



Demonstration Trials with Winter Cover Protection

A Swedish - Finnish Project Results from the first winter demonstration year 2007/2008

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Appendix 1



1 Notice for the reader

The aim of the Swedish–Finnish project, showing the effect of winter protection cover, could not be succesfully done at the trial greens in Finland in winter 2007/2008. Because of the serious disease situation on the trial greens, only one green was covered at Aulanko Golf course. The covering time was quite short, 13.12.2007–11.3.2008. The golfers at Aulanko course are accustomed to start playing on the course in the beginning of May, which is the reason why the winter covers had been taken off so early and the spring cover put on.

Also the trials in Sweden faced some problems during the autumn and winter 2007/2008. Due to early snow (late October and early November), it was necessary to get rid of the snow on the greens before we could cover them. It was not possible to treat the greens with fungicide at time just before the covering, but we decided to cover the greens anyway. Our intention was to spray the half part of the trials and not spray the other. The reason for that was to see the effectiveness of the fungicide.

The demonstration trial at Timrå GK was situated on green number 11 and 13. From the beginning we was planning to cover green 10 and 16, but due to ice which had built up at these greens after the early snow it was necessary to change greens. The management does not differ between greens. The demonstration trial at Bodens GK was situated on green 11 and 12.

The greens at Timrå GK were covered 21.11.2007 and covered off the 30.03.2008 (green 13) and 07.04.2008 (green 11). At Bodens GK the covering time was between 15.11.2007 and 05.05.2008.

It has been problem with the temperature loggers, some of these have not worked properly. Due to that there is no temperature information from all different covering techniques

Finish part of the project

2 The experimental site and management of trial area in the summer 2007

The demonstration trial on Aulanko Golf Oy situated on the eldest of the two courses, on Hugo course (built in1940). It is a nine holes course. The trial greens were greens number one and six. The covers were during three months on the sixth green. The grass species on the green is annual meadow grass (*Poa annua*).

2.1 Cutting and cutting height

Period	Grass height mm	Cutting times
113.5. 2007	6,0	4
1420.5.2007	5,0	4
21.519.7.2007	4,0	53
20.713.9.2007	3,5	48
1420.9.2007	4,0	2
21.94.10.2007	4,5	5

Table 1 Cutting height of grass on the trial green



2.2 Fertilizers inputs

Table 2 Fertilization time and amount of given nutrients in the summer 2007

Date	Fertilizer type		kg per l	na	
		Fertilizer	Ν	Р	Κ
2.5.2007	BioGolf Start 9-12-0	134	12	16	
7.5.2007	Greencare 13–3–12	250	25	7,5	30
7.6.2007	Greencare 13–3–12	170	22	5,0	20
27.6.2007	Greencare 13–3–12	200	26	6,0	24
16.7.2007	Greencare 13–3–12	170	22	5,0	20
7.8.2007	Greencare 13–3–12	250	25	7,5	30
31.8.2007	Greencare 6–5–25	250	15	12,5	63
19.9.2007	Greencare 6–5–25	250	15	12,5	63
Sum			162	72	250

2.3 Fungicide treatments

The following fungicides were used:

- 18.7.1007 propiconazole (Tilt)
- 30.8.2007 propiconazole (Tilt)
- 18.9.2007 propiconazole (Tilt)
- 5.10.2007 propiconazole (Tilt)
- 26.10.2007 prochloraz (Sportak 45 HF)
- 12.12.2007 iprodione (Rovral 75WG)

2.4 Other treatments

- 4.9.2007 wetting agent and plant growth booster (Kemigreen Flow)
- 12.10.2007 plant growth booster (Turf PG)
- 29.10.2007 plant growth booster (Turf PG)

2.5 Other greenkeeping managements

Rolling

- 24.5.2007
- 14.6.2007
- 5.7.2007
- 26.7.2007
- 16.8.2007

Sand dressing

- 24.5.2007
- 14.6.2007
- 5.7.2007
- 26.7.2007
- 16.7.2007

Aeration

- 23.5.2007 (spiking)
- 7.6.2007 (spiking)
- 20.6.2007 (spiking)
- 28.6.2007 (spiking)
- 16.7.2007 (spiking)
- 22.8.2007 (spiking)
- 19.9.2007 (spiking)
- 25.10.2007 (hollow tining)
- Verticutting

- 14.6.2007

- 5.7.2007
- 3.7.2007
- 26.7.2007
- 16.8.2007



Watering

- 1.-9.6.2007 daily watering, 15 min
- 11.-13.6.2007 daily watering, 15 min
- 16.-19.6.2007 daily watering, 15 min
- 22.-24.6.2007 daily watering, 15 min
- 1.-5.7.2007 daily watering, 10 min
- 4.-15.8.2007 daily watering, 10 min
- 17.-20.8.2007 daily watering, 10 min

3 Weather data

Mean temperatures, rainfall and the 30 year normal values are presented in Table 3. The daily mean temperature, minimum and maximum temperatures 1.12.2007–30.3.2007 are in Figure 1. The data are from the Hattula Lepaa weather station of Finnish Meteorological Institute, the nearest station to Aulanko Golf, situated some 12 km away from the course.

Table 3 Weather data of Hattula Lepaa weather station (Finnish Meteorological Institute) and the normal values for temperature and rainfall from the period 1971–2000 (FMI)

Year and month	Mean ter	mperature °C	Precipita	ation mm
	2007/2008	30 year normal	2007/2008	30 year normal
2007 May	10,6	9,8	30	34
2007 June	15,1	14,5	54	55
2007 July	16,6	16,4	119	80
2007 August	16,4	14,6	43	74
2007 September	9,9	9,4	58	54
2007 October	6,2	4,5	54	55
2007 November	-0,5	-0,5	39	48
2007 December	0,9	-4,5	48	42
2008 January	-1,2	-6,6	54	36
2008 February	-0,8	-7,1	57	27
2008 March	-1,5	-2,8	40	29
2008 April	5,7	2,7	37	30
2008 May	10,2	9,8	26	34





Figure 1 Daily mean temperature, minimum and maximum temperatures 1.12.2007–30.3.2008 (FMI)



Figure 2 Daily precipitation 1.12.2007–30.3.2008 (FMI)

The first snowfall was 12.-14.10.2007. The snowcover was 1-3 cm. There were short periods when the thickness of snow was 2-18 cm but it melted quite soon after falling. During the covering time 1.-12.1.2008 there was 1-8 cm snowcover, during 20.1.-11.3. was also snow cover, the thickest snowcover was on 4.2.2008, 24 cm.

After winter covers were taken off, the weather changed and the winter's coldest mean air temperature, -9,1 °C, was measured 21.3.2008. There were heavy snowfalls, too, and the



winter's thickest snowcover was measured 27.3.2008, when the green already was under spring cover.

4 Experimental plan and covers

4.1 Winter covers

The covering time was 13.12.2007–11.3.2008. Immediately after taking winter covers off, the spring cover was laid to green. Spring cover was taken off 14.4.2008.

The winter covers were:

A Bubble plastic, 10 mm bubble size (Finnstaples) + plastic film (black and white sides)

B Bubble plastic, 13 mm bubble size (KSAB Golf Equipment Ab) + plastic film (black and white sides)

- C Gromax Plus, non woven polyethene sheet 30 g/m^2 + plastic film (black and white sides)
- D Evergreen + plastic film (black and white sides)
- E Controll without covering

Widht of covered area was depending of the material breadth and was as follows

- A 3,6 m
- B 3,6 m
- C 5,3 m
- D 5,8 m
- E 5,8 m

Length of covered area was depending of the green form. Average covered area was $30-50 \text{ m}^2$

Sites of materials before covering with the plastic film are presented in Photo 1.







Photo 1 Trial green is covered and waiting for the black and white plastic film to cover the area from D (Evergreen), A (Finnstaples bubble plastic), B (KSAB bubble plastic) to C (Gromax Plus). E is the non-covered controll (Photo Petteri Lehmuskoski)

4.2 Temperature measurement

Temperatures were measured using Thermochron iButtons (Dallas Semiconductor). One button was located on soil under the cover and one in soil, 10 cm deep. In the soil the button was placed in the middle of the hole (Photos 2–3) and the soil core was put back on the button. The buttons saved eight times in a day the readings.



Photo 2 Button placed in depht -10 cm (Photo Petteri Lehmuskoski)



Photo 3 *The area after putting the soil core back* (*Photo Petteri Lehmuskoski*)



Unfortunately reading the data of the button, situated in controll treatment's soil -10 cm, failed. The other buttons worked reliably. The measuring accuracy of buttons is 0,5 °C.

4.3 Observations of the turfgrass

The visual survey of the turfgrass was made in autumn before covering and in spring when the covers were taken off. The subjects of observation were in autumn living ground cover %, visual density % and diseases damages %, in spring winter kill % and diseases damages %.

5 Results

5.1 Quality and growth of turfgrass

In autumn 2007 annual meadow grass of green was in good shape. Living ground cover was 95 %, visual density 95 % and diseases damages 0 %.

In spring the first observations were made 12.3.2008. The shape of grass was quite normal for annual meadow grass for South Finnish climatic conditions. The winter kill 30 % were same in all cover treatment and also in the controll area. Diseases damages were small, 10 % in all area. The only observable difference was in the color of turf. Turf in controll area had a greyish green shade (Photo 4), the color of turf under covers has a slightly greener tint. There were no differencies between the effect of covers on colour (Photo 5).



Photo 4 Color difference controll (E) versus turf under cover. The brownish granules are organic fertilizer applied immediately after taking covers off. (Photo Petteri Lehmuskoski)







Photo 5 *Turf under four covers in March. A (Finnstaples bubble plastic), B (KSAB bubble plastic), C (Gromax Plus), D (Evergreen). (Photo Petteri Lehmuskoski)*

The color difference between the covered areas and the uncovered controll was visible as late as 30.4. 2008 when the first cutting was done. After 4.5.2008 it wasn't any more noticeable.



5.2 Temperatures measured under cover and in soil

The isolation effect of different cover material was quite small when compared to the temperatures measured on soil surface without cover (Figure 3).



Figure 3 Daily mean temperature under covers. E = controll no covered, A = bubble plastic (Finnstaples), B = bubble plastic (KSAB), C = Gromax Plus, D = Evergreen.

The lowest and highest temperatures in soil were under Evergreen cover (Figure 4). All the margins are very small and can be explained by the measuring accuracy of buttons, which is 0,5 °C.



Svenska Golfförbundet



Figure 4 Daily mean temperature in soil -10 cm under covers. Vertical axis temperature scale differs from one in Figure 2. $A = bubble \ plastic \ (Finnstaples), B = bubble \ plastic \ (KSAB), C = Gromax \ Plus, D = Evergreen.$

When comparing the covers one by one, some differencies can be noticed. It might be possible that the isolation capability of KSAB bubble plastic is better than the Finnish one (Figures 5 and 6).





Figure 5 Temperatures under cover and in soil, cover bubble plastic (Finnstaples)

Mean daily air temperatures were high (+5,2 °C) in the end of December and there was no snow cover. After a few days, 5th January, the mean temperature was -7,7 °C. Same variation in temperatures was for example 11.1. (-2,3 °C, snow 4 cm) and 16.2. (-7,8 °C, snow 11 cm). Differences between temperatures measured under covers and those in soil were smaller under KSAB bubble plastic compared to Finnish one during these periods (Figures 5 and 6).

After one exceptionally mild winter and short covering period, the data is anyway very limited to make any too far going conclusions.





Figure 6 Temperatures under cover and in soil, cover bubble plastic (KSAB)

It also seems that the isolation capacity of Gromax Plus polyethene sheet is almost same as Evergreen (Figures 7 and 8), if the temperature fluctuations under cover and in soil compared to air ones, are concider as criterion.



Figure 7 Temperatures under cover and in soil, cover Gromax Plus

Temperature in soil -10cm

6.3 9.3 12.3





Figure 8 Temperatures under cover and in soil, cover Evergreen

Temperature under cover

6 Conclusions

After one exceptionally mild winter and short covering time of one green no recommendations can be given. The isolation capacity of bubble plastic might be some better than other covers. The only observable difference noticed in turf was the color. It was some paler in uncovered turf, but any differences in effect between the covers were not shown.

Determining the best covering time is very difficult when weather is changing all the autumn. Estimating the time, when the melting of the soil frost will any more be expected, and covering could be done, is a challenge for the greenkeepers.



Swedish part of the project

7 The experimental site and management of trial area in the summer 2007

At both Timrå GK and Bodens GK the dominated grass species on the green is annual bluegrass (*Poa annua*) and Rough bluegrass (*Poa trivalis*).

The management of the greens (see table 1-4) is from August (or September) until October (or November).

7.1 Cutting, cutting height, rolling and brushing

Period	Grass height (mm)	Cutting times	Rolling
1-3.8.2007	3,5	3	
4.8.2007	3,0	1	
5-10.8.2007	3,5	5	1
11.8.2007	3,0	1	
12-17.8.2007	3,5	5	1
18-19.8.2007	3,0	2	
20-24.8.2007	3,5	4	1
25.8.2007	3,0	1	
26.8-29.9.2007	3,5	21	13
30.9-6.10.2007	4,0	2	3
7.10.2007→	4,5	1	3

Table 2 Cutting and other management at Bodens GK during September to October

Period	Grass height (mm)	Cutting times	Rolling	Brushing
1-13.9.2007	4,3	6	3	5
14-31.9.2007	4,5	7	2	7
1-7.10.2007	4,5	3	2	4



7.2 Fertilizers inputs during late summer and autumn

Date	Fertilizer	Total amount	N	Р	K
		$(l/100m^2)$	$(kg/100m^2)$	$(kg/100m^2)$	$(kg/100m^2)$
1.8.2007	Wallco 5,1-1-4,3	1,73	0,088	0,017	0,074
8.8.2007	Wallco 5,1-1-4,3	1,27	0,065	0,013	0,055
15.8.2007	Wallco 5,1-1-4,3	1,27	0,065	0,013	0,055
22.8.2007	Wallco 5,1-1-4,3	1,18	0,060	0,012	0,051
29.8.2007	Wallco 5,1-1-4,3	1,18	0,060	0,012	0,051
5.9.2007	Wallco 5,1-1-4,3	0,98	0,050	0,010	0,042
10.9.2007	Wallco 5,1-1-4,3	0,78	0,040	0,008	0,034
17.9.2007	Wallco 5,1-1-4,3	0,69	0,035	0,007	0,030
24.9.2007	Wallco 5,1-1-4,3	0,49	0,025	0,005	0,021
1.10.2007	Wallco 5,1-1-4,3	0,37	0,019	0,004	0,016
8.10.2007	Wallco 5,1-1-4,3	0,25	0,013	0,003	0,010
16.10.2007	Wallco 5,1-1-4,3	0,25	0,013	0,003	0,010
23.10.2007	Wallco 5,1-1-4,3	0,25	0,013	0,003	0,010
29.10.2007	Wallco 5,1-1-4,3	0,12	0,006	0,001	0,005
Total		10,81	0,552	0,111	0,464

Table 3 Fertilization time and amount of given nutrients from 1 of August at Timrå GK

Table 4 Fertilization time and amount of given nutrients from 23 of July at Bodens GK

Date	Fertilizer	Total amount	Ν	Р	K
		$(kg/100m^2)$	$(kg/100m^{2})$	$(kg/100m^2)$	$(kg/100m^2)$
23.7.2007	Arena Green Plus 12-1-15	2,5	0,30	0,03	0,38
6.8.2007	Arena Start 22-3-10	2	0,44	0,06	0,20
27.8.2007	Arena Score 12-1,3-14	2,5	0,30	0,03	0,35
12.9.2007	Höstgrön 4,5-1-14	3	0,09	0,03	0,42
Total			1,13	0,12	1,35

7.3 Fungicide treatments

Following fungicides were used at Timrå GK from August until the covering time in November.

- 17.9.2007 Bitertanol (Baycor)
- 3-10.2007 Azoxystrobin (Amistar)

No fungicides were used at Bodens GK during this time.

7.4 Other treatments

At Timrå GK were following product used

• 15.8.2007 Verdera PS 1 litre/ha



7.5 Other greenkeeping managements

7.5.1 Timrå GK (August - October)

Verticutting (Thatch Away)

- 1.8.2007 1 mm in 2 directions •
- 7.8.2007 1 mm in 1 direction •
- 20.8.2007 1 mm in 2 directions
- 12.9.2007 1 mm in 1-2 directions

Sand dressing

•

Aeration

- 2.8.2007 -15.8.2007 (Spiker 7 cm)
- 8.8.2007
 - 14.8.2007
- -11.9.2007 (Spiker 7 cm)

-27.8.2007 (Spiker 7 cm)

- -4.10.2007 (Spiker 7 cm)
- 21.8.2007 • 30.8.2007
- 6.9.2007
- 13.9.2007
- 25.9.2007
- 4.10.2007
- 12.10.2007
- 24.10.2007 •

7.5.2 Bodens GK (September – October)

Sand dressing

- 3.9.2007
- 17.9.2007 •
- 24.9.2007 •
- 4.10.2007 •

8 Weather data

8.1 Weather data Timrå GK

In figure 1 the monthly precipitation is showed between August and April at Timrå GK. Most of the precipitation was in form of rain during the winter months.

Aeration - 9.10.2007 deep aerator





Figure 1. The measurement of precipitation at Timrå GK has been done from 1 of August 2007 until 10 of April 2008.

8.2 Weather data Bodens GK

In figure 2 the monthly precipitation is showed for September and October at Bodens GK. No account of precipitation has been done during the winter. Most of the precipitation was in form of snow from November until end of March. Some periods with thaw occurred during the winter.





Figure 2. The measurement of precipitation at Bodens GK has been done from 1 of September until 9 of October 2007.

9 Experimental plan and covers

9.1 Winter covers

The greens where covered at Timrå GK between 21.11.2007 and 30.03.2008 (green nr 13) and 7.4.2008 (green nr 11). At Bodens GK the covering time was between 15.11.2007 and 05.05.2008. The permeable winter cover ("spring cover") was left on the whole green (including control area A) after that date.

The winter covers were

- A. Control (no cover)
- B. KSAB Evergreen (permeable cover)
- C. KSAB Evergreen + KSAB Ice shield (impermeable cover)
- D. KSAB Evergreen + "bubble plastic" (as isolation) + KSAB Ice shield
- E. KSAB Evergreen + Plastic cover from Lantmännen Park och Mark

Sites of the different materials before covering with the impermeable sheet are presented in Photo 1.

9.2 Temperature measurement

Temperatures were measured by using Omega Temperature Loggers. On each green, one logger was placed in the soil under the cover (10 cm deep). One logger measured the ground temperature under each area (A to E) and one logger measured the air temperature. All loggers saved data every 2,5 hour during the covering time. Unfortunately, some of the logger does not worked properly, due to that there is not temperature information from all different covering techniques.

9.3 Observations of the turfgrass

A visual survey of the turfgrass was made in autumn before covering and in spring when the covers were taken off. The subjects of observation were in autumn; living ground cover (%), visual density



(scale 1-9, there 9 is maximum density) and disease damages (%). And in spring; winter kill (%) and disease damages (%).

10Results

10.1 Quality and growth of turfgrass

10.1.1 Timrå GK

In autumn 2007 (evaluation date 6.11) both greens were in very good condition. No differences in quality were seen between the different cover areas (A-E) of the greens. At both greens, the evaluation were decided to: Living ground cover 100 %, visual density 7 and disease damages 0%. The 21 of November the greens were covered (photo 1).

In spring 2008 the first observation were made 31.3.2008 at green 13 (photo 2) and 7.4.2008 at green 11. The second and first observation at green 13 (photo 3) and 11 respectively was made 8.4.2008. Between the first and second observation, green 13 was covered by the permeable cover. At a meeting with superintendents at golf courses in Medelpad and Ångermanland we discuss the result of the trial (picture 4). During the winter a lot of ice had covered the whole golf course. Some water had also flowed under the covers, particularly on green 11, see photo 4. The results from the spring observation are presented in table 5.



Photo 1. Green 13 at Timrå GK 21.11.2007. In the photo they are working to cover area C and D with the impermeable cover, Icehield (1). Photo Håkan Blusi







Photo 2. Cover area A, C, D and E on green 13 at Timrå GK, 31.3.2008. Cover area B is close to the trees. Photo Håkan Blusi



Photo 3. Cover area A and C on green 13 at Timrå GK 8.4.2008. Photo Boel Pettersson







Photo 4. Cover area A, C, D and E on green 13 at Timrå GK. 24.4.2008. Photo Boel Pettersson







Photo 5. Water has flowed under the covers on green 11 at Timrå GK. Grass on some parts of the covered area D and E have survived. Photo taken 24.4.2008 by Boel Pettersson

Evaluation	G13	G13	G13	G13	G13	G11	G11	G11	G11	G11
	Α	B	С	D	Ε	Α	B	С	D	Ε
Winter kill	100	95	50	40	40	100	100	90	80	80
(%)										
Disease	_*	_*	10	10	15	_*	_*	_*	10	15
damages (%)										

Table 5. Result from the evaluation of the trial greens in spring. Evaluation date 31.3.2008 at green 13 and 7.4.2008 at green 11. * Heavy damages due to ice at these areas, made it difficult evaluate damages caused by diseases.

10.1.2 Bodens GK

In autumn 2007 (evaluation date 30.10) both greens were in good condition. Only small differences were possible to see between the different cover areas (A-E) and between the two greens, see table 6.

Evaluation	G12	G12	G12	G12	G12	G11	G11	G11	G11	G11
	Α	B	С	D	Ε	Α	В	С	D	Ε
Living ground cover (%)	100	100	100	100	100	100	100	100	100	100
Visual density (1-9)	6	6	7	7	7	8	8	8	8	8
Disease damages	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Table 6. Result from the evaluation of the trial before the winter covering. Evaluation date 30.10.2007.



In spring 2008 the first observation were made 06.05.2008, see photo 6 and 7. Also in Boden the greens were covered by ice, but no water had flowed under the winter covers. But the survival under the different cover techniques was quite bad, see table 7.

Evaluation	G12	G12	G12	G12	G12	G11	G11	G11	G11	G11
	Α	В	С	D	Ε	Α	B	С	D	Ε
Winter kill	100	100	95	90	95	100	100	90	90	90
(%)										
Disease	_*	_*	_*	<1	<1	_*	_*	<1	<1	<1
damages (%)										

Table 7. Result from the evaluation of the trial greens in spring. Evaluation date 06.05.2008. * *Due to serious winter kill, it was difficult to evaluate damages caused by diseases.*



Photo 6. Green 11, 6 of May 2008 at Bodens GK, cover area A is nearest the camera. Photo Boel Pettersson







Photo 7. Cover area D and E at green 11, 6 of May 2008 at Bodens GK. Photo Boel Pettersson

10.2 Temperatures measured under cover and in soil

There were problems with the temperature loggers, some of these have not worked properly during the winter. Due to that there is no temperature information from all different covering techniques. The graphs with all measurements from the loggers at Timrå GK and Bodens GK are in appendix 1. Temperature measurements at Timrå GK after the beginning of April are done after covers had been taken off. The same situation at Bodens GK occurred in the beginning of May.

10.2.1. Timrå GK

Only 4 temperature loggers worked properly at Timrå GK, see appendix 1. The air temperature varied during most of the winter between -10° C and $+8^{\circ}$ C. The temperature at the ground, at cover area A (control) was below 0° C (with some exceptions) under the whole winter. Under cover area B and C the temperature varied between -10 to $+5^{\circ}$ C, most of the time. From middle of March the temperature was higher under cover area C compared to B. Notice that this measurements were done at two different greens.

10.2.2. Bodens GK

At Bodens GK results from 8 data loggers has been collected, see appendix 1. The air temperature varied between -20° to $+5^{\circ}$ C from November to beginning of April. All different cover areas had temperatures around 0° C (or below) under long period of the winter. Cover area A and D had temperatures down to -5 to -7° C in the end of December and beginning of January. At the same time cover area B and C had temperatures down to -10° C. The soil temperature under the trials was around -2 to -3° C most of the winter, with exception in the end of December and beginning of January when it was a bit colder (around -5 to -10° C).



11 Discussion and conclusions

The result of the different winter covering techniques has differed between the two golf courses. The circumstances before the covering with snowfall, forced us to shovel the snow from the greens before covering. It was not possible to get rid of all snow, and together with no fungicide treatment it will probably influenced the overwintering of the grass.

At Timrå GK the winter survival was fairly good in the areas which had been covered with an impermeable cover (cover area C, D and E). I am quite convinced that the partly bad winter survival in these areas was cause by water which flowed under the covers. The area covered with bubble plastic (D) had a stronger green colour compared to cover area C and E. Also a bigger area of the trial of cover area D had survived compared to the other C and E, which had been more damaged by water. Another reason for better survival in area D can be lack of oxygen in C and E due to a smaller air space between the cover and the ground. Both winter covering trials in U.S. and Canada and Superintendents experience of winter covering have showed the risk with lack of oxygen (or high CO_2 levels) under the covers. Some Superintendents have used drainage pipes as a chimney to ventilate under the cover (J.Skorulski and D.Minner, personal communications). Since we have no possibilities to measure oxygen or CO_2 level in this project, we have decided to create a more distinct air space between cover and ground and see if that can improve the survival next winter.

At Bodens GK was the snow cover permanent from the end of November until beginning of May. During thaw periods some ice occurred at the uncovered area (A) and over the covers at the rest of the greens. But the ice was more porous and not so thick and "hard" as it was at Timrå GK. Despite this fact, the winter survival in Boden was quite bad in all different cover areas. In cover area D and E the winter survival was slightly better compared to the other cover areas on green 12. Due to a long covering period (around 170 days) one reason for the bad result can also in this case be lack of oxygen or high levels of CO₂. Another possible reason can be nutrient deficiency, diseases or low temperatures at crown level. Some days under the winter, the temperature under the covers has been as low as -10°C. Studies abroad, for example in Canada (J. Dionne, 2000) have showed winter injuries on Poa annua at -10°C at crown level. It is probably several causes to the bad result in the trial at Bodens GK.

No recommendations can be given after one year of trial. It is necessary to develop the covering technique during next winter. One of the most important things is to keep the greens as dry as possible to improve the survival of the grass. The problem is to find the "right time" (date) to cover and avoid periods of melting snow during the autumn before the covering.

But is it economical to cover the greens instead of "re-saw" the greens in the spring? Probably you will not open the green much earlier in the spring after winter covering, but you will open it with a better quality if the covering has been successful. At many courses in North Sweden (Norrland) the green quality in May until end of June (in the northest part of the country) is not good. With an improvement of the green spring quality, the players will probably see more value for the membership or green fee during the springtime. It is easy as a golfer in the north part of the country to compare the cost for the membership and the length of the golf season (with good green quality) with the south part of the country. Is it worth the money to play 3 or 4 months with good quality? Or should you put the money on something else? One risk is that the golf clubs lose members due to this fact. And if we have technique that can improve the quality, why shouldn't we use it? Or at least do a test on some greens? Of course, winter covering is not the solution for all golf courses with hard winter circumstances, but I am convincing that it is an alternative for several courses. But



winter covering is not only a technique for the north part of the country; this is also something for courses situated in Stockholm, Mälardalen, Dalarna and Värmland etc. In these areas already some courses use covers with good result. In these regions it is probably not necessary to cover each year or on all greens depending of winter situation.

In an attempt to measure the cost to cover an 18 holes golf course, I have estimate following.

18 greens totally 1 hectare (10 000 m²) Fungicide treatment with 8 kg Chipco Green per hectare (recommended dose)

Covers (prices from 2008, SEK without VAT)	
Permeable cover, Evergreen	17,80 SEK per m ²
Impermeable cover, Ice Shield	15,80 SEK per m^2
Impermeable cover, Plastic from Lantmännen	$3,50 \text{ SEK per m}^2$
Bubble plastic	13,50 SEK per m^2

Fungicide Chipco Green*	690 SEK per kg
* Chipco Green is not allowed to	use after 31.12.2009
Total cost for 10 000 m ²	5 520 SEK
2	
10 000 m ² green area with	
Dormonhla aquar Eugraraan	170 000 CEV

6	
Permeable cover, Evergreen	178 000 SEK
Impermeable cover, Ice Shield	158 000 SEK
Impermeable cover, Plastic from Lantmännen	35 000 SEK
Bubble plastic	135 000 SEK

For example, it means that trial area C; Evergreen + Ice shield cost 336 000 SEK. If you can use the covers under 5 winters, the yearly cost will be around 67 000 SEK or under 10 winters about 34 000 SEK. In addition to that around 5500 SEK for fungicide treatment and labour cost (see below)

It is difficult to estimate the time it takes to cover one green, it depends among other things if the ground is frozen or not, if it necessary to cut down the cover in the ground to avoid water into the green and how "skilled" the staff are. Together with the Course Manager at Timrå GK, Håkan Blusi I have estimated it takes maximum 1 hour for 4 persons to cover one green (approximately 600 m²) with a permeable and impermeable cover. It will means 19 hours for a 18 holes (including putting green) course for 4 persons, or totally 76 working hours.

But as mention above, at some courses it is probably most interesting to cover just a few greens. The material cost (Evergreen and Ice Shield) for a green (600 m^2) will be around 20 000 SEK or approximately 12 800 SEK for trial area E (Evergreen and Plastic from Lantmännen).

12 References

Dionne, J. 2000.Winter Protection of Annual Bluegrass Golf Greens, USGA Green Section Record, Sep/Oct. p.11-13 Minner. D. 2007. Seminar Elmia Park och Golf, Jönköping

Skorulski. J. 2005. Seminar Elmia Park och Golf, Jönköping



Appendix 1

Timrå GK temperature loggers 2007/2008

G 10 = Green 11 G 16 = Green 13











Bodens GK temperature loggers 2007/2008

The arrow indicate when the measurement stops (5.5.2008)

















