

Effects of rolling and N-fertilization on dollar spot and *Microdochium* patch on golf greens in Scandinavia

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Abstract. Dollar spot was officially documented in Scandinavia in 2013 and the spread and damage from this disease has increased during last years. In summer 2017, on the golf greens with red fescue (Vallda GC, Sweden) and with the mixture of red fescue, colonial bentgrass and annual bluegrass (Roskilde GC, Denmark) rolling 2 times per week reduced dollar spot 61% and 37% and rolling 4 times per week reduced dollar spot 95% and 54%, respectively. Thus, rolling 3-4 times per week can be recommended on golf greens with dollar spot pressure. In the experiment 2018 dollar spot was reduced 24% with increase in nitrogen from 150 to 240 kg ha⁻¹ yr⁻¹ on creeping bentgrass/annual bluegrass golf green (Kävlinge GK, Sweden). However, the increased N-rate lead to a higher degree *Microdochium* patch from 14% to 30%.

1 Introduction

Dollar spot caused by *Clariireedia* spp. was officially documented in Norway in 2013 [1] and in Sweden in 2014 [2], and the disease found on more than 20 Nordic golf courses. The damage from dollar spot in Scandinavia varies and can be up to 70-80% dead turf on greens and fairways. There is no available fungicides with potential to control dollar spot in the Nordic countries, except for Sweden. According to EU-Directive 2009/128 EU on 'establishing a framework on sustainable use of pesticides', the management and control of any pests has to follow IPM (integrated pest management) principles. Regarding dollar spot, no research has been conducted in the Nordic environments on any control measures. Effective non-chemical measures for control of this disease are needed. From the previous studies in USA where dollar spot has been studied for at least 50 years, it is known that this disease is favoured by the combination of dry soil and a moist turf canopy [3]. Thus, daily rolling may significantly reduce dollar spot severity on golf greens due to it disperses concentrated guttation water [4] and contribute to increase in soil moisture [5]. Positive effect of rolling has also been observed by Danish greenkeepers [6]. From the previous studies in USA it also is known that dollar spot is favoured by such cultural practices as low fertilization, especially nitrogen [7,8]. The objectives of our study was to find the most

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efficient frequency for rolling on golf greens in Scandinavia and investigate effect of nitrogen on incidence of dollar spot.

2 Materials and methods

The field experiments on rolling were conducted on Vallda Golf & Country Club in Sweden (57°47'N 12°01'E) and Roskilde Golf Club (55°65'N 12°04'E) in Denmark in summer 2017. The golf greens consisted of pure red fescue (*Festuca rubra* L. ssp. *commutata* 40% and spp. *litoralis* 60%) in Vallda GC and of 33% red fescue (*Festuca rubra* L. ssp. *commutata* 16% and spp. *litoralis* 17%), 34% colonial bentgrass (*Agrostis cappillaris* L.), 27% ryegrass (*Lolium perenne* L.) and 6% annual bluegrass (*Poa annua* L.) in Roskilde GC. The greens were mowed 3-4 times per week to 5-5.5 mm in Vallda GC and 2 times per week to 11-14 mm at Roskilde GK. Annual nitrogen rate was 40 kg ha⁻¹ and 80 kg ha⁻¹ at Vallda GC and Roskilde GC, respectively. Through monthly topdressing the greens received annually 5 mm sand in Vallda GC and approx. 1 mm sand in Roskilde GC. The rolling treatments started on 5 June and on 12 June in Vallda GC and Roskilde GC, respectively. The following rolling treatments were compared: (i) no rolling (control); (ii) rolling 2 times per week; and (iii) rolling 4 times per week. Rolling was conducted using a Smithco roller, model 7530 Tournament LE Greens Roller (90-cm wide and 378-kg roll swath) in Vallda CG and a TRU-Turf RB4811A roller (122-cm wide and 290-kg roll swath) in Roskilde GC. The experiments were laid out as randomized complete block design with 3 reps on each golf green and the area for a single treatment (one plot) was 18 m² in Vallda GC and 7,2 m² in Roskilde GC. Corners of each plot were marked with spray at the start of the experiment, and the marks were maintained throughout the experiment. The dollar spot incidence was registered either by counting the number of individual infection centres per plot (Vallda GC, totally 3 times from June to September) or by determination of percentage of plot area covered with the disease (Roskilde GC, totally 5 times from June to October). Area under disease progress curve (AUDPC) was calculated by multiplying the difference in dollar spot incidence by the time (days) for this difference. The registrations were done prior to the start of the experimental rolling treatments and then in August and September in Vallda CG and monthly from June to October in Roskilde GK. No fungicides were applied on the greens in 2017. Ball roll was measured using the United States Golf Association (USGA) Stimpmeter in Vallda GC in August.

The field trial on effects of N-fertilization on dollar spot and Microdochium patch was conducted on a golf green with creeping bentgrass (predominated species) and annual bluegrass in Kävlinge Golf Club (55°47'N 13°09'E) in Sweden in 2017 and 2018. The green was mown regularly to 4 mm. The annual PK input amounted to 80 kg ha⁻¹ and 140 kg ha⁻¹, respectively. Two annual N rates were compared: 150 kg ha⁻¹ and 240 kg ha⁻¹. No fungicides were applied in 2017 and 2018. The experiments were laid out as randomized complete block design with 3 reps. The incidence of dollar spot was determined by counting the number of individual infection centres and incidence of Microdochium patch (in the spring 2019 only) was determined as percentage of plot area covered with the disease.

The data from each of three experiments were analysed by the SAS procedure proc ANOVA using the statements for one factorial randomized complete block design (SAS Institute, version 9.4). Fisher LSD at the p< 0.05 probability level identified significant differences among the treatments.

3 Results and discussion

On average for August-September 2017, rolling 2 and 4 times per week starting in June, reduced dollar spot 61% and 95%, respectively, on a red fescue green in Vallda GC as compared with no rolling (79 individual infection centres per 1 m² on the plots with no rolling) (Table 1 and Figure 1). As expressed by AUDPC values (18 Aug.-12 Sept.), dollar spot in Vallda GC was reduced 49% and 96% by rolling 2 and 4 times per week, respectively. On a golf green with red fescue and colonial bentgrass as predominant species in Roskilde GC a 27% and 62% reduction in AUDPC values (14 Sept.-26 Oct.) was observed after rolling 2 and 4 times per week, respectively, but it was not statistically significant as well as 37% and 54% reduction in dollar spot incidence on average for September and October as compared with no rolling (19% disease on the plots with no rolling). Our results are in agreement with Giordano et al. [5], in that study rolling 5 and 10 times per week resulted correspondingly in 22-72% and 88-91% reduction in dollar spot on putting green with mixture of creeping bentgrass and annual bluegrass. In that 3-yr experiment, reduction in AUDPC was always significant under rolling 10 times per week, but reduction in dollar spot under rolling 5 times per week was significant only in the years with high disease pressure [5]. It appears that low disease pressure was a reason for a less pronounced effect of rolling 3 times per week in dollar spot reduction also on a putting green with creeping bentgrass in an earlier study [4]. And as it was previously shown [4,5], rolling 4 times per week improved ball roll by 25% as compared with no-rolling-treatment in our study. We agree with Nikolai et al. [4] that importance of lightweight green rolling is still underestimated and in particular with respect to dollar spot. It appears that rolling 3-4 times per week can be appropriate for reduction of dollar spot; the field experiments on rolling on Vallda GC and Roskilde GC continue in summer 2018 to define sufficient frequency.

Table 1. Effect of rolling on dollar spot (DS) incidence on golf greens on Vallda GC (Sweden) and Roskilde GC (Denmark) in 2017.

Rolling	Vallda GC				Roskilde GC						
	DS infection centres			AUDPC	Ball roll	Percentage of plot covered with DS, %					
	5 June	18 Aug.	12 Sept.		18 Aug.	12 June	5 July	7 Aug.	14 Sept.	26 Oct.	AUDPC
No rolling	0	33 a	126 a	2329 a	247 a	0.2	1.1	4.2	27.7	10.5	893
2x/wk	0	10 b	58 b	1187 a	298 a	1.4	2.5	2.4	19.5	5.8	649
4x/wk	0	2 c	6 c	102 c	308 b	1.4	6.5	6.2	15.0	4.0	336
<i>p</i>		0.001	0.001	0.005	0.000	0.237	0.446	0.364	0.155	0.285	0.142

† Area under disease progress curve (AUDPC) from 18 Aug. to 12 Sept. 2017

‡ AUDPC from 18 Aug. to 12 Sept. 2017

In Kävlinge Golf Club, increase in annual N amount from 150 kg ha⁻¹ to 240 kg ha⁻¹ led to 16% dollar spot reduction (from 71 to 60 infection centres per m²) in 2017 ($p = 0.478$) and to 24% dollar spot reduction (from 100 to 76 infection centres per m²) in 2018 ($p = 0.01$). However, in March 2019 on the plots, which received 240 kg N ha⁻¹ in 2018 the *Microdochium* patch incidence, was 2 times higher than on the plots which received 150 kg N ha⁻¹ (30% vs. 14% *Microdochium* patch, respectively). An earlier report of Espevig et al. [9] showed that an increase in N-amount in the fall led to increase in *Microdochium* patch on annual bluegrass green but not on creeping bentgrass green. As a result of the present study, it is impossible to draw unambiguous conclusions about the advisability of using increased doses of N to fight dollar spot on golf greens which are exposed to *Microdochium* patch during winter time.



Figure 1. Rolling 4 and 2 times per week starting in June reduced dollar spot as compared with no rolling on a red fescue golf green in Vallda GC, 7 Sept.2017. Foto: Stefan Nilsson.

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