

The background features a top-left corner with a splash of dark soil and a bottom edge with a row of vibrant green grass. The central text is in a large, bold, black sans-serif font.

Weed Management on Golf Courses in the Light of Strict Pesticide Legislation

www.golfagronomy.de



@hahnturf



@hahn_turf



hahn turf agronomy



Daniel Hahn
Hahn turf Agronomy

Introduction

- Dr Daniel Hahn – Turf Agronomist & Scientist
- Former golf playing professional
- Former greenkeeper in Germany, Australia and USA
- Owner of Hahn Turf Agronomy



Myerscough
College

- BSc Sporsturf Science



Imperial College
London

- MSc Ecology

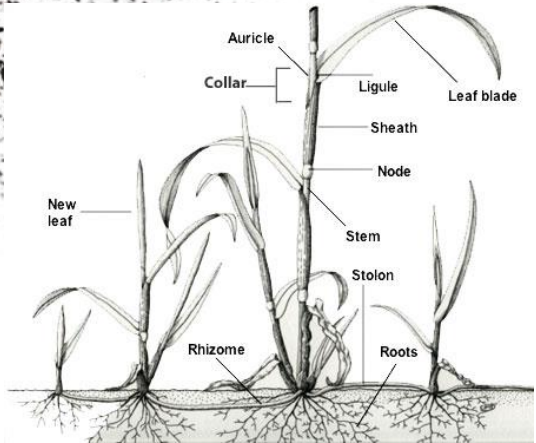


WAGENINGEN
UNIVERSITY & RESEARCH

- PhD Turfgrass Ecology

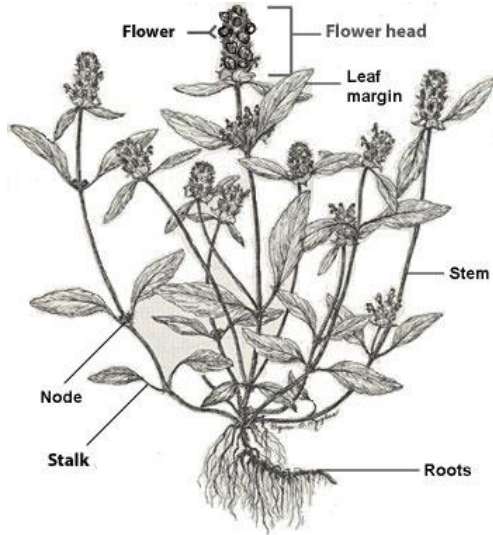
Types of Weeds in Turf

Grasses



- Narrow leaves
- Parallel veins
- Stems round and usually hollow

Broadleaves



- Broad leaves
- Leaves have one main vein

Sedges



- Perennials
- Found in moist soil

Rushes



What is a weed in turf?

„A weed can be any plant species that is not wanted for your specific turfgrass area“

Poa annua



www.wikipedia.org

Bermudagrass



Texas A&M Agrilife Extension
Photo by Casey Reynolds, PhD

Creeping bentgrass



North Dakota State University

Why control weeds anyway?

Larsen & Fischer (2005)

„Weeds in turfgrass (...) may reduce the functional and aesthetic qualities of turf“

Jason Henderson, Turfgrass Professor (2019)

„Weeds don't tolerate traffic as well as turfgrasses (...) leaving bare spots in high traffic areas (...) surfaces become harder (...) increasing risk of injury“

Michael P. Kenna, former USGA director (n.a)

*„Mowing frequency increases with high weed population (...) crabgrass & nutsedge can easily double mowing frequencies (...) more importantly turf weeds **do not meet the expectations of most golfers**“*

The background features a vertical gradient from dark soil on the left to white on the right, with a strip of green grass at the bottom.

Why control weeds anyway?

PennState Extension

„Some weeds are harmful to people because they attract bees, cause skin irritation or cause poisoning if ingested“

University of Delaware

„Weeds compete with the desired turfgrasses (...) If you don't control weeds your lawn will deteriorate over time.“

Weed control with herbicides?



*„The use of pesticides for purely **cosmetic reasons** is now **impossible to justify**“*



*“Some weeds **have the potential** to negatively impact playability (...) in these cases, control is necessary (...) some weeds may have little or no impact beyond aesthetics. As golfers, sometimes the best thing we can do (...) is to occasionally turn a blind eye to weeds that aren't really impacting our game. **Remember, it's only a weed if you think it is.**”*

Weeds from a player's perspective



Youtube: Weeds in Turf (Season 1 Episode 1): A Tour Pro's perspective

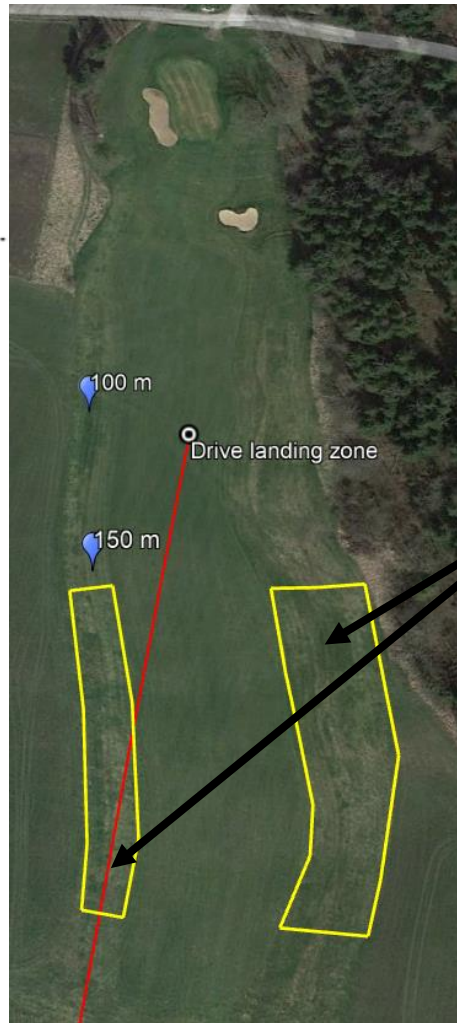
- The type of weed makes a big difference
- Tee boxes -> weeds can be used as an alignment
- Fairways -> weeds are not a problem (8 mm!), just psychological
- Semi-rough/ rough -> dandelion, plantain unacceptable
-> clover, means half a club more
-> flat lying dandelion actually an advantage
-> long shots are more problematic from weeds
- Green surrounds -> Weeds no problem, grain is the problem!



GOOD PLAYERS WANT CONSISTENCY!

“If you have too much weeds then just let them grow! Patches here and there are worse”

Weeds from a player's perspective

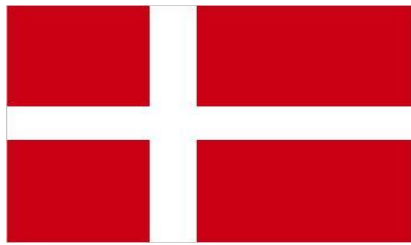


Focus weed management on this area?



Weed management in practice

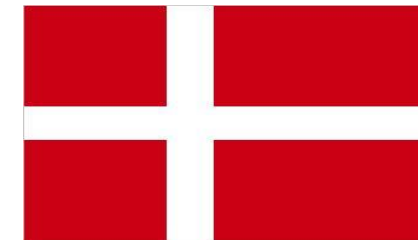
Case studies



General approach: 1, use blanket spray to reduce weed populations to acceptable levels
2, Hand weeding/ spot spraying the rest



Case Study - Royal Copenhagen



Golf courses maintained with minimal to no pesticide input, case studies from Denmark and Italy

Hahn, D.

Vorbemerkung

Im Rahmen des Forschungsprojektes (s. Beitrag in RASEN 3/19) zur Frage der Herbizid-freien Unkrautbekämpfung auf Golf-Fairways an der Universität Wageningen, besuchte der Autor, Daniel Hahn, einige Golfanlagen in Dänemark und in Italien, die auf den Einsatz von Herbiziden verzichten. Zur Motivation und Einschätzung der praktischen Möglichkeiten führte er kurze Interviews mit den verantwortlichen Head-Greenkeepern der Anlagen. Über zwei ausgewählte Golfanlagen wird im Folgenden berichtet.



Fig. 1: Royal Copenhagen Golf Club, aerial view of the 15th hole. (Foto. M. Nilsson)

Case study Royal Copenhagen Golf Club, Denmark

Background

Royal Copenhagen Golf Club is the oldest Golf course in Scandinavia (founded 1898) and is located north of Copenhagen. In 1928 the current 18 hole course was inaugurated; 16 of 18 holes are still played in the same order as back then. The golfcourse is situated in a public park and within a 1.000 acre deer park, which is still used by the royal family as hunting ground for deer. The golfcourse was redesigned by Tom Mackenzie and can be described as open Parkland. Copenhagen Golf Club is a members club, with about 1.100 members. The golfcourse is maintained by the superintendent Martin Nilsson and his team of six full-time greenkeepers.

Technical information

Royal Copenhagen Golf Club banned the use of pesticides completely by

Grass species composition greens	60 % <i>Festuca rubra</i> , 30 % <i>Agrostis capillaris</i> , 10 % <i>Poa annua</i>
Grass species composition fairways	90 years old, heterogeneous composition of many species (<i>Festuca</i> spp., <i>Lolium perenne</i> , <i>Poa</i> spp.)
Grass species composition tees	40 % <i>Festuca rubra</i> 40 % <i>Poa pratensis</i> , 20 % <i>Poa annua</i>

Tab. 1: Overview on the grass species composition on the Royal Copenhagen Golf Club.

The biggest challenge according to the Head-Greenkeeper is to keep the amount of weeds at an acceptable level. Greens are fertilised two to three times a year with granular applications of 60 kg Nitrogen/ha²/yr¹. The irrigation strategy is to apply water infrequently but 'deep' to reach a soil moisture level of 15-20 % volumetric water content (VMC) after irrigation. During the summer months syringing cycles are used to cool off the plants.

Greens are maintained by frequent cutting, mowing and rolling. Aeration

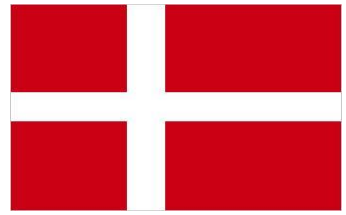
Interview as Q&A with Martin Nilsson, Head-Greenkeeper at RCGC

Is your golf course open all year round?

Yes. Greens are prepared for the winter period in August, which involves aeration and the last application of nitrogen. Greens are open all year round but after mid October greens are not cut anymore and only rolled. I believe that fescue dominated putting surfaces can produce good quality throughout the winter, even if they are



Case Study - Royal Copenhagen



Grass species composition greens	Fescue 60%, Colonial Bent 30%, Poa annua 10%
Fairways	90 years old composition of a variety of grasses
Pesticide free since	2011
Mowing heights greens, tees, fairways	4.2 / 9 / 14
Reason to go pesticide free	Forbidden by law to use pesticides on government owned land

What are the biggest challenges

Weeds

Fertilisation strategy

2-3 granular applications during the growing season with 60 kg Nitrogen/ ha⁻¹ / yr-1

Irrigation strategy

Deep and infrequent irrigation to a soil moisture target of 15-20%. Sometimes syringing cycles

Cultivation strategy

On greens only mowing, rolling and aerification before September. No verti-cutting or brushing.

Which biological products are used?

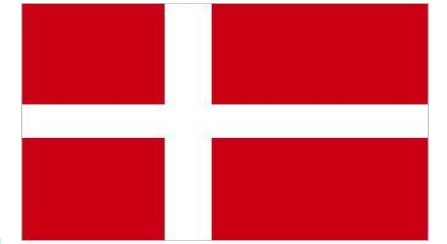
Seaweed as organic fertiliser source

Average green speed

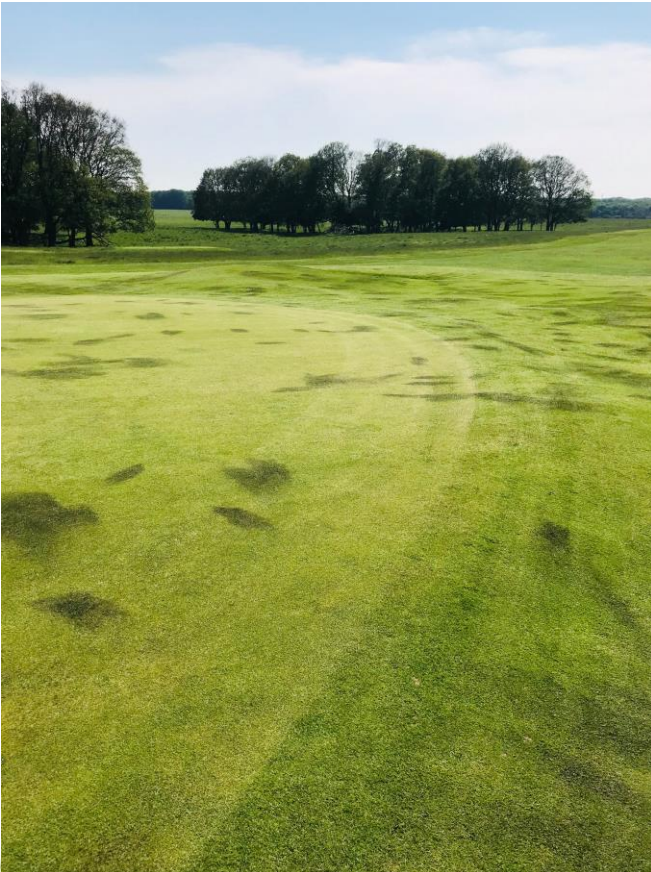
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Case Study - Royal Copenhagen



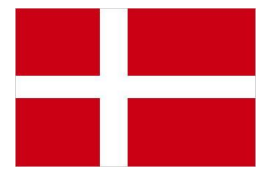
? You mentioned that by not using pesticides, you experienced the biggest problems with weed management? Can you explain why and how you deal with weed problems?



! Weeds establish opportunistically, hence whenever there is an opening in the turf swards, weeds can and will invade if seeds are present and the conditions are favourable for germination. We have not used any herbicides for the last 15 years and therefore weeds are present in all playing areas.

On greens and approaches we use spot treatments of iron sulphate (60 kg/ha) to weaken the weeds and allow the surrounding turf grasses to outcompete the weeds over time. For plantains we also use garlic products. From my experience, it seems that soil conditions deteriorate if weeds are present. Earthworms start invading and soil casts on the surface create problems for mowers.

Other Scandinavian Golfclubs



- **Main Challenge is weed control**
- Drainage work to improve Fescue growth
- Traffic control to manage winter wear
- Fairways have 2-3 cm thatch layer because of low budget. They are well drained (not a sandy soil!), have some fairy rings. 50 kg/ha/ yr N input



**Furesø
Golfklub**

- Main Challenges is **introducing red fescues on fairways**. Heavy soil with earthworm casts covering germinated seeds (suffocation)
- Intensive topdressing program
- Intensive overseeding program with limited success



**SMØRUM
GOLF KLUB**

- Main Challenge are the greens sown with fescue and bent mix. Bent has very broad leaves and also broad leaf weeds establish
- Very pale colour of fescue greens

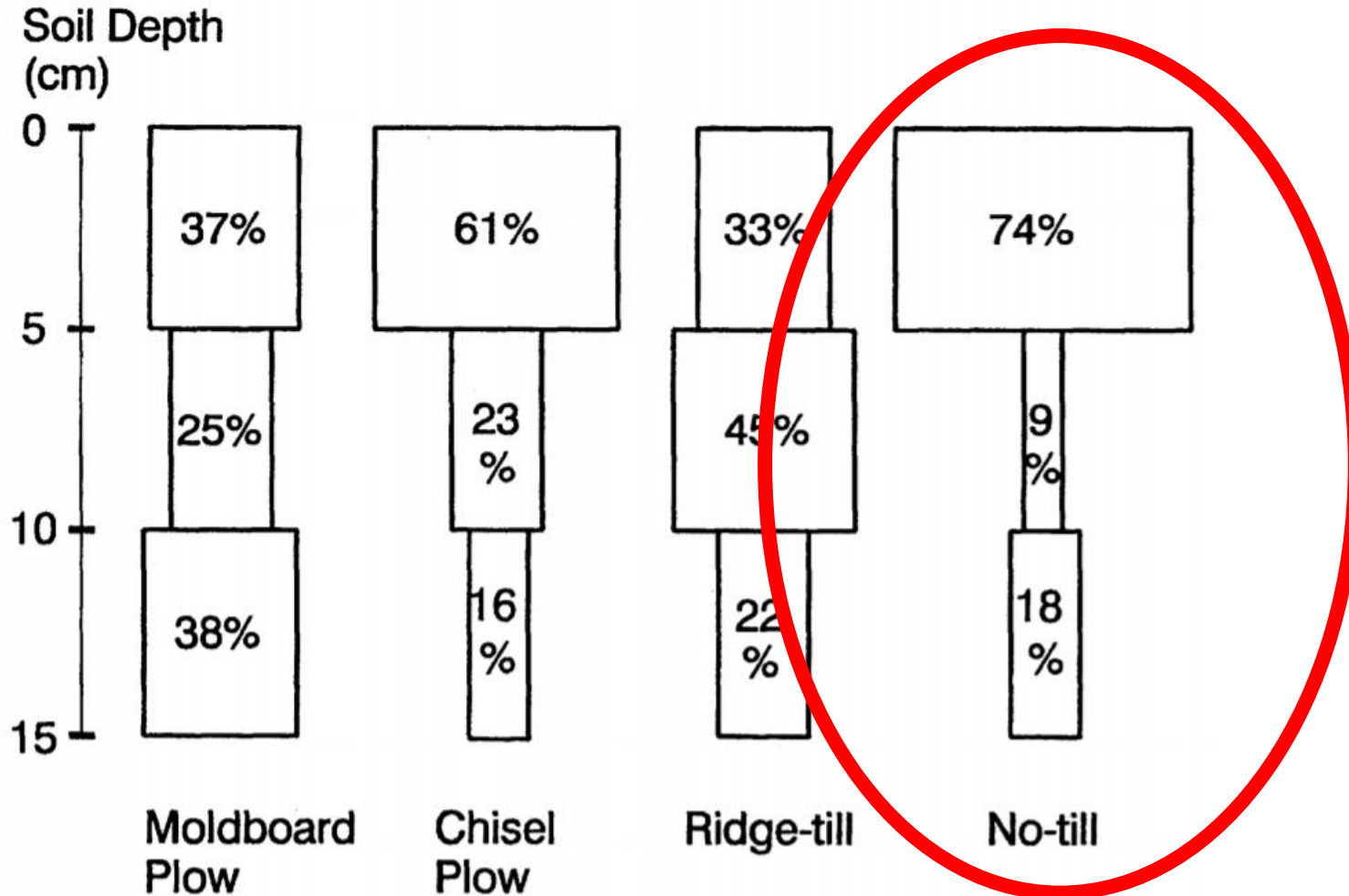
Case Study - Martha's vineyard



Acceptable weed cover at 15%!



Case Study - Martha's vineyard



Source: Clements et al. 1996

Case Study - Martha's vineyard

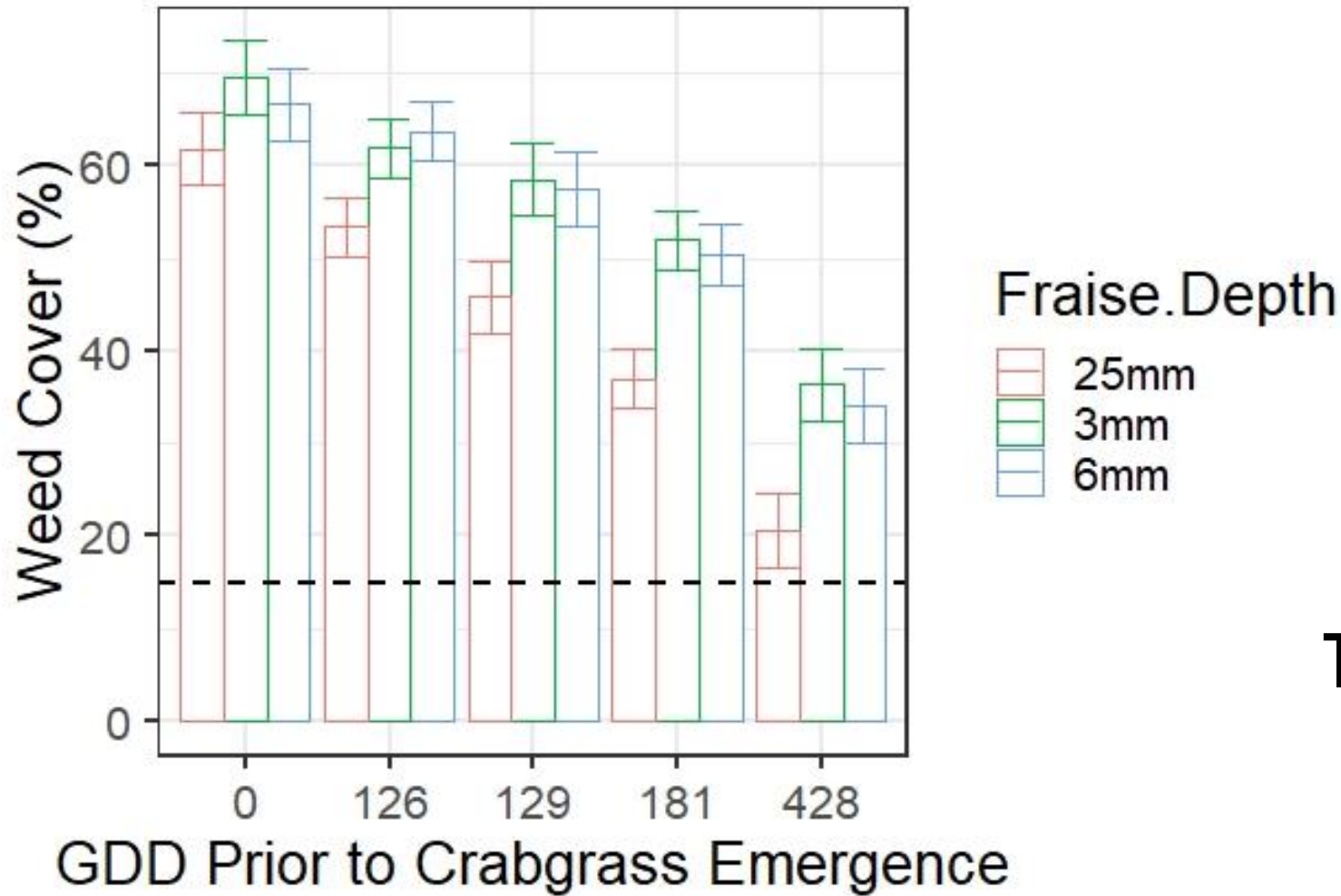


Grassland Establishment Methods

- Timing - Fall 2017 (Oct 3, Oct 30, Nov 21) and Spring 2018 (Apr 20, May 18)
- Fraise Harvest Depth – 3mm, 6mm, 25mm
- Fine-leaf fescue seed rate – 293 and 586 kg/ha
- Starter fertilizer (Nature Safe 10-2-8) 244 kg/ha

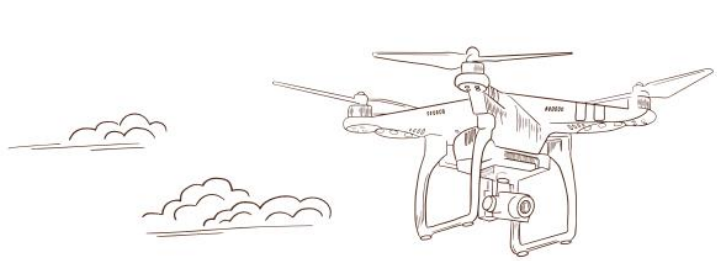


Case Study - Martha's vineyard



Time your practices!

Scientific Literature – D. Hahn



Good one!

Towards Strategies
to Manage Weeds in Turf
without
Herbicides



Hahn, D., Sallenave, R., Pornaro, C., & Leinauer, B. (2020). Managing cool-season turfgrass without herbicides: Optimizing maintenance practices to control weeds. *Crop Science*, 60(5): 2204-2220.

Hahn, D., Roosjen, P., Morales, A., Nijp, J., Beck, L., Velasco-Cruz, C. & Leinauer, B. (2021). Detection and quantification of broadleaf weeds in turfgrass using close-range multispectral imagery with pixel- and object-based classification. *International Journal of Remote Sensing*, 42(21): 8035-8055.

Hahn, D., Morales, A., Velasco-Cruz, C. & Leinauer, B. (2021). Assessing competitiveness of Fine Fescues (*Festuca* L. spp.) and Tall Fescue (*Schedonorus arundinaceus* (Schreb.) Dumort) established with white clover (*Trifolium repens* L., WC), daisy (*Bellis perennis* L.) and yarrow (*Achillea millefolium* L.). *Agronomy*, 11(11): 2226. <https://doi.org/10.3390/agronomy11112226>

Scientific Literature – Literature Review



Competitive Turf sward

- Select adapted species
- Adjust Nitrogen fertilisation to growth rate
- Mowing heights as high as possible
- Remove clippings in areas with high weed population
- Return clippings when fertiliser input is low and weed populations are low
- Maintain healthy turf
- Allelopathic species provide additional competition mechanism

AND



Weed removal

- Bioherbicide efficiency is currently low/ few products on the market
- Organic products exist for non-selective control
- Non selective thermal weed control
- Future seems to be spot treatment with autonomous weed robots

Scientific Literature - Allelopathy

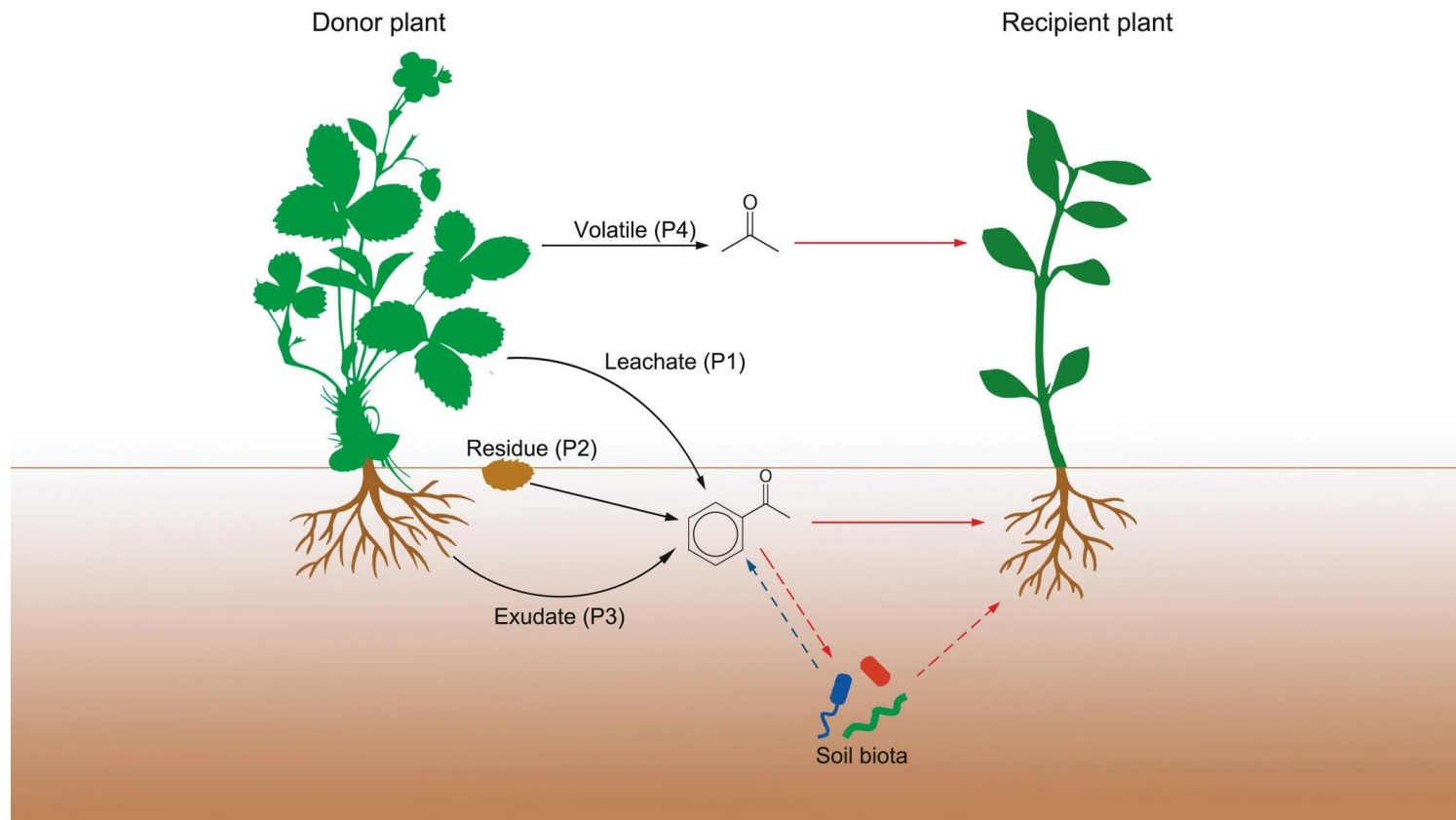


Figure 2, Multiple competition mechanisms in plant- plant growth interference. Adapted from Zhang et al (2020) Effect of allelopathy on plant performance: a meta-analysis. Doi: 10.1111/ele.13627

Scientific Literature *Steff*



- “Red fescues are the most sustainable cool season turf grass species”
- Require well drained soil (not necessarily sandy soils!), otherwise switch to Lolium
- Can take wear if a thatch layer is present (high in lignin), but fescue thatch is more porous
- Apparently shade tolerant, but bents and Poa invade in shade
- Chewing’s fescue probably the most winter hardy species (better than creeping bent!)
- Own opinion: fescue has less grain, therefore more consistent playing quality
- Divots on fairways don’t heal that quickly
- Use mixtures in Fairways. Chewings’ F. produces dense swards, Slender creeping F. has short rhizomes and repairs ball marks better, strong creeping is greener during drought
- Deficit irrigation with fescues can outcompete shallow annual weed species, but careful in spring when fescues have short roots and need to recover to be competitive
- Overseeding takes many years
- **“Fescue courses have weed problems, because low nitrogen rates stimulate clover growth. Increase the nitrogen input if herbicides can not be used”**



Scientific Literature – Be careful!!!

- Brian Horgan et al (2007) GCM -> „strong creeping Rf + Pp had significant more weeds (...) higher rates of fertilizer had fewer weeds (...) organic fertilizer led to more weeds“ -> **Chewings’s fescue** best result for low input management

STUDIES RARELY GIVE YOU A RECOMMENDATION TO FOLLOW! SO THINK ABOUT WHAT YOU WANT TO ACHIEVE AND LOOK SPECIFICALLY FOR THAT DATA! CONSIDER NOT READING ABSTRACTS OR CONCLUSIONS!

- Watkins et all (2010) -> Turfgrass species for low-input golf course fairways -> “Chewing’s fescue, sheep Fescue (*Festuca Ovina* L.), colonial bentgrass (*Agrostis capillaris* L.) and velvet bentgrass were the most interesting species for low input golf fairway management.” **SO WHICH ONE NOW?**

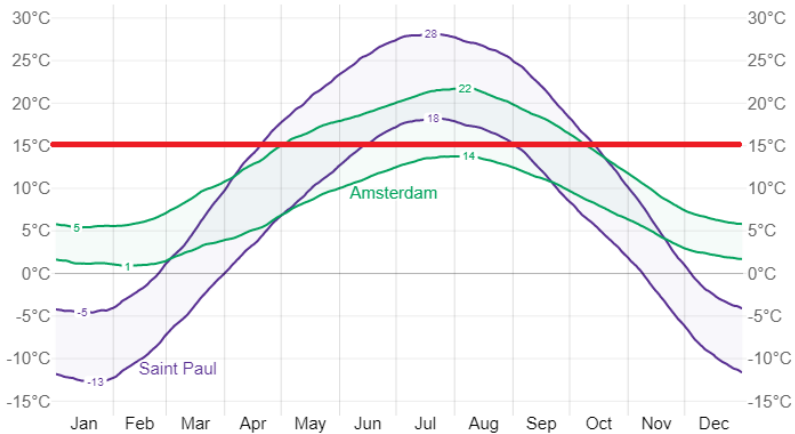


Figure 1, Average high/ low temperature differences <https://weatherspark.com/>

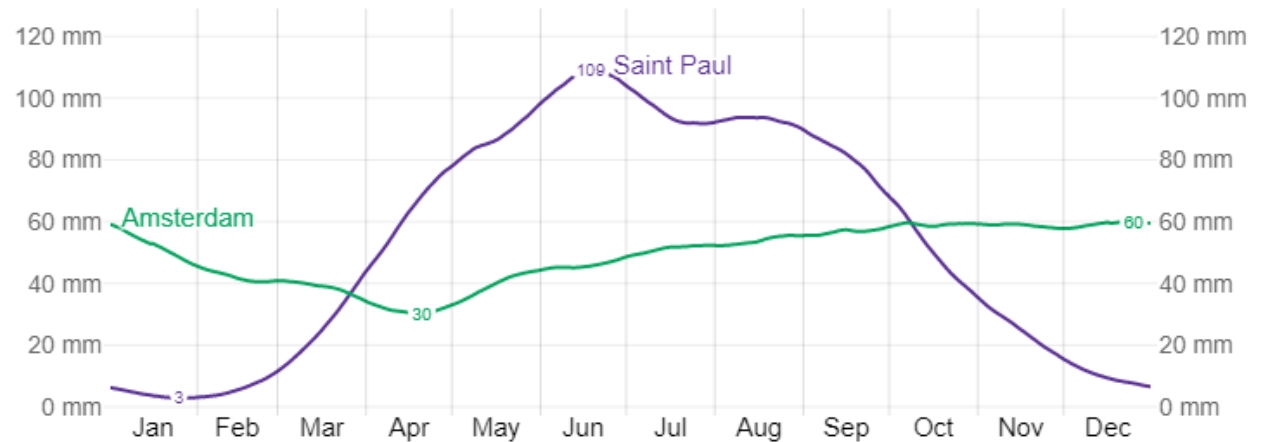


Figure 2, Average rainfall differences <https://weatherspark.com/>

Scientific Literature - Competition

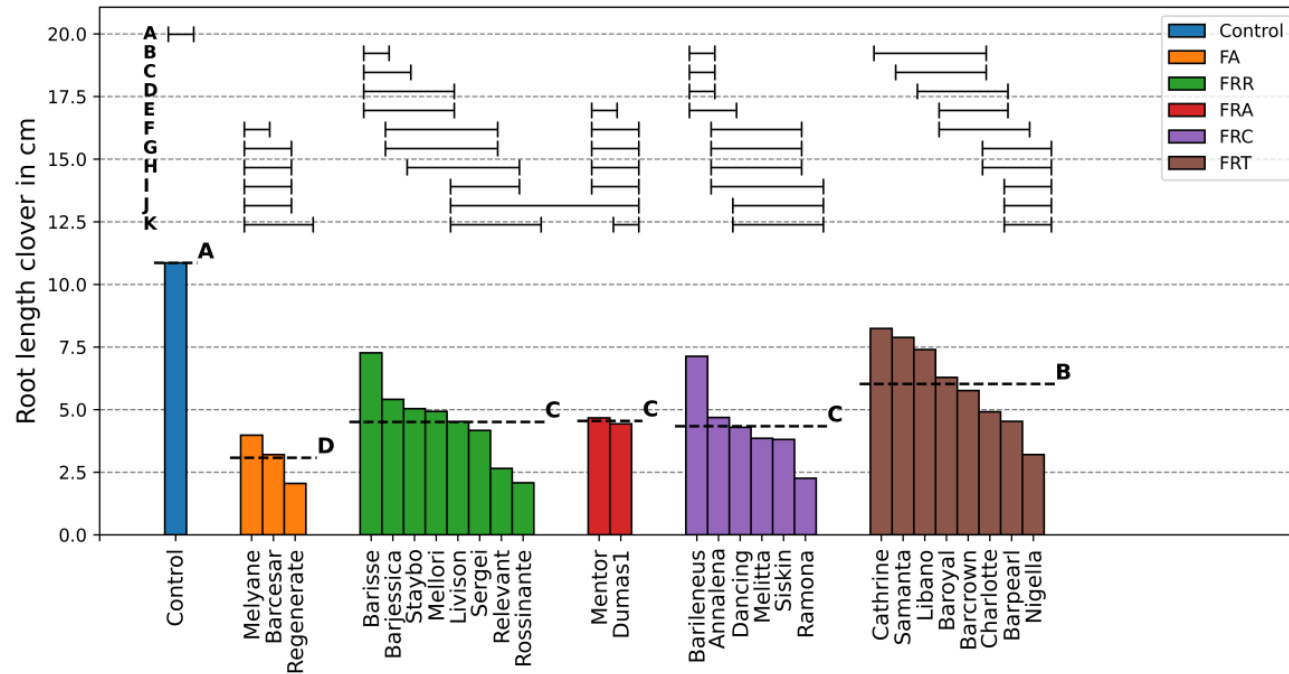


Figure 3, influence of Festuca on clover root length 30 DAS (D.Hahn, 2021)

on Average **-56%** root length reduction compared to controls

- FA = Tall fescue
- FRR = Strong creeping red fescue
- FRA = Hard fescue
- FRC = Chewings fescue
- FRT = Slender creeping red fescue

Bioherbicides

Table 2. Bioherbicides and their respective sources, target weeds, ecosystems, and registered names.

Source	Target Weeds	Ecosystem	Registered Name
<i>Xanthomonas campestris</i>	<i>Poa annua</i> L.	Turf, athletic fields	Commercialized-Camperico®
<i>Phoma macrostoma</i>	<i>Reynoutria japonica</i> Houltt.	Golf courses, agriculture, and agro-forestry	Commercialized-Phoma
<i>Streptomyces acidiscabies</i>	<i>Taraxacum officinale</i> L.	Turf	Commercialized-Opportune®
<i>Sclerotinia minor</i> Jagger.	<i>Taraxacum</i> spp.	Turf	Commercialized-Sarritor®

Hasan, M.; Ahmad-Hamdani, M.S.; Rosli, A.M.; Hamdan, H. Bioherbicides: An Eco-Friendly Tool for Sustainable Weed Management. *Plants* **2021**, *10*, 1212.

<https://doi.org/10.3390/plants10061212>



- Reduced risk of soil/ water contamination
- Soluble in water and adding surfactant not necessary
- Multiple mode of actions -> low risk of resistance



- Short half-life
- Short activity in the soil
- Very expensive to produce
- Low/ moderate efficiency
- High Phytotoxicity -> poisonous to mammals
- Product efficiency depends on environmental conditions

Personal observations 1 / 3

- Localised patches stand out not so much homogenous grass/weed areas
- Areas without sufficient irrigation coverage have a lot of weeds
- Areas with overlapping irrigation usually have a lot of moss and algae

Personal observations 2/3

- Fairways that have a wetting agent program do not have as much weeds
- Lowering cutting heights when weeds flower -> acceptable look
- Fertilised fairways have less weeds

Personal observations 3/3

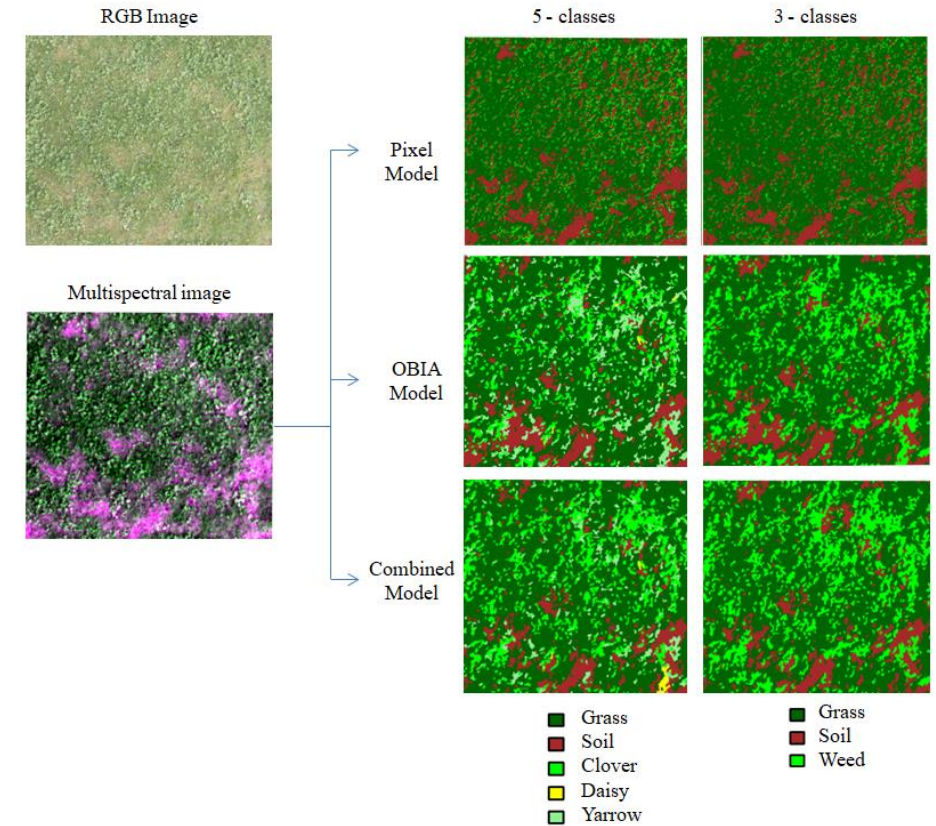
- The thicker the leaves of the weeds the more disruptive it is to playing quality
- Low growing weeds are not a problem (such as daisy)
- People don't notice weeds on tee boxes, but dislike weeds in rough because it gets „too thick to play out of it“
- Most greenkeepers knock down weed populations with a herbicide once, then control by spot spraying

Future research

- Which weeds are problematic?
- Do weeds interfere with playing quality? -> Objective data with Trackman etc.
- Trials with bioherbicides, wetting agents, fertilisation, mechanical weed removal options
- Cost associated with handweeding -> how can we make this more efficient?
- Grass species competition -> which cultivars are best suited to outcompete weeds in different areas?

Bottlenecks

- RESEACH FOCUSES TOO MUCH ON HERBICIDE PRODUCTS!
- FOR LARGE SCALE EXPERIMENTS WE NEED AUTOMATED WEED DETCTION AND IMAGE ANALYSIS!
- WHO HAS AN INTREST TO SPONSOR TRIALS? -> NO PRODUCT THAT CAN BE SOLD!
- GREENKEEPERS NEED TO RUN TRIALS AND COMMUNICATE MORE -> TIME ISSUE



Hahn, D., Roosjen, P., Morales, A., Nijp, J., Beck, L., Velasco-Cruz, C. & Leinauer, B. (2021). Detection and quantification of broadleaf weeds in turfgrass using close-range multispectral imagery with pixel- and object-based classification. *International Journal of Remote Sensing*, 42(21): 8035-8055.



THANK YOU



TURF AGRONOMY

by Dr. Daniel Hahn

