Application to
R&A Golf Course committee

Optimal maintenance for hardening and early spring growth of green turf grass

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Introduction

The tradition of research related to the golf sector is very young in the Scandinavian countries. However, during the last five years period some research on water and nutrient use efficiency has been performed. This has enabled development of a successful cooperation between the Swedish Golf Federation (SGF), the Fullerö Golf club (Fullerö GK) and the Swedish University of Agricultural Sciences (SLU), which we hope to be able to continue in this new research project. The Scandinavian Turfgrass Research Foundation was set up 2001 by the Scandinavian Golf Federations. The foundation was set up in order to encourage joint research and development activities, especially for golf courses. Today the foundation is funding five Scandinavian research projects.

To continue the development of Scandinavian research related to golf, we believe that the co-operation with R&A Golf Course Committee will be of major importance. We were very pleased to be able to host Nick Park and Steve Isaac in Sweden twice during 2003. The aim of their visits was to study and identify reasons for severe winter damages on different golf courses with and without chemical disease control. As a result, two important areas of research and development were identified, i.e. “Selection of grass species for putting greens in Scandinavia” and “Optimal maintenance for hardening and early spring growth”.

The Scandinavian Turfgrass Research Foundation has identified winter injury and winter stress management as one of the most important categories of research and education related to golf in Scandinavia, and we are very pleased to be able to develop this research area in co-operation with the R&A Golf Course Committee. Hereby we would like to suggest a plan for the project “Optimal maintenance for hardening and early spring growth”. The project is developed as a joint project between SGF, Fullerö GK, SLU, Norwegian Agricultural University (NLH) and the Scandinavian Turfgrass Research Foundation.

Background

Golf in Scandinavia is big and growing. In Sweden for example about 7% of the population plays golf. The Scandinavian countries have about one million golf players and even more people who want to play golf, but there is no room for them at existing golf courses. There are about 1000 golf courses in Scandinavia and a large number are under construction (Hammarström, 2003).

The climatic conditions in Scandinavia are unique, especially with respect to day length, daily mean temperature, and precipitation. The conditions also vary a lot from the south (55 degrees latitude) to the far north (70 degrees latitude). The middle part of Scandinavia, the Oslo, Stockholm and Helsinki area, is located at 59 to 60 degrees latitude. The climate in this area results in a short and very intensive golf season. Approximately, there are 35000 rounds of golf played per golf course during about six months.

Winter injury on turf, especially on putting greens, is a major problem on golf courses in Scandinavia. About 70% of the Scandinavian golf courses suffer severe winter damage every year. When turfgrass injury occurs, the opening of the golf course is delayed and the playing conditions on e.g. putting greens might not be acceptable until after mid June. This causes a loss of revenue for the golf club, in many cases more than 350 000 SEK (26 000 £) per year, as well as very dissatisfied members. It also causes increased maintenance costs and in some cases costs for reconstruction. When revenue is lost, maintenance costs are raised and golfers complain, there is also considerable pressure on the superintendent to quickly get the golf course, especially putting greens, back into playing condition (Stavås, 2003; Orsholm, 2003; Hammarström, 2003).

The most common grass species on putting greens in Scandinavia are Annual meadow-grass/Annual bluegrass (*Poa annua*), Chewing fescue (*Festuca rubra*), Common bent grass (*Agrostis capillaris*), and Creeping bent grass (*Agrostis stolonifera*) (Svärd, 2003). There are important differences in hardening and cold tolerance between species and varieties, but there are only a few studies done in this research area, especially on turfgrass cultivars within fescue varieties (*Festuca)* and Browntop bent (*Agrostis tenuis*) (Johansson, 1997).

Hardening and early spring growth is highly dependent on maintenance. It is important to identify maintenance strategies that help the plants to fully harden. More research is needed concerning construction and maintenance factors that influence plant hardening in the autumn and the early spring growth, e.g. plant nutrients and fertilising, disease control, plant regulators, soil organic matter and microbiological activity in the root zone, soil physical properties in the root zone, wearing and mowing in the late autumn. Due to the short days and low light intensity in Scandinavia during late autumn and winter, perennial plants become heterotrophs. They are therefore totally dependent on stored carbohydrates for their survival during this period. Nitrogen additions in excess of growth requirements during autumn may delay growth cessation, onset of hardening and the built up of carbohydrate stores. A regulated fertilisation, e.g. demand driven fertilisation, where nitrogen supply matches growth demand, may offer a solution to this problem (Ericsson, 2002).

Snow mold fungi are one of the main causes of winter damage on golfgreens. *Microdochium nivale (Fusarium nivale)* is most frequently found, but also damage caused by Tyhula species is seen on golf courses with snow cover. It is well known that different grass species have different resistance against snow mold fungi, but the effect of different fertilising and maintenance treatments in the autumn on winter damage by snow mould fungi has not yet been properly clarified. This question will therefore be addressed in this project.

Various types of spring protective cover are used to reduce damage caused by desiccation. Spring protective cover also enhances early spring growth. However, many superintendents report inconsistent results with the use of protective covers, and there are few precise recommendations for their use.

Objectives

The overall objective of this project is to develop and improve maintenance strategies to optimise overwintering of turf grass for high quality golf courses.

More specific objectives are:

1. to determine the effect of different fertilisation regimes on plant hardening in autumn, winter disease attacks and summer recovery, with and without chemical disease control.
2. to determine the effect of spring protective cover on early spring grass growth and remaining effects during summer
3. to determine differences concerning overwintering between turfgrass mixtures: 1) 40% Chewing fescue (*Festuca rubra* ssp. Commutata), 40% Slender Creeping Red fescue (*Festuca rubra* ssp. Litoralis) and 20% Browntop bent (*Agrostis tenuis*), 2) Creeping bentgrass (*Agrostis stolonofiera*) and 3) *Poa annua*.
4. to combine a research and demonstration project to encourage superintendents and agronomists together with researchers to be directly involved in the performance of the project and the application of findings.

Hypothesis

The project will test the following hypothesis:

1. Hardening and susceptibility towards turfgrass winter diseases is highly dependent on nitrogen and carbohydrate status of the plant, i.e. the fertilisation strategy.
2. Spring protective cover reduces damages to putting greens and enhances early spring turfgrass growth.
3. Late autumn nitrogen fertilisation increases early spring grass growth.
4. Autumn potassium fertilisation increases resistance towards winter damage.
5. Turf grass mixes of Chewing fescue, Slender Creeping Red fescue and Browntop bent are more resistant to winter damages than Creeping bentgrass and Annual meadow-grass on a chipping green.
6. Implementation of research results and new knowledge are guaranteed by directly involving superintendents and agronomists in the research process.

Material and Methods

General outline of the field experiment

The field experiment will be performed at Fullerö Golf Club (Fullerö GK) outside the city of Västerås ($59^{o}40'$ N, 16^{o}, 30' E) in the vicinity of the Stockholm region during three years. The climate in Västerås is cold temperate and can be regarded to represent the central part of Scandinavia as well as some parts of the Baltic countries, Russia and Canada.

Two different turf grass mixtures will be tested: 1) 40% Chewing fescue (*Festuca rubra* ssp. Commutata), 40% Slender Creeping Red fescue (*Festuca rubra* ssp. Litoralis) and 20% Browntop bent (*Agrostis tenuis*), and 2) Creeping bentgrass (*Agrostis stolonofiera*). A separate chipping green will be constructed for each mixture. In connection to the testing of the two different mixtures, also Annual meadow-grass (*Poa annua*) will be tested on an already existing green as a parallel study.

Four different fertilisation regimes with and without chemical disease control, as well as with and without spring protective cover will be tested (Figure 1). The field experiment will have a block design with three replicates of each treatment. *Normal fertilisation regime* means the normal fertilisation according to amount of nitrogen, used by the superintendents in the area. *Normal + late autumn N fertilisation* means one extra application of 0,2 kg N/100 m^2 2-3 weeks after the last clipping in the autumn. *Demand driven fertilisation* means N-fertilisation according to a climate driven growth curve (Ericsson, 2002). *Demand driven + autumn K fertilisation* means nitrogen fertilisation in accordance with the climate driven growth curve plus extra applications of K from early autumn. Fertilisation and irrigation will be adjusted to each turf grass mixture. The effect of the different fertilisation regimes on both overwintering and summer grass quality will be investigated.

For disease control of winter fungus there are three different fungicides allowed fore use in Sweden. They are Iprodion (trade name Chipco Green), Bitertanol (trade name Baycor) and Tiofanatmetyl (trade name Topsin). Applications will be made 3 times during late autumn and winter according to the general recommendations.

The spring protective covered plots will be covered in early spring after snow melting. A commercially available permeable cover on the market will be used.

	Block 1				Block 2				Block 3				
Fertilisation regime:	*N*	*N+N*	*D*	*D+K*	*N+N*	*D*	*D+K*	*N*	*D*	*N*	*N+N*	*D+K*	
3 m	X		X	X		X	X		X	X		X	No cover
3m		X			X			X			X		
3m	X		X	X		X	X		X	X		X	Cover
3m		X			X			X			X		
	3m	3m	3m	3m	3m	3m	3m	3m	3m	3m	3m	3m	

Figure 1: Draft sketch of one experimental green, with three blocks containing four different fertilisation regimes with and without chemical disease control and with and without spring protective cover. The fertilisation regimes are *Normal fertilisation regime* (*N*), *Normal + late autumn N fertilisation* (*N+N*), *Demand driven fertilisation* (*D*) and *Demand driven + autumn K fertilisation* (*D+K*). X means autumn chemical disease control. Each sub-plot is suggested to be minimum 3x3 and maximum 4x4 meters in size. This set up will be used for the Fescue and Browntop bent mixture and the Creeping bentgrass mixture.

The test on Annual meadow-grass (*Poa annua*) will be performed on an already existing green. The same fertilisation regimes as for the other grass mixtures will be tested, as well as the treatment with and without spring cover. All plots will be treated with chemical disease control (Figure 2).

	Block 1				Block 2				Block 3				
Fertilisation regime:	*N*	*N+N*	*D*	*D+K*	*N+N*	*D*	*D+K*	*N*	*D*	*N*	*N+N*	*D+K*	
3m	X	X	X	X	X	X	X	X	X	X	X	X	No cover
3m	X	X	X	X	X	X	X	X	X	X	X	X	Cover
	3m	3m	3m	3m	3m	3m	3m	3m	3m	3m	3m	3m	

Figure 2: Draft sketch of the Annual meadow-grass experimental green, with three blocks containing four different fertilisation regimes with and without spring protective cover. The fertilisation regimes are *Normal fertilisation regime* (*N*), *Normal + late autumn N fertilisation* (*N+N*), *Demand driven fertilisation* (*D*) and *Demand driven + autumn K fertilisation* (*D+K*). X means autumn chemical disease control. Each sub-plot is suggested to be minimum 3x3 and maximum 4x4 meters in size.

Green design and construction

Two separate chipping greens will be constructed according to the USGA recommendations (USGA, 1993), with organic matter content between 1 and 2%. Separate sprinkler irrigation systems will be installed for the two greens. The design of the greens will guarantee optimal surface water runoff to prevent ice cover injury. Impermeable cover will seal the bottoms of the greens. The greens will be located to guarantee uniform microclimate for the whole experimental area.

The green construction will start September 2004 and the seeding will be done in the spring 2005. This implies that the green can open for play and experimental work August 2005.

Since Annual meadow-grass mostly exists on old soil greens in Scandinavia, an already existing green will be selected for this test.

Measurements and analysis

To get accurate information on the boundary conditions for the field experiment, e.g. soil and climate conditions, weather parameters and soil temperature and moisture will be measured continuously during the project period. Also the macronutrient (NPK) status of the soil will be tested once a year.

Winter injury from snow mould fungi and other fungus will be measured in November to January and in April/May by ocular inspection. The percentage of the green area damaged by the different causes on each replicate will be determined, and a score of the damage on the different turfgrass mixtures and treatments will be calculated.

To be able to evaluate the effect of fertilisation strategies and of cover or no cover on grass recovery, grass production will be measured during one fertilisation interval in spring (late May), summer (July) and autumn (late September), for each subplot (Figure 1). Both above ground production and root production will be measured. Grass clippings will be sampled every second day during each fertilisation interval. Roots will be sampled once every fertilisation interval. At this stage we regard the “normal” intervals to be 14 days, and the demand driven intervals to be 7 days, according to earlier experiences. The grass (shoots and

roots) will also be sampled at one occasion in connection with opening in the spring (varies between mid March and mid May) and once in late in the autumn (late October)

The macro-nutrient (N, P, K) and carbohydrate content of shoots and roots will be determined as an indicator of grass quality. The nitrogen content will be determined once every fertilisation interval on composite samples. Grass clippings and roots, respectively, will be mixed to form a composite sample for each replicate in each fertilisation interval. The carbohydrate content is also an indicator on stress-tolerance, but will be measured only twice, late autumn and early spring, due to the associated high analytical costs.

Soil mineral N (NO_3, NH_4) will be determined immediately after taking away the spring protecting cover, in connection with each sampled fertilisation interval and in late October to evaluate differences in the soil pool of easily available nitrogen between the treatments.

To evaluate effects of management practices on playing quality, a questionnaire study will be performed twice a year, where the golf players will be asked to judge the grass performance and the playing quality of the turf grass.

The Annual meadow grass study will have a reduced sampling and analysis program, which focuses on the effect of different fertilisation regimes on overwintering and summer recovery, and of spring protective cover on early spring grass growth.

All sampling and measurements are specified in Appendix 1.

Implementation of research results

We see it as very important that the results from this project will be implemented among different stakeholder groups connected to the golf sector, i.e. superintendents, agronomists, different authorities etc. The agronomists and superintendents have been directly involved in the planning process of the project, and will also continue to be involved by, for example using the experimental results for educational purposes. Research results and new knowledge will be presented continuously and discussed in seminars and courses for superintendents in the Scandinavian countries. Field study days will be arranged yearly to demonstrate the effects of different strategies. Authorities will be informed about the project, seminars and field study days.

We suggest that the project should have a reference group with representatives for the agronomists and superintendents in the Scandinavian countries, Scandinavian research representatives, representatives for the Scandinavian Turfgrass Research Foundation, representatives for the R&A Golf Course Committee and a representative for the Royal Canadian Golf Association. The reference group will communicate mainly by e-mail and have two meetings during the project period.

Research results, new knowledge and recommendations will continuously be presented in superintendent´s technical magazines, on relevant web-pages, in study materials to be used by superintendents, and in scientific journals and conferences.

An important goal for the project is to improve the recommendations concerning management practices to improve the overwintering of golf turf grass and at the same time minimize negative environmental impacts.

Research competence

The project will be led by Dr Karin Blombäck at the Department of Soil Sciences at the Swedish University of Agricultural Sciences. Karin Blombäck has more than 10 years experience in education and research within the golf sector (e.g. Blombäck & Persson, 1998; Blombäck et al., 2003; Hedlund et al., 2003; Strandberg et al., 2001; Strandberg et al., 2003).

Dr Tom Ericsson at the Department of Landscape Planning at the Swedish University of Agricultural Sciences has more than 20 years research experience in plant mineral nutrition and carbohydrate dynamics. His field of expertise has during the past year been extended to the golf sector, where he is involved in both research and teaching.

Professor Arne Tronsmo will be responsible for the plant disease evaluation in the project. Arne Tronsmo has 20 years experience in plant disease research with specialisation in biological control, and 10 years experience in research, education and extension within the golf sector.

The staff at Fullerö GK took, together with the Swedish Golf Federation, the initiative to establish the first experimental green in Scandinavia in 1999. They have since then been heavily involved in the running of different scientific projects at Fullerö. Fullerö GK, the superintendent Mr Magnus Barth and his staff have successfully cooperated with the researchers, managed the experimental greens and have very willingly taken part in field visits, presentations and discussions in connection with the experiments at Fullerö GK.

The project will be coordinated by Maria Strandberg, Director of research and development at the Swedish Golf Federation. As a part of her job, Maria Strandberg is also coordinating the Scandinavian Turfgrass Research Foundation. Maria Strandberg has a background as a lecturer and director of studies at the Swedish University of Agricultural Sciences.

Timetable

	Construction year			Year 1			Year 2			Year 3				
Year:	2004	2005			2006			2007			2008			2009
Action:	Oct-Dec	Jan-Feb	Mar-June	July-Oct	Nov-Feb	Mar-June	July-Oct	Nov-Feb	Mar-June	July-Oct	Nov-Feb	Mar-June	July-Oct	Nov-Feb
Green management	Construction		Grow in	Opening 1 Aug. ← Management according to the research plan →										
Sampling and analysis[*)]	Background analysis			1st fert. interval		2nd fert. interval	3rd & 4th fert. int.		5th fert. interval	6th & 7th fert. int.		8th fert. interval	9th fert. interval	
				Late Oct.		Opening	Late Oct.		Opening	Late Oct.		Opening		
Identification of winter fungus					X	X		X	X		X	X		
Questionnaire						X	X		X	X		X	X	
Presentations[#)]				←									→	Popular and scientific publications

[*)] Three fertilisation intervals will be measured each experimental year. It gives a total of 9 fertilisation intervals that will be sampled during the project period. The green will open the 1 August 2005, and the first sampling will be done in late September 2005.

[#)] Presentations can be in form of seminars, popular articles in green keepers technical magazines, field days at Fullerö, scientific papers etc.

Costs

	Costs, SEK					
	2004	**2005**	**2006**	**2007**	**2008/2009**	**Total**
Green construction and design	500000*					**500000**
Equipment and background data	50000					**50000**
Green management, including fertilisers, fungicides, sand dress etc. and economical compensation to Fullerö GK		75000	75000	75000	75000	**300000**
Sampling and analysis,			725000	725000	725000	**2175000**
Salaries:						
Scientists, Sweden	90000	210000	360000	410000	560000	**1630000**
Technicians, Sweden		50000	300000	300000	300000	**950000**
Scientist, Norway	15000	30000	30000	30000	45000	**150000**
Travels, Norway-Sweden		5000	10000	10000	15000	**40000**
Reference group meetings and international conferences		60000		60000	50000	**170000**
Total:	**655000**	**430000**	**1500000**	**1610000**	**1770000**	**5965000**

*) Estimated cost for construction of 2 greens is 700 000 SEK. Of this, approximately 200 000 SEK are expected to be paid by sponsoring, and 500 000 SEK are applied for from R&A.

Totally applied for: <u>5 915 000SEK</u> for the project period 2004-2009.

	Costs, £ (using the rate from 28/1 2004; 100 SEK = 7,41 £)					
	2004	**2005**	**2006**	**2007**	**2008/2009**	**Total**
Green construction and design	37050					**37050**
Equipment and background data	3705					**3705**
Green management, including fertilisers, fungicides, sand dress etc. and economical compensation to Fullerö GK		5557	5557	5558	5558	**22230**
Sampling and analysis,			53722	53723	53723	**161168**
Salaries:						
Scientists, Sweden	6669	15561	26676	30381	41496	**120783**
Technicians, Sweden		3705	22230	22230	22230	**70395**
Scientist, Norway	1112	2223	2223	2223	3335	**11116**
Travels, Norway-Sweden		371	741	741	1112	**2965**
Reference group meetings and international conferences		4446		4446	3705	**12597**
Total:	**48536**	**31863**	**111149**	**119302**	**131159**	**442007**

Totally applied for: <u>441 268 GBP</u> for the project period 2004-2009.

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