

THE GRASS GUIDE 2015

AMENITY TURF GRASS SPECIES
FOR THE NORDIC COUNTRIES



Sterk

PREFACE

The first edition of STERF's Grass Guide was published in September 2012, based on more than 30 years testing of amenity turf grass species and varieties in the Nordic countries. This second edition is an update based primarily on the three last years' results in the variety testing programs SCANTURF (testing in lawns at 15 mm mowing height and football-type wear trials) and SCANGREEN (testing on greens at 3-5 mm mowing height), but also on results and experiences in other STERF projects, e.g. 'Fescue Green' and 'Turf-grass Survival in a Changing Winter Climate'.

This guide is about turf grass species, not varieties. The updates from 2012 are mostly small as there have not been major changes in the species' characteristics or areas of use during the past three years. For Norway, the biggest change is probably the implementation of a new Nature Diversity Act which has implications the use of non-native species in areas where turf is not cut regularly and therefore allowed to contaminate surroundings by flowering and seed production. New varieties have also been registered in most of the species, and information about that can be found in the variety lists that are updated annually at www.scanturf.org and www.sterf.org.

The revision of Grass Guide has been funded by the Scandinavian Turfgrass and Environment Research Foundation through the project SCANGREEN. We would like to thank Gudni Thorvaldsson, Erkki Hakamäki, Markku Niskanen, Gavin O'Mahoney, Asbjørn Nyholt, Kim Sintorn, Jon Atle Repstad and Bjørn Molteberg for critical review and valuable suggestions to the second edition.

NIBIO Turfgrass Research Group, Landvik, 1 September 2015

Agnar Kvalbein

Trygve S. Aamlid

CONTENTS

Introduction	3
Grass species for amenity turf	4
Review alphabetically by Latin name	7
Grass species and varieties	7
<i>Agrostis canina</i> L.	8
<i>Agrostis capillaris</i> L. (= <i>Agrostis tenuis</i> Sibth.)	9
<i>Agrostis stolonifera</i> L. (= <i>A. palustris</i> Huds.)	10
<i>Deschampsia caespitosa</i> L.	11
<i>Festuca rubra</i> L.	12
<i>Festuca trachyphylla</i> Hack.	14
<i>Festuca ovina</i> L.	14
<i>Lolium multiflorum</i> Lam.	14
<i>Lolium perenne</i> L.	15
<i>Poa annua</i> L.	17
<i>Poa pratensis</i> L.	18
<i>Poa supina</i> Schrad.	19
<i>Poa trivialis</i> L.	19
Glossary	20



INTRODUCTION

The Grass Guide 2015 is intended to help growers find the best grass species to meet their specific needs. Living grass can be used for a number of purposes other than food production and building material, for example as protection against erosion, re-vegetation after construction work in nature, ground cover for alpine ski slopes or camping sites, aesthetic elements of amenity turf, lawns, grassland and as a surface for different ball games.

This review concerning amenity turf only deals with grass-covered slopes, lawns, football pitches and golf courses. These different environments are characterised by different mowing frequency, degree of wear and mowing height.

The Nordic countries also have varying climate conditions and soil types. The amenity grass varieties described here have been tested at different locations and there are considerable differences in how the species cope, for example in Iceland compared with Southern Sweden or inland Scandinavia.

Choosing the right grass species is important in order to achieve good results, but different species have dif-

ferent maintenance requirements. It is not sensible to choose a grass species that can achieve the best result if the operating budget is too small to exploit the full potential of this particular species. This can actually prove to be worse than choosing a species that requires less care.

The Grass Guide is not a flora and thus we do not place high emphasis on botanical descriptions of the species included. However, we do highlight characteristics that are important for the value of amenity turf. Within each species, there are different varieties on the market. A variety is usually bred from several different ecotypes or populations. Because there are constantly new and better varieties on the market, a description of the varieties is not included in this guide. However, such descriptions are available on the internet in a format that is more easy to use and update.

The Grass Guide 2015 is intended for professionals and therefore it does not include an introduction to the grass plant in general or explanations of technical terms along the way. However, a glossary is included. The primary target group are professionals responsible for amenity turf.

GRASS SPECIES FOR AMENITY TURF

A quick overview of the grass species used in amenity turf is given in Table 1, which presents grass species used in parks, lawns and utility turf, and Table 2, which presents species used in sports grounds. Table 3 further ranks the different species for functional characteristics. The three tables are followed by a short chapter about each species.



Table 1. Grass species used in lawns, parks and utility turf

Botanical name	English (UK) name	Ornamental lawn	Lawn for recreation	Lawn with hard wear	Shaded lawn	Utility turf / Long grass
<i>Agrostis canina</i>	Velvet bent					
<i>Agrostis capillaris</i>	Common bent / browntop	X	X			X
<i>Agrostis stolonifera</i>	Creeping bent					
<i>Dechampsia caespitosa</i>	Tufted hair-grass				X	
<i>Festuca ovina</i>	Sheep's fescue					X
<i>Festuca rubra</i>	Red fescue (r.f.)					
<i>F.rubra ssp. commutata</i>	- Chewings fescue	X	X		X	X ²
<i>F.rubra ssp. litoralis</i>	- slender creeping r.f.	X	X		X	X ²
<i>F.rubra ssp. rubra</i>	- strong creeping r.f.	X	X		X	X
<i>Festuca trachyphylla</i>	Hard fescue					X ²
<i>Lolium multiflorum</i>	Westerwolds ryegrass			X		
<i>Lolium perenne</i>	Perennial ryegrass		X	X		
<i>Poa annua</i>	Annual meadow-grass ¹					
<i>Poa pratensis</i>	Smooth meadow-grass	X	X	X		
<i>Poa supina</i>	Prostrate meadow-grass			X		
<i>Poa trivialis</i>	Rough meadow-grass				X	

1) Annual meadow-grass is dispersed with soil and contaminated seed lots, and later by on-site seed production. It is rarely seeded, but there is often a large seed bank causing voluntary establishment

2) Chewings fescue, slender creeping red fescue and hard fescue are not native to Norway and should therefore not be for utility long grass areas in this country.



Table 2. Grass species used on football pitches and golf courses

Botanical name	English (UK) name	Football pitch	Green	Tee	Fairway	Cut rough	High rough
<i>Agrostis canina</i>	Velvet bent		X				
<i>Agrostis capillaris</i>	Common bent		X		X	X	X
<i>Agrostis stolonifera</i>	Creeping bent		X	X	X		
<i>Dechampsia caespitosa</i>	Tufted hair-grass	X		X			
<i>Festuca ovina</i>	Sheep's fescue						X
<i>Festuca rubra</i>	Red fescue						
<i>F. rubra ssp. commutata</i>	-chewings fescue	X	X	X	X	X	X ²
<i>F. rubra ssp. litoralis</i>	-slender creeping r.f.	X	X	X	X	X	X ²
<i>F. rubra ssp. rubra</i>	-strong creeping r.f.	X		X	X	X	X
<i>Festuca trachyphylla</i>	Hard fescue						X ²
<i>Lolium multiflorum</i>	Westerwolds ryegrass	X		X			
<i>Lolium perenne</i>	Perennial ryegrass	X	X ³	X	X ⁴		
<i>Poa annua</i>	Annual meadow-grass ¹						
<i>Poa pratensis</i>	Smooth meadow-grass	X		X	X	X	
<i>Poa supina</i>	Prostrate meadow-grass	X		X			
<i>Poa trivialis</i>	Rough-stalked meadow-grass		X ³				

1) Same footnote for annual meadow-grass as in Table 1.

2) Same footnote for Chewings fescue, slender creeping red fescue and hard fescue as in Table 1

3) Only for repair

4) Only for the fairway areas with the highest exposure to wear, mostly in Denmark and Southern Sweden



Table 3. Qualities of grass species used for amenity turf ranked on a scale of 1 to 9, where 9 indicates largest/best. The species annual meadow-grass, Westerwolds ryegrass, rough meadow-grass and creeping meadow-grass have only been tested to a limited extent in the Nordic countries

Botanical name	English (UK) name	Establishment rate	Tiller density	Fineness of leaves	Winter hardiness	Winter colour	Nutrient demand	Lateral growth	Wear tolerance	Resistance to in-season diseases	Mowing tolerance	Shade tolerance	Drought tolerance	Salt tolerance
<i>Agrostis canina</i>	Velvet bent	7	9	7	7	8	4	3	5	4	8	6	7	4
<i>Agrostis capillaris</i>	Common bent /brown top	6	6 ¹	5 ¹	6 ¹	4	5	5	3	3	7	5	3	2
<i>Agrostis stolonifera</i>	Creeping bent	6	8	5	6	4	7	7	5	5	8	4	3	5
<i>Dechampsia caespitosa</i>	Tufted hair-grass	3	5	4	8	4	6	1	5	8	4	8	3	4
<i>Festuca ovina</i>	Sheep's fescue	2	6	8	5	4	2	1	1	7	3	6	8	4
<i>Festuca rubra</i>	Red fescue													
<i>F.r. ssp. commutata</i>	- chewings fescue	4	6	7	7	4	4	1	4	8	6	7	6	6
<i>F.r. ssp. litoralis</i>	- slender creeping r.f.	4	6	7	6	6	4	3	5	7	6	7	7	7
<i>F.r. ssp. rubra</i>	- strong creeping r.f.	4	4 ²	6	6 ²	4 ²	4	5	3	6	4	7	8	6
<i>Festuca trachyphylla</i>	Hard fescue	3	6	7	5	4	2	1	1	7	4	6	9	5
<i>Loium multiflorum</i>	Westerwolds ryegrass	9	3	4	1	8	8	2	8	7	3	5	5	8
<i>Lolium perenne</i>	Perennial ryegrass	8	4	5	3	7	8	2	8	7	5	5	6	8
<i>Poa annua</i>	Annual meadow-grass	8	6	5	2	5	8	3	4	2	7	6	1	2
<i>Poa pratensis</i>	Smooth meadow-grass	2	3	4	8	3	7	8	6	5	4	3	3	3
<i>Poa supina</i>	Creeping meadow-grass	3	5	3	7	4	7	9	8	6	5	7	3	3
<i>Poa trivialis</i>	Rough meadow-grass	7	6	6	4	7	6	5	3	5	7	8	3	3

- 1) Significant variation among varieties. Norwegian turf varieties of common bent have lower tiller density, broader leaves, better winter hardiness and less winter greenness than varieties from more southern countries.
- 2) Significant variation among varieties. Norwegian turf varieties of strong creeping red fescue have higher tiller density, better winter hardiness and less winter greenness than varieties from more southern countries.

REVIEW ALPHABETICALLY BY LATIN NAME



Variety testing on Iceland. Photo: Gudni Thorvaldsson

GRASS SPECIES AND VARIETIES

The botanical classification of grass plants is complicated, and names and divisions vary from one flora to another. Botanical names other than those mentioned in this Grass Guide may therefore occur. Grass plants belong to the same species if they can pollinate each other and develop fertile seeds. There will always be variation within each species in nature. Botanists talk about subspecies, varieties, populations or ecotypes that are adapted to local conditions. Plant breeders collect plants and cross them into new varieties, which are then tested, approved and finally multiplied for sale as commercial seeds. For a variety to be approved and legally protected in terms of plant breeders' rights, there must be documentary evidence that it can be distinguished from other varieties, and that it is sufficiently uniform and stable under propagation. Within the same species, there may thus be varieties that differ from the plants found in nature.

It is always important to choose the best varieties within each species, because there can be considerable differences in terms of tiller density, fineness of

leaves, summer colour, winter colour, tolerance to winter stress, resistance to disease, wear tolerance and the ability to tolerate close mowing. When comparing varieties, these characters are usually summarised into a score for overall visual impression, which is used to rank the varieties from the best to the worst. At the websites www.scanturf.org and www.sterf.org, you will also be able to rank varieties for specific characters, if you consider some characters more important than others for your area of use.

Many countries have restrictions on the import and use of exotic grass species and varieties in natural areas. Defining what is exotic can be an issue, but in general it is best to use plant material originating near the area to be seeded. This ensures winter hardiness and prevents the turf differing too much from the surrounding natural environment.

Agrostis canina L.

	Velvet bent
	Velvet bentgrass
	Brunven
	Hundehvene
	Hundekvein
	Luhtarölli
	Týtulingresi

Velvet bent is found throughout the Nordic region in moist habitats, water edges and marshes, where it forms open tufts. In amenity turf the species is only used on golf greens, where it forms a denser turf than any other grass species. The colour is intense, bright green.

Velvet bent's growth rate is lower than that of creeping bent and the nutrient demand is not as high. The water consumption is slightly less than for other grass species, and it keeps an attractive colour and quality even during dry periods. The height growth is also low and, together with the high tiller density, this contributes to high green speed. The disadvantage that makes us reluctant to recommend velvet bent is that it produces a thatch that can be difficult to maintain. The canopy is so dense that it is difficult to get sand into the turf. This can easily result in soft greens, and in the worst case massive fungal attacks.

Velvet bent hardly grows laterally on greens and thus has poor ability to repair worn areas. Ball marks on the greens can therefore be a problem with frequent use.

Velvet bent is at least as susceptible to fungus diseases during the growing season, e.g. microdochium patch (*Microdochium nivale*, often referred to as 'Fusarium') as creeping bent. However, it is less infected by pink snow mould and especially by grey snow mould (*Typhula incarnata*) in the winter. Good winter hardiness is an important advantage of this species, and it tolerates ice encasement better than any other turf grass species. Its competitive ability against weeds is also good; even annual meadow-grass can be outcompeted in velvet bent greens. The species has not been tested outside golf greens, but we do not see any other areas of use.


There are not many varieties of velvet bent to choose from, and the availability of seed has been limited. Many Finnish greenkeepers have experience with this species, but its use in the other Nordic countries has been very limited in recent years. Some greenkeepers have tried velvet bent mixed with red fescue. These species fit well together when it comes to fertilisation level and irrigation strategy, and one of the intentions has been to improve the winter colour of the red fescue greens or to make the greens less firm. The challenge is to get a uniform and consistent mixture of the two species if soil moisture and light conditions vary on and between the greens.

The seeds of velvet bent are small (15 000 seeds per gram) and the seeding depth should not exceed 2-3 mm.



Kytäjä GC, Finland.

***Agrostis capillaris* L. (= *Agrostis tenuis* Sibth.)**

	Common bent / Browntop bent
	Colonial bentgrass
	Rödven
	Almindelig hvene
	Engkvein
	Nurmirölli
	Hálingresi

Common bent is a common grass species in moist and barren soils throughout the Nordic countries, especially in grazing areas. Common bent can be found more than 1300 m above sea level.

This grass species is used for amenity turf mainly in northern Europe and New Zealand. Common bent produces short runners both above and below ground and can form a dense sward. The colour usually appears somewhat dull. If it is not cut below 15 mm, the common bent sward can be fluffy and brownish at the base. This happens because the apex is pushed up so that the green leaves are not formed at the surface, but at some distance above the surface. Moreover, many varieties easily form panicles (stalks) that reduce the turf quality in fairways and lawns.

Common bent is more resistant than creeping bent to dollar spot (*Sclerotinia homoeocarpa*), but otherwise it is susceptible to the most common fungal diseases occurring during in the growing season, such as microdochium patch, take-all patch (*Gaeumannomyces graminis*) and brown patch (*Rhizoctonia solani*). Its winter hardiness is also variable. Norwegian varieties have good winter hardiness and should be considered for seed mixtures for fairways and ornamental lawns in regions where the winters are long and hard.

Common bent has a low wear tolerance and is therefore nearly always seeded in a mixture with other species. The most common mixture for golf greens is with red fescue. These two species are complementary, as both have relatively low fertiliser requirements, but common bent thrives better than red fescue in moist areas. The species to predominate is determined by environment, and the botanical composition may change depending on weather, soil conditions and mowing height.

Common bent copes better than red fescue with a very low cut (3 mm). Because the leaves are upright, common bent also requires a low cut in order to give a good ball roll. Greens dominated by common bent produce more thatch and are slightly softer than red fescue greens. Take-all patch, snow mould, microdochium patch and other diseases infect common bent more than red fescue, and red fescue tends to predominate in old patches caused by disease. All in all, common bent is not always an obvious partner of red fescue on golf green; in many cases red fescue used alone may produce just as good results.

On fairways, common bent can form a very dense turf, especially in moist areas.

The inflorescence of common bent is red to purple. On grass-covered slopes and uncut roughs the swaying panicles give a pleasant aesthetic impression, but the sward under the straws becomes denser than a corresponding sward of red fescue.

The seeds of common bent are small (10 000-15 000 seeds per gram), and the inclusion of this species in seed mixtures will often result in many plants. In green mixtures, 10% common bent and 90% red fescue give rise to roughly the same number of plants of each species. In mixtures for fairways and fine lawns, common bent should not constitute more than 5%.

Common bent must not be seeded deeper than 5 mm. It usually germinates and establishes quickly, but like other bents, it is more susceptible to irregular water supply during establishment than grasses with larger seeds.



Rauma GC, Norway.

***Agrostis stolonifera* L. (= *A. palustris* Huds.)**

	<i>Creeping bent</i>
	<i>Creeping bentgrass</i>
	<i>Krypven</i>
	<i>Krybende hvene</i>
	<i>Krypkvein</i>
	<i>Rönsyrölli</i>
	<i>Skriðlingesi</i>

Creeping bent is found wild all over the Nordic region. It is most common along the coast, but it can also be found up to 1000 m above sea level. Creeping bent naturally grows laterally, forming stolons (runners above ground). This enables the species to repair damages in the sward.

However, because of the stolons and the generally high growth rate, creeping bent forms much thatch that must be controlled by intensive maintenance. Creeping bent is often used on golf greens because the species tolerates low mowing (3 mm), but it has performed poorly in variety testing in Iceland. Its mowing height can be kept low even during the autumn. The good recuperative capacity makes creeping bent relevant also on tees and fairways. If seeded on fairways the maintenance budget of the golf course must be large enough to allow for regular vertical cutting to avoid the development of thatch and horizontally growing, ‘fluffy’ grass. On sand-based fairways, regu-

lar sand dressing is also important to avoid harmful thatch. The mowing height on fairway should not exceed 10 mm. The freezing tolerance of hardened plants of creeping bent is good and it usually survives long periods of ice encasement. Its major disadvantage is that it is susceptible to fungal diseases both during winter and summer. It is therefore difficult to keep this species free from diseases without using fungicides.

Breeding of new varieties of creeping bent has mainly taken place in North America, and there has been great progress when it comes to tiller density and leaf fineness. ‘Penncross’ was released in 1955 and was until ca. 2010 the most widely used variety in the Nordic countries, mostly because the seed was cheaper than of newer varieties. ‘Penncross’ is moderately dense, but has long stolons and thus a good capacity for repair. Today, newer varieties have mostly taken over; many of them have twice as high tiller density as ‘Penncross’ and therefore require a different management program to avoid thatch. American breeders are now mostly breeding for disease resistance and stress tolerance, but so far, they have not been focusing on the most common diseases on golf courses in the Nordic countries.

The seeds of creeping bent are small (10 000-15 000 seeds per gram), and the optimal sowing depth is 2-3 mm. Regular moisture supply during establishment is therefore very important.

In Iceland, creeping bent has not demonstrated acceptable quality in variety testing.

Creeping bent is rarely seeded in mixtures with other species in the Nordic countries, but it is common to use a blend of different creeping bent varieties with uniform colour and leaf fineness.



Variety testing on Iceland. Photo: Gudni Thorvaldsson

Deschampsia cespitosa L.

	Tufted hair-grass / tussock grass
	Tufted hairgrass / tussock grass
	Tuvtåtel
	Mosebunke
	Sølvbunke
	Nurmilauha
	Snarrótarpuntur

Tufted hair-grass grows all over the Nordic region and can be found up to 1470 m above sea level. The species has stiff, silica-containing leaves and naturally forms dense tufts on moist places.

Tufted hair-grass is marketed because it forms a dense sward even in shady places. During testing, the species has often been compared to smooth meadow-grass. Tufted hair-grass establishes almost as slowly as smooth meadow-grass, but it forms a denser turf. The winter hardiness is at least as good as that of smooth meadow-grass and it is less susceptible to fungal diseases. Wear tests have shown that the wear tolerance

is comparable to that of intermediate to good varieties of smooth meadow-grass. However, tufted hair-grass does not spread laterally and the recuperative capacity is therefore inferior to that of smooth meadow-grass. Over time there is a risk for unattractive turfs to develop in the lawn. The colour is lighter than for most varieties of smooth meadow-grass and ryegrass, and the high silica content can make the plants feel a little prickly. Dull mowers can give a white tinge to the sward.

Tufted hair-grass has been tested in mixtures with other species. Mixtures with smooth meadow-grass or red fescue with short or long runners are more stable over time than mixtures with other tuft-forming species such as ryegrass and Chewings fescue. Tufted hair-grass and meadow-grasses (smooth meadow grass or rough meadow grass in shaded areas) should contain about the same amount of the two components species to produce the best lawn.

The strong tendency to form tufts makes it necessary to keep the mowing height of tufted hair-grass below 40 mm. On the other hand, the species does not tolerate mowing below 10 mm, so it is primarily an alternative for shaded lawns. It was probably more widely used 10-15 years ago than today.





Seed lots of turfed hair-grass contain about 4000 seeds per gram.



Fairway trials at Fullerö GK, Sweden, June 2008.

***Festuca rubra* L.**

Underarter: *F. rubra* ssp. *rubra*, *F. rubra* ssp. *litoralis* (= *F. rubra* ssp. *trichophylla*), *F. rubra* ssp. *commutata*

	Red fescue (subspecies: 'strong creeping red fescue', 'slender creeping red fescue' and 'Chewings fescue', respectively).
	As in UK, but the Americans often use the collective term 'fine fescues', which also includes hard fescue and sheep's fescue.
	Rödsvingel (subspecies: 'rödsvingel med långa utlöpare', 'rödsvingel med korta utlöpare' and 'tätvuxen rödsvingel')
	Rødsvingel (names of subspecies correspond to Swedish)
	Rødsvingel (<i>F. rubra</i> ssp. <i>commutata</i> is often referred to as 'veirødsvingel', otherwise names correspond to Swedish and Danish)
	Punanata
	Rauðvingull

Red fescue can be divided into other subspecies than those mentioned in this Grass Guide. The division shown above was chosen because it is customary to refer to subspecies with a descriptive supplement: red fescue without/with short or long runners. Varieties in these subspecies also differ in tiller density, colour and winter hardiness.

Red fescue has narrow, almost thread-like leaves and is found wild in many different habitats, for example sparse forests, meadows and roadside verges, but it prefers dry areas. As the growth rate is low, red fescue competes the best with other species in relatively nutrient-poor areas. The low growth rate also limits red fescue's wear tolerance, and it is also relatively slow in establishment, particularly after re-seeding.

Despite these disadvantages, red fescue has a wide area of use, and in the Nordic countries it is the most widely used lawn grass. When uncut, it develops beautiful, red to brown seed stalks, but it can also be cut down to 5 mm and produces dense lawns at low mowing height. Red fescue also performs reasonably well in the shade.

The subspecies Chewings fescue, which grows naturally in tufts, is originally from Southern and Central Europe. It grows wild in Denmark and Skåne, but

in Norway, it is considered an alien, invasive species, included on 'the black list' of the Norwegian Biodiversity Information Centre. In Norway, it should therefore not be seeded in long grass areas where there is a risk for flowering and seed dispersal. For regularly cut lawns, however, Chewings fescue must be considered a valuable species because of its dense swards and high resistance to the most important turf grass diseases. On unsprayed greens, the overall winter hardiness of Chewings fescue is also better than for common or creeping bent, but its freezing tolerance in areas without snow cover is less than for creeping bent, and it is also less tolerant to long-term ice encasement. Chewings fescue has a nice, deep green colour, but most varieties lose their colour during winter, and some even in dry periods in summer.

The subspecies slender creeping red fescue belongs to beach meadows, in other words a slightly humid environment in which it is exposed to salt. The short rhizomes (runners below ground) enable this subspecies to compete better with annual meadow grass and mosses, and to repair damage better than Chewings fescue. The colour is normally lighter green and the winter colour is greener, but the winter hardiness is a little weaker than for Chewings fescue. Nordic variety testing nevertheless shows that the genetic progress in turf quality and winter hardiness has been greater for

slender creeping red fescue than for Chewings fescue. It may therefore be considered to increase the percentage of this subspecies in seed mixtures for greens and fine lawns, at least in southern Scandinavia. But slender creeping red fescue is not native to Norway, and just like Chewings fescue, it must therefore be avoided in seed mixtures for road verges or other long grass areas.

The subspecies strong creeping red fescue grows naturally all over the Nordic region and can be found at over 1800 m above sea level. The long rhizomes results in a relatively open sward, and it is therefore not suitable for greens. However, this subspecies retains its colour better than the other two subspecies during dry periods, and it may therefore be used in seed blends with the two other subspecies for fairways and lawns. The winter hardiness of strong creeping red fescue is usually less than of Chewings fescue, but the Norwegian variety 'Frigg' of strong creeping red fescue survives the winter better than any Chewings fescue.

Red fescue is well known to golfers from Scottish links courses. The species thrives in this nutrient poor, well-drained environment. Greens with pure red fescue become firm because the species only produces mode-

rate amounts of thatch. The thin, round leaves result in low rolling resistance and the ball roll can be good even if the mowing height is not lower than 5 mm. Fairways dominated by red fescue repair divots slowly and regular over-seeding might be necessary under excessive wear.

Red fescue is easily infected with red thread (*Laetisaria fuciformis*). It is also susceptible to pink snow mould and microdochium patch, but the patches are usually more superficial and diffuse than in alternative species of bent. Otherwise red fescue shows high resistance to the most common fungal diseases, and the species is therefore a good alternative if aiming for reduced use of fungicides. A deep root system (brown roots) enables the grass to survive dry periods. The nutrient demand is low, and altogether this makes red fescue an economical alternative where there are not particularly high demands on wear and recuperative capacity.

Seeds of red fescue are relatively large (600-1000 seeds per gram), but if water is not limiting, the establishment rate usually is lower than for the bents.



Checking out winter damages, mostly fungal diseases, at Landvik, Norway, spring 2010. From front to back: tall fescue (*Festuca arundinacea*), smooth meadow-grass (good overwintering) and ryegrasses. The partition in the middle, with good overwintering, is red fescue.

Festuca trachyphylla Hack.

	Hard fescue
	Hard fescue (see comment for red fescue)
	Hårdsvingel
	Bakkesvingel
	Stivsvingel
	Jäykkänata

Hard fescue and sheep's fescue are both low-input species with dense tufts and a low potential for growth.

The colour ranges from deep dark green for most varieties of sheep's fescue to greyish or almost bluish for some varieties of hard fescue. There are several subspecies. Only sheep's fescue is considered to be a native species at more elevated and in northern parts of the Nordic countries, but hard fescue is scattered after seeding along roads and in other low-maintenance areas. The winter hardiness of hard fescue and sheep's fescue varieties from Denmark and more southern countries is usually rather limited. Hard fescue and sheep's fescue establish slowly and have very low tolerance to wear, but they have low nutrient requirements, and especially hard fescue retains its green colour better than any other species in situations with extreme drought stress.

Festuca ovina L.

	Sheep's fescue
	Sheep's fescue (see comment above for red fescue)
	Fårsvingel
	Fåresvingel
	Sauesvingel
	Lampaannata
	Sauðvingull

Hard fescue and sheep's fescue have not been tested on greens, but tests show that they tolerate mowing down to 7 mm. Nevertheless, it is common to assume that they thrive best in dry, extensive areas, such as on grass roofs or together with herbs in flowering meadows. They also perform relatively well in shade. The two species are often referred to collectively because they have the same areas of use. Hard fescue is seeded in high roughs and along roads in Denmark, but according to the Norwegian Nature Diversity Act, only native varieties and ecotypes of sheep's fescue can be used in long grass areas in Norway.

Hard fescue contains about 1200 seeds per gram and sheep's fescue about 2000 seeds per gram.

Lolium multiflorum Lam.

	Italian ryegrass / Annual ryegrass
	Italian ryegrass / Annual ryegrass
	Italienskt rajgräs
	Rajgræs, italiensk
	Italiensk raigras
	Italianraiheinä
	Ítalskt rýgresi

Italian ryegrass is an annual, biannual or short-lived perennial species that forms loose tufts.

Some consider it to be a subspecies of *Lolium perenne*, with which it can also be crossed (hybrid ryegrass). The strictly annual varieties are named Westerwolds ryegrass.

Italian ryegrass has long been used in fodder production, but now there are varieties with higher density and finer leaves, which are suitable for the amenity turf market. These varieties can be used where there is a need for quick, temporary establishment of a turf cover that will almost certainly die during the winter. The foremost advantage of Italian ryegrass is its fast establishment from seeds. Otherwise, the qualities are very similar to those of perennial ryegrass.

Lolium perenne L.

	Perennial ryegrass
	Perennial ryegrass
	Engelskt rajgräs
	Almindelig rajgræs
	Flerårig rajgras
	Englanninraiheinä
	Vallarrýgresi

Perennial ryegrass forms loose tufts. The leaves have a fresh green colour throughout the year and a shiny underside. This is the world's most widely used grass species for amenity turf in temperate climates and the supply of varieties is immense. There are large differences in colour, and American breeders have released some very dark varieties.

Perennial ryegrass has a high growth potential and good wear tolerance, but the lateral growth is mostly rather poor. Therefore, damage to the sward must mainly be repaired by reseeding. Recently, there have

been varieties of so-called RPR (Regenerating Perennial Ryegrass) coming to the market. These varieties are supposed to have better recuperative capacity, but they have not yet been tested in variety trials in the Nordic countries.

Perennial ryegrass does not cease growth in the autumn to the same extent as winter hardy species do, and individual plants may therefore appear as strongly growing tufts among the other grass species in autumn. Many varieties also easily develop seed stalks. These characteristics underpin the need for regular mowing, even during the autumn. The strong fibres of the leaves require sharp cutting knives in order to prevent peeling and grey leaf tips.

Perennial ryegrass has poor winter tolerance and will often die out in the inland of the Nordic countries. However, it will normally survive in southern areas and along the coast. It is difficult to predict where this borderline is, as the winters are so different. The genetic progress in winter hardiness had been less than for tiller density and leaf fineness, and most variety trials show only small differences in winter survival. The past decade has brought to the market some tetraploid (double set of chromosomes) varieties for which a better tolerance to turf grass winter diseases has been documented, but it remains to be established if these varieties are also stronger against physical winter damages such as freezing temperatures, desiccation or ice encasement.



There has been a tendency among grass breeders, especially American companies, to breed darker ryegrass varieties. One of the consequences is that it is easier to spot invasion of annual meadow-grass. Landvik, Norway, 2008.



The strong fibres of the ryegrass leaves require sharp cutting knives in order to prevent peeling and grey leaf tips.

The great wear tolerance makes perennial ryegrass an important component of football turf. Where winter hardiness is important, perennial ryegrass should be used together with smooth meadow-grass.

On golf courses perennial ryegrass is primarily used to repair tees, but it can also be considered for use on high-traffic areas, such as bridge passages on fairways and at the entrance to tees. Otherwise perennial ryegrass is normally not recommended in the green areas and on fairways because it may form tufts, leading to randomness.

Perennial ryegrass can be seeded for fast repair of winter-damaged greens. For successful results, it is then important to use varieties that do not tolerate low mowing for extended periods. Otherwise, perennial ryegrass can become the predominant species and this often results in new winter damage.

In winter-mild parts of the Nordic countries perennial ryegrass can also be used in parks, especially in areas with high wear. Regular over-seeding must then be a part of the maintenance programme to prevent injured turf from being invaded by annual meadow-grass. Perennial ryegrass shows strong resistance to in-season diseases, but red thread disease often occurs if fertilizer inputs are too low.

Perennial ryegrass has large seeds (500 seeds per gram) and it germinates quickly and under drier conditions than most other species. The species is therefore often used in seed mixtures to repair sward damage. However, because of the negative characteristics mentioned above, perennial ryegrass should only be included in seed mixtures after careful consideration of the long-term consequences.



Winter damaged perennial ryegrass. Landvik, Norway, spring 2011.

Poa annua L.

	Annual meadow-grass
	Annual bluegrass
	Vitgröe
	Enårig rapgræs
	Tunrapp
	Kylänurmikka
	Varpasveifgras

Annual meadow-grass originated in Europe, but has spread all over the world. The plant is light green, usually forming flat tufts, and it can bloom all year round as long as there is no frost. It is extremely adaptable to different environments.

Annual meadow-grass is described as an annual to biennial plant, but one subspecies, *Poa annua* var. *reptans*, is perennial and spreads by short rhizomes.

Important characteristics of annual meadow-grass in amenity turf are its shallow root system, high susceptibility to several fungal diseases, high growth rate and poor winter hardiness. We do not recommend seeding annual meadow-grass, as there are no varieties on the market with sufficient qualities documented. However, annual meadow-grass establishes by itself in all types of short-cut grass areas. This is due to the species' amazing capacity to produce seeds, its high growth

rate and its ability to compete with other grass species. Seeds of annual meadow-grass are spread efficiently by contaminated seed lots or soils, and later by shoes and equipment. The annual types flower and produce seed throughout the year, but the most concentrated flowering period is usually in the beginning of June.

Annual meadow-grass germinates in voids in the sward even under unfavourable conditions. It grows well in areas where other cultivated grasses do not thrive; such as trampled or poorly drained areas. The plants are often completely dead in the spring, but new seeds germinate from the soil seed bank and dense sward is usually formed by the end of June.

Annual meadow-grass is well adapted to golf greens. It tolerates very low mowing and many of the world's best golf courses have annual meadow-grass on the greens. It is usually on such old greens that we find the perennial and creeping types. For this reason, annual meadow-grass is usually recognized as a favourable species for golf greens in countries where winter injuries is not common. But it requires high inputs of fertilizer, irrigation, pesticides and verticutting, and annual meadow-grass greens are therefore expensive to keep in a good condition. In the Nordic countries, with the harsh winters, we recommend to control annual meadow-grass as much as possible.

The seed of annual meadow-grass remains germinable for at least ten years in the soil, so when renovating turf, it is important to remove the top layer containing most of the seed bank.

The seed weight of annual meadow-grass corresponds to 3000-6000 seeds per gram.



Poa annua

Poa pratensis L.

	Smooth (stalked) meadow-grass
	Kentucky bluegrass
	Ängsgröe
	Engrapgræs
	Engrapp
	Niittynurmikka
	Vallarsveifgras

Smooth meadow-grass has the typical characteristics of the genus *Poa*. The leaves are folded and have a 'ski-track' in the middle, and they are equally wide all the way to the leaf tip, which is shaped like the bow of a boat.

Typical features of smooth meadow-grass are its dark, almost blue-green, colour and strong rhizomes. There are many different forms in nature, but unlike in red fescue, they are not classified as botanical subspecies. Smooth meadow-grass in amenity turf has relatively broad leaves and the tiller density is generally low, although there are large differences among varieties. Under the soil surface rhizomes make the turf strong and able to recover quickly from damage. The winter hardiness is very good.

Smooth meadow-grass thrives on fertile, clay soil and in agriculture it is recommended that the pH is kept above 6 for this species. The resistance to snow mould is good, but several leaf diseases can attack during the summer, including powdery mildew (*Blumeria graminis* spp. *poae*, formerly *Erysiphe graminis*), melting-out disease (*Drechslera poae*) and rust (*Puccinia poae-nemoralis*). Rust in particular can reduce the quality of grass in southern parts of the Nordic countries, but it is rarely necessary to use fungicides. There are large differences in varieties when it comes to resistance to disease.

Traditionally, low mowing of smooth meadow-grass is not recommended. The lowest mowing height that can be tolerated is, however, subject to discussion and again, there appear to be differences between varieties. In research performed in the US, some new varieties

were rated better at 12 mm mowing height than at 25 mm. Earlier recommendations for a minimum mowing height of 16-20 mm were based on experiences with heat stress, significantly higher disease pressure and more fertiliser than is common in the Nordic countries. Provided a bright, cool climate and steady, moderate fertiliser levels, our opinion is that new, dense and fine-leaved varieties of smooth meadow-grass tolerate a mowing height of 10 mm. Low mowing may, however, be stressful to smooth meadow-grass growing on football pitches, where large production of rhizomes is more important and light conditions are poorer.

Smooth meadow-grass establishes slowly. The seeds are relatively small (3000-5000 seeds per gram) and it takes time to establish a dense vegetation cover. Because of the slow establishment, annual meadow-grass can easily become dominant. Sodding is therefore an appropriate method to use where fast establishment is needed.

Smooth meadow-grass is the main species in almost all sod because the rhizomes are strong and bind the turf well together. This provides a robust commercial product that is easy to cut and install.

Smooth meadow-grass can be used in private lawns and parks where good winter hardiness is important and it should be used on sports grounds where the recuperative capacity and wear tolerance are of great importance.



Many varieties of smooth meadow-grasses are attacked by rust in damp coastal climates. Landvik, October 2011.

Poa supina Schrad.

	Prostrate meadow-grass / Creeping meadow-grass
	Supina bluegrass
	Trampgröe
	Lav rapgræs
	Veirapp
	Juurtonurmikka
	Skuggasveifgras

Prostrate meadow-grass is a perennial, broad-leaved grass with strong stolons. The colour is typically light green, almost yellowish.

It thrives best on moist, fertile soil and shows aggressive growth and good wear tolerance. It establishes almost as slowly as smooth meadow-grass but starts to grow earlier in spring. The drought tolerance is poor, but the winter hardiness is good, even at 5 mm mowing height. German studies have shown that this species out-competes other species in the shade, e.g. on tees and greens with intense wear and low mowing height. Some golf courses in winter-tough areas of Finland have seeded prostrate meadow-grass on greens, but for the most part, we consider it as a potential species for football pitches.

There are only a couple varieties available on the market and experiences from Nordic variety testing are limited. Seed lots of prostrate meadow-grass contain ca. 4000 seeds per gram.

Poa trivialis L.

	Rough (stalked) meadow-grass
	Rough bluegrass
	Kärrgröe
	Almindelig rapgræs
	Markrapp
	Karheanurmikka
	Hasveifgras

Rough meadow-grass has narrower leaves than smooth meadow-grass and normally grows in tufts, but it can also form short stolons. In nature, it grows in moist and shady areas and has a fairly light colour. A typical characteristic of unmown wind plants of rough meadow-grass are the long ligula (transparent membranes) along the seed stalks.

The bred varieties of rough-stalked meadow-grass are almost as dark as smooth meadow-grass and considerably darker than annual meadow-grass and prostrate meadow-grass. Rough meadow-grass has low wear to-

lerance and competes poorly with other species, but it may be useful in a mixture with red fescue under trees or other areas with poor light conditions.

Rough meadow-grass tolerates low mowing and establishes significantly faster than smooth meadow-grass, almost as quickly as annual meadow-grass. Seed of rough meadow-grass can therefore be used for repair of golf greens, but the dense, fine-leaved varieties that are marketed for this purpose are bred for overseeding of greens in the southern United States and are not very durable under Nordic conditions. They are not adapted to our light conditions, and are easily outcompeted by other species.

Seeds of rough meadow-grass are of the same size as seed of other meadow-grass species. There are 3000-5000 seeds per gram.



The typical characteristics of the genus Poa - the leaves are broad all the way to the leaf tip, which is shaped like the bow of a boat.

GLOSSARY

alien organism: organism that does not belong to any species or population occurring naturally on the site (definition from the Norwegian Biodiversity Act). Opposite: Native (site specific) species.

ball mark: depression and/or tear in a short-cut grass surface, caused by the impact of a golf

ball roll: See 'stimpmeter'

colour (=genetic colour): darkness of green. Should be rated when the grass is growing and not affected by stress

disease resistance: ability to resist fungal diseases. There may be differences between diseases occurring during the growing season and diseases mainly attacking the turf at low temperatures under snow cover

divots: tufts of grass (and soil) displaced by the stroke of a golf club

dressings: the act of spreading sand or a sand-based soil mix on the top of a grass surface

drought tolerance: expression is used both about the grass' ability to maintain a nice and green appearance during drought, and about its ability to recover once the drought period is over

ecotype: plants within one species that have developed specific characteristics in adaptation to the environment. Ecotypes cannot always be distinguished morphologically

erosion: loss of soil due to wind or water flow

establishment rate: can be expressed as the number of days from planting grass seeds until the surface is ready for use. Strongly influenced by temperature and fertilizer level

fairway: short-cut grass surface between tee and green, from which the ball can easily be played

fertilizer requirement: plants with high growth rates have high fertilizer requirements. Appropriate fertilizer inputs are determined by targeted growth rate, length of growing season, soil reserves and other growing conditions

fine lawn: see ornamental lawn

fungicide: chemical or biological compound used to control fungi that cause plant diseases

green: short-cut grass around the hole on a golf course

growth rate: a plant's ability to utilize nutrient availability and other growing conditions to produce biomass. This ability is genetically determined. See also 'fertilizer requirement'

horizontal growth (lateral growth): expression indicating the direction of growth for runners and sometimes grass leaves. See 'rhizome', 'stolon' and 'vertical growth'

leaf fineness (=leaf texture): width of grass leaves

mowing tolerance: character for grass tolerance to close mowing. Mowing height has a major impact on competition between grass species in a mixed sward

native species: species occurring naturally within a country or district

ornamental lawn: short-cut lawn with special aesthetic value. To be distinguished from recreational lawn

population: group of plants that belong to the same species and live in the same geographical area where they exchange genes and compete for resources

recuperative capacity: the capacity of a grass plant to repair voids in the surface, either through horizontal growth or by germination of seeds

rhizome: horizontal shoot (runner) below the soil surface. Can be distinguished from roots by having nodes with primordia for new shoots. See 'stolon'

runner: see 'rhizome' and 'stolon'

salt tolerance: ability to grow in soils with high concentration of salts

shade tolerance: ability to compete with other species under low light conditions. Grasses generally have high requirements to light compared with other plants

site specific species: see native species

species: basic unit in plant taxonomy. Plant with the same species can interbreed and produce fertile seed

stimpmeter: instrument for measuring the resistance to ball roll on a golf green. A golf ball is rolled onto the green, and the distance from the starting point to the stopping point is measured. Ball roll is usually expressed in feet. Fast greens have high stimpmeter values (10 feet)

subspecies: unit used in plant taxonomy / botanical classification. Subordinate to 'species'. Group of plants within one species that have certain characteristics

stolon: horizontal shoot (runner) above the soil surface. See 'rhizome'

tee: area from which the golf ball is first played at each hole. The tee should be flat and have a short-cut grass cover

thatch: layer of dead and living organic material that develops between the grass sward and the soil surface

tiller density: the number of tillers per area unit. Tiller density usually increases with lower mowing height and increasing fertilizer levels

tufts: elevation in the grass surface caused by plants with high density /accumulation of tillers. Tufted grasses do not form rhizomes or stolons, but have intravaginal tiller development resulting in tufts

utility turf: low-maintenance grass-covered area that is not cut or cut only once or twice a year. Include road verges, set-a-side land, green roofs etc.

variety (cultivar): assemblage of plants belonging to one species or subspecies. A variety should have an approved name and a description based on morphological characters or a DNA-profile that distinguish it from other varieties. Varieties are owned and protected by plant breeders

vertical growth (growth in height): usually expressed as mm per day or accumulated height growth during a season

weed: plant growing in the wrong place. Includes mosses and cultivated plants growing in the wrong place, e.g. white clover. Weeds are usually able to spread and compete with seeded plants

wear tolerance: ability to maintain surface quality during mechanical damage. Wear machines simulate the impact from the shoes of golf- or football players

winter colour: an expression for how green or faded (brown) the grass when it is not growing (outside the growing season). Winter colour can be influenced by autumn fertilisation

winter hardiness: ability to tolerate winter stress. There are many reasons for winter damage. Characters for winter hardiness summarize experiences over several years, whether damage is caused by low temperature, prolonged snow cover, desiccation, water, ice, or winter diseases



Seeding of test fields i Denmark, September 2011. Photo Anne Mette Dahl Jensen

Written by

**AGNAR KVALBEIN
TRYGVE S.AAMLID
NIBIO Turfgrass Research Group**

Sterf

STERF (Scandinavian Turfgrass and Environment Research Foundation) is the Nordic golf federations' joint research body. STERF supplies new knowledge that is essential for modern golf course management, knowledge that is of practical benefit and ready for use, for example directly on golf courses or in dialogue with the authorities and the public and in a credible environmental protection work. STERF is currently regarded as one of Europe's most important centres for research on the construction and upkeep of golf courses. STERF has decided to prioritise R&D within the following thematic platforms: Integrated pest management, Multifunctional golf facilities, Sustainable water management and Winter stress management. More information about STERF can be found at www.sterf.org