



Grower Summary

FV 425

Application of chlorophyll
fluorescence for prediction of
harvest maturity in broccoli

Annual 2016

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Project title: Application of chlorophyll fluorescence for prediction of harvest maturity in broccoli

Project number: FV 425

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Report: Annual report, April 2016

Previous report: Annual report 2015

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Date project commenced: 1 April 2014

Date project completed 30 November 2016
(or expected completion date):

GROWER SUMMARY

Headline

A non-destructive measurement of broccoli heads using chlorophyll fluorescence (CF) has been identified and is currently under development. It has potential to assess consignments of broccoli at the point of harvest and to predict the storage potential.

Background

It is difficult to pinpoint exactly when broccoli is at the right harvest maturity for good storage behaviour and shelf-life. Areas of a crop with seemingly identical heads, harvested at the same time, can show widely differing keeping qualities – which creates an obvious problem for managing the schedule of a crop that, thanks to variability in weather and consumer demand through the season, may need to be stored for up to three weeks to balance supply and demand.

However, the technology of chlorophyll fluorescence could potentially be used to monitor the maturity and health of broccoli heads. This project, is investigating two key questions: can chlorophyll fluorescence be used to assess heads at harvest for their subsequent keeping quality; and can the technology be used to inform crop management decisions in the field and after harvest?

Chlorophyll fluorescence

Green plant tissues contain chloroplasts, the microscopic organs within the cells where photosynthesis takes place. The chlorophyll molecules in the chloroplasts absorb sunlight. Most of the energy received is used to drive photosynthesis which in turn supplies energy to the plant, but a portion is unused and re-emitted by the chlorophyll as fluorescence. The more active the chloroplasts the more energy is released as fluorescence.

For decades scientists have used this as a tool to study some fundamental aspects of photosynthesis, for example, it can indicate both the concentration and the activity or health of chloroplasts within plant tissue. Chloroplasts are very sensitive, rapidly losing activity if the tissues become stressed, so measuring chlorophyll fluorescence has been used to assess crop health in the field and, in particular, disease load for arable crops. Changes in fruit and vegetable maturity are also associated with changes in chloroplast function and concentration. The ripening of most fruit involves very significant loss of green colour and that's down to a

loss of chloroplasts. It is already known, for example from work in project TF 142, that chlorophyll fluorescence can be a valuable tool to assess maturity of tree fruit.

Summary

As a technique that can measure both the concentration and the activity/health of chloroplasts within plant tissues, chlorophyll fluorescence has been used to assess maturity and health for a wide range of crops. Specifically chlorophyll fluorescence has been used to map changes in the health of broccoli during storage and shelf-life (FV 395) where a decline in the number of active chloroplasts is correlated with a reduction in head quality leading to senescence.

The overall objectives of this project are:

- 1) To optimise an existing chlorophyll fluorimeter for use on broccoli heads in collaboration with the manufacturer (Hansatech Instruments Limited)
- 2) To relate chlorophyll fluorescence profiles of broccoli to maturation in the field as estimated by the effective day degrees after transplant and morphological characteristics
- 3) To identify biochemical changes (antioxidants and isothiocyanates) during broccoli head maturation
- 4) To develop strategies for predicting the shelf-life of broccoli consignments at harvest in order to improve scheduling of broccoli marketing
- 5) To model broccoli head maturity, including biochemical and morphological changes in terms of chlorophyll fluorescence profile.

During the first year of the project it was found that measurement chlorophyll fluorescence characteristics of broccoli heads at harvest could provide a prediction of quality after storage. The evidence was not yet strong enough to suggest that it could be used to grade individual heads, but it could be used to predict the overall behaviour of consignments. As an illustration of this, Figure A shows a plot between the predicted and actual Maturity Index for four consignments of broccoli.

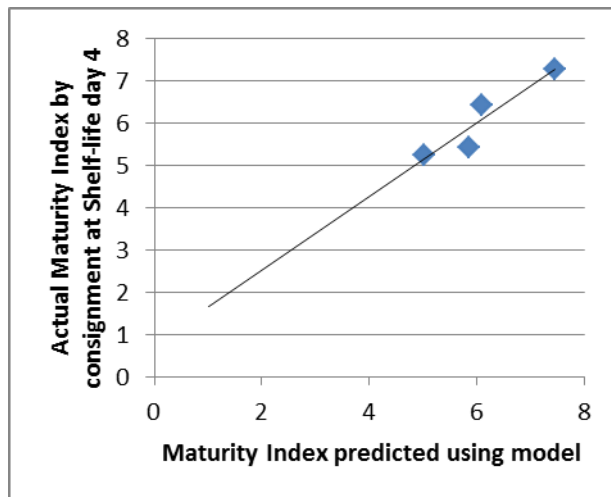


Figure A. 2014 Actual v predicted Maturity Index after 4 days shelf-life using the model developed using head diameter and chlorophyll fluorescence

During the second year of the project trials were conducted to test the CF measuring protocol in order to optimise the design of a specialised probe, and to test and refine the CF predictive model for broccoli harvested over a wider range of conditions.

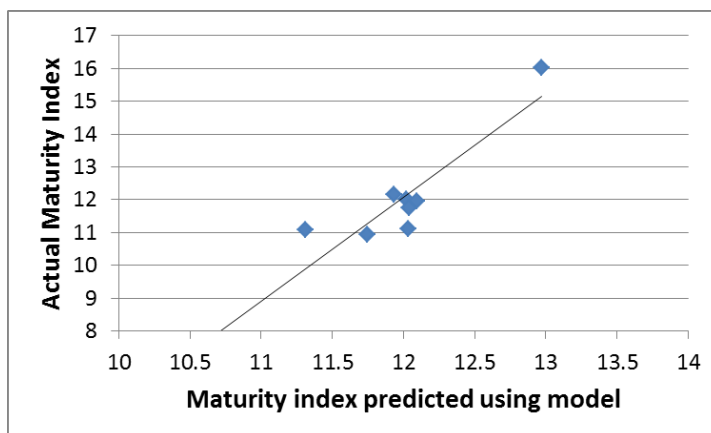


Figure B. 2015 Actual v predicted Maturity Index after 4 days shelf-life using the model developed using head diameter and chlorophyll fluorescence

Figure B shows a similar plot between the predicted and actual Maturity Index as shown in Figure A, but this time for eight consignments of broccoli in 2015.

As a result of the trials conducted this year, it has been shown that a more rapid measurement protocol can be used, using a single pulse, rather than the previous double pulse protocol. There is an indication that two sources of variability arise due to variable positioning of the probe on the broccoli head, and due to external light interfering with the chlorophyll fluorescence measurement. Both of these sources of variability can be overcome by design of a specialised measuring head. This will be investigated in the final season of the project.

Financial Benefits

The potential financial benefits from this project will arise as a result of growers being able to predict the storage potential of consignments, so that they can optimise scheduling of harvesting and the order of distribution of consignments.

Action Points

No specific change in practices is recommended at this stage of the project. However, in order to ensure that the technology development is focused as effectively as possible to industry needs, the researchers welcome input from growers on the way in which they would envisage using the technology.