined in 2012 compared to 2008 and 2009 (Table 1). The development of the relative frequencies of the cultivars tested over the five years showed a statistically significant site × year ($P < 0.001$) and site × cultivar ($P < 0.05$) interaction. Both interactions indicate that the individual cultivars responded differently to the site-specific climatic conditions and/or the management practices, which underlines the importance of testing cultivars under a broad range of climatic and management conditions.
The mean relative frequency per cultivar over the five years was highest for Arara and Arvicola (Table 1). This corresponds to the official variety results for stand-density, which also showed higher values for both cultivars (Suter *et al.*, 2012). The official stand-density ranking for Arara as the only diploid cultivar differed connotatively from the ranking of the other cultivars. This may be related to the fact that diploid cultivars generally build more tillers than tetraploids (Laidlaw, 2004). Salamandra and Alligator were the cultivars with low stand densities in the official testing programme. For both cultivars, the lowest relative frequency after 5 years was measured in our experiment. This indicates that the more frequent cutting in the official tests was a reasonable simulation of the short-term grazing effect on given cultivar.
Arara and Arvicola had the highest relative frequency after five years (Table 1).

Table 1. Relative frequencies (as %) of seven perennial ryegrass cultivars over a period of five years at five different sites under grazing conditions.

Cultivar	Site															Mean *(s.d.)*		
	Champvent			Gampelen			Hessigkofen			Hohenrain			Waldhof					
	08	09	12	08	09	12	08	09	12	08	09	12	08	09	12	08	09	12
Alligator	42	75	34	54	48	27	38	44	26	64	46	29	63	67	31	52 *(12)*	56 *(14)*	29 *(3)*
Arara	42	81	34	78	59	63	39	49	32	73	61	28	65	81	57	59 *(18)*	66 *(14)*	43 *(16)*
Soraya	57	74	35	61	53	48	42	45	29	63	50	43	68	60	39	58 *(10)*	56 *(11)*	39 *(7)*
Artesia	43	73	33	64	57	34	36	44	32	69	58	31	63	69	49	55 *(15)*	60 *(12)*	36 *(8)*
Arvicola	53	79	35	72	60	47	42	50	36	65	50	48	63	71	45	59 *(12)*	62 *(13)*	42 *(6)*
Elgon	51.5	76	33	56	51	28	34	44	34	58	51	36.5	63	62	35	53 *(11)*	57 *(12)*	33 *(3)*
Salamandra	49	58	30	51	53	27	36	36	29	58	50	34	64	69	42	52 *(11)*	53 *(12)*	32 *(6)*

Together with Soraya, these three cultivars showed the least reduction with respect to the relative frequency as compared to 2008 and 2009. We did not find any better persistence for Salamandra and Artesia, in contrast to the official persistence rankings. Alligator was the only cultivar for which we found the expected (according to the ranking of the official variety testing) lower persistence.
The reason for this discrepancy may be explained by differences in the parameters investigated, the different impact of grazing versus cutting conditions or the varying observation period. Nevertheless, it emphasizes the need for long-term observations under grazing conditions to evaluate the persistence of cultivars under grazing conditions.

Conclusion

The results from this study suggest that not only the site, but also the climatic and management conditions are important determinants for the performance of perennial ryegrass cultivars. This implies that cultivars should be tested under a wide range of environmental conditions.Furthermore, although simulating pasture conditions through more frequent cutting, as in the official tests, can result in a fair estimation of the short-term grazing resistance of a cultivar, it is not sufficient for the measurement of long-term grazing persistence, as this study has shown. While evaluating cultivars for cost-efficient, pasture-based livestock production, additional long-term observations under grazing conditions could be a worthwhile extension to the official variety recommendations.

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