

Poa trivialis, *Lolium perenne* or *Poa annua* as nurse crops for faster establishment of *Agrostis stolonifera* putting greens in Nordic climates

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Abstract

Seed mixtures with a nurse grass that germinates quickly at low soil temperatures can be an option for faster establishment of *Agrostis stolonifera* (AS) putting greens after winter damage. From 2015 to 2018 *Poa trivialis* (PT) 'Dark Horse' and *Lolium perenne* (LP) 'Chardin' were evaluated as nurse grasses in comparison with pure AS 'Independence' at two experimental sites in each of the two major climatic zones of the Nordic countries. *Poa annua* (PA) 'Two-Putt' was also included as a nurse grass in the northern zone. As an overall trend, establishment was faster with AS+LP than with AS+PT and AS+PA, which both had faster establishment than pure AS. In the northern zone, AS+PT produced better turf quality than pure AS in the seedling year and year after and tended to be superior even on average for the entire trial period (mean value 6.0 versus 5.8 for pure AS, 5.3 for AS+LP, and 4.6 for AS+PA; scale 1–9 where 9 is the highest quality). Within the same zone, AS+PT also suffered less overall winter damage than the other combinations and was less infected with microdochium patch than pure AS. In the southern zone, PT and especially LP were far more persistent than in the northern zone and compromised turfgrass quality compared with pure AS. In conclusion, we recommend PT as a nurse grass for faster establishment of AS putting in the northern zone, but not in the southern zone where AS should rather be seeded in a pure stand.

1 | INTRODUCTION

Re-establishment of golf course putting greens after winterkill can be challenging. It is important to have the turf re-established quickly despite low soil temperatures. To

achieve this, it is possible to use a nurse species to help establish turf more quickly. Perennial ryegrass (*Lolium perenne* L.) (LP) and rough-stalked meadow grass (*Poa trivialis* L.) (PT) (Edminster, 1994; Kvalbein et al., 2017) are nurse grasses that can be mixed with creeping bentgrass (*Agrostis stolonifera* L.) (AS). Annual meadow grass [*Poa annua* L. f. reptans (Hausskn.) T. Koyama] (PA) can also be used (e.g. Miltner et al., 2004), although few varieties of

Abbreviations: AS, *Agrostis stolonifera*; LP, *Lolium perenne*; PA, *Poa annua*; PT, *Poa trivialis*.

this species are commercially available as seeds (Vargas & Turgeon, 2004). While accelerating grow-in, it is important that the nurse species does not compromise the long-term functional and aesthetic quality of established creeping bentgrass putting greens.

Lolium perenne, *Poa trivialis* and *Poa annua* are all short-lived, temporary grasses in the northern climatic zone of the Nordic countries (Aamlid, Heltoft, Thorvaldsson, Jensen, Espevig et al., 2019; Aamlid, Waalen, Thorvaldsson, Jensen, Espevig et al., 2015). Although PT is ranked slightly more winter tolerant than LP, neither of them will usually survive the winter after seeding in these harsh conditions (Kvalbein et al., 2017). *Poa annua* is the least winter stress tolerant of the three species because of its high susceptibility to snow moulds and the fact that it rarely survives more than one month under ice cover (Aamlid et al., 2009; Waalen et al., 2017). However, LP, PT, and PA are usually competitive even at 3 mm mowing height and will normally continue to grow longer into the autumn than AS.

The aim of this study was to gain knowledge on the persistence and competitiveness of LP, PT, and PA when used as nurse grasses for faster establishment on creeping bentgrass putting greens in various parts of the Nordic countries.

2 | MATERIALS AND METHODS

2.1 | Experimental sites and treatments

Putting greens constructed according to the United States Golf Association's specifications (United States Golf Association, 2018) at Reykjavik GC, Iceland (64.1°N, 21.9°W, 30 m a.s.l.), NIBIO Apelsvoll, Norway (60.7°N, 10.9°E, 250 m a.s.l.), NIBIO Landvik (58.3°N, 8.5°E, 12 m a.s.l.), Norway, and Sydsjælland GC, Denmark (55.2°N, 11.9°E, 11 m a.s.l.) were seeded in June 2015. Reykjavik and Apelsvoll were considered to represent the northern climatic zone of the Nordic countries, and Landvik and Sydsjælland, the southern climatic zone. The mixtures were seeded according to a randomized complete block design as an add-on to the SCANGREEN variety trials at the respective sites (www.scanturf.org). Plot size was 1.0 m by 1.0 m and each trial had three blocks (replicates).

Creeping bentgrass 'Independence' was seeded alone (seeding rate 7.0 g m⁻²) or in mixture with LP 'Chardin' (20 g m⁻²), PT 'Dark Horse' (7.5 g m⁻²) or *Poa annua* 'Two-Putt' (7.5 g m⁻²). PA was not included in the southern zone because of space limitations on the experimental putting green at Landvik. Including preplant applications and depending on the length of growing season, the total fertilizer input in the grow-in year was 26, 30, and 34 g N m⁻² in NPK-balanced fertilizer types in Reykjavik, Apelsvoll, and Landvik, respectively. The Danish trial had to be reseeded in late August due

to irrigation failure and therefore received only 8 g N m⁻² in the seeding year. In the following years, the nitrogen rate averaged 15 g m⁻² in all trials.

In all trials, mowing started at 10 mm 3 to 4 wk after seeding. The lowest mowing height in the grow-in year was 7 mm in Reykjavik, 4.5 mm at Apelsvoll and 4.0 mm at Landvik. In the following years, plots were mowed at 3–4 mm three times per week. There was no use of pesticides or plant growth regulators in any of the trials. Plots were reseeded in case of more than 75% winter damage.

2.2 | Data collection

In all trials and throughout the 3–4 yr trial period, turfgrass quality was recorded once a month using a scale from 1 to 9, where 9 is the highest quality and 5 is the lowest acceptable quality. Turfgrass establishment rate was recorded 3 wk after seeding as percent of plot area covered with the seeded species/mixture. Microdochium patch was recorded as percent of plot area immediately after snow melt and at the monthly assessments during the growing season. Overall winter damage (biotic and abiotic) was recorded as the percent of plot area that was dead 1–2 wk after green-up in spring.

The botanical composition of the greens was examined at Apelsvoll in the October 2018 and at Landvik in October 2015, 2016 and 2017. Five random samples were taken with a small cylinder (19 mm in diameter) from each plot and the number of tillers of each species counted under a magnifying lens. The reason for not recording botanical composition at Apelsvoll before 2018 was that the entire trial had to be reseeded in 2016 after winter damage. Similarly, the botanical analyses at Landvik were discontinued in 2018 due to 100% damage for ice encasement in all species.

The results were analyzed separately for the northern and southern climatic zones using the procedure PROC ANOVA (SAS Institute, Cary, NC, USA). Whenever significant ($P \leq .05$) differences occurred, the Least Significant Difference (LSD) was calculated for comparison of pure AS and mixtures.

3 | RESULTS AND DISCUSSION

3.1 | *Poa trivialis* as a nurse grass

In the northern zone, plots seeded with AS+PT had higher turfgrass quality in 2015 (seeding year) and 2016 than plots seeded with pure AS (Table 1a). Although the difference between AS and AS+PT in coverage 3 wk after seeding was not significant, the difference in the seeding year can partly be explained by faster grow-in.

TABLE 1 Comparison of pure creeping bentgrass (AS) and creeping bentgrass seeded in mixtures with rough-stalked meadow grass (AS+PT), perennial ryegrass (AS+LP) and annual meadow grass (AS+PA; northern zone only) for turfgrass quality (overall and spilt into evaluation years), coverage 3 wk after seeding, *Microdochium* patch (mean of in-season disease and after snow melt in spring), and overall winter damage (abiotic + biotic) on putting greens in (a) the northern and (b) the southern climatic zone of the Nordic countries

	Turfgrass quality					Coverage 3 wk after seeding	Microdochium patch, per plot area	Overall winter damage
	Overall mean	2015	2016	2017	2018			
	1 to 9							
a) Northern climatic zone (Apelsvoll and Reykjavik)								
AS	5.8	4.9	6.0	6.4	5.8	43	2.1	17
AS+PT	6.0	5.9	6.6	6.2	5.4	53	1.6	14
AS+LP	5.3	5.6	5.4	5.3	5.4	70	1.2	22
AS+PA	4.6	6.5	5.0	4.5	3.5	53	— ^c	59
Sign.	*** ^a	***	***	***	***	^b	*	***
LSD 5%	0.4	0.6	0.6	0.6	0.7	—	0.6	9
b) Southern climatic zone (Landvik and Sydsjælland)								
AS	5.6	5.7	5.2	5.6	6.0	48	0.6	9
AS+PT	5.4	6.2	4.7	5.7	5.6	76	1.5	18
AS+LP	4.9	5.7	3.7	5.4	5.5	81	0.8	20
Sign.	^b	ns	***	ns	ns	ns	*	*
LSD 5%	—	—	0.7	—	—	—	0.7	8

^aThe following symbols are used:

*** $P \leq .001$;

** $P \leq .01$;

* $P \leq .05$;

^b $P \leq .10$; ns, $P > .10$.

^cAS+PA could not be evaluated for *Microdochium* patch in the northern zone due to severe abiotic winter damage.

Numerically, plots seeded with AS+PT had higher coverage and higher quality than plots seeded with pure AS even in the southern zone (Table 1b). Lack of statistical significance can mostly be explained by the irrigation failure causing a two months delay in seeding of the trial at Sydsjælland GC. However, in the year after seeding, turfgrass quality tended to be higher on plots seeded with pure AS than on plots seeded with AS+PT. Unlike in the northern zone, there was also less *Microdochium nivale* and overall winter damage on the pure AS plots than on AS+PT plots in the southern zone. This difference between climatic zones overall performance and susceptibility of PT to *Microdochium nivale* is in agreement with earlier comparisons of pure species in the SCANGREEN variety trials (Aamlid et al., 2015).

3.2 | *Lolium perenne* as a nurse grass

There was an overall trend to faster grow-in on plots seeded with AS+LP than on plots seeded with pure AS and – in the northern zone – on plots seeded with AS+PT or AS+PA (Table 1). To some extent the faster establishment with nurse grasses, especially LP, than with pure AS may be explained by the fact that the cultivar of AS used in these trials was ‘Inde-

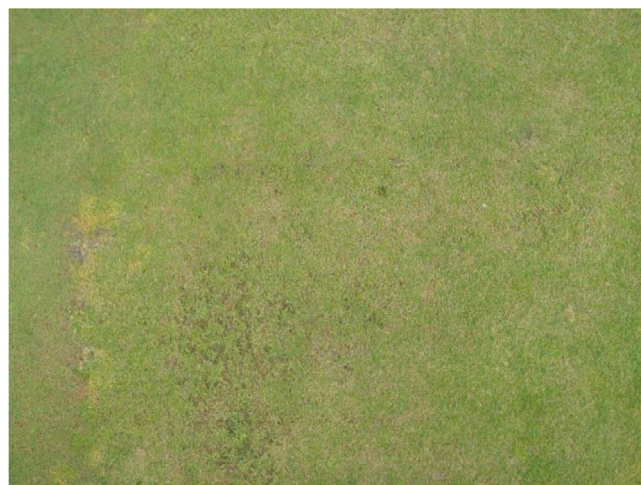


FIGURE 1 Close-up of plot seeded with a mixture of *Agrostis stolonifera* and *Lolium perenne* at Landvik (southern zone) in September 2016. Photo courtesy of Trygve S. Aamlid

pendence’ for which establishment has been shown to be more delayed by low soil temperatures than most other cultivars (Heineck et al., 2019). While the advantage of a nurse grass would probably have been less with a different cultivar of AS, AS+LP also had a higher resistance to *Microdochium nivale*

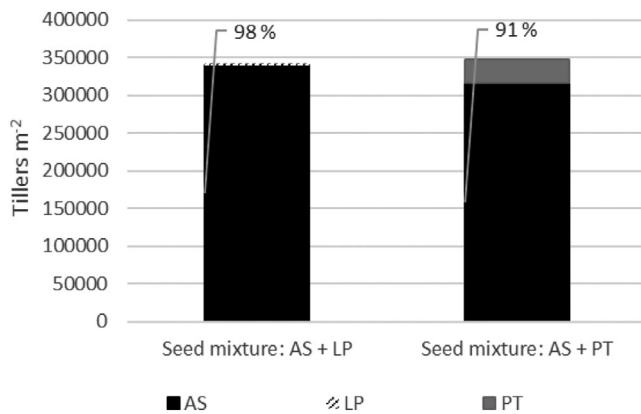


FIGURE 2 Tiller density and botanical composition in October 2018 of plots reseeded in June 2016 with *Agrostis stolonifera* (AS) in mixture with *Lolium perenne* (LP) or *Poa trivialis* (PT) at Apelsvoll, northern climatic zone. Figures above bars indicate percent AS

than pure AS in both zones. Despite this, on averaged for the entire trial period, the turf quality of AS+LP was ranked significantly behind pure AS and AS+PT in the northern zone and showed a similar trend also in the southern zone. Part of the reason was that that LP was more susceptible than AS to red thread (*Laetisaria fuciformis*) (data not shown) and that the inclusion of LP resulted in an open stand which allowed colonization by moss (species not identified), especially in the southern zone which had less snow cover during winter (Figure 1).

3.3 | *Poa annua* as a nurse grass (northern zone only)

Turfgrass quality was better with AS+PA than with pure AS, AS+LP and AS+PT in the seeding year (Table 1a). After that, the quality dropped to a level significantly behind that of pure AS, primarily because of severe winter damage in PA. Unlike pure AS, AS+PT and AS+LP, AS+PA had to be reseeded every year during the project period at Apelsvoll. This suggests not only that PA had low winter hardiness, but also that it was competitive and probably inhibited establishment of AS to a larger degree than PT and LP. The results are in agreement with the generally poor performance the commercially available PA ‘Two-Putt’ when tested as a pure cultivar in the SCANGREEN variety trials (Aamlid, Heltoft, Thorvaldsen, Jensen, Espevig, et al., 2019).

3.4 | Botanical composition

Two and a half years after reseeding in spring 2016, LP made up only 2% of the total tiller population on plots seeded with AS+LP at Apelsvoll (Figure 2). On plots seeded with AS+PT, the corresponding proportion of PT was 9%. PT was, in other words, slightly more persistent than LP in the northern zone, which is also in agreement early comparisons of the two species in pure stands (Aamlid et al., 2015, 2019).

At Landvik, LP made up 46, 36, and 26% of the canopy 6, 28, and 40 months after seeding, respectively (Figure 3). Although the proportion of LP decreased year by year, mixing in LP at seeding had stronger implications for turfgrass quality than in the northern zone. These implications were less with

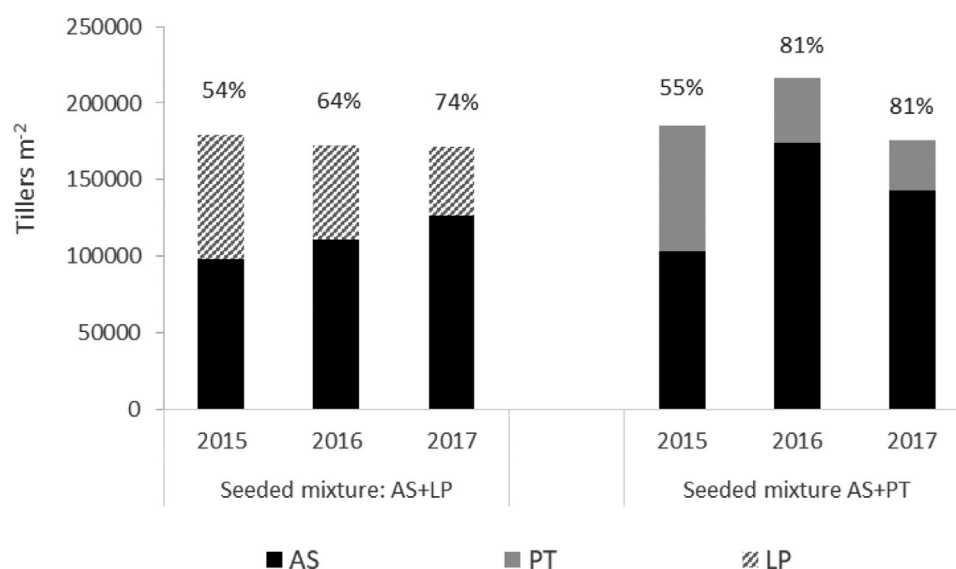


FIGURE 3 Tiller density and botanical composition in October 2015, 2016, and 2017 of plots seeded in June 2015 with *Agrostis stolonifera* (AS) in mixture with *Lolium perenne* (LP) or *Poa trivialis* (PT) at Landvik, southern climatic zone. Figures above bars indicate percent AS

AS+PT, where PT made up 55% of the canopy in the seeding year, but then stabilized around 20% in the two following years. However, unlike in the northern zone, AS+PT gave little or no advantage compared with pure AS in the southern zone.

4 | CONCLUSION

This research has shown that inclusion of PT as a nurse grass may result in faster grow-in and better turfgrass quality in the seeding year when seeding or reseeding AS putting greens in the northern climatic zone of the Nordic countries. *Poa trivialis* is less aggressive than LP and will have fewer negative implications for turfgrass quality should it survive the first winter after seeding. Neither PT nor LP can be recommended as nurse grasses in the southern climatic zone of the Nordic countries where they are more likely to survive and become a permanent component of the turfgrass canopy. The commercially available cultivar ‘Two-Putt’ of PA is not suited as a nurse grass when establishing creeping bentgrass putting greens.

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