New Project Summary Report for PE 015: Compact growth and improved shelf life in herbs

Project Number	30800150
Title	Inducing compact growth and improved shelf life in herbs by mimicking drought signals
Short Title	PE 015
Lead Contractor	Harper Adams University College
Other Contractors	N/A
Start & End Dates	1 September 2013 - 30 April 2014
Industry Representative	Ms Claire Donkin and Mr Simon Budge
Project Budget	£34,862
AHDB Contribution	£33,832

The Problem

Herb growers experience problems with inadequately-compact growth at several times of year. When less light is available in late winter and autumn, leaves and stems are thin and weak and more-prone to disease (Tom Davies, Personal Communication). These problems can prevent buyer specifications from being met and may lead to reduced shelf life. Currently, there is no low-cost method available to minimise these problems, and this concept note proposes a novel approach.

There is increasing evidence that when drought is detected by plant roots a chemical signal is produced which moves to the shoot and induces reduced growth (Schactman and Goodger, 2008). Basic research into the mechanism of root to shoot drought signalling has shown that the primary signal from the roots of droughted barley is changes in the pH of the xylem sap (Bacon et al., 1998). Less-acid sap is produced in droughted plants, and this acts as the signal to reduce leaf expansion. This effect can be simulated in various plant species by either: sprays of alkaline pH buffers (Aronsson, 2009; Sharp & Davies, 2009; Kettlewell et al., 2012), dusting leaves with lime (Kettlewell et al., 2012), or alkaline soil drenches (Sharp, Personal Communication). A rapid literature scan has indicated no previous published research on drought signalling in herb species, and there is now scope for exploiting the knowledge on other species to improve the growth of herbs.

Benefits to industry

Improving shelf life is currently a four star priority in the British Herb Trades Association (BHTA) R&D strategy, and BHTA (through Tom Davies) have agreed to support this 8 month pilot study. Claire Donkin (Lincolnshire Herbs) has agreed to be the industry representative on this project.

The pilot study will establish whether it is feasible to manipulate growth of any of the herbs tested to realise the benefit of more-compact growth without the detrimental effects of drought, and whether this can lead to improved shelf life. If successful, a low-cost, simple, environmentally-benign method of controlling growth and improving shelf life will become available to herb growers.

The main output will be a recommendation to HDC whether a detailed research project is justified. A detailed project will be necessary to optimise applications of alkaline buffers in a commercial setting and produce guidance which would be disseminated to herb growers primarily through the BHTA. Thus the main knowledge transfer is envisaged after a detailed follow-on project, but if results are favourable, discussion with HDC staff will determine whether it is appropriate for preliminary knowledge transfer to growers after the pilot study.

If the results are favourable, the issue will arise of designation of alkaline buffer applications as pesticides, thereby requiring Chemicals Regulation Directorate (CRD) approval. One of the main pH buffers used in past experiments on other species, potassium bicarbonate (KHCO3), is already approved as a horticultural fungicide under the Commodity Substance approval route. Dr Darren Mingo of CRD has confirmed that, given adequate evidence from efficacy data, an additional Commodity Substance approval as a plant growth regulator should be achievable.

Aims and Objectives

Project aims

The aim of the proposed pilot study is to explore the potential for mimicking the natural drought signals, which move from root to shoot, to give more-compact growth and improved shelf life in a range of herb species without the detrimental effects of water stress.

Project objectives

1. To screen four pot-grown herb species (coriander, flat parsley, mint, basil) for response of leaf, petiole and stem internode growth to alkaline pH buffer application and to saline application.

2. For the most-responsive herb species, to explore responses of leaf, petiole and stem internode growth to varying pH and spray frequency and saline concentration and spray frequency.

3. For the most-responsive herb species, to evaluate spray effects on potential shelf life.

Approach

The four herbs will be glasshouse-grown in pots in the autumn, winter and early spring when low light and weak growth are inherent problems. The experiments will be conducted using as similar conditions as possible to those at Lincolnshire Herbs, with plants supplied by Lincolnshire Herbs.

Food-grade potassium bicarbonate (KHCO3) will be used as a spray since this will be more-acceptable to retailers and consumers, and is specified in the existing Commodity Substance Approval of KHCO3 as a horticultural fungicide. Previous HDC-funded work on alkalising xylem sap pH in order to close stomata and save water in hardy nursery stock has found potassium bicarbonate to be effective (Davies et al.; 2010). Previous HDC-funded work on salt stress for pre-adapting brassica seedlings to cabbage root fly attack has demonstrated that soil drenches of sodium chloride (NaCl) can reduce leaf growth (Huckle, 2013). The mode of action is likely to be different to that of pH, probably through osmotic reduction in water uptake by roots. The opportunity will be taken to include, as a small component of the initial screens, treatments of sodium chloride drench, sodium chloride spray and potassium bicarbonate drench for comparison with the foliar treatments. Although problems of interference with nutrient uptake from drenches could be envisaged, it will be worthwhile to include these in case pH buffer application ultimately proves to be undesirable e.g. through leaf residues.

The treatments in the first experiment will be:

1. untreated;

2. foliar spray 0.02M KHCO3, adjusted using potassium hydroxide to pH 8

3. foliar spray 0.02M KHCO3, adjusted using potassium hydroxide to pH 9

4. foliar spray 0.02M KHCO3, adjusted using potassium hydroxide to pH 10

5. foliar spray 0.02M $KHCO_3$, adjusted using potassium hydroxide to pH 11

6. foliar spray 0.02M $KHCO_3$, adjusted using potassium hydroxide to pH 12

7. soil drench of 0.02M $KHCO_3$ adjusted using potassium hydroxide to pH 12

8. soil drench of 0.24M NaCl

9. spray of 0.24M NaCl

Two sprays will be applied one week apart. Sprays will be applied in a volume equivalent to 200 l/ha applied through flat fan nozzles using a static precision pot sprayer. Twenty replicate pots will be used with measurements on multiple stems per pot. Each pot will be thinned to a uniform number of plants per pot to standardise the competition between plants. Measurements will include petiole length, stem internode length and leaf lamina size using electronic callipers. Repeating measurements on different occasions will enable effects on rate of achievement of the minimum size specification to be determined, to understand any implications on production scheduling.

$KHCO_3$ sprays at 10 g/l (0.1M, with a wetter added) have caused phytotoxicity on parsley in recent research on mildew control (Defra, 2012). The risk of phytotoxicity is reduced in this work through reducing the concentration to one-fifth (0.02M) and omitting a wetter. Any phytotoxicity occurring will be assessed visually as % leaf area affected. In later experiments, a treatment with addition of a wetter will be included to assess potential for improving efficacy and effects on phytotoxicity.

In later experiments, potential shelf-life will be assessed through standard post-harvest assays of leaf colour using a Minolta colorimeter, and by cell membrane leakage using the conductivity method in Wagstaff et al. (2007).

The experimental design will be simple randomised block experiments for each herb species, with the blocks arranged under the lights over the glasshouse bench to be as similar light intensity as possible for the plants within each block. Previous work in controlled environment cabinets has shown that blocks remove little variation, so a completely randomised design will be used for these experiments.