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SCANGREEN 2015-18: Turfgrass species, varieties, seed mixtures and seed blends for Scandinavian putting greens

Final results from a four year testing period

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TITTEL/TITLE

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SUMMARY / SAMMENDRAG :

This is the final report from the STERF project: SCANGREEN 2015-18

Denne tekst er sluttrapport for STERF-prosjektet: SCANGREEN 2015-18

GODKJENT /APPROVED	PROSJEKTLEDER /PROJECT LEADER
HÅKON BORCH	TRYGVE S. AAMLID

Preface

For variety testing to be relevant to the end users it is critical that the trials are conducted under realistic conditions with regard to mowing height, wear, fertilization and other management practices. The SCANGREEN program was initiated in 2003 and involves testing of turfgrass species and varieties on sand-based golf greens at four sites in the Nordic countries. The evaluation is organized in four-year testing cycles and forms the basis for recommended variety lists at www.scanturf.org and www.sterf.org.

The present report gives a detailed account of methods and results obtained during the fourth SCANGREEN test cycle from 2015 to 2018. Unlike previous cycles, this evaluation also included seed blends and -mixtures of special relevance to the golf industry in the Nordic countries.

As with the earlier test cycles, SCANGREEN 2015-18 was funded 10% by fees paid by the seed companies entering varieties into the trials, and 90% by the Scandinavian Turfgrass and Environment Research Foundation (STERF). Thanks are expressed to both parties for funding and excellent collaboration during the course of the project.

NIBIO Landvik, 08.01.21

Trygve S. Aamlid

Project leader

Content

Abstract

Knowledge about and optimal choice of seed of the many new turfgrass varieties coming to the market is important for sustainable turfgrass management. The objective of SCANGREEN 2015-18 was to find species, varieties and seed blends/mixtures of *Agrostis, Festuca, Poa* and *Lolium* that are suited for pesticide-free management of putting greens in the two major climatic zones of the Nordic countries. The four test sites were Reykjavik GC, Iceland (64.1°N, 21.9°W, 30 m a.s.l) and NIBIO Apelsvoll (60.7°N, 10.9°E, 250 m a.s.l.) in the the northern zone, and NIBIO Landvik, Norway (58.3°N, 8.5°E, 12 m a.s.l.) and Sydsjælland GC, Denmark (55.2°N, 11.9°E, 11 m.a.s.l.) in the southern zone.

A total of 34 pure varieties (inclucing controls) and 9 seed blends/mixtures were evaluated from seeding in June 2015 until November 2018. The mowing height was 5 mm in *F. rubra*., *Poa pratensis*. and *L. perenne*, and 3-4 mm in *Agrostis* sp., *Poa trivialis* and *Poa annua*. Fertilizers were applied at a seasonal rate of ≈10 g N m^{-2} in *F. rubra, A. canina and A.capillaris* and 15-16 g N m^{-2} in *L. perenne. A.stolonifera and Poa* sp. The trials were mowed three times per week, subjected to wear from greens-type wear machines and otherwise managed according to good greenkeeping practice. The plots were evaluated in the growing season for visual turf quality, tiller density, leaf fineness, color, percent of plot area covered by undiseased turf of the seeded species, percent of plot area infected by disease (identified if possible), *Poa annua* invasion (Landvik only) and daily height increment. Abiotic and biotic winter damage were assessed in spring and percent of plot area covered by moss by the end of the project. The data were analysed by ANOVA and species, varieties within species, and combinations witin three groups of seed blends/mixtures ranked, firstly for decreasing turf quality, secondly for increasing winter damage and thirdly for increasing infection of in-season disease.

The evaluation showed that the following varieties, in prioritized order, can be recommended for golf greens in the five Nordic countries, based on the criterion that they were ranked equal to or better than the control varieties:

	Northern zone: Finland, central and northern parts of Sweden, northern and continental parts of Norway, Iceland	Southern zone: Denmark, coastal regions of southern Sweden and southern Norway
Festuca rubra ssp. commutata Control variety: Musica	Humboldt, Barchip	None
Festuca rubra ssp. litoralis Control variety: Cezanne	None	None
Agrostis capillaris Control variety: Jorvik	Heritage	Rhinegold, Heritage
Agrostis stolonifera Control variety: Independence	Luminary, Riptide, Ignite	Flagstick, Luminary, Riptide, Pure Distinction*
Lolium perenne Control variety: Chardin	Clementine	Clementine
Poa trivialis Control variety: Dark Horse	Sabrena 1	Qasar, Sabrena 1

*Pure Distiction is susceptible to winter damage and disease and shall only be used in the climatically best areas

Poa annua 'Two Put' was tested but can not be recommended on Nordic golf courses. *Poa pratensis* tolerated mowing at 5 mm but produced rather course putting surface. It is not an alternative for greens except perhaps at northern sites with extreme winter stress.

Evaluation of seed blends of *Festuca rubra* ssp. *commutata* 'Musica' and *F.rubra* ssp. *litoralis* 'Cezanne' at weight ratios 75/25, 50/50 and 25/75 showed that the optimal ratio for pure fescue greens is 75/25 in the northern zone and 50/50 in the southern zone.

Evaluation of *Lolium perenne* 'Chardin', *Poa trivialis* 'Dark Horse' or *Poa annua* 'Two Put' as nurse grasses to speed up (re)establishment of *A. stolonifera* 'Independence' showed that mixtures of

P.trivialis and *A. stolonifera* can be recommended in the northern zone and have few disadvantages even in the southern zone. Inclusion of *P. annua* cannot be recommended in any zone and inclusion of *L. perenne* only in the most winter-tough areas in the northern where there is no doubt that *L.perenne* will not survive the first winter.

Evaluation of mixtures of *F.rubra* and *A.stolonifera* or *A.canina* in comparison with the more traditional mixture of *F.rubra* and *A.capillaris* at fescue and creeping bentgrass management showed *F.rubra* + *A.stolonifera* to have certain advantages such as less disease, less *Poa annua* invasion and less height growth. This mixture warrants further investigation on Nordic golf courses.

1 Introduction

In-depth knowledge about turfgrass species and choice of new and improved varieties are prerequisites for sustainable turfgrass management on golf courses. Reviews by Aamlid & Gensollen (2015) and Meyer et al (2017) documented the progress that turfgrass breeders have made and are still making, not only for aesthetic characters such as color and leaf fineness, but also for disease resistance and abiotic stress tolerance. Surveys conducted among several hundred Nordic courses confirmed that continuus evaluation of new varieties under Nordic climate conditions is perceived as one of the most important tasks for the Scandinavian Turfgrass and Environment Research Foundation (STERF). (Melbye 2013, 2019).

One of the suggestions from these surveys, and also from an external committee that evaluated former SCANGREEN trials, was that it should be possible to include in SCANGREEN not only new varieties, but also seed mixtures between different species and seed blends between varieties within the same turfgrass species. Based on experiences from agriculture, this suggestion is relevant as seed mixtures and blends are usually regarded to provide a more diversified plant community with greater overall resistance to diseases. While turfgrass breeding and seed companies may prefer loyal customers that purchase seed from one company only, most turfgrass managers will probably agree that the ideal solution would be to compose optimal mixtures and blends for the individual golf course by choosing species and top-ranked varieties with complementary characteristics regardless of variety owner.

Golf in the Nordic countries is played at latitudes from 55 to 70^{0}N and altitudes from 0 to 900 m a.s.l. Due to the variation in climatic conditions, STERF has always presented two lists of recommended varieties, one for the northern and mostly continental zone and one for the southern and mostly coastal zone (Figure 1). These two climatic zones may also differ with regard to optimal seed blends and mixtures. Thus, in addition to the primary objective of testing new varieties of *Agrostis*, *Festuca*, *Poa* and *Lolium* for their suitability on golf course putting greens, the SCANGREEN 2015-18 test cycle also aimed at:

1. Defining the optimal ratio of slender creeping red fescue (*Festuca rubra* ssp. *litoralis*) to Chewings fescue (*F. rubra* ssp. *commutata*) in red fescue seed blends for greens in various parts of the Nordic countries. Nielsen (2010) suggested 67-75 % slender creeping red fescues and only 25-33 % Chewings fescues in blends for the Danish market, but this is probably different in more northerly areas as Chewings fescue is usually considered more winter-hardy than slender creeping red fescue.
2. Clarifying advantages and disadvantages of using fast-establishing nurse grasses such as perennial ryegrass (*Lolium perenne*), rough bluegrass (*Poa trivialis*) or even annual bluegrass (*Poa annua*) when seeding or reseeding creeping bentgrass (*Agrostis stolonifera*) greens. This question is particularly relevant on golf courses that often have to re-establish their greens at low soil temperatures in spring after winter kill.
3. Clarifying if creeping bentgrass or velvet bentgrass (*Agrostis canina*) can be alternative to colonial bentgrass (*Agrostis capillaris*) when used in mixture with red fescue on Nordic putting greens. The combination of red fescue and velvet bentgrass was tested by Calvache et al. (2016) who found velvet bentgrass to dominate, especially at high fertilizer levels. Less is know about red fescue + creeping bentgrass mixtures, which could potentially have benefits when it comes to disease resistance and recuperative capacity. Influenced by British traditions, it is often argued that the ecological adapations of these species are too different to be compatible on greens. However, red fescue + creeping bentgrass mixtures are commonly used in Germany, and in Norway, we have sometimes seen the two species to complement each other, although at ratios varying from year to year, on golf courses trying to convert their greens from fescue to creeping bentgrass or vice versa. An important question is if this untraditional combination of red fescue + creeping bentgrass, will be more durable and create a better putting surface when managed as fescue greens or creeping bentgrass greens ?

2 Materials and methods

2.1 Pure species and varieties entered by plant breeders / seed companies into the project

The trials included 27 candidate varieties and seven controls representing nine different species and subspecies (Table 1). *Poa pratensis* was included at NIBIO's own initiative to test the species' tolerance to low mowing, and if it could become an alternative species for greens often exposed to winter damage.

Seeding rates were 7, 30, 40, 15 and 25 g m^{-2} for *Agrostis* sp., *Festuca* sp., *Lolium perenne*., *Poa trivialis / Poa annua* and *Poa pratensis*.

Table 1. Varieties in SCANGREEN 2015-18 by species and breeding/seed companies. Varieties in bold are controls.

	Agrostis stolonifera	***Agrostis capillaris***	***Agrostis canina***	***F. rubra ssp. commutata***	***F. rubra ssp. litoralis***	***Poa trivialis***	***Poa annua***	***Lolium perenne***	***Poa pratensis***
DLF	**Independence** Flagstick	**Jorvik** Rhinegold Teetop	**Villa**[1]	Humboldt Wagner 1	**Cezanne** Aporina	Sabrena 1	Two Putt	**Chardin** Clementine	Becca[2]
Barenbrug	Ignite			**Musica** Barchip Aureline					
Everris	Memorial Riptide	Heritage							
Germinal					Borluna Mirador				
Semilas Fito	Valderrama					Winterway		Rinovo	
Svensk Jordelit	Pure Distinction Crystal Blue								
PGG Wrightson		Charles							
Landmark	Luminary								
Skånefrø						**Dark Horse**			
Weibulls Horto						Qasar			
DSV									Limousine
Total number	9[3]	5	1	5	4	4	1	3	2

[1]: *Agrostis canina* 'Villa'' was included at Reykjavik, Apelsvoll and Sydsjælland, but not at Landvik due to space limitations

[2]: *Poa pratensis* 'Becca' was included as a fill-in variety at Landvik only.

[3]: The number af varieties of *A. stolonifera* was extended to 16 in the trial at Landvik. The extra varieties were: '007', 'Declaration', 'Focus', 'MacKenzie', 'Tyee', 'Teeone' and 'Penncross'.

2.2 Seed blends and mixtures added to the trials

The seed blends were composed of the control varieties (Table 2).

Firstly, we compared seed blends of *Festuca rubra* where the seed weight ratio of ssp. *commutata* to ssp. *litoralis* was either 75/25, 50/50 or 25/75. Our hypothesis was that the proportion of ssp. *commutata* ought to be higher in the northern than in the southern test zone. These extra plots were managed as fescue greens: Mowing height 5 mm and low fertilizer inputs (approximately 10 g N m^{-2} yr^{-1})

Secondly, we compared *Lolium perenne* and *Poa trivialis* as nurse grasses to speed up establishment of *A. stolonifera*. A central question was the persistence of the two nurse grasses and how they would affect the quality of the putting green. These extra plots were managed as creeping bentgrass greens: Mowing height 3-4 mm and high fertilizer inputs approximately 15 g N m^{-2} yr^{-1}.

Thirdly, we studied seed mixtures of 90% *F.rubra* +10% *A.stolonifera* and 90% *F.rubra* +10% *A.canina* as alternatives to the traditional mixture of 90% *F.rubra* + 10% *A.capillaris*. *F.rubra* + *A.stolonifera* and *F.rubra* + *A.capillaris* were studied under both fescue and creeping bentgrass management, but *F.rubra* + *A. canina* was only under fescue management as earlier trials had shown *A. canina* to become too dominant under creeping bentgrass management (Calvache et al. 2017).

Table 2. Seed blends and mixtures, including seeding rates (g m^{-2}) of the different components

	***Festuca rubra* ssp. *commutata* 'Musica'**	***Festuca rubra* ssp. *litoralis* 'Cezanne'**	***Agrostis stolonifera* 'Independence'**	***Lolium perenne* 'Chardin'**	***Poa trivialis* 'Darkhorse'**	***Poa annua* 'Two-Put'**	***Agr. capillaris* 'Jorvik'**	***Agr. canina* 'Villa'**
Blends of *Festuca* subspecies								
75 % *commutata*, 25 % *litoralis*	22.5	7.5						
50 % *commutata*, 50 % *litoralis*	15.0	15.0						
25 % *commutata*, 75 % *litoralis*	7.5	22.5						
Nurse grasses for *Agrostis stolonifera*								
Lolium perenne			7.0	20.0				
Poa trivialis			7.0		0.75			
Poa annua			7.0			0.75		
Agrostis* sp. in mixtures with *Festuca								
Agrostis capillaris	13.5	13.5					3.0	
Agrostis stolonifera	13.5	13.5	3.0					
Agrostis canina	13.5	13.5						3.0

2.3 Experimental sites and protocol

The trials were established on USGA-spec. greens at Reykjavik GC, Iceland (64.1°N, 21.9°W, 30 m a.s.l.), NIBIO Apelsvoll (60.7°N, 10.9°E, 250 m a.s.l.) and 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.). Reykjavik and Apelsvoll were considered to represent the northern, and Landvik and Sydsjælland, the southern climatic zone of the Nordic countries (Fig. 1).

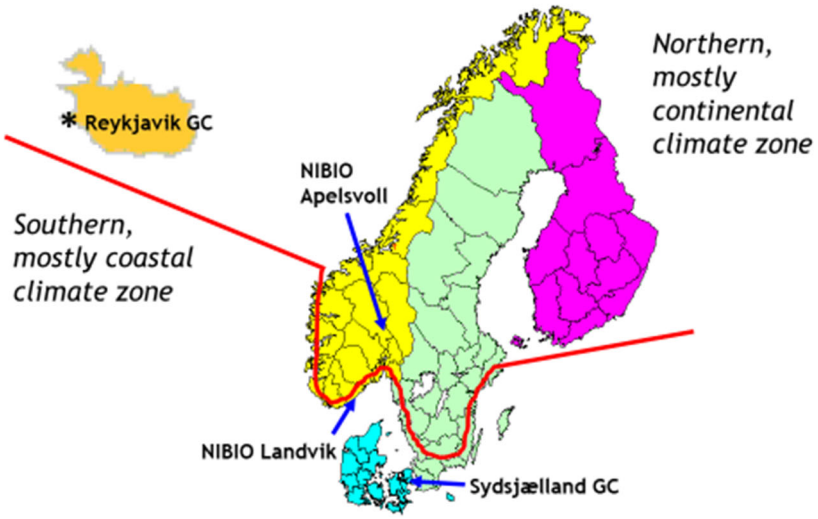

Figure 1. The four trial sites of Scangreen 2015-18. Red line indicates the border between northern and southern zone.

Soil samples taken from the substrates at the four greens in the seeding year showed between 1 and 2 % organic matter at all sites. The soil pH and content of magnesium and calcium was higher at Sydsjælland, and especilly at Reykjavik, than at the two Norwegian sites (Table 3)

Table 3. Soil analyses of substrates at seeding.

	Ignition loss, %	pH (H_2O)	Plant available nutrinets in AL extracts (0.1 M NH_4 lactate + 0.4 M acetic acid) (mg (kg dry soil)$^{-1}$)			
			P	K	Mg	Ca
Reykjavik GC	1.9	8.1	<20	200	120	2600
NIBIO Apelsvoll	1.5	6.4	38	26	21	390
Sydsjælland GC	1.3	7.6	42	26	55	950
NIBIO Landvik	1.5	6.3	33	26	16	340

The trials were established according to a split-plot designs with three blocks (replicates), species on main plots and varieties on subplots. This allowed different management of the various species. Plot size was 1.0 m x 1.0 m.

The protocol has been included in Appendix 1. Most importantly, there was no use of pesticides or plant growth regulators in any of the trials. The experimental greens were mowed three times per

week – Monday, Wednesday and Friday. The mowing heights and annual fertilizer rates varied among speices as shown in Table 4. There were some deviations from these prescriptions, especially in conjunction with recovery after winter damage; these deviations will be described in later sections of this report.

Table 4. Mowing height and annual fertilizer rates to main plots with different species.

	Mowing height low, 3 (-4) mm	Mowing height high, (5 mm)
Fertilizer rate low ≈ 10 g N m-2 yr^{-1}	*Agrostis capillaris* *Agrostis canina*	*Festuca rubra*
Fertilizer rate high ≈ 15 g N m-2 yr^{-1}	*Agrotis stolonifera* *Poa trivialis* *Poa annua*	*Lolium perenne* *Poa pratensis*

2.4 Weather conditions and implementation of protocol

The mean monthly temperatures were mostly higher than the 30 year reference (normal) period (1961-90) at all sites (Table 5). May-July 2018 were exceptional with record-high temperature at Sydsjælland and even more so at the two Norwegian sites. Together with low rainfall, this resulted in unusually high irrigation requirements in the last evaluation year. At Landvik, the need for extra irrigation was strengthened by the need to reseed all plots after nearly 100 % winter kill caused by a 'late winter' with lower-than-normal temperature and snow and ice cover well into March (Photo 1)

Photo 1. Experimental green at Landvik on 20 March 2018.

Photo: Trygve S. Aamlid

Table 5. Monthly temperature in °C (a) and monthly precipitation in mm (b) from the month of seeding (June) 2015 through December 2018 compared with the 30 year normal at the four experimental sites. (Weather data for Sydsjælland are from DMI station Brandelev). Some data from Reykjavik in 2017 and 2018 were missing.

a)	Reykjavik						Apelsvoll						Landvik						Sydsjælland				
	2015	2016	2017	2018	30yr		2015	2016	2017	2018	30yr		2015	2016	2017	2018	30yr		2015	2016	2017	2018	30yr
Jan.		0.3	1.3	-0.5	-0.5			-7.7	-4.2	-4.9	-7.4			-3.4	1.7	0.9	-1.6			-0.3	0.4	2.3	-0.1
Feb.		-0.8	2.8	-	0.4			-2.8	-3.8	-6.7	-7.0			1.2	0.4	-2.0	-1.9			2.0	1.6	-1.2	0.0
Mar.		2.6	1.6	2.2	0.5			1.3	0.7	-5.4	-2.5			3.4	3.4	-1.2	1.0			3.3	4.5	0.1	2.5
Apr.		4.2	3.0	4.8	2.9			3.9	3.7	3.5	2.3			6.1	6.5	6.7	5.1			6.1	6.2	8.7	6.3
May		6.6	8.6	5.9	6.3			10.7	10.1	15.1	9.0			12.3	11.9	14.9	10.4			13.1	12.1	14.6	11.5
June	9.2	11.0	10.0	8.9	9.0		12.6	15.1	13.5	16.0	13.7		13.9	15.8	15.5	17.0	14.7		13.0	16	15.2	17.1	15.0
July	11.3	12.5	11.6	10.7	10.6		14.8	15.8	15.0	20.7	14.8		15.8	16.4	16.1	20.3	16.2		16.0	16.7	15.4	20.0	16.2
Aug.	11.0	11.9	10.7	-	10.3		14.6	14.2	13.7	14.7	13.5		16.2	15.5	15.1	16.1	15.4		17.6	16.3	16.4	18.4	16.3
Sep.	9.2	8.6	9.5	7.0	7.4		10.8	13.6	10.3	11.1	9.1		12.9	15.1	13	12.9	11.8		13.3	16	13.2	14.5	13.3
Oct.	5.2	7.8	6.6	3.7	4.4		5.6	4.2	5.4	5.4	4.6		8.5	7.6	9.4	8.7	7.9		9.4	8.4	11.0	10.3	9.5
Nov.	1.9	3.3	-0.4	3.9	1.1		1.4	-1.2	-0.7	1.6	-1.3		5.6	2.7	3.5	5.5	3.2		7.0	3.6	5.7	5.5	5.0
Dec.	-0.5	3.7	-1.3	2.3	-0.2		0.1	-0.9	-4.9	-3.4	-5.3		4.8	3.7	1.7	2.0	0.2		5.9	4.0	3.4	3.9	1.8
Mean	-	6.0	5.3	-	4.4		-	5.5	4.9	5.6	3.6		-	8.0	8.2	8.5	6.9		-	8.8	8.8	9.5	8.1

b)	Reykjavik						Apelsvoll						Landvik						Sydsjælland				
	2015	2016	2017	2018	30yr		2015	2016	2017	2018	30yr		2015	2016	2017	2018	30yr		2015	2016	2017	2018	30yr
Jan.		67	74	-	76			46	8	60	37			149	65	221	113			41	12	75	46
Feb.		88	123	-	72			18	22	31	26			85	138	143	73			47	42	11	31
Mar.		115	42	36	82			42	21	18	29			117	117	48	85			43	56	48	38
Apr.		55	176	67	58			75	33	40	32			103	66	66	58			59	41	34	38
May		24	93	150	44			66	59	23	44			97	61	40	82			11	28	16	43
June	20	47	72	89	50		39	30	58	56	60		65	110	117	76	71		55	110	54	8	49
July	35	29	57	48	52		116	59	59	27	77		106	101	99	21	92		44	106	77	14	62
Aug.	65	38	-	20	62		52	109	144	59	72		185	122	125	76	113		51	93	67	122	59
Sep.	117	80	-	67	67		164	21	64	85	66		322	36	291	213	136		53	52	106	17	56
Oct.	186	258	-	133	86		2	39	67	46	64		72	117	346	56	162		41	72	90	39	52
Nov.	135	146	-	133	73		41	72	66	22	53		150	256	156	195	143		132	48	64	26	60
Dec.	129	168	-	96	79		41	10	43	55	40		160	43	116	215	102		91	22	33	55	53
Sum	-	1115	-	-	801		-	588	645	520	600		-	1340	1702	1375	1230		-	704	670	465	587

2.4.1 Establishment and maintenance of the trials in 2015

Details from the four trials are shown in Table 6. Seed of *Agrostis stolonifera* 'Valderrama' arrived late and was therefore seeded 2-3 weeks after the the other varieties at all sites except Sydsjælland. Turfgrass establishment was uniform in Reykjavik (Photo 2) and at Apelsvoll (Photo 3) but for unknown reason, some of the bentgrass plots established poorly and had to be reseeded twice at Landvik (Photo 4). Presumably due to inadequate irrigation, this was also the case for several plots of small-seeded species at Sydsjælland (Photo 5) Most of these problems were resolved in August and early September, and after that, all trials were assessed monthly for coverage and visual turf quality

Photo 2. Trial in Reykjavik on 30 July 2015, about six weeks after seeding. In this trial, mowing was very lenient in the seeding year.

Photo: Gudni Thorvaldsson.

Photo 3. Trial at Apelsvoll on 31 July 2015. All plots established nicely.

Photo: Wendy Waalen.

Table 6. Green type seeding dates and management in the seeding year 2015.

		Reykjavik	Apelsvoll	Landvik	Sydsjælland
Type of green		USGA-spec.	USGA-spec.	USGA-spec.	USGA-spec.
Year of construction		2007	2003	2003	2006
Type of organic matter in rootzone		Soil	3-30 cm: Composted garden waste	0-3 cm: Peat 4-30 cm: Composted garden waste	*Sphagnum* peat
Seeding date		22 June Ca 10 July: Valderrama	19 June 6 July: Valderrama	6-9 June 12 June: Mirador 7 July: Valderrama Reeseeding of problem plots: 23 July and 11 Aug.	24 June 26 Aug: Reseeding of all *Agrostis* sp. + *Poa trivialis* + mixtures
Preplant fertilizer	Type	Everris Pre-seeder 18-22-5	Grønn 8K dried chicken manure + bonbe meal	Marihøne 8-5-4 Plus dried chicken manure + bone meal	-
	N / P / K, g m^{-2}	9.0 / 4,8 / 2.1	5.0 / 1.9 / 3.1	5.0 / 3.1 / 2.5	-
Plots covered by tarp after seeding / days		Yes/11 days	No	Yes / 12 days	Yes (plots covered both after seeding and reseeding)
Ferti-lization after seeding	Fertilizer type(s)	Everris 18-22-05, Everris 19-19-5, Angus 12-3-9 and 6-5-11	Andersson 13-2-13 Arena Golf NK 13-15 Scotts Zero Phosphate 14-0-10	Andersson 13-2-13 Greenmaster 14-0-10 Wallco 5-1-4	G-Boost 20-0-4, G-Beast 6-6-6, G Kalimax 21-0-17 +Bionutria Ca + micro
	First application after seeding	30 June	6 July	25 June	Ca 20 July
	Last application before winter	29 Sept.	28 Sept.	27 Oct.	Last N: Wk 41. Last: K, Mg, S and Micro: wk 48
	Number of applications	16	9	13	9
	Total rate of N, P and K, to *A.stolonifera, Poa* sp., *L.perenne,* and high input mixtures, g m^{-2}	9.6/4.5/7	25 / 6 / 17	29 / 6 / 21[1] + 12 / 5 / 7 (on plots reseeded many times)	8.2 / 2.1 / 10.9 + preplant Samme rate to all species
	Total rate of N, P and K, to *F. rubra, A.capillaris, A.canina,* and low input mixtures g m^{-2}	6,7-3,2-4,9	17 / 5 / 11	20 / 5 / 14	
Mowing	Type of mower	Walk-behind	Walk – behind	Walk – behind	Rotary mower in Aug. before reseeding. Sep- Oct: Triplex
	First mowing after seeding	3 July	16 July	24 June	10 Aug (Only fescue and *Lolium* plots)
	Height of cut at first mowing	15 mm	9 mm	11 mm	-
	Lowest height in *Agrostis* sp., *Poa annua and Poa trivialis*	7 mm	4 mm	4.5 mm	-
	Lowest height in *Festuca/Lolium/Poa pratensis*	7 mm	6 mm	6 mm	-
	Last mowing before winter / height	29 Sept.: /7mm	12 Oct.: 4 / 6 mm	2 Nov.: 4.5 / 6 mm	-
Top-dressing	Type of sand	Pure sand, grain size 0-1 mm	Pure sand, grain size 0.2 – 0.7 mm	Pure sand, grain size 0.2 – 0.7 mm	-
	Number of applications	4	4	13	-
	Total height	4-5 mm	1.7 mm	2.8 mm	-
Verticutting, aeration		None	None	None	None

Photo 4. SCANGREEN trial at Landvik on 31 July. A few plots of Agrostis have been reseeded and are covered by white, permeable tarp.

Photo: Trygve S. Aamlid.

Photo 5. Seeding the SCANGREEN trial at Sydsjælland GK on 25 June 2015.

Photo: Anne Mette Dahl Jensen.

Photo 6. : SCANGREEN trial at Sydsjælland on 31 July 2015. Plots of Agrostis sp. and Poa trivialis had established poorly due to inadequate irrigation / poor seed-soil contact and therefore had to be reseeded in August.

Photo: Anne Mette Dahl Jensen.

Photo 7. SCANGREEN trial in Reykjavik on 24 Sept. 2015. Establishment was better than in earlier SCANGREEN trials on Iceland.

Photo: Gudni Thorvaldsson.

2.4.2 Winter 2015-16 and management in 2016

The ice cover in winter 2015-16 was long in Reykjavik and at Apelsvoll. *Lolium sp*. and *Poa annua* had to be reseeded in Reykjavik (Photo 8). Due to the reseeding and a following dry period in July, the trial received a lot of irrigation this year.

At Apelsvoll all species were reseeded in the beginning of June (Photo 9). At Landvik and Sydsjælland there were few winterdamages and no need for reseeding. At Landvik *Poa annua* 'Two Put' had severe injuries from microdochim patch (Photo 10), but it recovered without reseeding.

Management of the four trials in 2016 was mostly according to the protocol except that wear treatements were not conducted after reseeding at Apelsvoll (Table 7).

Photo 8. SCANGREEN trial in Reykjavik on 12 June 2016. Plots with Lolium perenne (back row) and Poa annua (three plots in central row)) had to be reseeded.

Photo: Gudni Thorvaldsson.

Photo 9. Reseeding all plots at Apelsvoll on 1-3 June 2016.

Photo: Wendy Waalen.

Table 7. Winter weather 2015-16 and green management of in 2016.

		Reykjavik	Apelsvoll	Landvik	Sydsjælland
Snow cover during winter	Duration of snow or ice cover	61 days	Snow: 90 days Ice: 60 days	6 periods with snow 56 days in total	9 days
	Soil frozen under snow or ice	49 days	From 25 Dec to 10 Apr.	Frozen only 21 days (mainly March)	9 days
Re-seeding	Species that had to be reseeded	*Lolium perenne* *Poa annua*	All species	None	None
	Reseeding, date	June 23	1-3 June	-	
Ferti-lization	Fertilizer type(s)	N-xt 9-5.5 Ammonium-sulfate Potassium-nitrate Angus 12-3-9 Iron sulfate	Arena Start 15-5-7 Arena Fairway 15-3-8 Scotts 12-0-9 Fe Arena Golf 13-0-15	Wallco 5-1-4 (liquid) Greenmaster 14-0-10 (granular) Andersson 13-2-13 (granular), Mn-sulfate	G Boost 20-0-4 G Beast 6-6-6 G Kalimax 21-0-17 Mg-sulfate Mn-sulfate Cu sulfate
	First application in spring	About 10 June	15 June (2 weeks (after reseeding)	6 April	4. April
	Last application before winter	About 1 Oct.	7. Oct.	1 Nov.	23 Oct.
	Number of applications	13	9	17	15
	Total rate of N, P and K, to *A.stolonifera and Poa spp.,* kg /100 m^2	12.5 / 1.5 / 9.8	24.5 / 3.3 / 16.3	15.8 / 1.8 / 12.4	25.9 / 2.3 / 23.8
	Total rate of N, P and K, to *A.capillaris, A.canina and F.rubra,* g m^{-2}	7.8 / 0.9 / 6.1	16.5 / 2.3 / 1.08	10.3 / 1.2 / 8.1	13.0/1.2/11.9
Mowing	Type of mower	Walk-behind	Walk-behind	Walk-behind	Triplex
	First in spring: Date / height	25 April / 5 mm.	14 June	8 April / 6.5 mm all species	6 mm
	Lowest height in *Agrostis sp. / P. tivialis / P.annua*	4 mm	4 mm	3 mm	4.2 mm
	Lowest height in *Festuca /Lolium/Poa pratensis*	5 mm	6 mm	5 mm	5 mm
	Last before winter: Date / height	7 Oct.	7 Oct., 4mm / 7 mm	28 Oct, 3 mm / 7 mm	3. Nov./ 6 mm
Irrigation	Number of times	93 (due to reseeding)	35	30	6
	Total quantity	372 mm	300 mm	460 mm	-
Top-dressing	Type of sand	Pure sand	Pure sand	Pure sand	Green Mix light (0.8 % OM)
	Number of applications	15	6	23	10
	Total height	-	3 mm	7.5 mm	-
Veriti-cutting	No of times, Agrostis	4	0	0	0
	No of times, other species	2	0	0	0
Slicing, 5 cm depth	No of times, *Agrostis*	0	2	8	0
	No of times, other species	0	2	8	0
Spiking, 6 mm tines	No of times, *Agrostis*	5	0	4	5
	No of times, other species	5	0	4	0
Deep aeration	Date	-	2. Nov	-	Dot machine
	Equipment, depth	-	Digging fork, 10 cm	-	16 cm
Rolling with wear machine	Number of passes	35 (11700 rounds of golf)	0	63 (21000 rounds of golf)	32 (16700 rounds of golf)

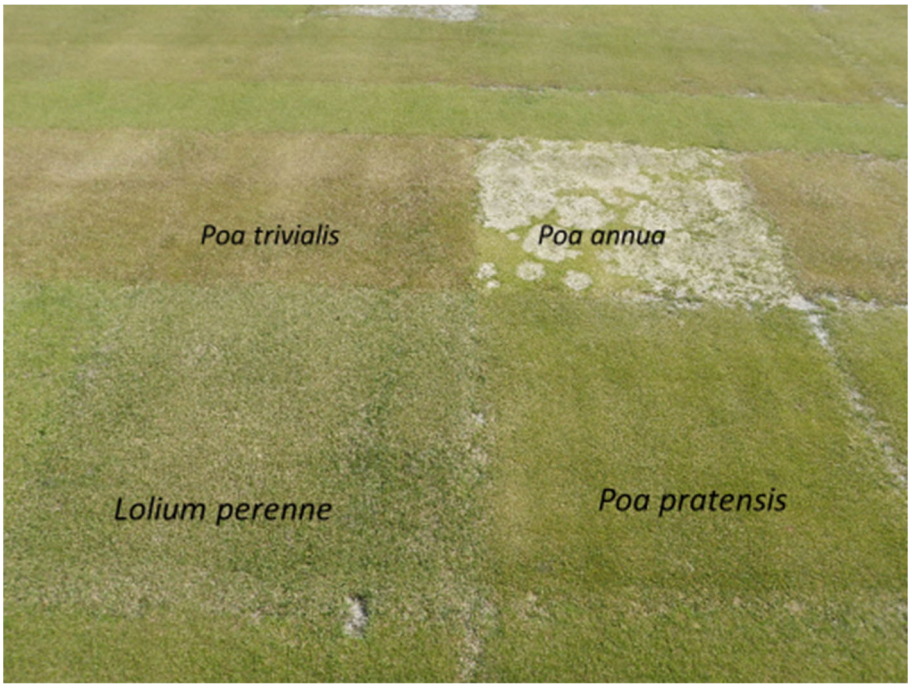

Photo 10.: Four species in SCANGREEN trial at Landvik on 6 May 2016. The only variety with severe winter injury (caused by microdochium patch) was Poa annua 'Two Put'.

Photo: Trygve S. Aamlid.

2.4.3 Winter 2016-17 and management in 2017

The duration of snow in Reykjavik and at Apelsvoll during the winter 2016-17 was not as long as the year before (Table 8). No species had to be reseeded in Reykjavik. At Apelvoll there was long-lasting ice cover (Photo 11), but it was crushed three times in January and February and never became very compact. In March we also spread granules of LECA to melt the ice at Apelsvoll (Photo 12). Despite this, all varieties of *Lolium sp.*, *Poa trivialis* and *Poa annua,* as well as *A. stolonifera* 'Pure Distinction' and *Agrostis capillaris* 'Charles' were dead and had to be reseeded in the beginning of June (Photo 13).

The second winter at Landvik was mild, and there was only some snow mold damage (Photo 14) . At Sydsjælland there were few winter damages and no need for reseeding, but the plots with *Poa trivialis* did not thrive and produced a dark purple color (Photo 15).

Table 8. Winter-weather 2016-17 and green management in 2017.

		Korpa	Apelsvoll	Landvik	Sydsjælland
Snow cover during winter	Duration of snow or ice cover	40 days	Snow:Feb-Mar. Ice:1 Dec-15 Mar.	16 days in Feb. + 10 days in March	11 days (snow)
	Soil frozen	Only a few days	1 Dec-15 Mar	16 days in Feb.	11 days
Re-seeding	Species / varieties / seed mixtures that had to be reseeded	None	*Poa trivialis* (all) Lolium *perenne* (all) Pa: 'Two Put', Ast: 'Pure Distiction', Acap: 'Charles' Mixture: Pa + Ast	None	None
	Reseeding, date	-	1 June	-	-
Fertilization	Fertilizer type(s)	PionerGreen 18-2-15 Ammonium-sulfate Potassium-nitrate Angus 12-3-9 Iron sulfate	Arena Høst Extra, Greenmaster 14-0-10, Arena Golf N, Proturf 12-5-20 Proturf 18-0-7	Wallco 5-1-5 (liquid) Greenmaster Cold Start Greenmaster 14-0-10 (granular)	G Boost 20-0-4 G Beast 6-6-6 G Kalimax 21-0-17 Mg-sulfate Mn-sulfate Cu- sulfate
	First application in spring	3 May	19 May	5 April	3 April
	Last application before winter	6 Oct.	1 Oct.	31 Oct.	18 Nov.
	Number of applications	15	11	16	17
	Total rate of N, P and K, to *A.stolonifera and Poa spp.,* g m^{-2}	15.4 / 1.9 / 11.5	15.4 / 2.4 / 18.7	14.6 / 1.63/ 9.93	30.4 / 3.4 / 26.0
	Total rate of N, P and K, to *A.capillaris, A.canina and F.rubra,* kg /100 m^2	9.6 / 1.2 / 7.2	10.0 / 1.6 / 12.2	9.5 / 1.1 / 6.5	17.5 / 2.3 / 14.1
Mowing	Type of mower	Walk Behind	Walk behind	Walk behind	Triplex
	First in spring: Date, height	3 May, 6 mm	19 May, 6mm	3 April , 5 / 7 mm	4 April, 6 mm
	Lowest height in *Agrostis sp.,* P. annua, P. trivialis	4 mm	4 mm	3 mm	4.2 mm
	Lowest height in *Festuca/Lolium/P.pratnsis*	5mm	6 mm	5 mm	5 mm
	Last before winter: Date / height	19 Oct.	18 Oct., 4 / 6mm	3.Nov., 3 / 7 mm	16 Nov./ 6 mm
Irrigation	Number of times	36	60	23	6
	Total quantity, mm	176 mm	600 mm	450 mm	-
Top-dressing	Type of sand	Pure Sand	Pure sand	0.3-0.5 mm	Green Mix light, 0.8 % OM
	Number of applications	8	9	31	8
	Total quantity	8 mm	-	7,75 mm	-
Veritcal mowing	No of times, Agrostis	4	0	0	0
	No of times, other species	2	0	0	0
Slicing, 5 cm depth	No of times, *Agrostis*	0	0	10	0
	No of times, other species	0	0	10	0
Spiking, 6 mm tines	No of times, *Agrostis*	2	9	1	5
	No of times, other species	2		1	0
Deep aeration,	Date	24 okt		-	Dot machine
	Equipment, depth	20cm		-	16 cm
Rolling with wear machine	Number of passes	35 (about 12000 rounds of golf)	10 (3333 rounds of golf)	43 (14330 rounds of golf)	28 (16700 rounds of golf)

Photo 11. SCANGREEN trial at Apelsvoll on 3 January 2017. The ice was 2-5 cm thick but porous.

Photo: Pia Heltoft.

Photo 12. SCANGREEN trial at Apelsvoll on 3 April 2017, shortly after snow and ice melt. First row comprises Poa pratensis 'Limousine' (green) and three varieties of Lolium perenne (all dead). Black granules (LECA) had been spread to melt the ice.

Photo: Pia Heltoft.

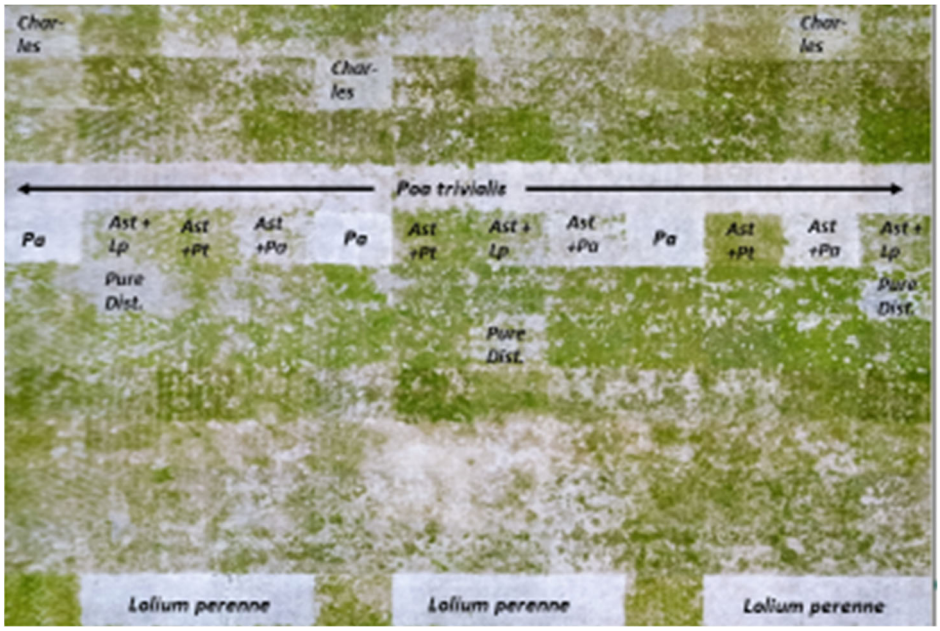

Photo 13. Photo taken from a drone over the SCANGREEN trial at Apelsvoll on 4 May 2017.

Photo: Maximilian Pircher

Photo 14. SCANGREEN trial at Landvik on 23 March 2017: Some snow mold, but no severe winter damage.

Photo: Trygve S. Aamlid

Photo 15: SCANGREEN trial at Sydsjælland in June 2017. Nearest row with brown plots are Poa trivialis.

Photo: Per Sørensen.

Photo 16. SCANGREEN trial at Korpa GC, Reykjavik, on 10 Oct. 2017.

Photo: Gudni Thorvaldsson.

2.4.4 Winter 2017-18 and management in 2018

The winter 2017-18 resulted in severe damages due to ice and melting water at Landvik. The damages were worse than at Apelsvoll, and all plots had to be reseeded in spring (Photos 17-21). For that reason and due to the dry summer the irrigation at Landvik in 2018 was twice as high as the preceding years (Table 9).

At Apelsvoll the snow was removed until mid January (Photo 22). The winter was more stable than at Landvik, and reeeding was limited to the same species, varieties and seed blends as the year before (Photo 23).

Photo 17. Landvik, 7 January 2018. High winter precipitation and fluctuating temperature resulted in ice and water damage.

Photo: Trygve S Aamlid

Photo 18. Ice-encased SCANGREEN-trial at Landvik, early March 2018. The snow had been removed two days before.

Photo: Trond Pettersen

Table 9. Winter weather 2017-18 and green management in 2018.

		Korpa	Apelsvoll	Landvik	Sydsjælland
Snow cover during winter	Duration of snow or ice cover	89 days (mostly snow)	Snow removed until mid-January. Porous ice cover: 90days	Ice: 16 days in Jan., 57 days from early Feb. to early April	15 days (snow)
	Soil frozen	85 days	1 Dec. -10 Apr.	5 -22 Dec. 5 Jan. - 9.Apr	15 days
Re-seeding	Species that were reseeded	None	*Poa trivialis* (all) Lolium *perenne* (all) Pa: 'Two Put', Ast: 'Pure Distiction', Acap: 'Charles' Mixture: Pa + Ast	All	None
	Reseeding, date	-	8 June and 5July	26 April – 3 May	-
Fertilization	Fertilizer type(s)	Pioner Green 18-2-15 Ammonium-sulfate Potassium-nitrate Angus 12-3-9 Iron sulfate	Greenmaster 14-0-10, Arena Høst Extra 7-4-15, Scotts Fairway 12-0-12, Scotts 12-6-9, Greenmaster Pro-Lite Zero P.	Greenmaster Cool Start 11-5-5, Wallco 5-1-4, Greenmaster 14-0-10	G Boost 20-0-4 G Beast 6-6-6 G Kalimax 21-0-17 Mg-sulfate Mn-sulfate Cu sulfate
	First application in spring	19 April	30 April	24 April	9 April
	Last application in fall	4 Oct.	1 Oct.	7 Nov.	22 Oct.
	Number of applications	13	12	17	15
	Total rate of N, P and K, to *A.stolonifera and Poa spp.*, g m^{-2}	14.0 / 1.9 / 11.5	15.4 / 5.6 / 15.5	30.0 / 6.2 / 20.4	25.9 / 2.3 / 23.8 Extra 8. Sep. 4.5 / 1.1 / 2. 2
	Total rate of N, P and K, to *A.capillaris, A.canina and F.rubra,* kg /100 m^2	9.6 / 1.2 / 7.2	10.0 / 3.6/ 1,0	14.6 / 1.63 / 9.9	13. 0 / 1.2 /11.9 Extra 8. Sep. 4.5 / 1.1/ 2.2
Mowing	Type of mower	Walk Behind	Walk behind	Walk behind	Triplex
	First in spring: Date / height	8 May / 7 mm	7 May / 6 mm	16 May / 10 mm (after reseeding)	9 April / 6 mm
	Lowest height in *Agrostis, Poa annua, Poa trivialis*	4 mm	4 mm	3 mm	4.2 mm
	Lowest height in *Festuca/Lolium/P.pratensis*	4.5 mm	6 mm	5 mm	5 mm
	Last before winter: Date / height	19 Oct.	15 Oct. 4 mm / 6 mm	15. Oct. 5 mm / 7 mm	18 Nov./6 mm
Irrigation	Number of times	8	60	48	6
	Total quantity, mm	38 mm	600 mm	900 mm	-
Top-dressing	Type of sand	Pure Sand	Pure sand	Pure sand, 0.3-0.5 mm	Green Mix light 0.8 % OM
	Number of applications	7	6	20	8
	Total height	10 mm	?	5 mm	?
Veritcal mowing	No of times, Agrostis	4		1	0
	No of times, other species	2		1	0
Slicing, 5 cm depth	No of times, *Agrostis*	0		4	0
	No of times, other species	0		4	0
Spiking, 6 mm tines	No of times, *Agrostis*	3	5	1	4
	No of times, other species	3		1	0
Deep aeration,	Date	0		-	Dot machine
	Equipment, depth	0		-	16 cm/dec. 17
Rolling with wear machine	Number of passes	32 (9667 rounds of golf)	17 (5667 rounds of golf)	34 (10333 rounds of golf	22 (7300 rounds of golf)

Photo 19. Landvik, 20 March 2018. The ice was crushed several times during winter, but it did not help much for turfgrass survival.

Photo: Trygve S Aamlid

Photo 20. Landvik, 22 April 2018. Most plots were dead.

Photo: Trygve S Aamlid

Photo 21. Landvik, 7 May 2018. Coverage with tarp and frequent irrigation after reseeding.

Photo: Trygve S Aamlid

Photo 22. SCANGREEN trial at Apelsvoll on 21 April 2018. Removal of the snow until 15 January caused the green to become bare earlier than surrounding areas.

Photo: Trygve S Aamlid

Photo 23 : Eric Watkins, Maria Strandberg and NIBIO scientists studying winter survival in SCANGREEN trial at Apelsvoll, 28 April 2018. Dead and surviving plots in foreground are Lolium perenne and Poa pratensis, respectively.

Photo: Lily Watkins.

Photo 24 : SCANGREEN trial in Reykjavik on 24 April 2018. Poa trivialis (all varieties in 6th column from the left), Poa annua 'Two Put' and the mixture of Agrostis stolonifera + Poa annua (single plots in 8th column from the left) were weakened by the winter, but they recovered during the next weeks without being reseeded.

Photo: Gudni Thorvaldsson.

Photo 25. Icelandic greenkeepers visiting SCANGREEN trial on 12 Dec. 2018.

Photo 26. The last registrations at Sydsjælland, November 2018.

Photo: Per Sørensen.

2.5 Assessments, statistical analyses and presentation of results

The trials were rated at monthly intervals for visual turf quality and most other characters. The complete observation program is outlined in the protocol in Appendix 1.

At all sites, the assessments were undertaken by experienced researchers/technicians. However, as no attempt was made to harmonize the use of scales at the four locations, values should not be used to compare turfgrass quality between the four sites.

The seed blends and seed mixtures were rated in the same way as the pure varieties and speices. For the assessment of *Lolium perenne*, *Poa trivialis* or *Poa annua* and as nurse grasses for *Agrostis stolonifera* 'Independence', we used pure 'Independence' as the control. For the evaluation of *Agrostis capillaris* 'Jorvik', *A. stolonifera* 'Independence' (both at two management regimes) and *A.canina* (fescue management) as companions for red fescue (50 % *F.rubra* ssp. *commutata* 'Musica' and 50 % *F.rubra* ssp. *litoralis* 'Cezanne') we used the pure fescue blend as control at fescue management and 'Independence' as control at creeping bentgrass management. At Landvik, the botanical composition on the mixed plot was determined by counting tillers in five core samples, each 19 mm in diameter, taken from each plot in October 2015, 2016 and 2017. A fouth sampling was planned by the end of the trial in October 2018 but had to be cancelled because of the complete winter kill in spring 2018. Instead, we determined in October 2018 the botanical composition of the same treatments which had been reseeded in June 2016 at Apelsvoll.

The experimental data were analyzed using the procedure PROC ANOVA (SAS Institute 2002). For comparison of species, values for all varieties (subplots) within each main plot (species) were averaged before the analyses. If on one date ?? all species had not been assessed due to slow establishment, winter damage or other reasons, these data were excluded from the comparions of species, but not from the observation of varieties within species.

The results for species and varieties within species were analysed separately for each of the four sites, for the northern climatic zone including Reykjavik and Apelsvoll, for the southern climatic zone including Landvik and Sydsjælland, and in one overall analyses including all four sites. When analysing data across sites, the main effect of species (varieties) and the interaction site x species (site x variety) were tested against species x block within site (variety x block within site) as the error term.. Whenever significant ($P \leq 0.05$) differences occurred, the Least Significant Difference (LSD) was calculated for comparison of species or varieties. *P*-values in the range 0.05-0.20 were referred to as 'tendencies'.

The results are presented in Tables 10-19. In these tables, species or varieties have been ranked for decreasing overall turf quality. In cases where two or more species (varieties) had the same scores, they were ranked secondly for increasing winter damage and thirdly for increasing infection of in-season diseases. This ranking was done to evaluate which species and varieties best suited for Integrated Pest Management, or even Pesticide-Free Management, of putting greens in the Nordic countries.

3 Results and discussion

3.1 Comparison of pure species (Table 10)

3.1.1 *Agrostis stolonifera*

The plots with creeping bentgrass were the most dense plots in the whole trial, and at Landvik it performed the highest turf quality score among species. In the southern testzone it was evaluated with the best overall quality together with Kentucy bluegrass.

3.1.2 *Agrostis capillaris*

As for creeping bentgrass the plots with colonial bentgrass were among species the most dense plots in the whole trial. Compared to the other traditionally green grasses the colonial bentgrass is more susceptible to *Microdochium nivale* in winter and *Microdochium* patch in summer. Take all patch was registered at Landvik and Sydsjælland and here the colonial bentgrass was more affected than the creeping bent.

3.1.3 *Agrostis canina*

The velvet bentgrass was not included at Landvik due to space limitations. At Sydsjælland it performed well in the first two evaluation years, but not in 2018. In the northern climatic zone it performed slightly better than colonial bentgrass.

3.1.4 *Festuca rubra ssp. commutata*

In the northern zone the Chewings fescue performed slightly better than the slender creeping fescue. At Iceland there were a lot of moss in the trial and especially in the plots with fescues. In the southern climatic zone it was ranged just below the slender creeping fescue in overall turf quality. The biggest difference between the two subspecies of fescue was at Landvik.

3.1.5 *Festuca rubra ssp. litoralis*

The slender creeping fescue were more suceptible to Microdochium patch (in season) than the creeping bentgrass. At Iceland there were a lot of moss in the trial and especially in the plots with *Festuca sp*.

3.1.6 *Lolium perenne*

The perennial ryegrass (cut at 5 mm) is not a good alternative when seeded in pure stand on greens. At Apelsvoll it had to be reseeded every spring. At Iceland the density of the perenniel ryegrass plots were very low and it got invaded by a lot of moss. The plots with ryegrass died in winter of abiotic damages and not because of diseases.

3.1.7 *Poa trivialis*

Like *Lolium perenne*, this species was not a good alternative when seeded in pure stand. At Apelsvoll it had to be reseeded every spring. Together with *Agrostis capillaris* and *Festuca rubra* ssp *litoralis*, the *Poa trivialis* was the most suceptible to *Microdochium nivale* on average for four sites.

3.1.8 *Poa annua*

This was the lowest ranked species on average for all sites. It is the second time we have tested a registered US variety of *Poa annua* ssp. *reptans* ('creeping bluegrass') in the SCANGREEN program. 'True Putt' received the lowest ranking in the first test round from 2003 to 2006 (Aamlid & Molteberg 2011) and 'Two Putt' performed no better this time. Among the weaknesses of 'Two Put' was virtually no resistance to micordochium patch (Photo 10) and very poor winter hardiness.

3.1.9 *Poa pratensis*

In the first trial year the Kentucy bluegrass performed the highest turf quality score in the Icelandic trials and performed very well also at the other sites. At Apelsvoll, the winter survival of Kentucy bluegrass was on level with creeping bentgrass and better than the other species. Half way through the project period the highest quality scores were still obtained by Kentucy bluegrass. This was due to less winter damages and better disease resistance than in any other species. However, the leaves of Kentucy bluegrass were coarse and stiff and the playing quality remains to be evaluated. At Landvik the plots with Kentucy bluegrass were invaded by *Poa annua* and other grass species in the last evaluation year and this also declined the playing quality (Photo 27). All in all, the results did not show that Kentucy bluegrass can perform as a green grass, but the trials confirmed that new and dense varieties of this species can tolerate lower mowing than we normally recommend.

Photo 27. Landvik, 18 Nov. 2018: First (closest) row left/right: Poa annua 'Two Put' / Poa pratensis 'Becca'. Second row: Poa trivialis 'Qasar' / Poa pratensis 'Limousine'. Third row: Poa trivialis 'Dark Horse' / Lolium perenne 'Chardin'. Fourth row: Poa trivialis 'Winterway' / Lolium perenne 'Clementine'. Fifth and most distant row: Poa trivialis 'Sabrena 1' / Lolium perenne 'Rinovo'. Notice microdochium patces in Poa annua 'Two Put' and contaminating grasses in Poa pratensis

Photo Trygve S. Aamlid

Table 10. Ranking of species after four years testing on putting greens in SCANGREEN trials at a) Korpa GC (Iceland); b) NIBIO Apelsvoll Research Center (Norway); c) average for Korpa and Apelsvoll representing the northern climatic zone of Scandinavia; d) Sydsjælland GC (Denmark), e) NIBIO Landvik Research Center (Norway), f) average for Sydsjælland and Landvik representing the southern climatic zone of Scandinavia; and g) average for all four test sites. Means of varieties within each species.

a) Reykjavik GC, Iceland (northern climatic zone)

	Turfgrass quality (1-9)																	In-season diseases, %						
No of observations	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall	Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	Total	Micro-dochum	Red thread	Take-all	Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	17	3	5	5	4	1	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
PP	6.3	6.7	7.1	6.5	5.1	7.2	6.3	5.9	-	6.3	4.8	7.5	4.0	3.1	-	-	92	0.0	0.0	-	-	0.0	8.3	0.61
AS	5.5	4.6	5.0	5.6	6.4	5.0	5.3	6.4	-	6.9	5.6	6.4	5.1	8.2	-	-	90	1.8	1.8	-	-	1.8	7.0	0.44
FRC	5.1	5.1	5.4	5.9	4.0	5.6	5.2	4.8	-	5.3	5.7	4.0	6.9	6.0	-	-	89	0.8	0.8	-	-	0.8	13.3	0.69
FRL	4.5	3.8	4.7	5.1	4.1	4.6	4.6	4.2	-	5.3	4.9	6.5	6.9	4.1	-	-	87	3.4	3.4	-	-	3.4	14.6	0.69
PT	4.4	6.3	5.1	4.2	3.1	4.0	4.3	5.1	-	6.0	6.0	4.5	5.8	29.6	-	-	78	1.2	1.2	-	-	1.2	13.3	0.88
ACAN	4.3	3.6	4.1	4.5	4.6	3.7	4.2	4.7	-	6.7	4.5	5.0	6.0	7.2	-	-	85	4.1	4.1	-	-	4.1	10.0	0.41
PA	4.3	7.3	2.7	3.9	4.6	2.2	4.3	5.4	-	6.9	3.7	6.0	4.3	49.0	-	-	79	6.9	6.9	-	-	6.9	5.0	0.59
ACAP	4.0	4.3	3.6	4.2	4.0	3.6	4.0	4.3	-	6.6	5.2	5.0	5.9	14.0	-	-	81	1.3	1.3	-	-	1.3	10.9	0.53
LP	3.2	6.3	2.9	3.3	1.8	2.1	3.5	3.2	-	5.3	5.2	7.5	3.7	53.8	-	-	63	0.0	0.0	-	-	0.0	21.1	1.06
P%	<0.1	<0.1	<0.1	<0.1	<0.	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1
LSD 5%	0.4	0.5	0.6	0.8	0.5	0.8	0.4	0.6	-	0.2	0.1	0.1	0.1	5.7	-	-	4	2.1	2.1	-	-	2.1	4.8	0.08

Abbreviations: ACAN: *Agrostis canina* (velvet bentgrass, ' Villa'); ACAP: *Agrostis capillaris* (colonial bentgrass / browntop, mean of 5 varieties); AS: *Agrostis stolonifera* (creeping bentgrass, mean of 9 varieties); FRC = *Festuca rubra* ssp. *commutata* (Chewing's fescue, mean of 5 varieties); FRL = *Festuca rubra* ssp. *litoralis* (slender creeping red fescue, mean of 4 varieties); LP: *Lolium perenne* (perennial ryegrass, mean of 3 varieties); PA: *Poa annua* (annual bluegrass / annual meadow grass, 'Two Put'; PP= *Poa pratensis* (Kentucky bluegrass / smooth (stalked) meadowgrass 'Limousine'); PT: *Poa trivialis* (rough bluegrass /rough (stalked) meadow grass, mean of 4 varieties). .

Table 10. Mean values for species (continued)

b) NIBIO Apelsvoll Research Center, Norway (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	1	6	5	1	2	3	3	0	19	12	12	0	0	16	0	6
FRL	5.8	5.6	7.1	6.7	4.2	4.3	6.2	6.3	51	4.8	6.2	4.8	6.0	34	4.7	-	94	0.7	0.7	-	-	1.7	-	0.73
PP	5.7	3.4	8.4	6.9	4.4	4.9	5.7	6.0	23	4.8	6.0	8.0	4.0	24	4.6	-	93	0.3	0.3	-	-	1.3	-	0.51
AS	5.6	5.3	6.7	6.1	4.7	4.7	6.1	5.8	43	6.3	6.4	6.3	6.6	31	6.6	-	91	1.4	1.4	-	-	2.7	-	0.50
FRC	5.5	5.5	7.0	6.9	3.3	3.9	6.1	5.7	50	4.8	5.8	3.3	6.0	42	7.5	-	90	1.5	1.5	-	-	2.5	-	0.86
ACAN	5.4	6.0	5.7	6.2	4.1	4.2	6.2	5.1	50	7.0	6.4	7.0	7.0	47	14.7	-	92	6.1	6.1	-	-	7.4	-	0.31
ACAP	4.5	4.9	5.3	5.3	2.9	3.4	4.8	4.7	52	6.2	5.9	4.9	6.0	63	10.3	-	81	5.8	5.8	-	-	6.2	-	0.44
LP	4.2	4.0	8.4	3.7	2.1	1.2	4.3	6.0	74	3.8	6.8	-[1]	3.1	100	-[1]	-	68	-[1]	-[1]	-	-	-[1]	-	-[1]
PA	3.8	6.1	5.4	3.9	1.1	1.3	4.2	4.8	62	4.3	6.2	-[1]	3.0	98	-[1]	-	60	-[1]	-[1]	-	-	-[1]	-	-[1]
PT	3.8	6.3	6.9	2.6	1.0	0.6	3.6	5.8	45	4.4	6.5	-[1]	4.0	100	-[1]	-	56	-[1]	-[1]	-	-	-[1]	-	-[1]
P%	<0.1	<1	<0.1	<0.1	<0.	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<5	-	<0.1	<0.1	<0.1	-	-	<0.1	-	<0.1
LSD 5%	0.7	1.2	0.6	0.4	1.4	0.9	0.7	0.6	10	0.4	0.3	0.9	0.3	19.6	5.5	-	6	0.7	0.7	-	-	1.0	-	0.09

[1]Winter color, diseases and daily height growth could not be assessed for *Poa annua*, *Poa trivialis* and *Lolium perenne* at Apelsvoll since the turf was dead and had to be reseeded in spring in all three evaluation years.

Table 10. Mean values for species (continued)

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	0	2	2	2	0	0	16	1	2
PP	6.0	5.1	7.7	6.7	4.7	6.0	6.0	5.9	23	5.5	5.4	7.8	4.0	13.5	4.6	-	93	0.1	0.1	-	-	0.7	8.3	0.56
AS	5.6	4.9	5.8	5.9	5.6	4.8	5.7	6.1	43	6.6	6.0	6.3	5.9	19.3	6.6	-	91	1.6	1.6	-	-	2.2	7.0	0.47
FRC	5.3	5.3	6.2	6.4	3.6	4.7	5.6	5.3	50	5.1	5.7	3.6	6.5	24.2	7.5	-	90	1.1	1.1	-	-	1.6	13.3	0.77
FRL	5.1	4.7	5.9	5.9	4.1	4.4	5.4	5.3	51	5.1	5.5	5.7	6.5	19.2	4.7	-	90	2.0	2.0	-	-	2.5	14.6	0.71
ACAN	4.8	4.8	4.9	5.3	4.4	3.9	5.2	4.9	50	6.8	5.5	6.0	6.5	27.1	14.7	-	88	5.1	5.1	-	-	5.8	10.0	0.36
ACAP	4.2	4.6	4.5	4.8	3.5	3.5	4.4	4.5	52	6.4	5.6	5.0	6.0	38.4	10.3	-	81	3.6	3.6	-	-	3.8	10.9	0.49
PT	4.1	6.3	6.0	3.4	2.0	2.3	4.0	5.4	45	5.2	6.3	-	4.9	64.7	-	-	67	-	-	-	-	-	13.3	-
PA	4.0	6.7	4.1	3.9	2.8	1.8	4.3	5.1	62	5.6	5.0	-	3.6	73.7	-	-	70	-	-	-	-	-	5.0	-
LP	3.7	5.2	5.7	3.5	1.9	1.6	3.9	4.6	74	4.5	6.0	-	3.4	76.9	-	-	66	-	-	-	-	-	21.1	-
P%	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<5	-	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1
LSD 5%	0.4	0.7	0.4	0.4	0.7	0.6	0.4	0.4	10	0.2	0.1	0.4	0.1	9.8	3	-	3	1.0	1.0	-	-	0.05	4.8	0.05
Interaction species x site	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	-	-	<0.1	-	<0.1

Table 10. Mean values for species (continued)

d) Sydsjælland GC, Denmark (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	0	4	6	7	4	9	4	0	16	10	2	6	3	3	0	17	8	5	1	3	9	6	0
PP	5.8	-	5.0	5.9	6.6	5.5	5.9	6.5	-	6.1	5.4	7.0	3.8	0.3	0.3	-	92	24.0[2]	0.0	0	0	0.2	1.6	-
AS	5.2	-	5.0	4.9	5.7	5.5	5.1	5.6	-	6.9	6.1	4.2	4.9	2.1	2.1	-	98	0.1	0.1	0	0.1	1.5	0.3	-
ACAN	4.9	-	5.3	5.3	4.1	5.5	4.6	5.0	-	6.7	4.7	5.0	5.9	3.8	3.8	-	97	2.4	4.9	0	0	4.6	1.4	-
FRL	4.7	-	4.5	5.1	4.4	4.5	4.8	4.7	-	5.5	4.5	4.5	7.0	2.6	2.6	-	95	1.5	3.0	0	0	3.0	6.0	-
FRC	4.6	-	4.4	5.0	4.4	4.3	4.7	4.8	-	5.5	4.4	4.5	7.2	3.1	3.1	-	94	2.1	2.5	0	0	4.0	6.6	-
ACAP	4.3	-	4.6	4.6	3.7	5.2	3.8	4.5	-	5.7	5.7	5.2	5.5	4.1	4.1	-	97	1.5	1.8	0	0	4.1	2.0	-
LP	3.6	-	2.7	4.7	3.4	3.9	3.8	3.2	-	3.3	5.9	6.1	3.4	0.7	0.7	-	94	4.1	1.0	3.6	0	0.7	4.3	-
PT	3.0	-	4.8	3.3	1.0	1.9	2.9	3.8	-	3.7	5.4	5.0	4.6	1.0	1.0	-	96	0.4	0.9	0	0	1.1	3.0	-
PA[1]	1.7	-	1.6	1.3	2.0	1.2	1.7	1.9	-	-	4.6	5.0	-	-	-	-	61	-	-	-	-	-	1.0	-
P%	<0.1	-	<0.1	<0.1	<0.	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<5	<5	-	<0.1	<0.1	<0.1	<0.1	>20	<0.1	<0.1	-
LSD 5%	0.3	-	0.3	0.3	0.6	0.5	0.4	0.1	-	0.1	0.1	0.3	0.1	2.3	2.3	-	2	1.1	1.2	0.9	-	1.9	1.1	-

[1]*Poa annua* 'Two Put' could not be assessed for tiller density, leaf fineness, overall winter damage, microdochium patch or total disease because of poor coverage.
[2]In-seasaon diseases in *Poa pratensis* 'Limousine' were mainly rust (*Puccinia poa-nemoralis*) and *Drechslera* leaf spot.

Table 10. Mean values for species (continued)

d) NIBIO Landvik Research Center, Norway (southern climatic zone)

	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
No of observations	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
AS[1]	5.9	6.0	5.6	6.4	5.6	5.5	6.0	6.2	63	7.2	6.1	4.2	6.5	24.3	3.5	0.0	90	0.9	0.4	0.1	0.5	1.2	0.1	0.8	0.99
FRL	5.6	6.0	5.1	6.2	5.3	5.5	5.5	6.0	61	6.6	5.9	5.7	7.9	33.4	0.3	0.0	88	1.1	0.0	1.8	0.0	0.2	0.4	4.0	1.10
ACAP	5.4	5.9	5.2	5.2	5.6	4.9	5.5	5.6	56	7.4	6.1	5.4	6.6	38.7	4.5	0.0	86	3.8	1.8	0.0	2.5	3.3	0.2	3.0	1.15
FRC	5.3	5.5	5.0	5.5	5.2	5.6	5.4	4.9	82	6.3	6.1	3.9	7.9	33.7	0.3	0.0	89	1.2	0.1	1.6	0.0	0.2	0.4	3.4	1.26
PP	5.3	5.7	5.8	5.3	4.6	5.4	5.2	5.3	94	5.7	6.2	5.3	5.0	34.2	0.8	0.0	86	1.0	0.3	0.3	0.0	0.6	0.9	4.7	0.90
LP	5.1	5.0	4.9	5.1	5.4	4.9	5.2	5.1	99	4.9	6.1	6.2	4.7	34.5	0.3	0.2	89	0.6	0.1	0.6	0.0	0.2	0.8	3.1	1.60
PT	3.9	5.2	3.6	3.5	4.1	3.9	3.8	4.0	65	4.3	6.6	5.6	6.5	43.7	8.3	0.3	81	1.4	0.3	0.7	0.1	3.6	1.1	3.1	1.33
PA	3.5	4.6	2.3	3.3	4.8	2.1	4.5	3.2	95	4.8	3.3	4.9	4.8	77.4	37.9	0.0	80	10.9	8.7	0.2	0.5	23.1	1.3	-	1.11
P%	<0.1	<0.1	<0.1	<0.1	<5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	>20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<5	6	<0.1
LSD 5%	0.4	0.6	0.4	0.6	0.8	0.4	0.5	0.4	18	0.1	0.2	0.3	0.2	10.6	4.2	-	4	1.4	2.4	0.6	0.8	2.7	0.7	-	0.09

[1]Means or the same 9 varieties of creeping bentgrass as at the three other sites.
(*Agrostis canina* was not included in the trial at Landvik)

Table 10. Mean values for species (continued)

e) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1
AS	5.6	6.0	5.3	5.7	5.7	5.5	5.6	5.9	63	7.1	6.1	4.2	5.7	13.2	2.8	0.0	94	0.5	0.3	0.0	0.3	1.3	0.2	0.99
PP	5.6	5.7	5.4	5.6	5.6	5.5	5.6	5.9	94	5.9	5.8	6.2	4.4	17.2	0.5	0.0	89	12.5[1]	0.1	0.1	0.0	0.4	1.3	0.90
FRL	5.1	6.0	4.8	5.7	4.8	5.0	5.1	5.4	61	6.1	5.2	5.1	7.4	18.0	1.5	0.0	92	1.3	1.5	0.9	0.0	1.6	3.2	1.10
FRC	5.0	5.5	4.7	5.3	4.8	5.0	5.0	4.9	82	5.9	5.3	4.2	7.6	18.4	1.7	0.0	92	1.6	1.3	0.8	0.0	2.1	3.5	1.26
ACAP	4.9	5.9	4.9	4.9	4.7	5.0	4.6	5.1	56	6.6	5.9	5.3	6.1	21.4	4.3	0.0	91	2.7	1.8	0.0	1.2	3.7	1.1	1.15
LP	4.4	5.0	3.8	4.9	4.4	4.4	4.5	4.2	99	4.1	6.0	6.1	4.1	17.6	0.5	0.2	92	2.4	0.6	5.2	0.0	0.5	2.6	1.60
PT	3.5	5.2	4.2	3.4	2.5	2.9	3.3	3.9	65	4.0	6.0	5.3	5.6	22.4	4.7	0.3	89	0.9	0.6	0.4	0.1	2.3	2.0	1.33
PA	2.6	4.6	1.9	2.3	3.4	1.6	3.1	2.6	95	-	4.0	4.9	-	-	-	0.0	70	-	-	0.1	0.2	-	1.2	1.11
P%	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<5	<0.1	>20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
LSD 5%	0.2	0.6	0.2	0.3	0.5	0.3	0.3	0.3	18	0.1	0.1	0.2	0.1	4.9	2.1	-	2	0.5	0.3	0.5	0.4	1.1	0.7	0.09
Interaction species x site	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<5	<0.1	-	<0.1	<0.1	<5	<0.1	<0.1	<0.1	<0.1	-

[1]In-seasaon diseases in *Poa pratensis* 'Limousine' were mainly rust (*Puccinia poa-nemoralis*) and *Drechslera* leaf spot.

Table 10. Mean values for species (continued)

f) Mean of four sites, both climatic zone

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	3	4	4	3[1]	1	4	3[1]	3[1]	2	2	3[1]	3	3
PP	5.8	5.3	6.6	6.2	5.1	5.8	5.8	5.9	59	5.7	5.6	6.6	4.2	15.4	0.5	0.0	91	8.3	0.1	0.1	0.0	0.2	3.6	0.67
AS	5.6	5.3	5.6	5.8	5.6	5.1	5.6	6.0	53	6.8	6.1	4.9	5.8	16.3	2.8	0.0	92	0.9	0.8	0.0	0.3	1.5	2.5	0.64
FRL	5.1	5.2	5.3	5.8	4.5	4.7	5.3	5.3	56	5.6	5.4	5.6	6.9	18.6	1.5	0.0	91	2.0	2.1	0.9	0.0	2.2	7.0	0.84
FRC	5.1	5.4	5.5	5.8	4.2	4.8	5.3	5.1	66	5.5	5.5	4.1	7.0	21.3	1.7	0.0	91	1.4	1.1	0.8	0.0	1.6	6.8	0.93
ACAP	4.5	5.0	4.7	4.8	4.1	4.3	4.5	4.8	54	6.5	5.7	5.2	6.0	29.9	4.3	0.0	86	2.2	1.6	0.0	1.2	2.9	4.4	0.71
LP	4.0	5.1	4.7	4.2	3.2	3.0	4.2	4.4	86	4.3	6.0	6.6	3.7	47.2	0.5	0.2	79	1.6	0.4	5.2	0.0	0.3	8.7	-
PT	3.8	5.9	5.1	3.4	2.3	2.6	3.6	4.7	55	4.6	6.1	5.0	5.2	43.5	4.7	0.3	78	1.0	0.8	0.4	0.1	2.0	5.8	-
PA	3.3	6.0	3.0	3.1	3.1	1.7	3.7	3.8	79	-	4.5	5.3	-	-	-	0.0	70	-	-	0.1	0.2	-	2.5	-
P%	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	>20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
LSD 5%	0.2	0.4	0.2	0.3	0.4	0.3	0.2	0.3	10	0.1	0.1	0.1	0.1	4.0	2.1	-	2	0.4	0.2	0.5	0.4	0.7	1.1	0.04
Interaction species x site	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

[1]Results from Apelsvoll not included

3.2 Varieties of *Festuca rubra* ssp. *commutata* (Table 11)

None of the four candidate varieties of Chewings fescue performed better than the control variety 'Musica' on average for four sites. 'Humboldt' and 'Barchip were ranked slightly higher than 'Musica' on average for the northern zone but they were significantly behind 'Musica' at Landvik and allowed more moss into the plots on average for all sites. They may nonetheless have a certain interest because of darker color and 'Humboldt' also because of less height growth. 'Aureline' ('14FR 818') had the lowest performance at all sites and cannot be recommended for Nordic putting greens.

3.3 Varieties of *Festuca rubra* ssp. *litoralis* (Table 12)

In slender creeping red fescue, the situation resembled that in Crewings fescue: None of the three candidate varieties outperformed the control variety 'Cezanne' at any site. On average for sites, their overall scores were significantly lower. 'Mirador' appeard to be slightly stronger against red thread but it was slow in establishment and had 12 % higher growth rate than 'Cezenne'. Our results are in agreement with STRI/BSPB (2019) which ranks the four varieties in the order: Cezanne > Aporina > Mirador > Borluna.

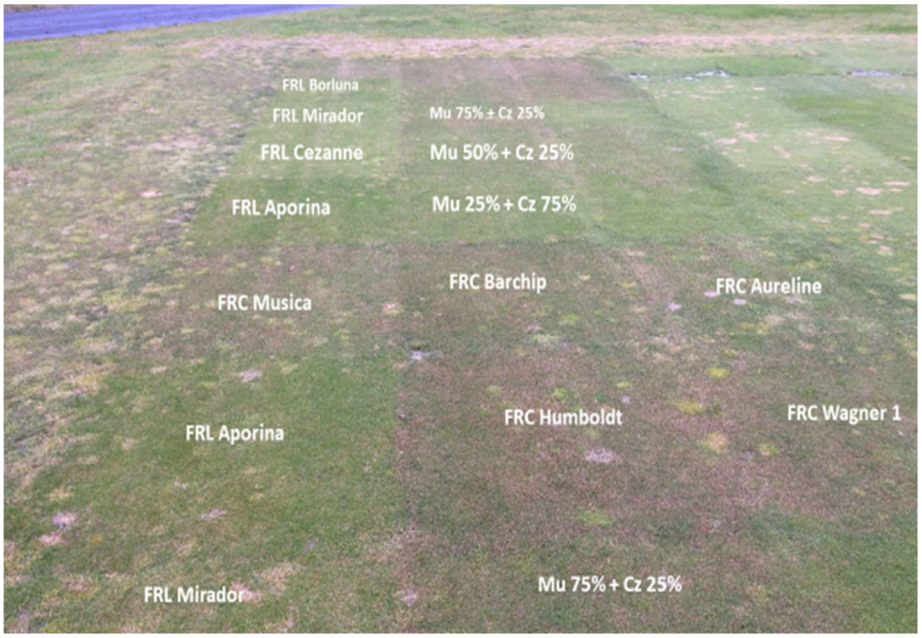

Photo 28. Landvik, 21 Feb. 2019 (after the evaluation period was officially finished). Chewings fesue (FRC) and slender creeping red fescue (FRL) showed significant differences in winter color, but there were only small and insignificant differences in Poa annua invasion. The winter color of seed blends was as expected from the ratio of FRC 'Musica' to FRL 'Cezanne'.

Photo Trygve S. Aamlid.

Table 11. Ranking of Chewings fescue (*Festuca rubra ssp. commutata*) varieties after four years testing on putting greens in SCANGREEN trials at a) Korpa GC (Iceland); b) NIBIO Apelsvoll Research Center (Norway); c) average for Korpa and Apelsvoll representing the northern climatic zone of Scandinavia; d) Sydsjælland GC (Denmark), e) NIBIO Landvik Research Center (Norway), f) average for Sydsjælland and Landvik representing the southern climatic zone of Scandinavia; and g) average for all four test sites.

a) Reykjavik GC, Iceland (northern climatic zone)

	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
No of obser-vations	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	3	5	5	4	1	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
Musica	5.3	5.4	5.7	6.2	4.0	5.7	5.5	5.0	-	5.3	4.9	4.0	6.9	4.6	-	-	90	0.7	0.7	-	-	0.7	9.3	0.67
Barchip	5.3	5.1	5.5	6.3	4.2	5.8	5.3	5.1	-	5.3	6.1	4.0	6.9	6.7	-	-	91	0.6	0.6	-	-	0.6	15.5	0.68
Wagner 1	5.1	5.3	5.3	6.1	4.0	5.7	5.3	4.8	-	5.2	6.3	4.0	6.9	8.1	-	-	90	1.8	1.8	-	-	1.8	10.7	0.76
Humboldt	5.1	5.0	5.6	5.7	3.9	5.5	5.1	4.8	-	5.3	6.0	4.0	6.9	4.0	-	-	90	0.6	0.6	-	-	0.6	14.3	0.66
Aureline	4.7	4.7	4.9	5.3	3.8	5.2	4.7	4.6	-	5.2	5.1	4.0	6.9	6.4	-	-	86	0.2	0.2	-	-	0.2	17	0.66
P%	15	>20	>20	10	>20	>20	13	>20	-	>20	<0.1	>20	>20	>20	-	-	<5	>20	>20	-	-	>20	9	>20
LSD 5%	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	3	-	-	-	-	-	-	-

Table 11. Ranking of *Chewings fescue (Festuca rubra ssp. commutata)* varieties (continued)

b) NIBIO Apelsvoll Research Center, Norway (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	0	12	11	1	2	3	3	0	19	12	12	0	0	16	0	6
Humboldt	5.7	5.5	6.5	6.9	4.3	4.4	6.4	5.6	55	4.4	5.6	3.3	6.0	35.1	5.0	-	93	1.5	1.5	-	-	2.2	-	0.76
Wagner 1	5.6	5.8	7.3	7.0	3	3.8	6.1	5.9	50	4.4	5.9	2.7	6.0	44.0	7.9	-	90	1.2	1.2	-	-	2.3	-	0.86
Musica	5.5	5.7	7.1	6.9	3.2	3.9	6.2	5.8	53	4.5	5.4	3.3	6.0	43.7	8.9	-	90	1.7	1.7	-	-	3	-	0.89
Barchip	5.4	5.3	6.8	7.0	3.3	3.9	6.0	5.6	43	4.4	6.0	3.3	6.0	37.9	5.6	-	91	1.7	1.7	-	-	2.4	-	0.98
Aureline	5.1	5.1	7.3	6.7	2.4	3.4	5.6	5.6	48	4.5	5.3	3.7	6.0	51.3	10.3	-	88	1.1	1.1	-	-	2.6	-	0.79
P%	>20	12	<1	>20	>20	>20	>20	<5	18	>20	<5	>20	>20	>20	9	-	>20	>20	>20	-	-	>20	-	>20
LSD 5%	-	-	0.4	-	-	-	-	0.2	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	2	2	2	2	2	2	2	1	2	2	1	2	2	1	0	2	1	1	0	0	1	1	1
Humboldt	5.4	5.2	6.1	6.3	4.1	5.0	5.8	5.2	55	4.8	5.8	3.7	6.5	19.6	5.0	-	91	1.1	1.1	-	-	1.4	14.3	0.71
Barchip	5.4	5.2	6.2	6.7	3.7	4.9	5.7	5.3	43	4.9	6.1	3.7	6.5	22.3	5.6	-	91	1.2	1.2	-	-	1.5	15.3	0.83
Musica	5.4	5.6	6.4	6.5	3.6	4.8	5.8	5.4	53	4.9	5.2	3.7	6.5	24.1	8.9	-	90	1.2	1.2	-	-	1.8	9.3	0.78
Wagner 1	5.3	5.5	6.3	6.5	3.5	4.7	5.7	5.3	50	4.8	6.1	3.3	6.5	26.1	7.9	-	90	1.5	1.5	-	-	2.0	10.7	0.81
Aureline	4.9	4.9	6.1	6.0	3.1	4.3	5.1	5.1	48	4.9	5.2	3.8	6.5	28.9	10.3	-	87	0.7	0.7	-	-	1.4	17.0	0.73
P%	<5	>20	>20	<5	17	>20	<5	15	18	20	<0.1	>20	>20	>20	9	-	8	>20	>20	-	-	>20	9	>20
LSD 5%	0.4	-	-	0.4	-	-	0.4	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Interaction variety x site	>20	>20	<5	>20	>20	>20	>20	11	-	>20	<1	>20	>20	>20	-	-	>20	>20	>20	-	-	16	-	>20

Table 11. Ranking of *Chewings fescue (Festuca rubra ssp. commutata)* varieties (continued)

d) Sydsjælland GC, Denmark (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	18	0	5	6	7	5	9	4	0	16	16	3	6	3	3	0	17	8	5	1	3	9	6	0
Humboldt	4.6	-	4.1	5.0	4.9	4.4	4.8	4.8	-	5.6	4.7	5.0	7.3	1.9	1.9	-	94	2.8	3.3	0	0	3.7	7.1	-
Wagner 1	4.6	-	4.2	5.1	4.5	4.1	4.8	4.9	-	5.6	4.9	5.3	7.0	2.4	2.4	-	95	2.0	2.2	0	0	3.4	6.6	-
Musica	4.5	-	4.1	5.0	4.3	4.1	4.6	4.8	-	5.7	4.5	4.7	7.3	1.4	1.4	-	95	1.2	1.4	0	0	2.1	5.0	-
Barchip	4.5	-	4.2	5.0	4.2	3.9	4.7	4.8	-	5.6	4.8	5.2	7.3	4.4	4.4	-	94	1.4	2.1	0	0	4.2	7.6	-
Aureline	4.4	-	4.1	4.9	4.1	3.7	4.7	4.7	-	5.6	4.6	4.7	7.2	5.4	5.4	-	94	3.1	3.6	0	0	6.4	6.8	-
P%	>20	-	<1	>20	>20	9	>20	>20	-	>20	<0.1	<1	<0.1	>20	>20	-	>20	16	>20	>20	>20	<5	>20	-
LSD 5%	-	-	0.1	-	-	-	-	-	-	-	0.1	0.3	0.1	-	-	-	-	-	-	-	-	2.3	-	-

e) NIBIO Landvik Research Center, Norway (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter, %	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
Musica	5.9	6.0	5.8	6.4	5.3	6.4	5.9	5.6	94	6.8	5.6	4.4	8.0	33.6	0.1	0	89	0.5	0.1	0.7	0	0.1	0.3	3.2	1.35
Barchip	5.4	5.5	5.1	5.6	5.3	5.4	5.6	5.0	77	6.5	6.5	3.7	7.9	33.7	0.4	0	90	0.6	0.0	1.2	0	0.1	0.5	2.8	1.22
Humboldt	5.3	5.2	5.0	5.3	5.6	5.6	5.4	4.7	80	6.3	6.2	4.1	7.9	33.8	0.5	0	89	1.3	0.2	1.7	0	0.3	0.2	2.6	1.13
Wagner 1	5.0	5.4	4.8	5.2	4.9	5.5	5.1	4.5	83	6.0	6.5	3.7	7.8	33.6	0.2	0	88	1.3	0.2	1.7	0	0.2	0.5	4.7	1.27
Aureline	5.0	5.3	4.6	5.2	4.8	5.2	5.0	4.8	78	6.1	5.8	3.7	8.0	33.7	0.2	0	87	2.2	0.2	3.0	0	0.2	0.5	3.8	1.30
P%	<0.1	7	<1	<1	11	<1	<1	<0.1	6	<0.1	<0.1	<1	17	>20	20	<20	<5	<5	>20	<1	>20	>20	>20	>20	<5
LSD 5%	0.3	-	0.4	0.4	-	0.5	0.4	0.3	-	0.3	0.1	0.5	-	-	-	-	2	0.9	-	0.9	-	-	-	-	0.11

Table 11. Ranking of *Chewings fescue (Festuca rubra ssp. commutata)* varieties (continued)

f) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	2	2	3	1	2	2	2	2	2	2	2	1
Musica	5.2	6.0	4.9	5.7	4.8	5.2	5.2	5.2	94	6.3	5.1	4.5	7.6	17.5	0.8	0	92	0.9	0.7	0.3	0	1.1	2.6	1.35
Humboldt	5.0	5.2	4.5	5.2	5.2	5.0	5.1	4.8	80	5.9	5.4	4.5	7.6	17.8	1.2	0	92	2.0	1.8	0.8	0	2.0	3.6	1.13
Barchip	4.9	5.5	4.6	5.3	4.8	4.7	5.1	4.9	77	6.1	5.7	4.4	7.6	19.1	2.4	0	92	1.0	1.1	0.6	0	2.2	4.1	1.22
Wagner 1	4.8	5.4	4.5	5.1	4.7	4.8	4.9	4.7	83	5.8	5.7	4.5	7.4	18.0	1.3	0	91	1.7	1.2	0.9	0	1.8	3.6	1.27
Aureline	4.7	5.3	4.4	5.1	4.5	4.5	4.8	4.7	78	5.8	5.2	4.2	7.6	19.5	2.8	0	90	2.7	1.9	1.5	0	3.3	3.6	1.30
P%	<1	7	<0.1	<1	13	<1	>20	<1	6	<0.1	<0.1	7	<0.1	>20	>20	>20	9	<0.1	17	<0.1	>20	<0.1	>20	<5
LSD 5%	0.2	-	0.2	0.3	-	0.3	-	0.2	-	0.1	0.1	-	0.1	-	-	-	-	1.0	-	0.4	-	1.1	-	0.11
P%, interaction	<1	-	<0.1	<0.1	>20	<5	13	<0.1	-	<0.1	<0.1	<1	16	>20	>20	>20	>20	>20	>20	<0.1	>20	<0.1	>20	-

g) Mean of four sites, both climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest	Winter color (1-9, 9 most freshly	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during	Typhula blight during winter, %	In-season coverage of healthy turf of	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	4	4	4	3	1	2	2	2	2	2	2	2	1
Musica	5.3	5.7	5.7	6.1	4.2	5.0	5.5	5.3	74	5.6	5.1	4.1	7.0	20.8	3.5	0	91	1.0	1.0	0.3	0	1.5	4.9	0.97
Humboldt	5.2	5.2	5.3	5.7	4.7	5.0	5.4	5.0	68	5.4	5.6	4.1	7.0	18.7	2.4	0	91	1.6	1.4	0.8	0	1.7	7.2	0.85
Barchip	5.1	5.3	5.4	6.0	4.2	4.8	5.4	5.1	60	5.5	5.9	4.0	7.0	20.7	3.4	0	91	1.1	1.1	0.6	0	1.8	7.8	0.96
Wagner 1	5.1	5.5	5.4	5.8	4.1	4.8	5.3	5.0	66	5.3	5.9	3.9	6.9	22.0	3.5	0	91	1.6	1.3	0.9	0	1.9	5.9	0.96
Aureline	4.8	5.0	5.2	5.6	3.8	4.4	5.0	4.9	63	5.3	5.2	4.0	7.0	24.2	5.3	0	89	1.7	1.3	1.5	0	2.3	8.1	0.92
P%	<0.1	5	<1	<0.1	<5	<5	<1	<0.1	<5	<0.1	<0.1	>20	<0.1	19	7	>20	<1	11	>20	<0.1	>20	11	<5	9
LSD 5%	0.2	0.5	0.2	0.2	0.5	0.4	0.3	0.2	7	0.1	0.1	-	0.1	-	-	-	2	-	-	0.4	-	-	2.3	-
P%, interaction	10	>20	<0.1	<1	>20	>20	>20	>20	>20	<0.1	<0.1	17	<0.1	>20	12	-	>20	<5	8	<0.1	>20	<0.1	19	>20

Table 12. Ranking of slender creeping red fescue (*Festuca rubra ssp. litoralis syn. trichophylla*) varieties after four years testing on putting greens in SCANGREEN trials at a) Korpa GC, (Iceland); b) Apelsvoll Research Center (Norway); c) average for Korpa and Apelsvoll representing the northern climatic zone of Scandinavia; d) Sydsjælland GC (Denmark), e) Landvik Research Center (Norway); f) average for Sydsjælland and Landvik representing the southern climatic zone of Scandinavia; and g) average for all four test sites.

a) Reykjavik GC, Iceland (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	3	5	5	4	1	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
Cezanne	4.7	4.7	5.1	5.3	3.8	5.2	4.9	4.2	-	5.3	4.7	6.5	6.9	4.2	-	-	88	3.1	3.1	-	-	3.1	16.7	0.68
Borluna	4.6	3.6	4.7	5.0	4.5	4.2	4.7	4.4	-	5.3	5.2	6.5	6.9	3.1	-	-	87	3.2	3.2	-	-	3.2	13.3	0.74
Aporina	4.5	3.8	4.6	5.1	4.1	4.7	4.5	4.2	-	5.4	4.7	6.5	6.9	3.3	-	-	87	4.5	4.5	-	-	4.5	11.7	0.65
Mirador	4.3	3.3	4.2	5.1	4.0	4.3	4.4	4.0	-	5.3	4.8	6.5	6.9	5.9	-	-	84	2.7	2.7	-	-	2.7	16.7	0.70
P%	<0.1	6	>20	12	>20	19	<0.1	>20	-	>20	<0.1	>20	>20	>20	-	-	6	17	17	-	-	17	>20	>20
LSD 5%	0.1	-	-	-	-	-	0.1	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 12. Ranking of slender creeping red fescue (*Festuca rubra ssp. litoralis syn. trichophylla*) varieties (continued)

b) NIBIO Apelsvoll Research Center (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	1	12	12	1	2	3	3	0	19	12	12	0	0	16	0	6
Cezanne	6.1	6.0	7.5	6.9	4.5	4.5	6.7	6.3	50	4.4	5.7	4.7	6.0	28.3	5.2	-	95	0.5	0.5	-	-	1.7	-	0.62
Mirador	6.1	5.9	7.0	6.5	5.1	4.9	6.4	6.5	53	4.4	5.8	4.7	6.0	35.4	4.3	-	96	0.9	0.9	-	-	1.8	-	0.80
Aporina	5.5	5.0	7.0	6.7	3.8	4.0	5.9	6.1	48	4.4	5.8	4.7	6.0	42.8	5.2	-	93	0.8	0.8	-	-	1.9	-	0.83
Borluna	5.4	5.6	6.9	6.6	3.3	3.6	5.6	6.4	53	4.5	5.7	5.3	6.0	30.9	4.2	-	92	0.4	0.4	-	-	1.3	-	0.66
P%	>20	>20	15	>20	>20	11	18	>20	>20	>20	>20	>20	>20	>20	>20	>20	>20	17	17	-	-	>20	-	>20
LSD 5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	2	2	2	2	2	2	2	1	2	2	1	2	2	1	0	2	2	2	0	0	2	1	2
Cezanne	5.4	5.3	6.3	6.1	4.2	4.9	5.8	5.2	50	4.9	5.2	5.6	6.5	16.2	5.2	-	92	1.8	1.8	-	-	2.4	16.7	0.65
Mirador	5.2	4.6	5.6	5.8	4.6	4.6	5.4	5.3	53	4.8	5.3	5.6	6.5	20.7	4.3	-	90	1.8	1.8	-	-	2.3	16.7	0.75
Borluna	5.0	4.6	5.8	5.8	3.9	3.9	5.2	5.4	53	4.9	5.4	5.9	6.5	17.0	4.2	-	90	1.8	1.8	-	-	2.2	13.3	0.70
Aporina	5.0	4.4	5.8	5.9	3.9	4.3	5.2	5.1	48	4.9	5.3	5.6	6.5	23.1	5.2	-	90	2.7	2.7	-	-	3.2	11.7	0.74
P%	12	10	6	<5	>20	<5	7	>20	>20	14	14	>20	>20	>20	>20	-	>20	10	10	-	-	8	>20	>20
LSD 5%	-	-	-	0.2	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interaction variety x site	10	>20	>20	>20	10	>20	13	>20	-	<1	>20	>20	>20	>20	>20	-	18	15	15	-	-	20	-	17

Table 12. Ranking of slender creeping red fescue (*Festuca rubra ssp. litoralis syn. trichophylla*) varieties (continued)

d) Sydsjælland GC, Denmark (southern climatic zone)

No of observations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	18	0	5	6	7	5	9	4	0	16	16	3	6	3	3	0	17	8	5	1	3	9	6	0
Cezanne	4.7	-	4.3	5.0	4.7	4.5	4.9	4.8	-	5.7	4.8	4.7	7.0	1.6	1.6	-	95	1.8	3.3	0	0	2.5	4.8	
Borluna	4.7	-	4.3	5.1	4.7	4.1	5.0	5.0	-	5.5	5.2	4.7	6.7	3.2	3.2	-	94	2.1	4.3	0	0	3.9	6.7	-
Mirador	4.5	-	4.1	5.2	4.1	4.1	4.7	4.6	-	5.7	4.9	4.7	7.2	4.5	4.5	-	95	1.0	2.0	0	0	3.9	7.5	-
Aporina	4.4	-	4.0	5.1	4.0	4.1	4.5	4.5	-	5.7	4.9	4.8	7.1	1.3	1.3	-	95	1.2	2.3	0	0	1.9	5.0	-
P%	14	-	<0.1	<0.1	>20	14	14	>20	-	<1	<0.1	<0.1	<0.1	20	20	-	7	<5	<1	>20	>20	20	<5	-
LSD %	-	-	0.1	0.1	-	-	-	-	-	0.1	0.1	0.1	0.1	-	-	-	-	0.7	0.8	-	-	-	2.00	-

e) NIBIO Landvik Research Center, Norway (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
Aporina	5.9	6.1	5.3	6.5	5.6	5.8	5.7	6.2	78	6.9	5.6	5.9	8.0	33.7	0.4	0	89	1.1	0.0	1.7	0	0.2	0.3	3.2	1.18
Cezanne	5.9	6.4	5.5	6.4	5.4	5.7	5.6	6.4	71	6.9	5.7	5.6	7.9	34.1	0.3	0	88	1.3	0.1	2.2	0	0.2	0.1	4.4	1.02
Mirador	5.6	5.6	5.0	6.5	5.3	5.3	5.5	6.1	22	6.6	5.8	5.6	7.9	33.2	0.5	0	89	0.7	0.0	1.0	0	0.2	0.2	4.4	1.09
Borluna	5.2	5.8	4.7	5.6	4.9	5.2	5.0	5.5	72	6.1	6.4	5.5	7.6	32.7	0.1	0	88	1.3	0.0	2.2	0	0.0	0.8	4.2	1.11
P%	<0.1	10	6	<0.1	19	9	<0.1	<0.1	<1	<0.1	<0.1	>20	<5	>20	<5	>20	>20	8	13	15	>20	<5	15	>20	8
LSD 5%	0.2	-	-	0.3			0.2	0.2	20	0.2	0.3	-	0.2	-	0.2	-	-	-	-	-	-	0.1	-	-	-

Table 12. Ranking of slender creeping red fescue (*Festuca rubra ssp. litoralis syn. trichophylla*) varieties (continued)

f) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Microdochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1
Cezanne	5.3	6.4	4.9	5.7	5.0	5.1	5.3	5.6	71	6.3	5.3	5.2	7.4	17.8	1.0	0	92	1.5	1.7	1.1	0.0	1.3	2.5	1.02
Aporina	5.1	6.1	4.7	5.8	4.8	4.9	5.1	5.4	78	6.3	5.2	5.3	7.5	17.5	0.8	0	92	1.2	1.2	0.9	0.0	1.0	2.6	1.18
Mirador	5.1	5.6	4.5	5.9	4.7	4.7	5.1	5.4	22	6.1	5.3	5.2	7.6	18.8	2.5	0	92	0.9	1.0	0.5	0.0	2.1	3.9	1.09
Borluna	4.9	5.8	4.5	5.3	4.8	4.6	5.0	5.2	72	5.8	5.8	5.1	7.2	18.0	1.7	0	91	1.7	2.2	1.1	0.0	2.0	3.8	1.11
P%	<1	10	<5	<0.1	>20	<5	15	9	<1	<0.1	<0.1	6	<0.1	>20	14	>20	9	<1	<0.1	11	>20	17	<1	8
LSD 5%	0.2	-	0.3	0.2	-	0.3	-	-	20	0.1	0.1	-	0.1	-	-	-	-	0.4	0.4	-	-	-	0.9	-
P%, interaction variety x site	<0.1	-	<5	<0.1	8	>20	<0.1	<0.1	-	<0.1	<1	>20	7	7	16	>20	>20	>20	<0.1	11	>20	14	<5	-

g) Mean of four sites, both climatic zones

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Microdochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	4	4	4	3	1	4	4	4	2	2	4	3	3
Cezanne	5.3	5.7	5.6	5.9	4.6	5	5.5	5.4	60	5.6	5.3	5.4	6.9	17	2.4	0	92	1.7	1.7	1.1	0	1.9	7.2	0.77
Mirador	5.1	5.0	5.1	5.8	4.6	4.7	5.2	5.3	38	5.5	5.3	5.4	7.0	19.8	3.1	0	91	1.3	1.4	0.5	0	2.2	8.1	0.86
Aporina	5.1	5.0	5.3	5.8	4.4	4.6	5.2	5.3	63	5.6	5.3	5.4	7.0	20.3	2.3	0	91	1.9	1.9	0.9	0	2.1	5.6	0.89
Borluna	5.0	5.0	5.1	5.6	4.3	4.3	5.1	5.3	63	5.4	5.6	5.5	6.8	17.5	2.5	0	90	1.8	2.0	1.1	0	2.1	7.0	0.83
P%	<1	<5	<1	<0.1	>20	<1	<1	>20	<0.1	<0.1	<0.1	>20	<0.1	>20	>20	>20	>20	5	<5	11	>20	>20	>20	10
LSD 5%	0.2	0.2	0.3	0.1	-	0.4	0.3	-	10	0.1	0.1	-	0.1	-	-	-	-	0.4	0.4	-	-	-	-	-
P%, interaction variety x site	<1	>20	>20	<0.1	7	15	<5	<1	<0.1	<0.1	<0.1	>20	<0.1	>20	6	>20	>20	<5	<0.1	11	>20	<5	>20	>20

3.4 Varieties of *Agrostis capillaris* (Table 13)

The variety 'Charles' (CT 3030), originally from New Zealand, stood out negatively with more abiotic and biotic winter damage and thus lower overall impression than the other colonial bentgrass varieties. Unlike the other varieties, 'Charles' had to be reseeded every spring at Apelsvoll (Photo 29). These poor results are in strong contrast to STRI/BSPB (2019) which ranked 'Charles' as the no 1 variety of colonial bentgrass. Our results were in agreement with STRI's findings that 'Charles' had higher tiller density and finer leaves than other colonial bentgrass varieties, but under Nordic conditions, these characters are secondary to good winter survival and microdochium patch resistance.

In our trials, the highest ranked varieties were 'Rhinegold' ('DLFPS-AT-3026') at Reykjavik and Landvik and 'Heritage' ('PPG AT 101') at Apelsvoll and Sydsjælland. 'Heritage' was a little darker and had less winter damage than 'Rhingold' at Apelsvoll, but it was more susceptible to microdochium patch and allowed more moss into the plots on average for the two sites in the southern zone. 'Teetop' ('DLF ATE 3006') had high growth rates and no particular advantage compared with the control variety 'Jorvik'.

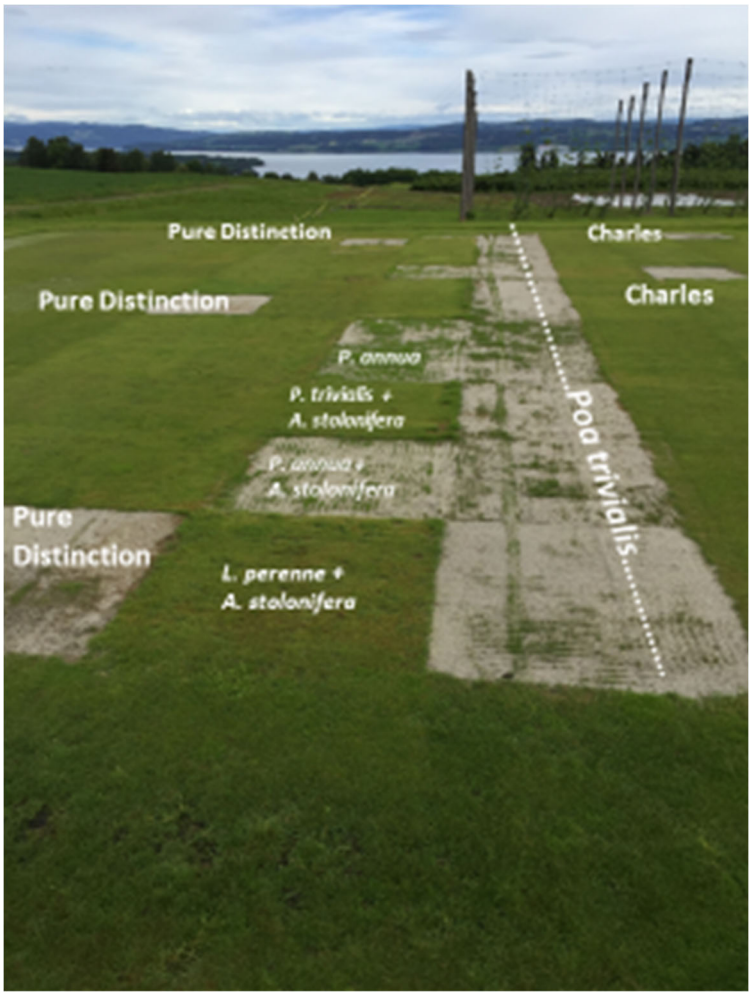

Photo 29. The winter 2016-17 revealed clear differences in winter hardiness among species, varieties and seed mixtures at Apelsvoll. Pure stands of Poa annua, Poa trivialis and Lolium perenne (not in photo) were all dead. 'Pure Distinction' and 'Charles' were distinct exception to otherwise good survival in Agrostis stolonifera and Agrostis capillaris, respectively. Mixtures of Agrostis stolonifera and Lolium perenne and Agrostis stolonifera and Poa trivialis survived but mixtures of Agrostis stolonifera and Poa annua died. Picture taken in June after reseeding.

Photo: Pia Heltoft.

Table 13. **Ranking of colonial bentgrass (browntop , *Agrostis capillaris*) varieties after four years testing on putting greens in SCANGREEN trials at a) Korpa GC, (Iceland); b) Apelsvoll Research Center (Norway); c) average for Korpa and Apelsvoll representing the northern climatic zone of Scandinavia; d) Sydsjælland GC (Denmark); e) Landvik Research Center (Norway); f) average for Sydsjælland and Landvik representing the southern climatic zone of Scandinavia; and g) average for all four test sites.

a) Reykjavik GC, Iceland (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	3	5	5	4	1	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
Rhinegold	4.3	4.7	3.9	4.5	4.2	3.8	4.3	4.4	-	6.5	5.2	5.0	5.9	13.1	-	-	84	1.6	1.6	-	-	1.6	10	0.48
Teetop	4.2	4.7	3.8	4.5	4.2	3.7	4.2	4.6	-	6.7	5.1	5.0	5.9	9.0	-	-	84	1.4	1.4	-	-	1.4	10.7	0.53
Jorvik	4.2	4.2	3.7	4.3	4.4	3.8	4.1	4.5	-	6.7	5.3	5.0	5.9	10.3	-	-	83	0.7	0.7	-	-	0.7	10.7	0.53
Heritage	4.1	4.3	3.9	4.3	4.1	3.7	4.1	4.4	-	6.7	5.3	5.0	5.9	11.4	-	-	83	1.3	1.3	-	-	1.3	11.7	0.54
Charles	3.3	3.8	2.7	3.5	3.3	2.8	3.2	3.8	-	6.6	5.3	5.0	5.9	26.2	-	-	71	1.6	1.6	-	-	1.6	11.7	0.58
P%	7	>20	<5	13	>20	14	6	>20	-	>20	11	>20	>20	>20	-	-	<5	>20	>20	-	-	>20	>20	>20
LSD 5%	-	-	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-

Table 13. Colonial bentgrass / browntop (*Agrostis capillaris*) (continued)

b) NIBIO Apelsvoll Research Center (northern climatic zone)

No of observations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	1	12	11	1	2	3	3		19	12	12	0	0	16	0	6
Heritage	5.3	5.5	5.7	6.4	4.0	4.5	5.8	5.3	52	6.3	6.0	5.7	5.5	39.6	8.6	-	93	6.1	6.1	-	-	6.3	-	0.39
Jorvik	5.0	4.9	5.2	6.3	3.7	4.5	5.4	4.9	45	6.0	5.7	5.0	5.7	68.0	11.7	-	90	6.0	6.0	-	-	6.5	-	0.40
Rhinegold	4.7	4.9	5.5	6.4	2.7	3.7	5.2	4.8	52	6.0	5.9	4.3	5.3	56.2	12.7	-	87	5.3	5.3	-	-	6.2	-	0.39
Teetop	4.7	4.8	5.4	6.2	2.9	3.8	5.1	4.8	58	5.8	5.7	4.7	5.5	62.2	8.3	-	88	6.1	6.1	-	-	5.9	-	0.58
Charles	2.6	4.7	4.8	1.0	1.1	0.3	2.6	3.6	53	-	-	-	-	88.2	-	-	46	-	-	-	-	-	-	.
P%	<0.1	>20	<5	<0.1	<1	<0.1	<0.1	<0.1	>20	>20	>20	>20	>20	<5	>20	-	<0.1	>20	>20	-	-	>20	-	<5
LSD 5%	0.4	-	0.5	0.4	1.0	0.9	0.6	0.3	-	-	-	-	-	28.3	-	-	7	-	-	-	-	-	-	0.11

[1]Charles could not be scored for several characters due to poor winter survival and repeated reseeding.

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	0	2	1	1	0	0	1	1	2
Heritage	4.7	4.9	4.8	5.4	4.0	4.1	5.0	4.8	52	6.5	5.6	5.3	5.7	25.5	8.6	-	88	3.7	3.7	-	-	3.8	11.7	0.46
Jorvik	4.6	4.5	4.5	5.3	4.1	4.2	4.7	4.7	45	6.3	5.5	5.0	5.8	39.2	11.7	-	87	3.3	3.3	-	-	3.6	10.7	0.46
Rhinegold	4.5	4.8	4.7	5.5	3.4	3.7	4.8	4.6	52	6.2	5.5	4.7	5.6	34.7	12.7	-	86	3.4	3.4	-	-	3.9	10.0	0.44
Teetop	4.5	4.7	4.6	5.3	3.5	3.7	4.7	4.7	58	6.3	5.4	4.8	5.7	35.6	8.3	-	86	3.8	3.8	-	-	3.7	10.7	0.56
Charles	2.9	4.2	3.7	2.3	2.2	1.6	2.9	3.7	53	-	-	-	-	57.2	-	-	58	-	-	-	-	-	11.7	-
P%	<0.1	>20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	>20	>20	16	>20	>20	<1	>20	-	<1	>20	>20	-	-	>20	>20	<5
LSD 5%	0.4	-	0.4	0.4	0.7	0.6	0.4	0.4	-	-	-	-	-	14.2	-	-	5	-	-	-	-	-	-	0.07
Interaction variety x site	<1	>20	>20	<0.1	<5	<0.1	<0.1	14	-	>20	>20	>20	>20	14	-	-	<0.1	>20	>20	-	-	>20	-	<5

Table 13. Colonial bentgrass / browntop (*Agrostis capillaris*) (continued)

d) Sydsjælland GC, Denmark (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	18	0	5	6	7	5	9	4	0	16	16	3	6	3	3	0	17	8	5	1	3	9	6	0
Heritage	4.4	-	4.7	4.6	4.0	5.1	3.9	4.8	-	5.9	6.2	4.8	5.4	14.2	14.2	-	98	0.	0.8	0.0	0.0	9.9	1.9	-
Rhinegold	4.4	-	4.8	4.5	3.9	5.1	3.9	4.5	-	5.7	6.0	4.7	5.5	1.6	1.6	-	99	0.	0.0	0.0	0.0	1.1	1.1	-
Jorvik	4.2	-	4.6	4.7	3.4	4.7	3.7	4.7	-	5.5	5.9	4.8	5.5	2.0	2.0	-	96	0.	2.0	0.0	0.0	2.1	2.5	-
Charles	4.2	-	4.2	4.4	4.0	5.0	3.7	4.5	-	5.9	5.8	4.6	5.5	2.5	2.5	-	95	4.	4.2	0.0	0.0	5.6	2.3	-
Teetop	4.2	-	4.4	4.7	3.3	4.9	3.6	4.4	-	5.7	5.8	4.8	5.6	0.4	0.4	-	97	1.	1.9	0.0	0.0	1.9	2.2	-
P%	>20	-	<0.1	>20	>20	>20	>20	>20	-	<5	<0.1	>20	<5	14	14	-	<0.1	<5	<5	>2	>2	16	7	-
LSD 5%	-	-	0.2	-	-	-	-	-	-	0.3	0.1	-	0.1			-	1	2.	2.6	-	-	-	-	-

e) NIBIO Landvik Research Center, Norway (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
Rhinegold	5.5	6.0	5.5	4.9	6.2	5.4	5.7	5.5	72	7.3	6.2	5.1	6.4	35.1	1.4	0.0	87	4.4	1.9	0.0	3.3	1.9	0.1	2.9	1.13
Teetop	5.5	5.8	5.4	5.3	5.7	4.9	5.8	5.6	53	7.6	5.8	5.8	6.7	39.6	4.7	0.0	88	2.9	1.6	0.0	1.7	3.2	0.1	2.7	1.33
Jorvik	5.5	6.3	5.3	5.1	5.7	5.1	5.5	5.7	67	7.3	6.9	5.1	6.6	35.5	1.9	0.0	87	4.3	1.7	0.1	3.1	2.0	0.2	3.9	1.14
Heritage	5.4	5.8	5.4	5.5	5.1	5.5	5.2	5.7	30	7.2	6.4	5.2	6.4	35.5	2.1	0.0	83	2.6	1.3	0.0	1.8	1.8	0.2	3.7	1.17
Charles	5.0	5.3	4.6	4.9	5.3	3.7	5.4	5.4	58	7.7	5.4	5.7	7.0	48.1	12.4	0.0	83	5.0	2.5	0.0	2.4	7.5	0.2	1.6	0.97
P%	>20	>20	18.0	>20	>20	>20	>20	>20	>20	>20	<0.1	<1	<0.1	<5	<1	>20	6	>2	>20	>2	>20	<0.1	>20	>20	<0.1
LSD 5%	-	-	-	-	-	-	-	-	-	-	0.5	0.4	0.2	7.1	4.3	-	-	-	-	-	-	2.0	-	-	0.09

Table 13. Colonial bentgrass / browntop (*Agrostis capillaris*) (continued)

f) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1
Rhinegold	5.0	6.0	5.1	4.7	5.0	5.2	4.8	5.0	72	6.5	6.1	4.9	5.9	18.4	1.5	0	93	2.2	1.0	0.0	1.7	1.5	0.6	1.13
Heritage	4.9	5.8	5.1	5.1	4.5	5.3	4.5	5.2	30	6.6	6.3	5.0	5.9	24.8	8.1	0	90	1.5	1.0	0.0	0.9	5.8	1.1	1.17
Jorvik	4.8	6.3	5.0	4.9	4.5	4.9	4.6	5.2	67	6.4	6.4	4.9	6.0	18.7	1.9	0	92	2.6	1.9	0.0	1.6	2.0	1.3	1.14
Teetop	4.8	5.8	4.9	5.0	4.5	4.9	4.7	5.0	53	6.7	5.8	5.3	6.1	20.0	2.6	0	92	2.4	1.7	0.0	0.9	2.6	1.2	1.33
Charles	4.6	5.3	4.4	4.7	4.6	4.4	4.5	4.9	58	6.8	5.6	5.1	6.3	25.3	7.5	0	89	4.7	3.4	0.0	1.2	6.5	1.3	0.97
P%	16	>20	<5	>20	>20	<1	>20	17	<5	<5	<0.1	20	<0.1	9	7	>20	<1	<5	<1	>20	>2	<5	<5	<0.1
LSD 5%	-	-	0.4	-	8	0.5	-	-	0.3	0.3	0.2	-	0.1	-	-	-	2	1.9	1..3	-	-	3.8	0.5	0.09
Interaction variety x site	>20	-	>20	>20	-	<1	>20	>20	>20	>20	<0.1	5	<0.1	<5	<5	-	<5	>20	12	>20	>20	7	6	-

Table 13. Colonial bentgrass / browntop (Agrostis capillaris) (continued)

g) Mean of four sites, both climatic zones.

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	4	4	4	3	1	4	4	4	2	2	4	3	3
Heritage	4.8	5.2	4.9	5.2	4.3	4.7	4.7	5.0	41	6.5	6.0	5.2	5.8	25.2	8.3	0	89	2.6	2.4	0	0.9	4.8	4.6	0.70
Rhinegold	4.7	5.2	4.9	5.1	4.2	4.5	4.8	4.8	62	6.4	5.8	4.8	5.8	26.5	5.2	0	89	2.8	2.2	0	1.7	2.7	3.7	0.67
Jorvik	4.7	5.1	4.7	5.1	4.3	4.5	4.7	4.9	56	6.4	5.9	5.0	5.9	28.9	5.2	0	89	3.0	2.6	0	1.6	2.8	4.4	0.69
Teetop	4.6	5.1	4.7	5.2	4.0	4.3	4.7	4.8	56	6.5	5.6	5.1	5.9	27.8	4.5	0	89	3.1	2.8	0	0.9	3.1	4.3	0.81
Charles	3.8	4.6	4.1	3.5	3.4	3.0	3.7	4.3	56	-	-	-	-	41.3	-	0	74	-	-	0	1.2	-	4.7	-
P%	<0.1	15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	>20	15	<0.1	>20	12	<0.1	>20	>20	<0.1	>20	>20	>20	>20	18	>20	<0.1
LSD 5%	0.2	-	0.3	0.3	0.4	0.4	0.3	0.3	-	-	0.1	-	-	7.5	-	-	3	-	-	-	-	-	-	0.05
P%, interaction variety x site	<0.1	>20	>20	<0.1	<0.1	<0.1	<0.1	<5	>20	7	<1	>20	>20	<1	>20	>20	>20	>20	>20	>20	>20	7	>20	<0.1

3.5 Varieties of *Agrostis stolonifera* (Table 14)

'Riptide' ('PPG AP 101'), 'Luminary' and 'Flagstick' were ranked higher than the control variety 'Independence' on average for all sites. 'Ignite' was also better than 'Independence' in the northern zone, whilst 'Pure Distinction' was better than 'Independence' in the southern zone. The latter was primarily due to 'Pure Distinction's ' high density, but it also stood out with a significantly lighter color than the other varieties, in many ways resembling *Agrostis canina* (Photo 30). Because of poor winter survival, not only at Apelsvoll (Photo 29), but also at Reykjavik, 'Pure Distinction' can clearly not be recommended for putting greens in the northern zone. Its recommendation in the southern zone is also questionable because of high susceptibility to microdochium patch (Photo 31).

Part of the explanation why so may new varieties were ranked higher than the control variety 'Independence' in this test cycle may be that 'Independence', along with 'Memorial', was rather slow in establishment. For 'Independence', this is unlike earlier SCANGREEN cycles, and it should be investigated further whether it was genetically determined or due to the quality of the particular seed lot used in this test cycle. Heineck et al (2019) recently published results showing 'Independence' to be more sensitive to low soil temperatures during establishment than other creeping bentgrass varieties.

Becaue of late entrance into the test round, 'Valderrama' was seeded later and a little distant from the other creeping bentgrass varieties at all sites except Sydsjælland. This may perhaps explain why 'Valderrama' – relative to the other varieties – had its best performance at Sydsjælland. 'Valderrrama' has been entered into the the new SCANGREEN trials starting 2019 to get a safer evaluation of the variety.

One variety that has recently aquired a certain popularity in Norway and Sweden, but was a disappointment in these trials was 'Memorial'. On average for the four trial sites, the variety had significantly coarser leaves, lower tiller density and more vigorous height growth than the other varieties (Photo 32). At Landvik, 'Memorial' resembled the old 'Penncross' (Table 14e).

Photo 30. Landvik, 18 June 2017: 'Pure Distinction' had higher density and lighter color than 'Luminary'.

P-hoto: Trygve S. Aamlid

Photo 31. Tatsiana Espevig studying patches in 'Pure Distinction' shortly after snow melt at Landvik on 25 Feb. 2019 (after trial period was officially finished). In these patches she identified both Microdochium nivale and Typhula incarnata.

Photo: Trygve S. Aamlid

Photo 32. Landvik, 18 June 2017: Memorial had lower tiller density and coarser leaves than 'Ignite'.

Photo: Trygve S. Aamlid

Table 14. Ranking of *creeping bentgrass (Agrostis stolonifera)* varieties after four years testing on putting greens in SCANGREEN trials at a) Korpa GC (Iceland); b) Apelsvoll Research Center (Norway); c) average for Korpa and Apelsvoll representing the northern climatic zone of Scandinavia; d) Sydsjælland GC (Denmark); e) Landvik Research Center (Norway); f) average for Sydsjælland and Landvik representing the southern climatic zone of Scandinavia; and g) average for all four test sites.

a) Reykjavik GC, Iceland (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micr-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	3	5	5	4	1	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
Flagstick	6.0	6.1	5.2	5.9	6.9	5.5	5.8	6.9	-	7.1	5.7	6.5	5.0	5.7	-	-	93	1.3	1.3	-	-	1.3	6.7	0.42
Luminary	5.8	4.9	5.5	5.7	6.6	5.3	5.6	6.6	-	7.0	5.6	6.5	5.0	9.2	-	-	92	2.2	2.2	-	-	2.2	6.3	0.39
Ignite (V8)	5.6	4.5	5.1	5.6	6.7	5.0	5.5	6.3	-	7.0	5.8	6.5	5.0	5.9	-	-	92	1.9	1.9	-	-	1.9	5.0	0.44
Riptide	5.6	3.8	5.0	5.9	6.7	4.5	5.4	6.7	-	6.9	5.6	6.5	5.0	11.2	-	-	90	1.8	1.8	-	-	1.8	5.0	0.42
Independence	5.5	3.9	4.9	5.8	6.7	5.0	5.3	6.5	-	7.0	5.8	6.5	5.0	5.7	-	-	91	1.7	1.7	-	-	1.7	6.0	0.41
Valderrama	5.5	6.6	4.9	5.0	5.9	4.8	5.3	6.2	-	6.3	5.4	5.5	5.8	8.4	-	-	88	0.2	0.2	-	-	0.2	4.3	0.55
Crystal Blue	5.3	3.4	4.7	5.5	6.5	4.7	5.1	6.2	-	7.0	5.7	6.5	5.0	7.3	-	-	90	1.9	1.9	-	-	1.9	7.7	0.40
Memorial	5.2	4.3	4.8	5.3	5.9	5.2	4.9	6.0	-	6.9	5.8	6.5	5.0	5.6	-	-	90	2.1	2.1	-	-	2.1	9.0	0.52
Pure Distinct.	5.2	3.8	4.7	5.4	6.0	4.7	4.8	6.4	-	6.8	5.2	6.5	5.0	14.8	-	-	85	3.1	3.1	-	-	3.1	13.3	0.44
P%	<5	<0.1	15	>20	7	5	<5	20	-	<0.1	<0.1	<0.1	<0.1	<5	-	-	<5	<5	<5	-	-	<5	<1	<1
LSD 5%	0.5	1.0	-	-	-	0.6	0.5	-	-	0.2	0.1	0.1	0.1	5.4	-	-	5	1.2	1.2	-	-	1.2	3.6	0.05

Table 14 . Creeping bentgrass (*Agrostis stolonifera*) (continued)

b) NIBIO Apelsvoll Research Center, Norway (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter, %	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	1	12	11	1	2	3	3		19	12	12	-	-	16	-	6
Riptide	6.5	5.8	7.1	6.7	6.2	5.7	7.1	6.3	43	6.4	6.0	6.7	5.7	24.7	6.7	-	98	1.2	1.2	-	-	2.5	-	0.47
Luminary	6.3	6.1	6.6	6.5	6.0	5.6	6.9	6.1	48	6.4	6.0	5.7	5.5	22.7	6.0	-	98	1.8	1.8	-	-	3.0	-	0.28
Ignite (V8)	6.1	6.2	6.6	6.9	5.1	5.1	6.5	6.4	48	6.3	6.3	6.7	5.7	25.6	6.7	-	97	1.6	1.6	-	-	2.8	-	0.48
Independence	6.1	5.9	7.0	7.1	4.9	5.0	6.7	6.2	43	6.4	6.3	6.7	5.7	28.3	7.1	-	97	1.1	1.1	-	-	2.6	-	0.57
Memorial	6.0	5.0	6.6	6.7	5.5	5.4	6.5	5.8	37	6.0	6.1	6.0	5.2	23.4	6.2	-	97	1.4	1.4	-	-	2.6	-	0.71
Crystal Blue	5.9	5.5	7.0	6.7	4.7	4.9	6.4	6.0	47	6.3	6.1	6.0	5.2	27.8	7.3	-	96	1.4	1.4	-	-	2.7	-	0.56
Flagstick	5.7	4.9	6.5	6.7	4.8	4.9	6.1	5.8	30	6.3	6.1	6.3	5.7	30.6	6.8	-	96	1.6	1.6	-	-	2.7	-	0.47
Valderrama	5.3	3.0	6.6	7.0	4.6	5.2	5.6	5.3	-[2]	6.0	6.1	6.0	5.5	18.0	6.2	-	94	1.6	1.6	-	-	2.6	-	0.46
Pure Distinct.[1]	2.9	5.3	6.2	1.0	0.8	0.6	3.1	3.9	50	-	-	-	-	73.1	-	-	46	-	-	-	-	.	-	.
P%	<0.1	<0.1	>20	<0.1	<0.1	<0.1	<0.1	<0.1	11	<5	7	<5	>20	<1	>20	-	<0.1	>20	>20	-	-	>20	-	<1
LSD 5%	0.7	0.9	-	0.5	1.7	1.1	0.8	0.6	-	0.2	-	0.7	-	23.0	-	-	4	-	-	-	-	-	-	0.14

[1]Pure Distinction could not be scored for several characters due to poor winter survival and repeated reseeding

[2]Valderrama was seeded some days after the other varieties due to late arriving seed. Figures on establishment rate are therefore not comparable.

Table 14. Creeping bentgrass (*Agrostis stolonifera*) (continued)

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	0	2	2	2	0	0	2	1	2
Luminary	6.0	5.5	6.1	6.1	6.3	5.5	6.2	6.3	48	6.7	5.8	6.1	5.3	15.9	6.0	-	95	2.0	2.0	-	-	2.6	6.3	0.33
Riptide	6.0	4.8	6.1	6.3	6.4	5.1	6.2	6.5	43	6.7	5.8	6.6	5.3	17.9	6.7	-	94	1.5	1.5	-	-	2.2	5.0	0.44
Ignite (V8)	5.9	5.4	5.8	6.2	5.9	5.1	6	6.3	48	6.7	6.1	6.6	5.3	15.7	6.7	-	94	1.7	1.7	-	-	2.4	5.0	0.46
Flagstick	5.9	5.5	5.8	6.3	5.9	5.2	6	6.3	30	6.7	5.9	6.4	5.3	18.1	6.8	-	94	1.4	1.4	-	-	2.0	6.7	0.45
Independence	5.8	4.9	6.0	6.4	5.8	5.0	6	6.3	43	6.7	6.0	6.6	5.3	17.0	7.1	-	94	1.4	1.4	-	-	2.1	6.0	0.49
Memorial	5.6	4.7	5.7	6	5.7	5.3	5.7	5.9	37	6.5	6.0	6.3	5.1	14.5	6.2	-	93	1.7	1.7	-	-	2.4	9.0	0.62
Crystal Blue	5.6	4.5	5.8	6.1	5.6	4.8	5.7	6.1	47	6.6	5.9	6.3	5.1	17.6	7.3	-	93	1.6	1.6	-	-	2.3	7.7	0.48
Valderrama	5.4	4.8	5.7	6	5.3	5	5.4	5.8	-	6.2	5.8	5.8	5.6	13.2	6.2	-	91	0.9	0.9	-	-	1.4	4.3	0.51
Pure Distinct.	4.0	4.5	5.5	3.2	3.4	2.6	4	5.2	50	-	-	-	-	43.9	-	-	65	-	-	-	-	-	13.3	-
P%	<0.1	<0.1	>20	<0.1	<0.1	<0.1	<0.1	<0.1	11	<0.1	<0.1	<0.1	<5	<0.1	>20	-	<0.1	<5	<5	-	-	<5	<1	<0.1
LSD 5%	0.4	0.6	-	0.5	0.9	0.6	0.5	0.4	-	0.1	0.1	0.3	0.3	11.4	-	-	3	0.6	0.6	-	-	0.7	3.6	0.07
Interaction variety x site	<0.1	<0.1	19	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<1	<5	<1	-	-	<0.1	<5	<5	-	-	18	-	<0.1

Table 14. Creeping bentgrass (*Agrostis stolonifera*) (continued)

d) Sydsjælland GC, Denmark (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	18	0	5	6	7	5	9	4	0	16	16	3	6	3	3	0	17	8	5	1	3	9	6	0
Flagstick	5.3	-	4.8	4.9	6.1	5.0	5.	5.6	-	7.1	6.2	4.5	4.8	0.4	0.4	-	99	0.0	0.0	0.0	0.0	0.3	0.1	-
Independence	5.3	-	5.0	5.0	5.9	5.3	5.	5.8	-	6.9	6.3	4.6	4.7	0.5	0.5	-	99	0.0	0.0	0.0	0.0	0.4	0.3	-
Valderrama	5.2	-	4.5	5.5	5.6	5.0	5.	5.2	-	6.7	6.3	5.8	6.6	1.5	1.5	-	96	0.1	0.3	0.0	0.0	1.0	0.3	-
Memorial	5.2	-	4.9	4.9	5.8	5.1	5.	5.6	-	6.8	6.3	4.7	4.4	1.6	1.6	-	99	0.0	0.0	0.0	0.0	1.0	0.1	-
Ignite (V8)	5.2	-	5.1	4.7	5.9	5.2	5.	5.5	-	6.9	6.4	4.7	4.6	3.1	3.1	-	99	0.1	0.0	0.0	0.0	2.1	0.5	-
Pure Distinct.	5.2	-	5.2	4.9	5.6	5.2	5.	5.7	-	7.1	6.0	4.3	4.7	8.4	8.4	-	99	0.2	0.0	0.0	1.0	5.7	0.2	-
Riptide	5.0	-	4.2	5.0	5.8	5.3	4.	5.2	-	7.1	6.4	4.3	4.7	0.7	0.7	-	93	0.0	0.0	0.0	0.0	0.4	0.1	-
Luminary	5.0	-	4.5	4.8	5.6	5.0	4.	5.7	-	7.0	6.3	4.5	4.4	1.1	1.1	-	97	0.5	0.4	0.0	0.0	1.1	0.2	-
Crystal Blue	4.8	-	4.3	4.8	5.4	5.0	4.	5.8	-	7.0	6.3	4.4	4.8	1.9	1.9	-	96	0.0	0.0	0.0	0.0	1.3	0.4	-
P%	>20	-	>20	<5	12	>20	14	>20	-	<0.1	<0.1	<0.1	<0.1	<1	<1	-	>20	>20	>20	>20	>20	<1	>20	-
LSD 5%	-	-	-	0.5	-	-	-	-	-	0.1	0.1	0.2	0.1	3.2	3.2	-	-	-	-	-	-	2.8	-	-

Table 14. Creeping bentgrass (*Agrostis stolonifera*) (continued)

e) NIBIO Landvik Research Center, Norway (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
Luminary	6.7	6.9	6.7	6.9	6.3	6.6	6.8	6.7	60	7.6	6.3	4.7	6.5	23.8	9.6	0	92	1.0	0.2	0.0	0.8	1.6	0.0	0.3	0.92
Riptide	6.5	6.4	6.4	7.1	5.8	6.2	6.4	6.7	69	7.6	5.7	4.5	6.7	19.4	1.4	0	93	0.5	0.3	0.2	0.1	0.6	0.1	0.6	0.97
Flagstick	6.3	5.9	5.8	6.6	6.6	6.0	6.5	6.2	40	7.4	6.3	4.1	6.5	23.2	1.4	0	93	0.8	0.1	0.0	0.7	0.4	0.0	1.4	0.93
OO7	6.3	6.3	6.0	6.8	6.0	5.9	6.4	6.6	65	7.6	6.4	4.4	6.9	24.9	1.5	0	91	0.5	0.3	0.1	0.2	0.7	0.1	0.5	0.94
Pure Distinct.	6.2	7.1	6.0	6.4	5.8	5.4	6.3	6.8	80	8.0	4.6	4.6	6.9	20.3	7.7	0	90	2.3	0.8	0.0	1.5	2.6	0.1	0.8	0.88
Focus	6.0	5.8	5.5	6.6	5.8	5.6	6.0	6.2	43	7.0	6.1	3.6	6.3	25.4	1.5	0	89	0.5	0.2	0.0	0.2	0.7	0.3	0.1	0.97
Declaration	6.0	6.0	5.2	6.6	6.2	5.8	5.9	6.5	44	7.2	5.8	4.6	6.4	26.7	1.3	0	91	1.1	0.4	0.0	0.5	0.7	0.2	0.2	0.93
MacKenzie	5.9	6.1	5.4	5.9	6.4	5.3	6.2	6.0	59	7.3	5.7	4.2	6.7	20.7	2.8	0	92	1.1	0.4	0.0	0.9	1.1	0.4	0.8	0.98
Ignite (V8)	5.9	6.4	5.5	6.3	5.4	5.5	5.9	6.1	85	7.0	6.5	3.8	6.6	29.7	1.0	0	90	0.7	0.5	0.1	0.3	0.7	0.1	0.2	1.02
Independence	5.8	5.7	5.1	6.3	6.1	5.1	6.0	6.0	48	7.0	6.3	3.9	6.4	17.3	2.1	0	93	0.8	0.4	0.1	0.4	0.9	0.3	0.6	0.96
Tyee	5.8	6.1	5.3	6.2	5.5	5.1	5.8	6.2	68	6.9	5.9	3.9	6.4	23.7	3.8	0	91	0.9	0.3	0.1	0.6	1.7	0.2	0.2	1.04
Crystal Blue	5.8	6.6	5.7	6.3	4.7	5.3	5.8	6.1	89	7.0	6.4	4.6	6.3	26.4	3.7	0	89	0.8	0.5	0.0	0.2	1.4	0.1	0.3	1.04
Teeone	5.6	5.9	5.1	6.2	5.1	4.8	5.7	6.0	67	6.9	7.1	4.0	6.5	33.8	2.7	0	88	1.1	0.8	0.0	0.3	1.6	0.1	0.7	0.95
Valderrrama	5.3	4.2	4.7	6.1	5.6	4.6	5.5	5.6	.[1]	6.8	6.6	3.8	6.3	31.9	1.9	0	87	0.7	0.5	0.1	0.6	1.0	0.1	1.2	1.01
Penncross	5.2	5.8	4.6	5.1	5.8	4.5	5.3	5.6	62	6.4	5.9	3.4	5.9	29.0	2.3	0	91	1.7	0.6	0.0	0.7	1.2	0.5	1.2	1.24
Memorial	4.9	5.3	4.4	5.5	4.6	4.4	5.0	5.3	32	6.4	6.1	3.6	6.0	26.9	2.8	0	87	0.6	0.6	0.0	0.1	1.2	0.3	1.8	1.16
P%	<1	<1	<5	<5	>20	<1	7	<0.1	>20	<0.1	<0.1	<5	<0.1	>20	>20	>20	>20	6	6	>20	>20	11	<5	14	<0.1
LSD 5%	0.8	1.2	1.2	0.9	-	1.0	-	0.6	-	0.5	0.4	0.8	0.3	-	-	-	-	-	-	-	-		0.3	-	0.1

[1]Valderrama was seeded some days after the other varieties due to late arriving seed. Figures on establishment rate are therefore not comparable.

(The trial at Landvik was extended with seven more varieties than at the other sites)

Table 14. Creeping bentgrass (*Agrostis stolonifera*) (continued)

f) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1
Flagstic	5.8	5.9	5.3	5.8	6.3	5.5	6.0	5.9	40	7.2	6.3	4.3	5.6	11.8	0.9	0	96	0.4	0.1	0.0	0.3	0.3	0.1	0.93
Luminary	5.8	6.9	5.6	5.9	6.0	5.8	5.8	6.2	60	7.3	6.3	4.6	5.5	12.5	5.4	0	95	0.7	0.3	0.0	0.4	1.4	0.1	0.92
Riptide	5.7	6.4	5.3	6.0	5.8	5.8	5.7	6.0	69	7.3	6.1	4.4	5.7	10.0	1.0	0	93	0.2	0.1	0.1	0.1	0.5	0.1	0.97
Pure Distinct.	5.7	7.1	5.6	5.6	5.7	5.3	5.7	6.2	80	7.6	5.3	4.4	5.8	14.4	8.1	0	94	1.3	0.4	0.0	1.2	4.1	0.2	0.88
Independence	5.6	5.7	5.1	5.6	6.0	5.2	5.6	5.9	48	7.0	6.3	4.2	5.6	8.9	1.3	0	96	0.4	0.2	0.1	0.1	0.6	0.3	0.96
Ignite (V8)	5.5	6.4	5.3	5.5	5.7	5.4	5.6	5.8	85	7.0	6.4	4.2	5.6	16.4	2.0	0	95	0.4	0.3	0.0	0.1	1.4	0.3	1.02
Crystal Blue	5.3	6.6	5.0	5.6	5.1	5.1	5.1	6.0	89	7.0	6.4	4.5	5.5	14.2	2.8	0	93	0.4	0.2	0.0	0.1	1.3	0.3	1.04
Valderrrama	5.3	4.2	4.6	5.8	5.6	4.8	5.5	5.4	-	6.8	6.5	4.8	6.5	16.7	1.7	0	92	0.4	0.4	0.1	0.3	1.0	0.2	1.01
Memorial	5.1	5.3	4.7	5.2	5.2	4.8	5.0	5.5	32	6.6	6.2	4.1	5.2	14.2	2.2	0	93	0.3	0.3	0.0	0.1	1.1	0.2	1.16
P%	<1	<0.1	<5	<5	7	<0.1	6	<1	<5	<0.1	<0.1	<5	<0.1	>20	6	>20	>20	<5	>20	15	6	<0.1	>20	7
LSD 5%	0.4	1.0	0.6	0.4	-	0.4	-	0.4	39	0.2	0.2	0.4	0.2	-	-	-	-	0.6	-	-	-	1.3	-	-
P%, interaction variety x site	<0.1	-	<0.1	<1	>20	<0.1	<5	<1	-	<0.1	<0.1	<0.1	<0.1	>20	>20	-	14	12	11	15	>20	11	18	-

Table 14. Creeping bentgrass (*Agrostis stolonifera*) (continued)

g) Mean of four sites, both climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter, %	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs. %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	4	4	4	3	1	4	4	4	2	2	4	3	3
Riptide	5.9	5.3	5.7	6.2	6.1	5.4	5.9	6.2	56	7.0	5.9	5.5	5.5	14.0	2.9	0	93	0.9	0.8	0.1	0.1	1.4	1.7	0.62
Luminary	5.9	6.0	5.8	6.0	6.1	5.6	6.0	6.3	54	7.0	6.1	5.3	5.3	14.2	5.6	0	95	1.3	1.1	0.0	0.4	2.0	2.2	0.53
Flagstic	5.8	5.6	5.6	6.0	6.1	5.3	6.0	6.1	35	6.9	6.1	5.4	5.5	15.0	2.9	0	95	0.9	0.7	0.0	0.3	1.2	2.3	0.61
Independence	5.7	5.1	5.5	6.0	5.9	5.1	5.8	6.1	46	6.8	6.2	5.4	5.5	13.0	3.2	0	95	0.9	0.8	0.1	0.1	1.4	2.2	0.65
Ignite (V8)	5.7	5.7	5.6	5.9	5.8	5.2	5.8	6.1	67	6.8	6.3	5.4	5.5	16.1	3.6	0	95	1.0	1.0	0.0	0.1	1.9	1.9	0.65
Crystal Blue	5.4	5.2	5.4	5.8	5.3	4.9	5.4	6.0	68	6.8	6.1	5.4	5.3	15.9	4.3	0	93	1.0	0.9	0.0	0.1	1.8	2.7	0.67
Memorial	5.3	4.9	5.2	5.6	5.4	5.0	5.4	5.7	34	6.5	6.1	5.2	5.1	14.3	3.5	0	93	1.0	1.0	0.0	0.1	1.7	3.1	0.80
Valderrama	5.3	4.6	5.2	5.9	5.4	4.9	5.5	5.6	.	6.5	6.1	5.3	6.1	15.0	3.2	0	92	0.7	0.6	0.1	0.3	1.2	1.6	0.67
Pure Distinct.	4.9	5.4	5.5	4.4	4.5	4.0	4.8	5.7	65	-	-	-	-	29.2	-	0	80	-	-	0.0	1.2	-	4.6	-
P%	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1	<0.1	<0.1	>20	<0.1	<0.1	>20	>20	<0.1	<5	<5	15	6	<5	<0.	<0.1
LSD 5%	0.3	0.5	0.4	0.3	0.6	0.4	0.4	0.3	2	0.1	0.1	-	0.2	6.6	-	-	2	0.4	0.3	-	-	0.6	1.2	0.07
P%, interaction variety x site	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	>20	<0.1	<0.1	<0.1	<0.1	<0.1	>20	-	<0.1	<5	<1	15	>20	>20	<0. 1	<5

3.6 Varieties of *Lolium perenne* (Table 15)

The most pronounced difference between the two candidate varieties of *Lolium perenne* was that 'Rinovo' had a very dark color, whilst 'Clementine' was light green, more like the control variety 'Chardin'. The dark color in 'Rinovo' gave the plots a less uniform appearance as *Poa annua* invasion increased towards the end of the trial period (Photo 33).

'Clementine' received the highest scores for turfgrass quality in both climatic zones. Two of its advantages compared with the control variety 'Chardin' were a significantly higher tiller density and a 12% reduction in height growth on average for all sites. The statistical analyses showed significantly more winter damage in 'Clementine' than in Chardin', but the difference between 75 and 78 % winter kill (Table 15c) is probably too small too have any practical relevance for golf courses using perennial ryegrass in northern parts of Scandinava.

Photo 33. Landvik, 25 Feb. 2019 (after the test period was officially finished): There was a significant color difference among varieties of Lolium perenne: 'Clementine' (top) and 'Rinovo' (bottom) The dark color in 'Rinovo' formed a strong contrast to invading plants of Poa annua.

Photo: Trygve S. Aamlid

Table 15. Ranking of perennial ryegrass (*Lolium perenne*) varieties after four years testing on putting greens in SCANGREEN trials at a) Korpa GC (Iceland); b) Apelsvoll Research Center (Norway), c) average for Korpa and Apelsvoll representing the northern climatic zone of Scandinavia; d) Sydsjælland GC (Denmark); e) Landvik Research Center (Norway), f) average for Sydsjælland and Landvik representing the southern climatic zone of Scandinavia; and g) average for all four test sites.

a) Reykjavik GC, Iceland (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	3	5	5	4	1	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
Chardin	3.4	6.5	3.2	3.5	1.8	2.0	3.7	3.4	-	5.3	5.1	7.5	3.7	50.7	-	-	67	0.0	0.0	-	-	0.0	20	1.12
Clementine	3.2	6.5	2.7	3.6	1.8	2.0	3.6	3.2	-	5.3	5.2	7.5	3.7	56.4	-	-	63	0.0	0.0	-	-	0.0	21.7	1.05
Rinovo	3.0	6.0	2.8	2.9	1.8	2.2	3.2	3.1	-	5.3	5.3	7.5	3.7	54.2	-	-	58	0.0	0.0	-	-	0.0	21.7	1.02
P%	>20	>20	14	>20	>20	>20	>20	>20	-	>20	<5	>20	>20	<5	-	-	>20	>20	>20	-	-	>20	>20	>20
LSD 5%	-	-	-	-	-	-	-	-	-	-	0.1	-	-	3.4	-	-	-	-	-	-	-	-	-	-

b) NIBIO Apelsvoll Research Center, Norway (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	1	6	5	1	2	3	0	0	19	0	0	0	0	0	-	6
Clementine	4.4	4.5	8.5	3.7	2.0	1.2	4.4	6.3	73	3.9	6.4	-	3.0	100	-	-	69	-	-	-	-	-	-	-
Rinovo	4.2	3.9	8.3	3.6	2.2	1.2	4.3	6.0	73	3.9	7.8	-	3.0	100	-	-	69	-	-	-	-	-	-	-
Chardin	4.1	3.8	8.3	3.7	1.9	1.2	4.2	5.8	75	3.7	6.1	-	3.3	100	-	-	68	-	-	-	-	-	-	-
P%	>20	7	>20	>20	>20	>20	>20	9	>20	<1	<0.1	-	>20	>20	-	-	>20	-	-	-	-	-	-	-
LSD 5%	-	-	-	-	-	-	-	-	-	0.1	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-

Many characters could not be determined for *Lolium perenne* at Apelsvll since all plots sufferered 100 % winter kill and had had to be reseeded every year.

Table 15. Perennial ryegrass (*Lolium perenne*) (continued)

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment. %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	2	2	2	2	2	2	2	1	2	2	1	2	2	0	0	2	1	1	0	0	1	1	1
Chardin	3.8	5.1	5.8	3.6	1.9	1.6	4.0	4.6	75	4.5	5.6	7.5	3.5	75.3	-	-	68	0	0	-	-	0	20.0	1.12
Clementine	3.8	5.5	5.6	3.6	1.9	1.6	4.0	4.8	73	4.6	5.8	7.5	3.3	78.2	-	-	66	0	0	-	-	0	21.7	1.05
Rinovo	3.6	4.9	5.5	3.3	2.0	1.7	3.7	4.5	73	4.6	6.6	7.5	3.3	77.1	-	-	64	0	0	-	-	0	21.7	1.02
P%	>20	17	>20	>20	>20	>20	>20	>20	>20	<0.1	<0.1	>20	>20	<1	-	-	>20	-	-	-	-	-	>20	>20
LSD 5%	-	-	-	-	-	-	-	-	-	0.1	0.2	-	-	1.4	-	-	-	-	-	-	-	-	-	-
Interaction variety x site	>20	>20	19	>20	>20	>20	>20	>20	-	<0.1	<0.1	-	>20	<1	-	-	13	-	-	-	-	-	-	-

d) Sydsjælland GC, Denmark (southern climatic zone)

No of observations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment. %	*Poa annua* encroachment, %
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	18	0	5	6	7	5	9	4	0	16	16	3	6	3	3	0	17	8	5	1	3	9	6	0
Chardin	3.7	-	2.4	4.7	3.9	3.7	3.9	3.4	-	3.2	5.8	5.7	3.3	1.4	1.4	-	96	4.5	0.9	30.7	0.0	0.9	2.7	
Clementine	3.5	-	2.7	4.8	3.2	3.4	3.8	3.2	-	3.8	5.7	5.7	3.6	0.3	0.3	-	94	3.6	1.3	25.0	0.0	0.7	6.3	-
Rinovo	3.5	-	2.6	4.7	3.0	3.6	3.7	3.0	-	3.1	6.8	6.4	3.3	0.4	0.4	-	93	4.3	0.9	31.7	0.0	0.6	3.9	-
P%	20	-	<0.1	>20	7	>20	>20	14	-	<1	<0.1	<1	<5	12	12	-	<5	>20	>20	>20	>20	>20	<5	-
LSD %	-	-	-	-	-	-	-	-	-	0.2	0.1	0.3	0.3	-	-	-	2	-	-	-	-	-	1.8	-

Table 15. Perennial ryegrass (*Lolium perenne*) (continued)

e) NIBIO Landvik Research Center, Norway (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
Clementine	5.5	5.3	5.3	5.5	5.9	5.1	5.7	5.6	99	5.3	5.3	6.2	5.0	34.9	0.3	0.7	90	0.8	0.1	0.7	0	0.2	0.8	2.0	1.47
Chardin	5.3	4.8	5.1	5.3	5.8	5.1	5.4	5.3	99	5.0	5.0	6.8	5.1	34.2	0.2	0.0	89	0.6	0.2	0.7	0	0.2	0.8	2.5	1.74
Rinovo	4.5	4.9	4.4	4.4	4.5	4.3	4.6	4.5	98	4.3	7.9	5.6	4.0	34.3	0.2	0.0	87	0.6	0.1	0.6	0	0.1	0.9	4.8	1.60
P%	<0.1	<5	<1	<0.1	<0.1	<0.1	<0.1	<1	>20	<0.1	<0.1	<1	<0.1	11.0	>20	>20	<1	>20	>20	>20	>20	>20	>20	13	<5
LSD 5%	0.2	0.4	0.4	0.2	0.2	0.2	0.2	0.4	-	0.1	0.3	0.4	0.2	-	-	-	1	-	-	-	-	-	-	-	0.16

f) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1
Clementine	4.5	5.3	4.0	5.1	4.5	4.3	4.8	4.4	99	4.6	5.5	5.9	4.3	17.6	0.3	0.7	92	2.2	0.7	4.5	0	0.4	3.6	1.47
Chardin	4.5	4.8	3.8	5.0	4.8	4.4	4.6	4.3	99	4.1	5.4	6.2	4.2	17.8	0.8	0.0	93	2.5	0.5	5.5	0	0.6	1.8	1.74
Rinovo	4.0	4.9	3.5	4.6	3.8	4.0	4.1	3.7	98	3.7	7.4	6.0	3.7	17.3	0.3	0.0	90	2.4	0.5	5.6	0	0.3	2.4	1.60
P%	<0.1	<5	<0.1	<0.1	<0.1	<1	<0.1	<0.1	>20	<0.1	<0.1	<5	<0.1	>20	9	>20	<0.1	>20	>20	>20	>20	>20	<1	<5
LSD 5%	0.1	0.4	0.1	0.1	0.3	0.2	0.2	0.2	-	0.1	0.1	0.2	0.2	-	-	-	1	-	-	-	-	-	1.0	0.16
Interaction variety x site	<0.1	-	<0.1	<0.1	<1	<1	<1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<5	7		<5	>20	>20	>20	>20	>20	>1	-

Table 15. Perennial ryegrass (*Lolium perenne*) (continued)

g) Mean of four sites, both climatic zones

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	4	4	4	3	1	4	3	3	2	2	3	3	2
Clementine	4.2	5.4	4.8	4.4	3.2	2.9	4.4	4.6	86	4.6	5.7	6.5	3.8	47.9	0.3	0.7	79	1.5	0.5	4.5	0	0.3	9.6	1.26
Chardin	4.1	5.0	4.8	4.3	3.4	3.0	4.3	4.5	87	4.3	5.5	6.6	3.8	46.6	0.8	0.0	80	1.7	0.4	5.5	0	0.4	7.8	1.43
Rinovo	3.8	4.9	4.5	3.9	2.9	2.8	3.9	4.1	86	4.1	7.0	6.5	3.5	47.2	0.3	0.0	77	1.6	0.3	5.6	0	0.2	8.8	1.31
P%	<0.1	<5	<5	<1	<5	11	<0.1	<5	>20	<0.1	<0.1	<5	<0.1	<1	9	>20	<5	>20	>20	>20	>20	>20	>20	<1
LSD 5%	0.2	0.4	0.2	0.2	0.3	-	0.2	0.3	-	0.1	0.1	0.1	0.2	0.7	-	-	2	-	-	-	-	-	-	0.09
P%, interaction variety x site	<1	>20	<1	<5	<5	<1	<1	17	>20	<0.1	<0.1	<0.1	<0.1	<0.1	7	-	13	>20	>20	>20	>20	>20	>20	7

3.7 Varieties of *Poa trivialis* (Table 16)

The only signicant differences among varieties of *Poa trivialis* were: (1) Darker in-season color in 'Sabrena 1' than in the other three varieties; (2) a better winter color in 'Sabrena 1' and 'Qasar' than in 'Winterway'; and (3) more microdochium in spring in 'Winterway' than in 'Sabrena 1' and 'Qasar'. 'Sabrena 1' received the highest rank for turf quality in both zones, but differences were altogether small and insignificant.

Photo 34a,b. Landvik, 7 Sep. 2017: Poa trivials had fine leaves but was not very competitive. Two years after seeding, many other grasses, including coarse type of bentgrass, had invaded the plots at Landvik.

Photo: Trygve S. Aamlid

Table 16. Ranking of rough bluegrass (rough meadow grass, *Poa trivialis*) varieties after four years testing on putting greens in SCANGREEN trials at a) Korpa GC (Iceland); b) Apelsvoll Research Center (Norway), c) average for Korpa and Apelsvoll representing the northern climatic zone of Scandinavia; d) Sydsjælland GC (Denmark); e) Landvik Research Center (Norway), f) average for Sydsjælland and Landvik representing the southern climatic zone of Scandinavia; and g) average for all four test sites.

a) Reykjavik GC, Iceland (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	3	5	5	4	1	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
Sabrena 1	4.6	6.1	5.1	4.7	3.2	4.0	4.4	5.6	-	5.9	6.0	4.5	5.8	30.1	-	-	79	1.2	1.2	-	-	1.2	10	0.87
Dark Horse	4.5	6.2	4.9	4.5	3.3	3.7	4.5	5.2	-	6.0	6.0	4.5	5.8	31.8	-	-	79	1.6	1.6	-	-	1.6	11.7	0.89
Winterway	4.4	6.6	5.1	4.1	3.0	4.2	4.3	5.0	-	6.0	6.0	4.5	5.8	28.2	-	-	77	1.3	1.3	-	-	1.3	15	0.91
Qasar	4.2	6.3	5.1	3.5	2.8	4.2	4.0	4.7	-	6.0	6.0	4.5	5.8	28.1	-	-	75	0.9	0.9	-	-	0.9	16.7	0.85
P%	>20	>20	>20	>20	<5	>20	18.0	>20	-	>20	>20	>20	>20	>20	-	-	>20	>20	>20	-	-	>20	>20	>20
LSD 5%	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

b) NIBIO Apelsvoll Research Center, Norway (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	1	6	5	1	2	3	3	0	19	0	0	-	-	0	-	0
Dark Horse	3.9	6.1	7.1	2.7	1.1	0.6	3.6	6.0	47	4.6	6.5	-	4.0	100	-	-	58	-	-	-	-	-	-	-
Sabrena 1	3.8	6.5	7.2	2.5	0.9	0.6	3.6	5.8	43	4.3	6.5	-	4.0	100	-	-	56	-	-	-	-	-	-	-
Winterway	3.7	6.2	6.5	2.8	1.0	0.7	3.6	5.6	48	4.5	6.4	-	4.0	100	-	-	56	-	-	-	-	-	-	-
Qasar	3.7	6.3	6.8	2.6	0.8	0.6	3.5	5.7	43	4.1	6.6	-	4.0	100	-	-	55	-	-	-	-	-	-	-
P%	>20	>20	>20	>20	>20	>20	>20	>20	<5	>20	<5	-	>20	>20	-	-	>20	-	-	-	-	-	-	-
LSD 5%									3	-	0.1													

Many characters could not be determined at Apelsvoll since all plots sufferered 100 % winter kill and had to be reseeded every year.

Table 16. Rough bluegrass (*Poa trivialis*) continued

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)																	In-season diseases, %						
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall	Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	Total	Micro-dochum	Red thread	Take-all	Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	2	2	2	2	2	2	2	2	1	2	2	1	2	2	0	0	2	1	1	0	0	1	1	1
Sabrena 1	4.2	6.3	6.2	3.6	2.0	2.3	4.0	5.7	43	5.1	6.3	4.5	4.9	64.9	-	-	68	1.2	1.2	-	-	1.2	10.0	0.87
Dark Horse	4.2	6.2	6.0	3.6	2.2	2.2	4.1	5.6	47	5.3	6.3	4.5	4.9	65.9	-	-	69	1.6	1.6	-	-	1.6	11.7	0.89
Winterway	4.1	6.4	5.8	3.4	2.0	2.4	4.0	5.3	48	5.2	6.2	4.5	4.9	64.0	-	-	67	1.3	1.3	-	-	1.3	15.0	0.91
Qasar	3.9	6.3	6.0	3.1	1.8	2.4	3.7	5.2	43	5.1	6.3	4.5	4.9	64.1	-	-	65	0.9	0.9	-	-	0.9	16.7	0.85
P%	20	>20	>20	20	<5	>20	7	>20	<5	>20	<1	>20	>20	>20	-	-	6	>20	>20	-	-	>20	>20	>20
LSD 5%	-	-	-	-		-	-	-	3	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Interaction variety x site	>20	>20	14	18	>20	>20	>20	>20	-	>20	<1	-	>20	>20	-	-	>20	>20	-	-	-	-	-	-

d) Sydsjælland GC (southern climatic zone)

No of observations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	0	4	6	7	4	9	4	0	16	10	2	6	3	3	0	17	8	5	1	3	9	6	0
Winterway	3.1	-	4.7	3.4	1.0	1.9	2.9	3.9	-	3.8	5.3	5	4.4	1.0	1.0	-	96	0.4	0.8	0.0	0.0	1.0	3.3	
Qasar	3.0	-	4.7	3.2	1.0	1.9	2.8	3.7	-	3.6	5.3	5	4.5	0.8	0.8	-	96	0.4	0.9	0.0	0.0	0.9	3.1	-
Dark Horse	3.0	-	4.6	3.3	1.0	1.9	2.9	3.7	-	3.7	5.3	5	4.9	1.0	1.0	-	96	0.4	0.8	0.0	0.0	1.1	3.7	-
Sabrena 1	3.0	-	4.9	3.2	1.0	1.9	2.9	3.8	-	3.8	5.5	5	4.8	1.3	1.3	-	96	0.5	1.0	0.0	0.0	1.3	1.9	-
P%	>20	-	<5	19	>20	>20	>20	>20	-	<0.1	<0.1	>20	<1	7	7	-	>20	>20	>20	>20	>20	>20	>20	-
LSD 5%	-	-	0.1	-	-	-	-	-	-	0.1	0.1	-	0.2	-	-	-	-	-	-	-	-	-	-	

Table 16. Rough bluegrass (*Poa trivialis*) continued

e) NIBIO Landvik Research Center, Norway (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
Sabrena 1	4.0	5.4	3.8	3.9	3.8	4.3	3.8	4.2	62	4.6	6.9	5.9	6.6	42.2	7.1	0.0	81	1.6	0.4	0.8	0.2	3.3	0.8	2.5	1.25
Qasar	4.0	5.1	3.8	3.4	4.4	3.8	4.0	4.0	63	4.4	6.5	5.8	6.5	42.4	7.0	0.0	81	0.9	0.3	0.6	0.0	3.1	1.5	3.8	1.38
Dark Horse	3.9	5.3	3.7	3.4	3.9	3.9	3.8	3.9	76	4.2	6.6	5.5	6.6	45.8	8.9	0.3	81	1.9	0.2	0.7	0.3	3.8	1.2	3.2	1.30
Winterway	3.7	4.8	3.3	3.2	4.3	3.7	3.6	3.8	58	4.2	6.6	5.2	6.4	44.2	10.2	1.0	82	1.1	0.1	0.8	0.0	4.2	0.7	3	1.38
P%	>20	>20	>20	<5	>20	>20	>20	>20	>20	>20	7	6	14	>20	8	>20	>20	17	>20	>20	>20	11	>20	>20	14
LSD 5%	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

f) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1
Qasar	3.5	5.1	4.3	3.3	2.7	2.9	3.4	3.9	63	4..0	5.9	5.4	5.5	21.6	3.9	0.0	88	0.7	0.6	0.3	0.1	2.0	2.3	1.38
Sabrena 1	3.5	5.4	4.4	3.5	2.4	3.1	3.3	4.0	62	4.2	6.2	5.4	5.7	21.8	4.2	0.0	88	1.1	0.7	0.4	0.1	2.3	1.4	1.25
Winterway	3.4	4.8	4.0	3.3	2.7	2.8	3.3	3.9	58	4.0	6.0	5.1	5.4	22.6	5.6	1.0	89	0.7	0.4	0.4	0.0	2.6	2.0	1.38
Dark Horse	3.4	5.3	4.2	3.4	2.4	2.9	3.3	3.8	76	3.9	6.0	5.3	5.7	23.4	5.0	0.3	89	1.1	0.5	0.4	0.0	2.5	2.5	1.30
P%	>20	>20	>20	>20	>20	>20	>20	>20	>20	7	<1	<5	<0.1	>20	<5	>20	>20	11	>20	>20	>20	9	>20	14
LSD 5%	-	-	-	-	-	-	-	-	-	-	0.1	0.2	0.1	-	1.2	-	-	-	-	-	-	-	-	-
Interaction variety x site	15	-	16	17	18	>20	>20	19	-	>20	>20	<5	<5	>20	<5	-	>20	19	>20	>20	>20	7	>20	-

Table 16. Rough bluegrass (*Poa trivialis*) continued

g) Mean of four sites, both climatic zone)

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	3	4	4	3	1	4	3	3	2	2	3	3	2
Sabrena 1	3.9	6.0	5.3	3.6	2.2	2.7	3.7	4.8	53	4.7	6.2	5.1	5.3	43.4	4.2	0.0	78	1.1	0.9	0.4	0.1	1.9	4.2	1.06
Dark Horse	3.8	5.9	5.1	3.5	2.3	2.5	3.7	4.7	61	4.6	6.1	5.0	5.3	44.6	5.0	0.0	79	1.3	0.9	0.4	0.0	2.2	5.5	1.10
Qasar	3.7	5.9	5.1	3.2	2.2	2.6	3.6	4.5	53	4.5	6.1	5.1	5.2	42.8	3.9	1.0	77	0.7	0.7	0.3	0.1	1.6	7.1	1.11
Winterway	3.7	5.9	4.9	3.4	2.3	2.6	3.6	4.6	53	4.6	6.1	4.9	5.1	43.3	5.6	0.3	78	0.9	0.7	0.4	0.0	2.2	6.3	1.14
P%	>20	>20	11	6	>20	>20	>20	19	14	>20	<0.1	<5	<0.1	>20	<5	>20	10	17	>20	>20	>20	13	>20	20
LSD 5%	-	-	-	-	-	-	-	-	-	-	0.1	0.2	0.1	-	1.2	-	-	-	-	-	-	-	-	-
P%, interaction variety x site	>20	>20	>20	9	<5	>20	>20	>20	16	>20	<1	<1	<0.1	>20	<5	-	>20	>20	>20	>20	>20	>20	>20	>20

3.8 Seed blends of *Festuca rubra* subspecies (Table 17)

For the seed blends of *Festuca rubra* where the weight ratio of ssp. *commutata* 'Musica' to ssp. *litoralis* 'Cezanne' was either 75/25, 50/50 or 25/75, the results indicated, overall, that the blends were superior to the pure subspecies/varieties because the two subspecies complemented each other. The finding that ssp. *litoralis* had less winter damage and less microdochium patch than ssp. *commutata* at Apelsvoll was unexpected and can probably be explained by uneven exposure to ice and melting water in the fescue section of this trial (see Photo 13; fescues covered the three rows closest to *Lolium perenne*). At Reykjavik, the seed blend composed of 75 % 'Musica' and 25 % 'Cezanne' obtained the highest qulity score which was more in line with our hypothesis, namely that the pure fescue seed blends for the northern zone should be dominated by ssp. *commutata*.

In the southern zone, the seed blend containing 50 % of each of the two subspecies obtained the highest score at both Sydsjælland and Landvik. This ratio also seemed to give the best compromise between winter color (Photo 28) and resistance to red thread and microdochium patch.

It should be emphasized that these results are solely based on the two varieties 'Musica' and 'Cezanne'. We can not conclude that the optimal seed ratios will be the same when using other varieties of the two subspecies.

3.9 *Poa annua, Poa trivialis* or *Lolium perenne* as nurse grasses for A. *stolonifera* (Table 18)

We compared *Poa annua* (PA) *Poa trivialis* (PT) and *Lolium perenne* (LP) as nurse grasses to speed up establishment of *A. stolonifera,* especially after winter damages. Because of space limitations, PA was not included at Landvik. A central question was the persistence of the three nurse grasses and how this would affect turfgrass quality over time.

On average for sites, turfgrass coverage developed faster with *Lolium perenne* than with *Poa* sp. as nurse grasses. There were no difference between *Poa annua* 'Two Put' and *Poa trivialis* 'Dark Horse' in this regard.

On average for the three sites where it was included, AS+PA produced better quality than pure AS, AS+LP or AS+PT in the seeding year 2015. After a drop in 2016, AS+PA also produced better turf quality than pure AS in 2017 and 2018 in the winter-mild climate at Sydsjælland. As compared with pure AS, the quality of the AS+PA combination was nonetheless reduced in the fall because of more microdochium patch.

In Reykjavik, the quality of AS+PA dropped to a level significantly below that of pure AS after the seeding year. This was even more the case at Apelsvoll where AS+PA, as the only of the there combinations, had to be reseeded every year during the project period (Photo 29). This suggests that PA was more competitive and probably inhibited establishment of AS to a larger degree than PT and LP. In northern and other areas exposed to winter damage, it therefore seems risky to use PA as a nurse grass for AS. *Poa trivialis* seems to be a safer choice as shown by the high overall scores for this combination at Reykjavik and especially at Apelsvoll. Our recommendation to use *Poa trivialis* as a nurse gras for *Agrostis stolonifera* in the northern zone is also supported by the fact that this combination suffered less overall winter damage and showed a better overall resistance to microdochium patch than pure AS.

Despite faster establishment, AS+LP was ranked significantly behind pure AS and AS+PT on average for the two sites in the northern zone. Part of the reason for this was more winter damage. The botanical analyses of the samples taken at Apelsvoll in fall 2018, approximately two and a half year after seeding, nonetheless showed that the tough winters at this location had been more halmful to the LP than for the AS and that most of the LP seeded into the plots had disappeared. This suggests that even the addition of LP to AS when re-establishing greens after winter damage is relatively safe in continental parts of the northern climatic zone. In contrast, the introduction of LP to speed up establishment can not be recommended for Iceland or in parts of the northern coastal zone of Norway where there is a greater risk that LP will persist and become a permanent part of the canopy.

On average for the two sites in the southern zone, AS+PT produced turf quality slightly below pure AS, whilst AS+LP was significantly behind. Unlike the situation at Apelsvoll, Figure 3 shows that LP made up 26 % of the AS + LP canopy two years after seeding at Landvik. Among the implications of this were more red thread, more moss and 72 % more growth in height when compared to the pure AS control. This shows clearly that introduction of LP as a nurse grass ought to be avoided when reseeding greens in the southern zone. Introduction of PT will have less negative consequences, but the advantages are also smaller and the need for nurse crops less important since winter damages are not so common as in the northern zone.

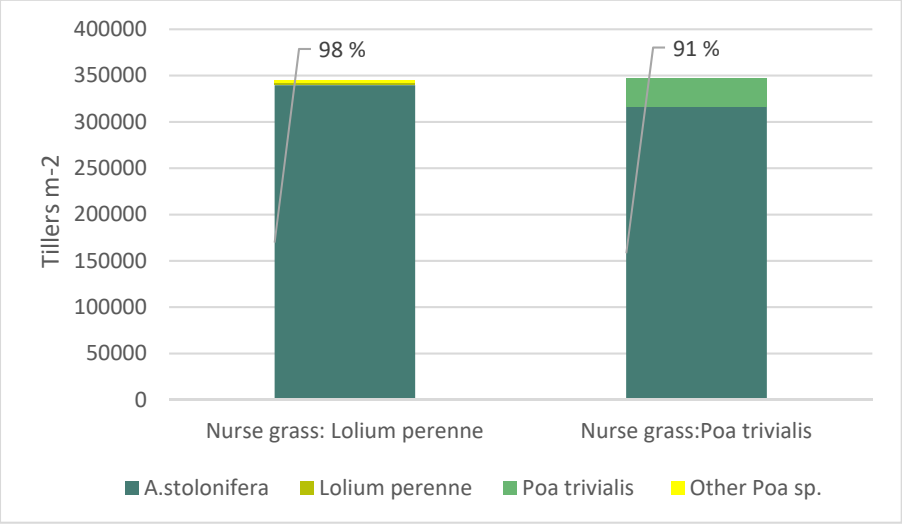

Figure 2. Tiller density / botanical composition in October 2018 of plots of *Agrostis stolonifera* 'Independence' seeded at Apelsvoll in June 2016 with the nurse grasses *Poa trivialis* 'Dark Horse' and *Lolium perenne* 'Chardin'. Figures above bars indicate per cent *Agrostis stolonifera*.

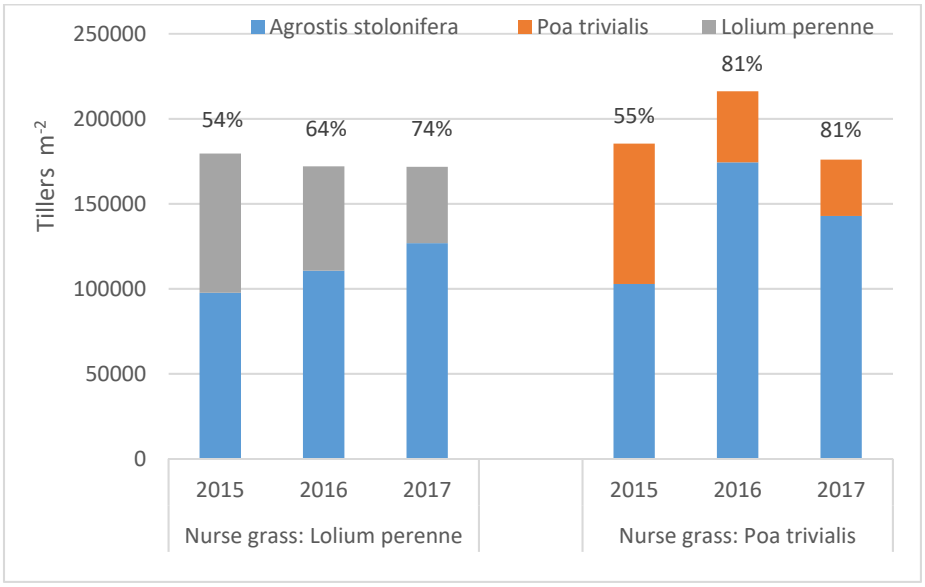

Figure 3. Tiller density / botanical composition in October 2015, 2016 and 2017 of plots of *Agrostis stolonifera* 'Independence' seeded in June 2015 with the nurse grasses *Poa trivialis* 'Dark Horse' and *Lolium perenne* 'Chardin' at Landvik. Figures above bars indicate per cent *Agrostis stolonifera*.

Table 17. Ranking of pure varieties and seed blends of Chewings fescue (*Festuca rubra* ssp. *commutata*) 'Musica' and slender creeping red fescue (*Festuca rubra* ssp. *litoralis* syn. *trichophylla*) 'Cezanne' (Mu75Cz25: 75% Musica and 25 % Cezanne; Mu50Cz50: 50% Musica and 50% Cezanne; Mu25Cz75: 25% Musica and 75 % Cezanne) after four years testing on putting greens in SCANGREEN trials at a) Korpa GC (Iceland); b) Apelsvoll Research Center (Norway), c) average for Korpa and Apelsvoll representing the northern climatic zone of Scandinavia; d) Sydsjælland GC (Denmark); e) Landvik Research Center (Norway), f) average for Sydsjælland and Landvik representing the southern climatic zone of Scandinavia; and g) average for all four test sites.

a) Reykjavik GC, Iceland (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	3	5	5	4	2	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
Mu75Cz25	5.5	5.3	5.9	6.2	4.6	6.0	5.7	5.0	-	5.5	4.9	4.0	6.9	3.1	-	-	94	1.1	1.1	-	-	1.1	6.7	0.61
Musica	5.3	5.4	5.7	6.2	4.0	5.7	5.5	5.0	-	5.3	4.9	4.0	6.9	4.6	-	-	90	0.7	0.7	-	-	0.7	9.3	0.67
Mu25Cz75	4.9	4.8	5.5	5.5	3.8	5.5	5.0	4.1	-	5.3	4.8	4.0	6.9	5.6	-	-	90	3.1	3.1	-	-	3.1	13.0	0.56
Mu50Cz50	4.8	4.6	5.3	5.5	3.8	5.5	4.9	4.2	-	5.3	4.8	4.0	6.9	4.3	-	-	89	3.3	3.3	-	-	3.3	15.7	0.59
Cezanne	4.7	4.7	5.1	5.3	3.8	5.2	4.9	4.2	-	5.3	4.7	6.5	6.9	4.2	-	-	88	3.1	3.1	-	-	3.1	16.7	0.68
P%	5	>20	10	8	>20	8	8	<5	-	<5	<1	>20	>20	>20	-	-	<1	<0.1	<0.1	-	-	<0.1	<5	10
LSD 5%	0.6	-	-	-	-	8.0	-	0.8	-	0.1	0.1	-	-	-	-	-	2	0.7	0.7	-	-	0.7	5.3	-

Table 17. Ranking of pure varieties and seed blends of *Festuca rubra* ssp. *commutata* 'Musica' and (*Festuca rubra* ssp. *litoralis* 'Cezanne' (continued)

b) NIBIO Apelsvoll Research Center, Norway (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter, %	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	1	12	11	1	2	3	3	0	19	12	12	0	0	16	0	6
Cezanne	6.1	6.0	7.5	6.9	4.5	4.5	6.7	6.3	50	4.4	5.7	4.7	6.0	28.3	5.2	-	95	0.5	0.5	-	-	1.7	-	0.62
Mu25Cz75	6.1	5.5	7.5	6.8	4.9	4.9	6.4	6.5	57	4.5	5.6	4.0	6.0	33.9	3.5	-	95	0.6	0.6	-	-	1.2	-	0.85
Mu75Cz25	6.0	6.0	7.5	6.9	4.2	4.3	6.5	6.4	57	4.6	5.5	3.7	6.0	38.3	6.3	-	93	0.8	0.8	-	-	1.9	-	0.89
Mu50Cz50	5.9	5.7	7.4	7.0	4.2	4.6	6.4	6.2	55	4.5	5.5	4.0	6.0	35.3	5.8	-	94	0.9	0.9	-	-	1.7	-	0.89
Musica	5.5	5.7	7.1	6.9	3.2	3.9	6.2	5.8	53	4.5	5.4	3.3	6.0	43.7	8.9	-	90	1.7	1.7	-	-	3.0	-	0.89
P%	>20	>20	>20	>20	>20	>20	>20	>20	>20	>20	11	>20	>20	>20	>20	>20	>20	<5	<5	>20	>20	7	>20	12
LSD 5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	0.7-	-	-	-	-	-

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	0	2	2	2	0	0	2	1	2
Mu75Cz25	5.8	5.6	6.7	6.5	4.4	5.1	6.1	5.7	57	5.0	5.2	3.8	6.5	20.7	6.3	-	93	1.0	1.0	-	-	1.5	6.7	0.75
Mu25Cz75	5.5	5.2	6.5	6.2	4.3	5.2	5.7	5.3	57	4.9	5.2	4.0	6.5	19.7	3.5	-	92	1.9	1.9	-	-	2.2	13.0	0.70
Cezanne	5.4	5.3	6.3	6.1	4.2	4.9	5.8	5.2	50	4.9	5.2	5.6	6.5	16.2	5.2	-	92	1.8	1.8	-	-	2.4	16.7	0.65
Mu50Cz50	5.4	5.1	6.3	6.2	4.0	5.1	5.6	5.2	55	4.9	5.2	4.0	6.5	19.8	5.8	-	91	2.1	2.1	-	-	2.5	15.7	0.74
Musica	5.4	5.6	6.4	6.5	3.6	4.8	5.8	5.4	53	4.9	5.2	3.7	6.5	24.1	8.9	-	90	1.2	1.2	-	-	1.8	9.3	0.78
P%	>20	>20	>20	>20	>20	>20	>20	>20	>20	<5	>20	<0.1	>20	>20	>20	-	>20	<0.1	<0.1	-	-	<5	<5	>20
LSD 5%	-	-	-	-	-	-	-	-	-	0.1	-	0.7	-	-	-	-	-	0.5	0.5	-	-	0.6	5.3	-
P%, Interaction mixture x site	11	>20	8	10	>20	>20	>20	<5	-	>20	<1	8	>20	>20	-	-	7	-	-	-	-	<0.1	-	<5

Table 17. Ranking of pure varieties and seed blends of *Festuca rubra* ssp. *commutata* 'Musica' and (*Festuca rubra* ssp. *litoralis* 'Cezanne' (continued)

d) Sydsjælland GC (southern climatic zone)

No of observations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	0	4	6	7	4	9	4	0	16	16	2	6	3	3	0	17	8	5	1	3	9	6	0
Mu50Cz50	4.9	-	4.5	5.1	5.2	5	5.2	4.7	-	5.8	4.6	4.7	-	1.1	1.1	-	96	0.9	1.6	0	0	1.6	5.0	-
Mu25Cz75	4.9	-	4.5	5.3	5.0	4.7	5.2	4.8	-	5.8	4.6	4.7	-	1.2	1.2	-	96	1.0	1.8	0	0	1.7	6.8	-
Cezanne	4.8	-	4.6	5.0	4.7	4.9	4.9	4.8	-	5.7	4.8	4.7	-	1.6	1.6	-	95	1.8	3.3	0	0	2.5	4.8	-
Mu75Cz25	4.6	-	4.5	4.8	4.5	4.3	4.8	4.6	-	5.8	4.6	4.7	-	0.8	0.8	-	95	1.0	1.5	0	0	1.4	6.5	-
Musica	4.6	-	4.4	5.0	4.3	4.3	4.6	4.8	-	5.7	4.5	4.7	-	1.4	1.4	-	95	1.2	1.4	0	0	2.1	5.0	-
P%	15	-	<0.1	<0.1	>20	15	10	>20	-	<1	<0.1	>20	-	>20	>20	-	>20	8	<1	>20	<20	>20	>20	-
LSD 5%	-	-	0.1	0.1	-	-	-	-	-	0.1	0.1	-	-	-	-	-	-	-	0.8	-	-	-	-	-

e) NIBIO Landvik Research Center, Norway (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
Mu50Cz50	6.1	6.4	5.8	6.5	5.9	6.1	6.1	6.1	86	7.0	5.6	5.2	8.0	33.2	0.1	0.0	90	0.5	0.1	0.9	0.0	0.1	0.2	2,4	1.14
Mu25Cz75	6.0	6.4	5.6	6.4	5.7	5.8	6.0	6.2	87	7.0	5.7	5.2	7.9	33.8	0.1	0.0	89	0.8	0.1	1.3	0.0	0.1	0.1	2.4	1.09
Mu75Cz25	5.9	6.2	5.6	6.3	5.8	6.1	5.9	5.8	80	6.9	5.6	5.1	8.0	33.3	0.1	0.0	90	0.7	0.0	1.0	0.0	0.1	0.2	2.5	1.19
Musica	5.9	6.0	5.8	6.4	5.3	6.4	5.9	5.6	94	6.8	5.6	4.4	8.0	33.6	0.1	0.0	89	0.5	0.1	0.7	0.0	0.1	0.3	3.2	1.35
Cezanne	5.9	6.4	5.5	6.4	5.4	5.7	5.6	6.4	71	6.9	5.7	5.6	7.9	34.1	0.3	0.0	88	1.3	0.1	2.2	0.0	0.2	0.1	4.4	1.02
P%	9	18	>20	>20	>20	>20	<1	<0.1	>20	>20	>20	<1	>20	6	14	>20	<5	11	>20	10	>20	13	>20	<5	<0.1
LSD 5%	-	-	-	-	-	-	0.2	0.2	-	-	-	0.4	-	-	-	-	1	-	-	-	-	-	-	1.1	0.06

Table 18. Ranking of pure varieties and seed blends of *Festuca rubra* ssp. *commutata* 'Musica' and (*Festuca rubra* ssp. *litoralis* 'Cezanne' (continued)

f) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter, %	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	1	2	3	1	2	2	2	2	2	2	2	1
Mu50Cz50	5.5	6.4	5.2	5.8	5.5	5.5	5.7	5.4	86	6.4	5.1	4.9	8.0	17.2	0.6	0.0	93	0.7	0.9	0.4	0.0	0.8	2.6	1.14
Mu25Cz75	5.5	6.4	5.0	5.9	5.3	5.2	5.6	5.5	87	6.4	5.1	4.9	7.9	17.5	0.7	0.0	92	0.9	1.0	0.7	0.0	0.9	3.5	1.09
Mu75Cz25	5.3	6.2	5.0	5.6	5.1	5.2	5.3	5.2	80	6.3	5.1	4.9	8.0	17.0	0.4	0.0	93	0.8	0.8	0.5	0.0	0.7	3.4	1.19
Cezanne	5.3	6.4	5.1	5.7	5.0	5.3	5.3	5.6	71	6.3	5.3	5.2	7.9	17.8	1.0	0.0	92	1.5	1.7	1.1	0.0	1.3	2.5	1.02
Musica	5.2	6.0	5.1	5.7	4.8	5.3	5.2	5.2	94	6.3	5.1	4.5	8.0	17.5	0.8	0.0	92	0.9	0.7	0.3	0.0	1.1	2.6	1.35
P%	<5	18	>20	10	17	>20	<1	<5	>20	<1	<1	<0.1	>20	10	>20	>20	<5	<1	<0.1	6	>20	16	>20	<0.1
LSD 5%	0.19	-	-	-	-	-	0.3	0.3	-	0.1	0.1	0.2	-	-	-	-	1	0.4	0.4	-	-	-	-	0.06
P%, Interaction	>20	-	6	>20	>20	<5	>20	<5	-	>20	>20	<0.1	-	-	>20	>20	10	>20	<0.1	6	>20	>20	>20	-

g)Mean of four sites, both climatic zones.

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter, %	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	4	3	4	3	1	4	4	4	2	2	4	3	3
Mu25Cz75	5.5	5.6	5.7	6.0	4.8	5.2	5.7	5.4	72	5.7	5.2	4.5	6.9	18.6	1.6	0.0	92	1.4	1.4	0.7	0.0	1.5	6.6	0.83
Mu75Cz25	5.5	5.8	5.9	6.0	4.7	5.2	5.7	5.5	69	5.7	5.1	4.4	7.0	18.9	2.4	0.0	93	0.9	0.9	0.5	0.0	1.1	4.5	0.90
Cezanne	5.4	5.7	5.7	5.9	4.6	5.1	5.5	5.4	60	5.6	5.3	5.4	6.9	17.0	2.4	0.0	92	1.7	1.7	1.1	0.0	1.9	7.2	0.77
Mu50Cz50	5.4	5.5	5.7	6.0	4.8	5.3	5.7	5.3	71	5.7	5.1	4.5	7.0	18.5	2.3	0.0	92	1.4	1.5	0.4	0.0	1.7	7.0	0.87
Musica	5.3	5.7	5.7	6.1	4.2	5.1	5.5	5.3	74	5.6	5.1	4.1	7.0	20.8	3.5	0.0	91	1.0	1.0	0.3	0.0	1.5	4.9	0.97
P%	>20	>20	>20	>20	>20	>20	>20	>20	13	<5	<1	<0.1	>20	>20	20	>20	>20	<0.1	<0.1	6	>20	<0.1	<5	<0.1
LSD 5%	-		-	-	-	-	-	-		0.1	0.1	0.1	-	-	-	-	-	0.3	0.3	-	-	0.4	1.8	0.08
P%, interaction	6	>20	<5	<5	>20	>20	<5	<1	>20	6	<1	<0.1	>20	>20	19	>20	<5	<0.1	<0.1	6	>20	<0.1	<0.1	<1

Table 18. Evaluation of *Poa trivialis* 'Dark Horse) (PT), *Poa annua* 'Two Put' (PA) and *Lolium perenne* 'Chardin' (LP) as nurse grasses when establishing or reestablishing *Agrostis stolonifera* 'Independence' (AS). AS was always seeded at 7 g m^{-2} (ordinary seeding rate when establishing creeping bentgrass greens), while the nurse grasses were seeded at rates 7.5 g m^{-2} for PT og PA, and 20 g m^{-2} for LP (half rate compared to when seedling the same species in pure strand on green). All mixtures were maintained as creeping bentgrasses.

a) Reykjavik GC, Iceland (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter, %	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	3	5	5	4	2	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
AS	5.5	3.9	4.9	5.8	6.7	5.0	5.3	6.5	-	7.0	5.8	6.5	5.0	5.7	-	-	91	1.7	1.7	-	-	1.7	6.0	0.41
AS + PT	5.4	5.3	5.3	5.6	5.5	5.5	5.1	6.7	-	6.4	5.9	5.0	5.5	11.2	-	-	90	2.2	2.2	-	-	2.2	5.0	0.72
AS + PA	4.9	7.0	3.4	4.7	5.4	3.2	4.7	6.6	-	6.7	4.0	6.0	4.4	31.7	-	-	85	3.4	3.4	-	-	3.4	5.0	0.63
AS + LP	4.6	5.6	3.2	4.7	5.4	3.0	4.5	6.0	-	6.7	5.7	6.0	5.6	17.6	-	-	83	1.1	1.1	-	-	1.1	8.3	0.51
P%	7	<0.1	<1	7	15	<0.1	15	>20	-	<5	<0.1	<0.1	<0.1	<1	-	-	14	8	8	-	-	8	>20	<0.1
LSD 5%	-	0.9	1.1	-	-	0.9	-	-	-	0.4	0.1	0.2	0.2	11.5	-	-	-	-	-	-	-	-	-	0.10

b) NIBIO Apelsvoll Research Center, Norway (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter, %	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	1	12	11	1	2	3	3	0	19	12	12	0	0	16	0	0
AS + PT	6.5	6.5	8.0	6.8	5.3	5.1	6.9	6.9	53	6.6	6.6	6.0	7.0	16.7	4.3	-	98	0.2	0.2	-	-	0.9	-	-
AS	6.1	5.9	7.0	7.1	4.9	5.0	6.7	6.2	43	6.4	6.3	6.7	5.7	28.3	7.1	-	97	1.1	1.1	-	-	2.6	-	-
AS + LP	6.0	5.7	7.5	5.8	5.4	5.0	6.3	6.3	70	6.6	6.5	4.0	7.0	26.5	4.2	-	97	0.5	0.5	-	-	1.3	-	-
AS + PA	4.3	6.0	6.5	4.3	1.6	2.4	4.7	5.1	53	4.5	6.7	-[1]	3.0	86.9	-[1]	-	67	-[1]	-[1]	-	-	-[1]	-	-
P%	<0.1	>20	<1	<1	<0.1	<5	<0.1	<0.1	10	<0.1	14	<1	<0.1	<0.1	<5	-	<0.1	<5	<5	-	-	<5	-	-
LSD 5%	0.56	-	0.6	0.9	1.0	2.1	0.7	0.3	-	0.3	-	0.1	0.6	16.1	2.6	-	7	0.6	0.6	-	-	0.9	-	-

[1] AS + PA could not be assessed for winter color or diseases because of winter damage and reseeding.

Table 18. Evaluation of nurse grasses when seeding / reseeding Agrostis stolonifera 'Independence' greens (continued)

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	0	2	2	2	0	0	2	1	1
AS + PT	6.0	5.9	6.6	6.2	5.4	5.3	6.0	6.8	53	6.5	6.2	5.5	6.2	14.0	4.3	-	94	1.2	1.2	-	-	1.6	5.0	0.72
AS	5.8	4.9	6.0	6.4	5.8	5.0	6.0	6.3	43	6.7	6.0	6.6	5.3	17.0	7.1	-	94	1.4	1.4	-	-	2.1	6.0	0.41
AS + LP	5.3	5.6	5.4	5.3	5.4	4.0	5.4	6.1	70	6.6	6.1	5.0	6.3	22.0	4.2	-	90	0.8	0.8	-	-	1.2	8.3	0.51
AS + PA	4.6	6.5	5.0	4.5	3.5	2.8	4.7	5.8	53	5.6	5.3	-	3.7	59.3	-	-	76	-	-	-	-	-	5.0	0.63
P%	>0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	<0.1	<0.1	<0.1	<0.1	<0.1	<5	-	<0.1	8	8	-	-	<5	>20	<0.1
LSD 5%	0.4	0.6	0.6	0.6	0.7	1.0	0.5	0.4	-	0.2	0.2	0.5	0.3	8.8	2.6	-	5	-	-	-	-	0.6	-	0.10
P%, Interaction mixture x site	<1	<0.1	<1	<5	<0.1	<5	<1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	-	-	<1	-	-

d) Sydsjælland GC (southern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	0	3	6	7	4	9	4	0	16	10	3	0	3	3	0	17	8	5	3	1	9	6	0
AS + PA	5.5	-	4.0	5.9	6.4	5.3	6	5.1	-	6.2	4.8	5.3	-	2.8	2.8	-	98	6.0	1.3	3.3	0	2.3	0.4	-
AS	5.4	-	5.3	5.0	5.9	5.6	5.2	5.8	-	6.9	6.2	4.6	-	0.5	0.5	-	99	0.0	0	0	0	0.4	0.3	-
AS + PT	5.4	-	4.6	5.9	5.6	5.5	5.4	5.7	-	6.5	5.8	5.3	-	0.8	0.8	-	99	1.6	1.3	0	0	1.0	0.5	-
AS + LP	4.7	-	3.3	5.4	5.5	4.9	5.1	4.4	-	5.9	5.8	5.2	-	1.4	1.4	-	97	2.2	0.4	5.4	0	0.8	1.4	-
P%	<0.1	-	<0.1	<01	<1	<1	<1	<1	-	<0.1	<0.1	<0.1	-	7	7	-	<1	<5	8	18	>20	7	<1	-
LSD 5%	0.12	-	0.4	0.3	0.4	0.3	0.3	0.5	-	0.2	0.1	0.1	-	-	-	-	1	3.3	-	-	-	-	0.4	-

Table 18. Evaluation of nurse grasses when seeding / reseeding Agrostis stolonifera 'Independence' greens (continued)

e) NIBIO Landvik Research Center, Norway (southern climatic zone)[1]

No of observations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
AS	5.80	5.7	5.1	6.3	6.1	5.1	6.0	6.0	48	7.0	6.3	3.9	6.4	17.3	2.1	0.0	92	0.8	0.4	0.1	0.4	0.9	0.3	0.6	0.96
AS + PT	5.36	6.2	4.7	5.4	5.6	4.9	5.4	5.7	76	6.7	6.5	5.1	6.3	35.9	6.7	0.0	88	1.3	0.2	0.5	0.4	1.9	0.2	1.5	1.34
AS + LP	5.05	5.7	4.1	5.4	5.5	4.3	5.3	5.2	81	5.9	5.5	5.9	5.8	34.4	1.6	0.0	87	1.2	0.2	0.4	0.4	0.7	0.8	2.5	1.65
P%	>20	>20	>20	14	>20	>20	>20	>20	>20	19	<1	<1	>20	9	11	>20	>20	>20	<5	<5	>20	<5	>20	>20	<1
LSD 5%	-	-	-	-	-	-	-	-	-	-	0.4	1.0	-	-	-	-	-	-	0.2	0.3	-	0.7	-	-	0.27

[1] AS + PA was not included at Landvik because of space limitations

f) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	1	2	3	1	2	2	2	2	2	2	2	1
AS	5.6	5.7	5.2	5.6	6.0	5.3	5.6	5.9	48	7.0	6.2	4.2	6.4	8.9	1.3	0.0	96	0.4	0.2	0.1	0.2	0.6	0.3	0.96
AS + PT	5.4	6.2	4.7	5.7	5.6	5.2	5.4	5.7	76	6.6	6.1	5.2	6.3	18.3	3.7	0.0	93	1.5	0.7	0.3	0.2	1.5	0.4	1.34
AS + LP	4.9	5.7	3.7	5.4	5.5	4.6	5.2	4.8	81	5.9	5.6	5.5	5.8	17.9	1.5	0.0	92	1.7	0.3	2.9	0.2	0.8	1.1	1.65
P%	8	>2	<1	>20	>20	<5	>20	<1	>20	<1	<0.1	<0.1	>20	<5	8	>20	11	6	<1	<5	>20	<5	<5	<1
LSD 5%	-	-	0.7	-	-	0.5	-	-	-	0.6	0.2	0.4	-	8.0	-	-	-	-	0.4	2.0	-	0.7	0.6	0.27
P%, Interaction mixture x site	>20	-	>20	<1	>20	>20	>20	>20	-	>20	<0.1	<1	-	6	6	-	>20	>20	<1	<5	>20	>20	>20	-

Table 18. Evaluation of nurse grasses when seeding / reseeding Agrostis stolonifera 'Independence' greens (continued)

g1) Mean of four sites, both climatic zones (excluding the mixture AS + PA)

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	4	3	4	2	1	4	4	4	2	2	4	3	2
AS	5.7	5.1	5.6	6.0	5.9	5.2	5.8	6.1	46	6.8	6.1	5.4	5.7	13.0	3.2	0.0	95	0.9	0.8	0.1	0.2	1.4	2.2	0.68
AS + PT	5.7	6.0	5.6	5.9	5.5	5.2	5.7	6.2	65	6.6	6.2	5.4	6.3	16.1	3.9	0.0	94	1.3	1.0	0.3	0.2	1.5	1.9	1.03
AS + LP	5.1	5.6	4.5	5.3	5.5	4.3	5.3	5.5	75	6.3	5.9	5.3	6.1	20.0	2.4	0.0	91	1.3	0.6	2.9	0.2	1.0	3.5	1.08
P%	<1	<5	<0.1	<0.1	>20	<0.1	9	<0.1	11	<1	<0.1	>20	<5	<5	17	>20	<1	>20	<5	<5	>20	<5	10	<0.1
LSD 5%	0.3	0.6	0.4	0.3	-	0.4	-	0.3	-	0.3	0.1	-	0.5	5.5	-	-	2	-	0.3	2.0	-	0.4	-	0.12
P%, interaction variety x site	>20	11	<1	<1	>20	<1	>20	<5	>20	<5	<0.1	<0.1	<1	<5	<1	>20	11	<5	<1	<5	>20	<5	>20	<0.1

g2) Mean of the trials at Reykjavik GC, NIBIO Apelsvoll and Sydsjælland GC that included AS + PA.

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	1	4	4	4	3	4	2	1	4	4	4	1	1	4	2	1
PTAS	5.8	5.9	6.0	6.1	5.5	5.4	5.8	6.4	53	6.5	6.1	5.4	6.2	9.6	2.5	-	96	1.3	1.2	0.0	0.0	1.4	2.8	0.72
AS	5.7	4.9	5.7	5.9	5.8	5.2	5.7	6.2	43	6.8	6.1	5.9	5.3	11.5	3.8	-	96	0.9	0.9	0.0	0.0	1.5	3.2	0.41
LPAS	5.1	5.6	4.7	5.3	5.4	4.3	5.3	5.6	70	6.4	6.0	5.1	6.3	15.2	2.8	-	93	1.3	0.7	5.4	0.0	1.1	4.9	0.51
PAAS	4.9	6.5	4.6	5.0	4.5	3.6	5.1	5.6	53	5.8	5.2	-	3.7	40.5	-	-	83	-	-	3.3	0.0	-	2.7	0.63
P%	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	<0.1	<0.1	<0.1	<0.1	<0.1	10	-	<0.1	>20	<5	18	>20	>20	11	<0.1
LSD 5%	0.3	0.6	0.4	0.4	0.5	0.6	0.3	0.3	-	0.1	0.1	0.3	0.3	5.7	-	-	3	-	0.4	-	-	-	-	0.10
P%, interaction variety x site	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<5	-	<0.1	<1	<1	-	-	<1	>20	-

3.10 Seed mixtures of Festuca and Agrostis (Table 19)

We studied seed mixtures of 90% *F.rubra* +10% *A.stolonifera* as an alternative to the traditional mixture of 90% *F.rubra* + 10% *A.capillaris* at 'creeping bentgrass management' (low mowing / high fertilizer) and at 'fescue management' (high mowing / low fertilizer). At fescue management the mixture of 90% *F.rubra* +10% *A.canina* was also included. The mixtures were compared with pure fescue at 'fescue mangement' and with pure creeping bentgrass at ''creeping bentgrass management".

Overall scores for turfgrass quality showed that mixtures were better than pure species (Table 19). At the 'high mowing/low fertilizer' the mixtures were better than the pure fescue, and at 'low mowing/high fertilizer' the mixtures were better than the pure creeping bentgrass. The only exception was at Sydsjælland where the mixtures were susceptible to winter damages due to microdochium patch and therefore had lower quality scores than the pure fescue greens.

At the 'high mowing/low fertilizer' the overall impression was that the combination of fescue and velvet bentgrass was the best due to higher tiller density and a better color, but this mixture had more thatch than the others. Our recommendations based on these and earlier observations (Calvache et al. 2017) are that a mixture of fescue and velvet bentgrass should be fertilized less than 10 g N m^{-2} yr^{-1} and the proportion of velvet bentgrass lower than 10 % in the seed mixture.

The mixtures of fescue + creeping bentgrass and fescue + colonial bentgrass at both 'high mowing/low fertilizer' and 'low mowing/high fertilizer' showed only small differences in green quality. At Reykjavik the combination of fescue and colonial bentgrass gave the best score at 'low mowing/high fertilizer', but that was opposite in the trials in Norway. At Landvik the combination of fescue and creeping bentgrass was less invaded by *Poa annua* than the combination of fescue and colonial bentgrass. Disease infections in colonial bentgrass +fescue were also slightly higher than in creeping bentgrass + fescue. The difference was significant for microdochium patch but not for take all patch. The height growth of the mixtures was measured at Landvik and Reykjavik, and results showed less vertical growth in creeping than in colonial bentgrass at both management regimes. (Photo 35). Horizontal growth was not measured but was probably the other way round for this character. If so, this would explain why there was less *Poa annua* in the mixtures with creeping bentgrass, because of more competition from the bentgrass. However, horizontal growth can also have the consequence that the fescue is outcompeted.

Photo 35 Mixed plots at Landvik on 9 Sep. 2016. Colonial bentgras + fescue to the left and creeping bentgrass + fescue to the right. Colonial bentgrass had more upright growth than creeping bentgrass

Photo: Trygve S. Aamlid

Regardless of management, fescue made up only 10-13 % of the total tiller number in the creeping bentgrass + fescue combination two and a half years after seeding at Apelsvoll (Figure 4). For colonial bentgrass + fescue, the botanical compostion appeared to be easier to manipulate by management. The latter finding and also the total dominance of *Agrostis canina* in plots seeded with velvet bentgrass + fescue at Apelsvoll, are in good agreement with Calvache et al. (2017) who also found that the ratio between fescue and bentgrass was more influenced by fertilizer level than by mowing height.

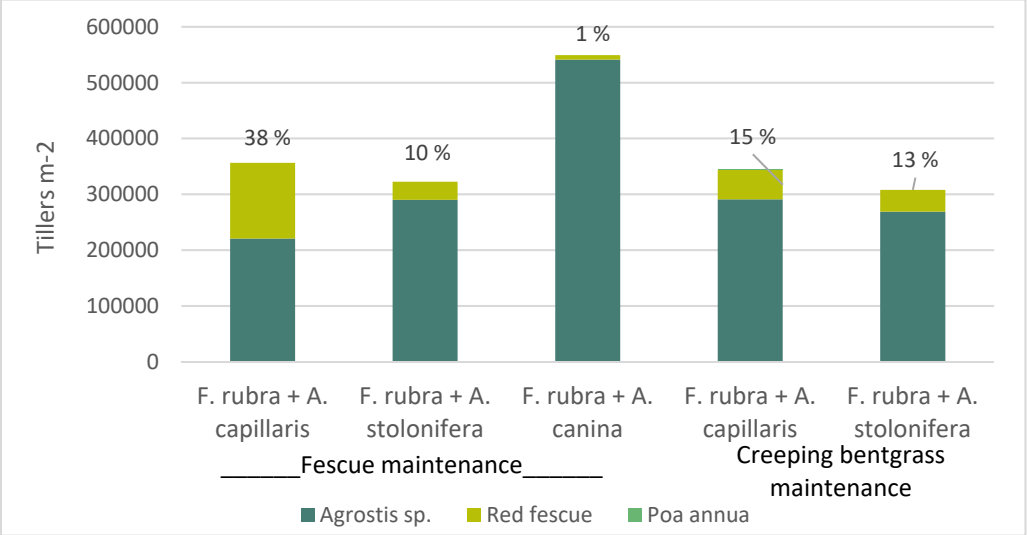

Figure 4. Tiller density / botanical composition in October 2018 of plots of *Festuca rubra* seeded with various species of *Agrostis* at Apelsvoll in June 2016. Figures above bars indicate per cent *Festuca rubra*.

Photo 36 Mixed fescue / bentgrass plots with fescue maintenance, Landvik, 6 July 2018. Closest plot is colonial bentgrass + fescue, central plot is creeping bentgrass + fescue and plot in background is velvet bentgrass + fescue. There was a pressure from Poa annua in this trial but the mixed lots had less contamination than the pure varieties in the neighbour plots.

Photo: Trygve S. Aamlid

At Landvik the turfgrass canopies were not as dense and the proportion between fescue and various bentgrass species more balanced than at Apeslvoll (Figure 5, Photo 36). Recordings over three years also showed that the mixed greens had a relatively stable botanical composition (Figure 5). Unlike the situation at Apelsvoll, the fescue/ bentgrass ratio was influenced by management not only for colonial bentgrass + fescue but also for creeping bentgrass + fescue. An interesting observation was that the proportion of fescue on plots seeded with creeping bentgrass + fescue increased over time when the green was subjected to fescue management.

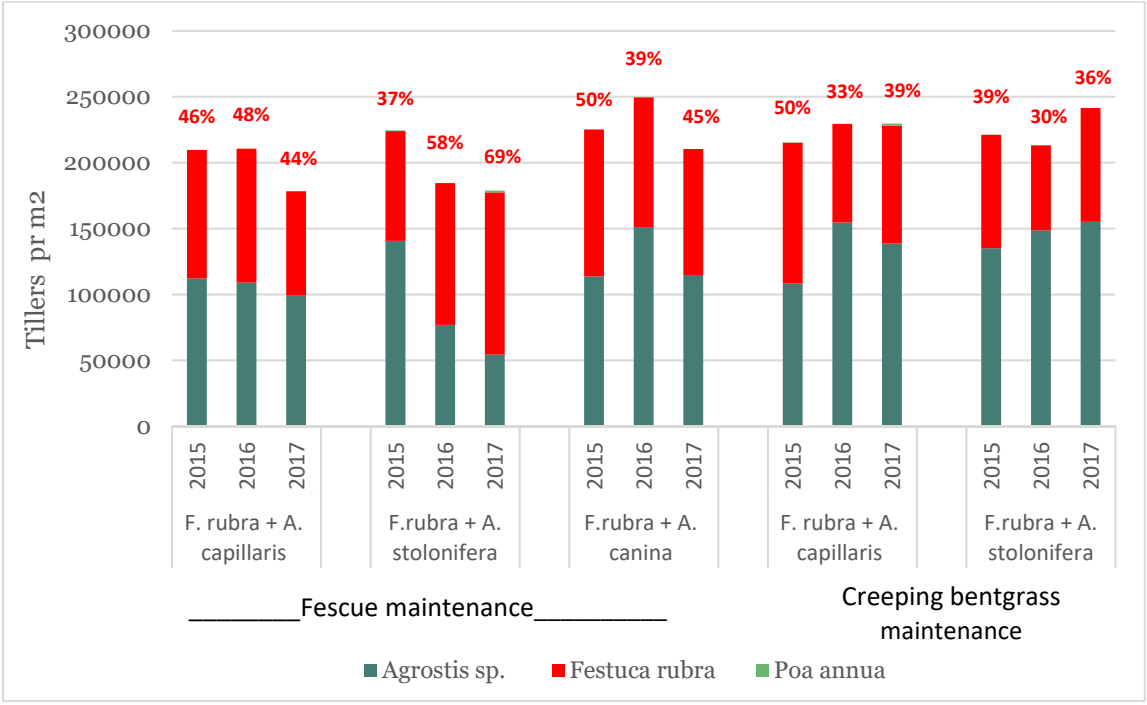

Figure 5. Tiller density / botanical composition in October 2015, 2016 and 2017 of plots of *Festuca rubra* seeded with various specis of *Agrostis* at Landvik in June 2015. Figures above bars indicate per cent *Festuca rubra*.

In conclusion, our results suggest that mixtures of fescue and creeping bentgrass can give a good green quality with less *Poa annua* and less in-season diseases than the traditional mixture of fescue and colonial bentgrass. More reseach should be put into the optimal management of mixed creeping bentgrass / fescue greens.

Table 19. Ranking of *Agrostis stolonifera* 'Independence' (seeded at 7 g m^{-2}) and seed mixtures between Festuca rubra (FR = 50 % *F.rubra* ssp. *commutata* 'Musica' and 50 % *F.rubra* ssp. *litoralis* ssp. 'Cezanne'; seeded at 30 g m^{-2} and mixtures between FR (27 g m^{-2}) and *Agrostis canina* (ACAN) 'Villa', *Agrostis capillaris* (AS) 'Jorvik' or *Agrostis stolonifera* (AS) 'Independence' (all seeded at 3 g m^{-2}) after four years testing on putting greens in SCANGREEN trials at a) Korpa GC (Iceland); b) Apelsvoll Research Center (Norway), c) average for Korpa and Apelsvoll representing the northern climatic zone of Scandinavia; d) Sydsjælland GC (Denmark); e) Landvik Research Center (Norway), f) average for Sydsjælland and Landvik representing the southern climatic zone of Scandinavia; and g) average for all four test sites.

AS, FR+ACAP and FR+AS were maintained as either creeping bentgrass (mowing height 3 mm, annual N-rate ≈ 16 g N m^{-2}) or as red fescue (mowing height 5 mm, annual N-rate ≈ 10 g N m^{-2}), and the species / mixtures have been ranked within each of these groups. Upper, shaded area indicates creeping-bentgrass maintenance. Lower, unshaded area indicates red fescue maintenance.

a) Reykjavik GC, Iceland (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	3	5	5	4	2	11	4	0	11	11	2	6	3	0	0	17	6	6	0	0	6	1	11
FR+ACAP	5.6	5.6	5.5	6.0	5.3	5.0	5.5	6.2	-	6.0	5.2	5.5	5.9	2.0	-	-	91	0.9	0.9	-	-	0.9	6.0	0.70
AS	5.5	3.9	4.9	5.8	6.7	5.0	5.3	6.5	-	7.0	5.8	6.5	5.0	5.7	-	-	91	1.7	1.7	-	-	1.7	6.7	0.41
FR+AS	5.2	4.9	5.1	5.5	5.2	4.5	5.2	5.6	-	6.1	5.2	5.5	5.9	2.0	-	-	88	0.9	0.9	-	-	0.9	10.0	0.66
FR+ACAN	5.2	4.0	5.4	5.9	4.8	6.0	5.0	5.2	-	5.7	4.8	5.0	6.8	1.4	-	-	91	1.9	1.9	-	-	1.9	9.0	0.49
FR+AS	5.1	4.1	5.2	5.7	4.8	5.7	5.1	4.8	-	5.6	4.9	5.0	6.8	0.9	-	-	91	1.4	1.4	-	-	1.4	11.7	0.54
FR+ACAP	5.0	4.8	5.3	5.5	4.3	5.3	4.9	4.8	-	5.5	5.0	5.0	6.8	3.1	-	-	90	1.7	1.7	-	-	1.7	12.3	0.55
FR	4.8	4.6	5.3	5.5	3.8	5.5	4.9	4.2	-	5.3	4.8	4.0	6.9	4.3	-	-	89	3.3	3.3	-	-	3.3	15.7	0.59
P%	<1	<1	>20	>20	<0.1	<5	7	<0.1	-	<0.1	<0.1	<0.1	<0.1	<5	-	-	<5	<1	<1	-	-	<1	13	<0.1
LSD 5%	0.4	0.7	-	-	0.7	0.8	-	0.6	-	0.6	0.2	0.1	0.1	2.7	-	-	2	0.9	0.9	-	-	0.9	-	0.08

Table 19. Ranking of seed mixtures between *Agrostis* and *Festuca* (continued)

b) NIBIO Apelsvoll Research Center, Norway (northern climatic zone)

No of obser-vations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fine-ess (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	19	4	4	5	6	3	13	6	1	12	11	1	2	3	3	0	19	12	12	0	0	16	0	6
FR+AS	6.5	6.3	7.2	7.5	5.3	5.7	7.2	6.1	60	6.4	6.2	6.3	6.0	31.8	3.0	-	98	0.3	0.3	-	-	0.9	-	0.51
AS	6.1	5.9	7.0	7.1	4.9	5.0	6.7	6.2	43	6.4	6.3	6.7	5.7	28.3	7.1	-	97	1.1	1.1	-	-	2.6	-	0.57
FR+ACAP	6.1	6.1	6.2	7.5	4.8	5.3	6.8	5.7	57	5.9	6.4	5.3	5.8	36.3	5.3	-	96	2.8	2.8	-	-	3.3	-	0.67
FR+ACAN	6.8	6.7	6.8	7.2	6.5	5.7	7.6	6.5	57	7.1	6.3	6.7	6.2	22.4	4.4	-	97	3.1	3.1	-	-	3.5	-	0.23
FR+AS	6.6	6.6	7.5	7.5	5.3	5.2	7.1	7.0	55	6.0	6.2	5.7	5.3	20.0	4.2	-	97	0.7	0.7	-	-	1.4	-	0.46
FR+ACAP	6.6	5.8	6.7	7.4	6.5	6.1	7.3	6.3	47	5.5	6.2	4.3	5.5	23.2	4.8	-	97	2.3	2.3	-	-	3.1	-	0.70
FR	5.9	5.7	7.4	7.0	4.2	4.6	6.4	6.2	55	4.5	5.5	4.0	6.0	35.3	5.8	-	94	0.9	0.9	-	-	1.7	-	0.89
P%	>20	>20	<0.1	10	17	>20	>20	<1	>20	<0.1	<0.1	<0.1	6	>20	12	-	>20	<0.1	<0.1	-	-	<0.1	-	<0.1
LSD 5%	-	-	0.4	-	-	-	-	0.6	-	0.3	0.2	0.1	-	-	-	-	-	1.0	1.0	-	-	1.0	-	0.18

Table 19. Ranking of seed mixtures between *Agrostis* and *Festuca* (continued)

c) Mean of two sites, northern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	0	2	2	2	0	0	2	1	2
AS	5.8	4.9	6.0	6.4	5.8	5.0	6.0	6.3	43	6.7	6.0	6.6	5.3	17.0	7.1	-	94	1.4	1.4	-	-	2.1	6.0	0.49
FR+ACAP	5.9	5.9	5.9	6.8	5.1	5.1	6.2	5.9	57	6.0	5.8	5.4	5.9	19.2	5.3	-	94	1.8	1.8	-	-	2.1	6.7	0.68
FR+AS	5.8	5.6	6.1	6.5	5.3	5.1	6.2	5.8	60	6.2	5.7	5.9	6.0	16.9	3.0	-	93	0.6	0.6	-	-	0.9	10.0	0.58
FR+ACAN	6.0	5.3	6.1	6.6	5.7	5.8	6.3	5.8	57	6.4	5.5	5.8	6.5	11.9	4.4	-	94	2.5	2.5	-	-	2.7	9.0	0.36
FR+AS	5.8	5.4	6.4	6.6	5.0	5.4	6.1	5.9	55	5.8	5.6	5.3	6.1	10.4	4.2	-	94	1.0	1.0	-	-	1.4	11.7	0.50
FR+ACAP	5.8	5.3	6.0	6.5	5.4	5.7	6.1	5.6	47	5.5	5.6	4.7	6.2	13.2	4.8	-	94	2.0	2.0	-	-	2.4	12.3	0.63
FR	5.4	5.1	6.3	6.2	4.0	5.1	5.6	5.2	55	4.9	5.2	4.0	6.5	19.8	5.8	-	91	2.1	2.1	-	-	2.5	15.7	0.74
P%	15	12	7	8	<5	17	>20	<0.1	>20	<0.1	<0.1	<0.1	<0.1	11	12	-	>20	<0.1	<0.1	-	-	<0.1	13	<0.1
LSD 5%	-	-	-	-	1.0			0.4	-	0,2	0,1	0,5	0,3	-	-	-	-	0.6	0.6	-	-	0.6	-	0.09
P%, Interaction mixture x site	<5	<5	<0.1	>20	<1	12	14	<0.1	-	<0.1	<0.1	<1	<0.1	>20	-	-	>20	-	-	-	-	<0.1	-	<0.1

Table 19. Ranking of seed mixtures between *Agrostis* and *Festuca* (continued)

d) Sydsjælland GC (southern climatic zone)

No of observations	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	17	0	4	6	7	4	9	4	0	16	10	2	0	3	3	0	17	8	5	3	1	9	6	0
FR+AS	6.0	-	4.7	5.9	7.4	6.1	6.1	6.1	-	6.1	5.0	6.4	-	6.7	6.7	-	99	0.9	0.7	0	0	4.6	0.5	-
FR+ACAP	6.0	-	4.8	5.8	7.3	6.0	6.1	6.1	-	6.1	5.0	6.2	-	2.9	2.9	-	99	0.9	0.8	0	0	2.1	1.1	-
AS	5.4	-	5.3	5.0	5.9	5.6	5.2	5.8	-	6.9	6.2	4.6	-	0.5	0.5	-	99	0.0	0.0	0	0	0.4	0.3	-
FR	4.9	-	4.5	5.1	5.2	5.0	5.2	4.7	-	5.7	4.3	4.7	-	1.1	1.1	-	96	0.9	1.6	0	0	1.6	5.0	-
FR+ACAN	4.6	-	4.6	4.9	4.2	5.2	4.3	4.4	-	5.1	4.7	5.2	-	14.8	14.8	-	96	1.9	2.1	0	0	10.5	2.4	-
FR+AS	4.5	-	4.7	4.9	3.8	4.8	4.2	4.4	-	5.1	4.7	5.2	-	16.4	16.4	-	96	1.8	2.2	0	0	11.6	2.0	-
FR+ACAP	4.4	-	4.5	4.8	4.0	5.1	4.1	4.3	-	5.0	4.7	5.2	-	22.1	22.1	-	96	1.6	2.3	0	0	15.2	2.5	-
P%	<0.1	-	<0.1	<0.1	<0.	<0.1	<0.1	<0.1	-	<0.1	<0.1	<1	-	6	6	-	<0.1	<0.1	<1	->20	>20	<5	<1	-
LSD 5%	0.3	-	0.3	0.3	0.8	0.5	0.5	0.4	-	0.1	0.2	0.8	-	-	-	-	1	0.6	1.0	-	-	10.4	1.9	-

Table 19. Ranking of seed mixtures between *Agrostis* and *Festuca* (continued)

e) NIBIO Landvik Research Center, Norway (southern climatic zone)

	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Micro-dochium patch, all obs, %	Moss encroachment, %	*Poa annua* encroachment, %	Daily height growth, mm
No of obser-vations	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all				
	24	3	7	8	6	6	11	7	1	17	16	4	6	3	3	1	21	22	15	2	11	23	5	2	18
FR+AS	6.8	6.8	6.7	7.2	6.4	6.8	7.0	6.5	98	7.5	5.6	4.9	6.8	33.4	0.7	0	89	0.3	0.1	0.1	0.2	0.3	0.1	2.4	1.50
FR+ACAP	6.4	7.1	6.1	6.4	6.4	6.4	6.6	6.2	97	7.4	5.8	5.5	6.9	34.0	0.9	0	89	1.8	0.8	0.2	1.3	0.8	0.2	1.3	1.48
AS	5.8	5.7	5.1	6.3	6.1	5.1	6.0	6.0	48	7.0	6.3	3.9	6.4	17.3	2.1	0	93	0.8	0.4	0.1	0.4	0.9	0.3	0.6	0.96
FR+ACAN	6.7	6.8	6.3	6.6	7.3	6.4	6.9	6.6	94	7.7	5.5	5.2	7.7	33.4	0.8	0	91	1.1	0.0	0.8	0.5	0.4	0.1	1.9	0.99
FR+ACAP	6.3	6.5	5.7	6.4	6.6	6.0	6.3	6.3	95	7.1	6.1	5.6	7.2	33.9	0.3	0	91	0.6	0.1	0.6	0.3	0.2	0.1	1.8	1.06
FR+AS	6.1	6.1	5.3	6.5	6.4	5.9	6.2	6.1	95	6.9	5.8	5.0	7.4	33.2	0.5	0	91	0.5	0.0	0.9	0.0	0.3	0.0	3.3	1.08
FR	6.1	6.4	5.8	6.5	5.9	6.1	6.1	6.1	86	7.0	5.6	5.2	8.0	33.2	0.1	0	90	0.5	0.1	0.9	0.0	0.1	0.2	2.4	1.14
P%	<1	<1	<1	6	8	<0.1	<5	10	<5	<0.1	<1	<1	<0.1	<5	6	>20	>20	<5	<1	<5	6	<1	18	>20	<0.1
LSD 5%	0.5	0.6	0.6	-	-	0.6	0.7	-	31	0.2	0.4	0.6	0.3	9.6	-	-	-	0.9	0.4	0.5	-	0.4	-	-	0.14

Table 19. Ranking of seed mixtures between *Agrostis* and *Festuca* (continued)

f) Mean of two sites, southern climatic zone

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	2	1	2	2	2	2	2	2	1	2	2	2	1	2	3	1	2	2	2	2	2	2	2	1
FR+AS	6.4	6.8	5.7	6.6	6.9	6.4	6.6	6.3	98	6.8	5.3	5.6	6.8	20.0	3.7	0	94	0.6	0.4	0.1	0.1	2.4	0.3	1.50
FR+ACAP	6.2	7.1	5.5	6.1	6.8	6.2	6.3	6.1	97	6.8	5.4	5.8	6.9	18.5	1.9	0	94	1.3	0.8	0.1	0.6	1.5	0.7	1.48
AS	5.6	5.7	5.2	5.6	6.0	5.3	5.6	5.9	48	7.0	6.2	4.2	6.4	8.9	1.3	0	96	0.4	0.2	0.1	0.2	0.6	0.3	0.96
FR+ACAN	5.6	6.8	5.5	5.8	5.7	5.8	5.6	5.5	94	6.4	5.1	5.2	7.7	24.1	7.8	0	94	1.5	1.1	0.4	0.2	5.4	1.2	0.99
FR	5.5	6.4	5.2	5.8	5.5	5.5	5.7	5.4	86	6.3	5.0	4.9	8.0	17.2	0.6	0	93	0.7	0.9	0.4	0.0	0.8	2.6	1.14
FR+ACAP	5.3	6.5	5.1	5.6	5.3	5.6	5.2	5.3	95	6.1	5.4	5.4	7.2	28.0	11.2	0	94	1.1	1.2	0.3	0.2	7.7	1.3	1.06
FR+AS	5.3	6.1	5.0	5.7	5.1	5.3	5.2	5.2	95	6.0	5.2	5.1	7.4	24.8	8.5	0	94	1.1	1.1	0.4	0.0	6.0	1.0	1.08
P%	<0.1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<5	<0.1	<0.1	<0.1	<0.1	<1	<5	>20	>20	<0.1	<1	<1	<5	<5	<0.1	<0.1
LSD 5%	0.3	0.6	0.3	0.3	0.6	0.4	0.4	0.3	31	0.1	0.2	0.5	0.3	8.6	7.3	-	-	0.5	0.5	0.2	0.4	4.9	0.9	0.14
P%, Interaction mixture x site	<0.1	-	<0.1	<5	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<1	-	14	<5	-	<5	<0.1	<1	<1	<5	<5	<0.1	-

Table 19. Ranking of seed mixtures between *Agrostis* and *Festuca* (continued)

g)Mean of four sites, both climatic zones.

No of sites	Turfgrass quality (1-9)								Coverage 3 wk after sowing, %	Tiller density (1-9)	In-season color (1-9, 9 is darkest green)	Winter color (1-9, 9 most freshly green)	Leaf fineness (1-9)	Overall winter damage,%	Microdochium patch during winter,	Typhula blight during winter, %	In-season coverage of healthy turf of sown species, %	In-season diseases, %				Microdochium patch, all obs, %	Moss encroachment, %	Daily height growth, mm
	Overall mean	2015	2016	2017	2018	Spring	Summer	Fall										Total	Micro-dochum	Red thread	Take-all			
	4	3	4	4	4	4	4	4	2	4	4	4	3	4	2	1	4	4	4	2	2	4	3	3
FR+AS	6.1	6.0	5.9	6.5	6.1	5.8	6.4	6.1	79	6.5	5.5	5.8	6.2	18.5	3.5	0	94	0.6	0.5	0.1	0.1	1.7	3.5	0.89
FR+ACAP	6.0	6.3	5.7	6.5	5.9	5.7	6.3	6.0	77	6.4	5.6	5.6	6.2	18.8	3.1	0	94	1.6	1.3	0.1	0.6	1.8	2.7	0.95
AS	5.7	5.1	5.6	6.0	5.9	5.2	5.8	6.1	46	6.8	6.1	5.4	5.7	13.0	3.2	0	95	0.9	0.8	0.1	0.2	1.4	2.2	0.65
FR+ACAN	5.8	5.8	5.8	6.2	5.7	5.8	6.0	5.7	75	6.4	5.3	5.5	6.9	18.0	6.7	0	94	2.0	1.8	0.4	0.2	4.1	3.8	0.57
FR+AS	5.6	5.6	5.7	6.2	5.1	5.4	5.7	5.6	75	5.9	5.4	5.2	6.5	17.6	7.0	0	94	1.1	1.1	0.4	0.0	3.7	4.6	0.69
FR+ACAP	5.6	5.7	5.5	6.0	5.3	5.7	5.7	5.4	71	5.8	5.5	5.0	6.5	20.6	9.1	0	94	1.5	1.6	0.3	0.2	5.1	5.0	0.77
FR	5.4	5.5	5.7	6.0	4.8	5.3	5.7	5.3	71	5.6	5.1	4.5	7.0	18.5	2.3	0	92	1.4	1.5	0.4	0.0	1.7	7.0	0.87
P%	<0.1	<1	<5	<0.1	<0.1	<5	<0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1	>20	6	>20	16	<0.1	0.1	<1	<5	<5	<1	<0.1
LSD 5%	0.3	0.5	0.2	0.2	0.5	0.4	0.3	0.2	16	0.1	0.1	0.3	0.2	-	4.9	-	-	0.4	0.4	0.2	0.4	2.4	2.3	0.08
P%, interaction variety x site	<0.1	<5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	>20	<0.1	<0.1	<0.1	<0.1	<1	<1	-	17	<0.1	<0.1	<1	<5	<0.1	12	<0.1

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Appendix 1: Protocol for Scangreen 2015-18

PROTOCOL FOR SCANGREEN -
TESTING OF TURFGRASS VARIETIES ON SCANDINAVIAN
GOLF GREENS 2015-2018

Revised by Trygve S. Aamlid, June 2015

TRIAL PERIOD
Varieties are tested in the sowing year plus three evaluation years.

ENTRANCE OF VARIETIES INTO TRIALS
Cool season grasses relevant for testing on greens are velvet bentgrass *(Agrostis canina)*, colonial bentgrass (UK: browntop, *Agrostis capillaris)*, creeping bentgrass *(Agrostis stolonifera),* chewings fescue (*Festuca rubra* ssp. commutata), slender creeping red fescue (*Festuca rubra* var. *trichophylla)*, perennial ryegrass *(Lolium perenne)*, annual bluegrass (UK: annual meadowgrass, *Poa annua),* rough bluegrass (UK: annual meadowgrass, *Poa trivialis)* and prostate bluegrass (UK: prostrate meadowgrass, *Poa supina)*.

Applications should be submitted to NIBIO Turfgrass Research Group, Landvik, Reddalsveien 215, N-4886 Grimstad, Norway.
Seed of optimal quality should be shipped without charge by the variety owner/representative to NIBIO Landvik. On request the variety owner/representatives should also send seed of reference varieties to ensure that these are of optimal seed quality.

REFERENCE VARIETIES

Candidate varieties will be tested against two reference varieties of the same species or subspecies: Varieties to be used in 2015 are:

Agrostis canina	Villa
Agrostis capillaris	Jorvik
Agrostis stolonifera	Independence
Festuca rubra ssp. commutata	Musica
Festuca rubra ssp. litoralis (trichophylla)	Cezanne
Lolium perenne	Chardin
Poa trivialis	Dark Horse

EXPERIMENTAL SITES, EXPERIMENTAL DESIGN AND PLOT SIZE
The trials are conducted on sand-based golf greens at Korpa GC, Reykjavik, Iceland and Bioforsk Apelsvoll, Gjøvik, Norway, representing the North- Scandinavian test zone, and Sydsjælland GC, Mogenstrup, Denmark and Bioforsk Landvik, Grimstad, Norway, representing the South-Scandinavian test zone. Each trial is established according to a split plot design with three blocks, species on main plots and varieties on subplots. The field plan must allow different mowing heights and different fertilizer levels to the different species. Between species, there should be at least 1 m borders seeded with a non-running grass species (e.g. chewings fescue) to avoid contamination among species. The plot size is 1.0 m x 1. 0 m. Sowing rates are to 0.7, 3.0, 1.5 and 4.0 kg pr. 100 m^2 for bentgrasses, fescues, bluegrasses and perennial ryegrass, respectively.

ESTABLISHMENT OF TRIALS

Before sowing, the sand-based green must be compressed and levelled out carefully to avoid any settling or low spots during the experimental period. The highest point should be in the middle of the trial, thus allowing 0.5 % inclination in all four directions. The seedbed must be compacted so that footsteps do not penetrate more than 1 mm at sowing.

One to two days before sowing, fertilizers should be raked into the top layer (see next paragraph) and the rootzone irrigated to field capacity.

Sowing of plots is carried out on a day without wind and using a LxBxH = 1m x 1m x 0.5 m sowing box that prevents seeds from contaminating eighbor plots. The seed should be raked carefully into the upper seedbed (ideal sowing depth 0.5-1.0 cm) before trampling by foot. Make sure there is no seed under the feet before moving to a new plot. After seeding, the experiment is covered with a white, permeable tarp to reduce evaporation from the seedbed and to prevent erosion by wind or water. The tarp must be removed within 2-3 days after emergence to avoid seedlings from growing into the tarp (5-10 days after sowing depending on soil temperature).

MOWING

The trials should be mowed with triplex or single (walk-behind) green mowers at least three times per week (Monday, Wednesday, Friday). Sharp knives is important to record the correct performance of each variety.

Sowing year:

Mowing is preceded by a light-weight rolling to ensure a firm and uniform surface and avoid scalping at the first mowing. The first mowing is carried out to 9 mm when the fastest growing varieties have reached a height of 12 mm. After that, the mowing height is lowered 1 mm per week to 6 mm for red fescue, perennial ryegrass and prostate bluegrass and to 4 mm for bentgrasses, annual bluegrass and rough bluegrass. These are the lowest mowing heights to be implemented in the grow-in year.

Evaluation years:

The first mowing in spring is conducted with a bench-setting of 7 mm for fescues, perennial ryegrass and prostrate bluegrass, and 5 mm for bentgrasses, annual bluegrass and rough bluegrass. Then the mowing height is reduced by 0.5 mm per week to a minimum height of 5 mm and 3 mm, respectively. Starting between 1 and 15 September depending on the length of growing season, the mowing height is increased by 0.5 mm per week in fescues, perennial ryegrass and *Poa* sp.. The mowing height in *Agrostis* sp. is not increased before winter.

FERTILIZER INPUTS

The trials should receive a balanced applications of granular or liquid fertilizers every second week. The total fertilizer rate is adjusted for rootzone composition (e.g. use of compost amendment) and length or growing season at each experimental site.

Sowing year:

A slow-release organic or inorganic fertilizer, rich in P, is raked into the upper 3-4 cm of the rootzone before sowing. The total N-rate is adjusted to 0.7 kg N/100 m^2.

After seeding, the first fertilizer application is carried out shortly after field emergence / tarp removal. Then fertilizers are applied weekly during the first five weeks after emergence. After that the application frequency is reduced to every second week. Provided seeding in late May or early June, the total fertilizer application in the grow-in year should correspond to c. 3.0 kg N/100 m^2 in creeping bentgrass, perennial ryegrass and bluegrasses, and c. 2.0 kg N/100 m^2 in velvet bentgrass, colonial bentgrass and red fescues.

Evaluation years:
The trials receive fertilizer every second week according to a fertilizer plan set up before the growing season. Provided no special need for repair after damages, the recommended seasonal rate is 1.4 - 1.6 kg N/100m^2 to creeping bentgrass, bluegrasses and perennial ryegrass. To velvet bentgrass, colonial bentgrass and fescues, each application should be reduced by 35% compared with the other species. Fertilizer applications in weeks with verticutting or aeration treatments should be carried out after these treatments.

IRRIGATION
The field capacity of the rootzone and the distribution uniformity of the irrigation system should be determined before starting the trial. Rain gauges should be set out in a grid of 2m x 2m and irrigation uniformity checked during a night with no wind. A distribution uniformity of less than 75 (100 x the average of the 25% of gauges with least water / the overall average) is not acceptable and should result in adjustments of the irrigation system.

During germination and field emergence, the trial should be irrigated with 2 mm water every second hour from 0800 h to 1800 h.

After grow-in and in the evaluation years, the trial should always receive 3-5 mm water after each fertilization or topdressing. Apart from this, the green is deficit-irrigated to 80 % of field capacity three to four times per week based on TDR measurements. The preferred timing of irrigation is in the morning between dawn and 8 am.

TOPDRESSING
Starting not later than two months after seeding, the trial should be topdressed with pure sand, grain size 0.2-0.7 mm, or a compost-amended sand (Green Mix, ignition loss not higher than 1.0 %) at least once a month. The best way to dress the greens is a weekly dusting, e.g, 0.30 liter sand per m^2. The amount should be doubled in conjunction with verticutting or surface aeration (see later paragraphs). Depending on the length of the growing season, the seasonal amount of topdressing sand should correspond to 8-10 mm. The sand must be distributed uniformly to all plots, either by hand or using a dressing machine.

WEAR
Starting in the first evaluation year, the trials are exposed to the wear and compaction from a friction wear drum, equipped with soft spikes. With six passes per week, this corresponds to 20.000 rounds of golf per year. The drum is pulled by a small tractor (Gator) and the direction is varied from time to time.

Photo: Friction wear drum with golf spikes

SURFACE AERATION
Starting in the first evaluation year, all plots are be aerated to 3-4 cm depth once a month. The aeration can can be accomplished with a slicer or with an aerator equipped with 6 mm soild tines. Aeration is always followed by double ampount of topdressing.

OTHER MAINTENANCE
Removal of dew and guttation water
As far as possible, dew should be removed in the morning, at least on days without mowing.

Soil surfactant
To avoid hydrophobicity and uneven distribution of soil water, it is recommended to treat the experimental area with a soil surfactant up to four times from 1 April to 1 Aug.

Verticutting
Plots seeded with bentgrasses, prostrate bluegrass and annual bluegrass can be verticut to 1 mm depth up to five times per season. Less verticutting is needed if there is no accumulation of thatch. Plots seeded with fescues and species are normally not verticut. Verticutting should be followed by double amount of topdressing. Avoid verticutting on hot days.

Deep aeration and hollow tine coring
Root and thatch development should be monitored at least twice per season. If the rootzone is compact and the average root depth, measured as the depth of intact hanging cylinder, is less than 15 cm, the green should be be deep-aerated and decompressed to 20-25 cm depth using a Vertidrain or similar machine.

Hollow tine coring should normally be avoided as it can lead to contamination of different varieties among plots.

RESEEDING AFTER WINTER DAMAGE
Reseeding of plots in spring should only be carried out if the winter damage of at least one variety within a species is so severe that its live turf cover in spring is less than 25 % of plot area on average for the three blocks. In this case, all plots within that species should be verticut and/or surface aerated, reseeded with the same amount of seed as used for the initial establishment, and topdressed with double amount of sand. Fertilizer rates and mowing heights should be adjusted to facilitate as fast recovery as possible.

RECORDINGS

Sowing year
Coverage: Per cent of plot area covered with undiseased turf of the sown species, diseased turf, weeds (both dicots and grasses) and bare soil is recorded for the first time three weeks after sowing and then on the first of every month until the soil is frozen or the experiment is covered by snow. If not immediately clear, diseases should be diagnosed by sending samples to Bioforsk Turfgrass Diagnostic Lab. at Landvik. Coverage of weeds and diseases can be recorded with one decimal. The lowest figure to be used is 0.1% of plot area (10 cm^2).

Turfgrass visual quality (overall impression): This is an overall score for live ground cover, uniformity, greenness, fineness, disease resistance and shoot density, scale 1-9 where 9 is the best turf. It is recorded on the same dates as coverage.

Tiller density (1-9, 9 is the highest tiller number per m^2**)** is recorded at the last assessment for the season (either 1 October or 1 November)

Evaluation years

Coverage, weeds and diseases are recorded as per cent of plot area on the first of each month during the growing season (see description above)

Turfgrass visual quality is assessed on the first day of each month during the growing season (see description above)

Tiller density is assessed on the first of each month during the growing (see description above)

Color (darkness) (scale 1-9 where 1-very light, 3-light, 5-medium, 7-dark and 9- very dark green) is assessed on the first of each month during the growing season

Fineness of leaves (leaf texture) (scale 1-9, 1-very course, 3-course, 5-medium, 7-fine and 9-very fine) is assessed on 1 May and 1 September.

Turf height is measured before mowing on the first Monday in each month during the growing season. At least three readings are taken with a John Deere prism per plot. Daily height increments are calculated from the readings and information about mowing height (bench setting) at the previous mowing (usually on the preceding Friday).

Snow molds are recorded as per cent of plot area on the same day or the day after snow melt. The casual patogen should be stated and/or samples sent to the Bioforsk Turfgrass Diagnostic Lab.

Overall winter damage, i.e. per cent of plot area dead due to abiotic or biotic damages should be recorded 1-2 weeks after green-up. The reason for damage should be recorded as far as possible.

Winter color is the intensity of green color outside the growing season: 1-completely brown/withered, 5-pale green, 7-green and 9-intensely green. If no snow cover, winter color should be assessed on 1 December and 1 March. Otherwise winter color should be assessed shortly before and shortly after the period of snow cover.

NIBIO
NORWEGIAN INSTITUTE OF
BIOECONOMY RESEARCH

NIBIO - Norwegian Institute of Bioeconomy Research was established July 1 2015 as a merger between the Norwegian Institute for Agricultural and Environmental Research, the Norwegian Agricultural Economics Research Institute and Norwegian Forest and Landscape Institute.

The basis of bioeconomics is the utilisation and management of fresh photosynthesis, rather than a fossile economy based on preserved photosynthesis (oil). NIBIO is to become the leading national centre for development of knowledge in bioeconomics. The goal of the Institute is to contribute to food security, sustainable resource management, innovation and value creation through research and knowledge production within food, forestry and other biobased industries. The Institute will deliver research, managerial support and knowledge for use in national preparedness, as well as for businesses and the society at large.
NIBIO is owned by the Ministry of Agriculture and Food as an administrative agency with special authorization and its own board. The main office is located at Ås. The Institute has several regional divisions and a branch office in Oslo.

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