Non-herbicidal Weed Control for Turf Areas

Daniel Hahn and Bernd Leinauer
Wageningen University and Research
Centre for Crop Systems Analysis

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As part of the 'Green-Deal 2020', the Dutch government is considering to ban most pesticides in order to move the agricultural and turf sector towards a greener and more sustainable future. However, the ban of most pesticides requires ecological alternatives. Sustainable management starts with choosing a grass species that is adapted to the specific growing environment. Due to legislative changes, turfgrass species no longer just need to produce high quality surfaces, but also need to have natural resistance against abiotic and biotic stresses. Particularly public lawns require grass species that not only have superior traffic tolerance but also come with a host plant resistance against stresses because they are often maintained on a small budget.

1) New turfgrasses to exhibit allelopathy

One approach to more sustainable turf management practices is to provide cultivars with an ability to produce quality playing surfaces in conjunction with allelopathic abilities against weeds. Fescue (*Festuca spp*.) varieties, known for their allelopathic ability, could be used for such an approach. In bio-assay procedures, tall fescue (*Festuca arundinacea*) exudates reduced seedling growth of rape (*Brassica nigra L*.), birdsfoot trefoil (*Lotus corniculatus L*.), red clover (*Trifolium pratensis L*.), and many more common turf weeds (Elroy et al., 1985). Bertin et al (2009) showed that weed suppression greatly varies between cultivars; hence further research needs to establish which varieties could be suitable for fine-turf areas. Recently, Guo et al. (2015) provided deeper understanding of the underlying mechanism of allelopathy in turfgrass species. Cluster analysis showed that the compositions of root exudates are a result of unique interactions between cultivars and endophyte infestation. However, a practical approach for turf managers to make use of these findings remains absent.

Once a suitable species and/or variety for a specific area (greens, fairways, and public lawns) is identified, research is needed to investigate and possibly establish a strategy to make best use of such a variety. Furthermore, a breeding program can be developed to select for weed resistant turfgrass varieties. Previous researchers tested toxic exudates on weed seedlings, however turf managers mainly need products to control established weed plants. One goal can be to isolate root exudates and investigate the results after a concentrated formulation is sprayed on common weed species.

Methodologies for such a project have been developed within the last years. For example, putative compounds can be isolated from a methanol extract of root material and the chemical structure can be determined by high-resolution mass spectrometry, infrared spectroscopy and 1H NMR. The task of this project will be to identify suitable grass species or varieties with an allelopathic ability to control common turf weeds. The allelopathic effect of suitable plant species will be tested on a variety of common weed species and if they affect monocots and dicots equally well.

2) New management strategies for weed control

A second approach will investigate management strategies on the improvement of plant health and the allelopathic ability of the desired grass plants to provide a competitive advantage over common turf weeds. Research into fertilisation mechanisms of endophytes such as nitrogen fixation, solubilisation of phosphate, siderophore production etc. could give rise to the development of fertiliser management regimes which accord with the possible legislative changes. It is known that some endophytes promote plant growth through the production of hormones, stimulators and stress controllers, which work in a similar fashion to plant growth regulator products (for example by lowering ethylene levels, which in turn promotes plant growth). An indirect effect of stimulating plant growth is an induced biotization, i.e. biological disease control. Neotyphodium endophytes enhance fitness of host plants and provide protection against nematodes, insect herbivores and fungal pathogens as shown by Siegel et al. (1987), Latch (1993) and Schardl & Phillips (1997). Understanding the plant-microbe interaction in detail will help us to develop management practices that enhance fitness and the allelopathic abilities of grasses.

An alternative approach for controlling weeds includes investigating products that reduce fitness and fecundity of weedy plants. To identify biological herbicides for turf areas we propose to test already available products, which are used in agricultural settings. These products include allelopathic plant materials such as a mixture of pine (*Pinus* L.), hinoki (*Chamaecyparis obtusa* Endl.), or Japanese cedar (*Cryptomeria japonica* D. Don) and bamboo (Bambusoideae; Poaceae) vinegar (Guillon, 2003; Ogata et al., 2008; Miyake, 2009). However, information is missing, whether such products also work on turf.

Objective:

The overall aim of the project is to research approaches for weed free, sustainable turfgrass areas. Such approaches should be holistic and may consist of identifying grass species with allelopathic effects on weed species, management approaches to improve fitness of the desired species, and a breeding program towards weed resistant turfgrass species.

Time Table:

July 1, 2017	Start of Ph.D. program
July – December, 2017:	Design and implementation of specific project(s) first draft of review/perspective manuscript
December 2017:	submit report to DTRF
on or before July 1, 2018:	submit review/perspective manuscript for review Approval of Training and Supervision Plan and final research proposal Go/No-go evaluation
Spring, summer, fall 2018:	Data collection, analysis,
December 2018:	submit report to DTRF – submit paper to a journal
Spring, summer, fall 2019:	Data collection, analysis,
December 2019:	submit research report to DTRF – submit paper to a journal
Spring, summer, fall 2020:	Data collection, analysis,
December 2019 – spring 2021:	final research report – submit paper to a journal, Dissertation, Graduation

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