Grower Summary

SF 144

Early detection of stress in strawberry plants using hyperspectral image analysis

Annual 2015

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of this report, please email the AHDB Horticulture office (hort.info.@ahdb.org.uk), quoting your AHDB Horticulture number, alternatively contact AHDB Horticulture at the address below.

AHDB Horticulture,
AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel – 0247 669 2051

AHDB Horticulture is a Division of the Agriculture and Horticulture Development Board.

Project Number:	SF 144
Project Title:	Early detection of stress in strawberry plants using hyperspectral image analysis
Project Leader:	Andrew French University of Nottingham, Jubilee campus, Wollaton Road, Nottingham, NG8 1BB
Contractor:	University of Nottingham
Industry Representative:	Marion Regan, Hugh Lowe Farms, Farm Office, Barons Place, Mereworth, Maidstone, Kent ME18 5NF
Report:	Annual report, 2015
Publication Date:	01 July 2015
Previous report/(s):	None
Start Date:	1 May 2014
End Date:	31 April 2017
Project Cost:	£67,878

GROWER SUMMARY

Headline

- This project is developing a system to detect indicators of stress in strawberry plant physiology using hyperspectral image analysis, a non-invasive technique.

Background and expected deliverables

Regular crop inspection by experienced growers and trained agronomists is an essential activity necessary to maintain the health and productivity of any crop. When signs of biotic or abiotic stress are detected within a crop, there is a high probability that the causative stimulus has already had an impact on the productivity of the affected plants and may potentially spread to the whole crop depending on what the cause is.

Finding ways to automatically detect adverse stress would be beneficial to the horticultural industry and could lead to a reduction in the volume of fertiliser and pesticides used through targeted applications, and early intervention would also reduce the damage caused to the crop. The physical parameters of a plant can be measured using automated phenotyping, which is an automatic high-throughput process that scans and analyses the physical features of a plant. This process decreases the time taken to measure the quantitative parameters of a plant, for example: leaf area or chlorophyll pigment concentration. Hyperspectral imaging is a recent tool in phenotyping and includes extra colour information that cannot be observed by the human eye or a digital camera.

The aim of this project is to use hyperspectral imaging to analyse and detect the onset of stress in strawberry plants in relation to certain diseases, pests or environmental conditions. Strawberry plants will be subjected to diseases, pests or drought in order to capture a time series of how the plants are responding to these biotic and abiotic stresses. The images will be collected using hyperspectral cameras and will include both spatial information, (the location of the pixels in the image), and spectral information, (the narrow bands of contiguous wavelengths from visible light to near infra-red light). The plants will be imaged at East Malling Research (EMR) and the University of Nottingham.

Once the images have been captured, the strawberry plants need to be identified in the images using a technique known as ‘segmentation’. This means labelling objects within the image by finding similar properties such as colour, shape or texture. Once the plants have been located in the images, the hyperspectral information can then be analysed over time. Hyperspectral data contains important information related to physical processes, such as the chlorophyll content and the cell structure. For example, during drought the amount of chlorophyll reduces which means a relative increase in light—specifically red wavelengths—being reflected by the plant instead of being absorbed.

This work is being done as part of the AHDB Horticulture Studentship scheme, designed to train new scientists to work in the UK horticultural industry. The scientist working on this project is Amy Lowe who is jointly supervised by Andrew French (University of Nottingham) and Nicola Harrison (East Malling Research).

Summary of the project and main conclusions

To date, eight strawberry varieties, with three replicates of each, have been grown at EMR then transferred to glasshouses at the University of Nottingham for imaging using the hyperspectral camera system. This initial dataset is a time series of images from well-watered strawberry plants through to just-visible onset of drought. The strawberry plants were imaged once a day over four consecutive days.

The images have been segmented using Non-negative matrix factorisation (NMF). This uses the hyperspectral information to label the image areas based on the different materials in the image. NMF can also discriminate between the leaves, flowers, stamen and overturned leaves, for example the matrix factorisation is by parts. When this uses spectral information it will identify the signatures within the input matrix. The matrix could also focus on features to separate the parts within the image such as the leaf veins.

Further image analysis techniques will be implemented in 2015 along with analysing the data to find stress markers. To build-on and enhance the pilot dataset collected in 2014, we will generate new datasets using the hyperspectral imaging system at EMR, with the aim of investigating strawberry responses to powdery mildew (*Podosphaera aphanis*), two-spotted spider mite (*Tetranychus urticae*) and drought.

In addition, further computational analyses will be undertaken with focus on image recognition of individual leaves on the plant and determining the orientation of the leaf to build a geometric model of the plant. This will allow analysis on the flat facing leaves and also to analyse the same leaf over time.

Financial benefits

For this annual report it is not appropriate to undertake a cost/benefit analysis.

Action points for growers

- There are no action points for growers at this stage of the project.