Studentship Project: Annual Progress Report 01/10/2021 to 31/10/2022

Student Name:	**Haidee Tang**	**AHDB Project Number:**	**SF/TF 170/a**
Project Title:	**Using climatic and imaging data to predict apple maturity.**		
Lead Partner:	NIAB		
Supervisor:	Xiangming Xu, Jinya Su, Xiaojun Zhai		
Start Date:	01/10/2021	**End Date:**	31/09/2025

1. Project aims and objectives

The project aim is to use climatic and imaging data to predict apple maturity. Flowering time and apple maturation rate is affected by the climate.
My first objective is to model climate data to improve the precision of harvest date predictions. This includes investigating the relationship between temperature, flowering time and apple maturation rate. Other factors such as positioning in the tree will also be explored to see if maturation of apples are affected by fruit position in the tree. Historical flowering time data and climate data from the last 80 years will be used to train and test the models.

Secondly, I aim to explore the use of imaging to determine fruit quality. Imaging provides a means to determine fruit maturity without destructively assessing fruit. Images of fruit at harvest will be taken using a multispectral camera then assessed for their maturation stage with industry standard protocols. A hyperspectral camera, provided by Plant and Food Research, will be used to image fruit in New Zealand in their coming season. Spectroradiograph data pre-collected from before I started my PhD will be used to determine what imaging resolution (spectroradiograph, multispectral or hyperspectral) is needed to best predict maturity and to understand which wavelengths change with maturation.

2. Key messages emerging from the project

No key messages yet, the data has just been collected. Historical data is in the process of analysis for flowering time data. The spectroradiograqph data has not been analysed yet but the data has been reformatted and cleaned up in preparation for analysis.

3. Summary of results from the reporting year

During the flowering season, I tagged flowers as they bloomed to know the date the flowers were open to pollination. At harvest time, I collected the tagged fruit and noted their positions. Images were taken, using a multispectral camera then their maturity (firmness, brix and starch) was assessed. Currently, I have finished the collections for this year.

4. Key issues to be addressed in the next year

Models will be trained with historical flowering time and climate data to compare the performance between different models. The best model(s) will be used to predict flowering time and harvest time of apple trees in the Kent region. To improve the model, I will investigate the age of the fruit and position within the tree. The tagged flowers will tell me whether the maturity of the fruit correlates with the age of the fruit, with the age being days from bloom. To determine whether the position of the fruit have an effect on apple development, I will group the fruit by their positions (north facing, south facing, east facing, west facing, upper region, inner region or lower region) to see if the position affects the development of apples. This will be done in R. Flowers will again be tagged in the following flowering season in the UK for a second year of data collection.

Spectroradiography is a imaging method that captures the data from a small region of fruit. Spectroradiograph data will be used to determine which wavelengths can be used to detect apple maturity parameters (firmness, sugar and starch). This data has been collected and will be analysed in R.

Multispectral imaging is an imaging method which captures images in several bands of wavelengths (red, blue, green, near-infrared and infrared). This data has been collected in the UK this year and will be analysed in Python to determine whether multispectral imaging can be used to determine apple maturity ripeness parameters.

Hyperspectral imaging captures the data from a wide range of wavelengths and thus has the highest level of spectral resolution. Collection of hyperspectral image data will be done in New Zealand alongside maturity assessments. The comparison of the three image resolutions will be used to determine whether maturity parameters can be determined with imaging and what resolution is required to do so. Another collection of fruit will be done in the UK for a third data collection. The type of camera used will be determined by this years results.

5. Outputs relating to the project

(events, press articles, conference posters or presentations, scientific papers):

Output	**Detail**
Poster at Hereford orchard walk	**06/07/2022 – Poster presentation and networking with growers**
CTP student talk	**18/07/2022 – Conveying the key ideas of my projects to other students and supervisors in a 5 minute presentation**
Fruit Focus	**13/07/2022 – Networked with industry partners and agricultural companies.** - **Manned the NIAB tent for 1 hr and chatted to interested parties about my project and the CTP programme**
08/10/2022	**Presented a Poster at the British Classification Society event 2022 at the University of Essex. Won 3rd place in the poster presentation**

6. Partners (if applicable)

Scientific partners	University of Essex
Industry partners	Charnee Butcher and Lorraine Boddinton
Government sponsor	UKRI BBSRC (CTP)