Studentship Project: Annual Progress Report 09/2022 to 09/2023

Student Name:	Emily Johnstone	AHDB Project Number:	SF/TF 170/a
Project Title:	Overcoming the limitations to yield in strawberry		
Lead Partner:	BBRSC		
Supervisor:	Dr Carrie-Anne Twitchen, Professor Paul Hadley and Dr Mark Else		
Start Date:	19/09/2021	End Date:	19/09/2025

1. Project aims and objectives

Previous research at the University of Reading developed an optimal plant propagation growing model to produce high-flowering strawberry plants (Twitchen, 2018). Twitchen (2018) found that the highest flowering plants were produced when propagated in a heated glasshouse (20℃) for 9-weeks during the autumn with 12 hours of supplementary lighting provided by high-pressure sodium (HPS) lamps. Under these conditions the transplants produced larger crowns offering an increased number of sites for floral initiation. However, the marketable yield of these plants was limited as a large proportion of the berries were below marketable size. Therefore, the aim of this research is to investigate how to overcome source limitation during fruit development of these high-flowering plants, to increase the proportion of berries which make it to marketable fruit size.

The present research will continue to propagate plants in a heated glasshouse at 20℃ for 9 weeks, but instead of utilising HPS lighting as a form of supplementary lighting, light emitting diodes (LEDs) will be used. The industry is in the process of transitioning towards the use of LEDs as they are consistently proving to be a more economical alternative (Katzin, Marcelis and Mourik, 2021; Pattison, Hansen and Tsao, 2018; Yoomak, Jettansen, Ngaopitakkul, Bunjongjit and Leelajindakrairerk 2018). When investigating how to overcome source limitation during fruit development these elite plants will be compared to plants propagated under standard conditions in a heated glasshouse at 14℃ with no supplementary lighting. This project will investigate how to overcome source limitation during fruit development of Junebearer strawberry cultivars through both environmental manipulation and crop management techniques. This project will also aim to further optimise the environmental conditions during plant propagation to maximise floral initiation and minimise early expression of inflorescences.

2. Key messages emerging from the project

Propagation

- Plants propagated under supplementary light and heat initiated significantly more inflorescences than those under standard conditions.
- Starting the propagation treatment during or before flower initiation is necessary to maximise the number of inflorescences which remain within the crown.

- Propagating under LED lighting does not significantly affect the number of inflorescences initiated within the crown compared to HPS lighting.

Fruit Development

- As daytime temperature increases, berry size decreases regardless of propagation treatment.
- Supplementary CO_2 is beneficial for increasing berry size in elite plants regardless of temperature, but the level of supplementary CO_2 required to increase berry size is dependent on the temperature.
- Supplementary CO_2 can be beneficial for increasing berry size in control plants as the temperature increases.

3. Summary of results from the reporting year

Propagation

In year one and two crown dissections were performed on transplants on arrival and prior to planting in the field after they had received their respective propagation treatments and been exposed to a period of chilling. On arrival, year one plants had initiated significantly more inflorescences within the crown compared to year two plants of the same cultivar (Figure 1). Junebearer strawberry plants are known to initiate inflorescences within their crowns during the shortening days of late summer and autumn prior to going dormant which happens when the temperature decreases and the daylength becomes even shorter. Plants in year 1 were received in November after initiation had already occurred, and the plants were either becoming or had become dormant this was likely the cause of the early flower expression seen, as dormant plants would interpret the increase in daylength and warm temperatures of the propagation environment as the environmental triggers to break dormancy and express their inflorescences, as opposed to initiating inflorescences within the crown.

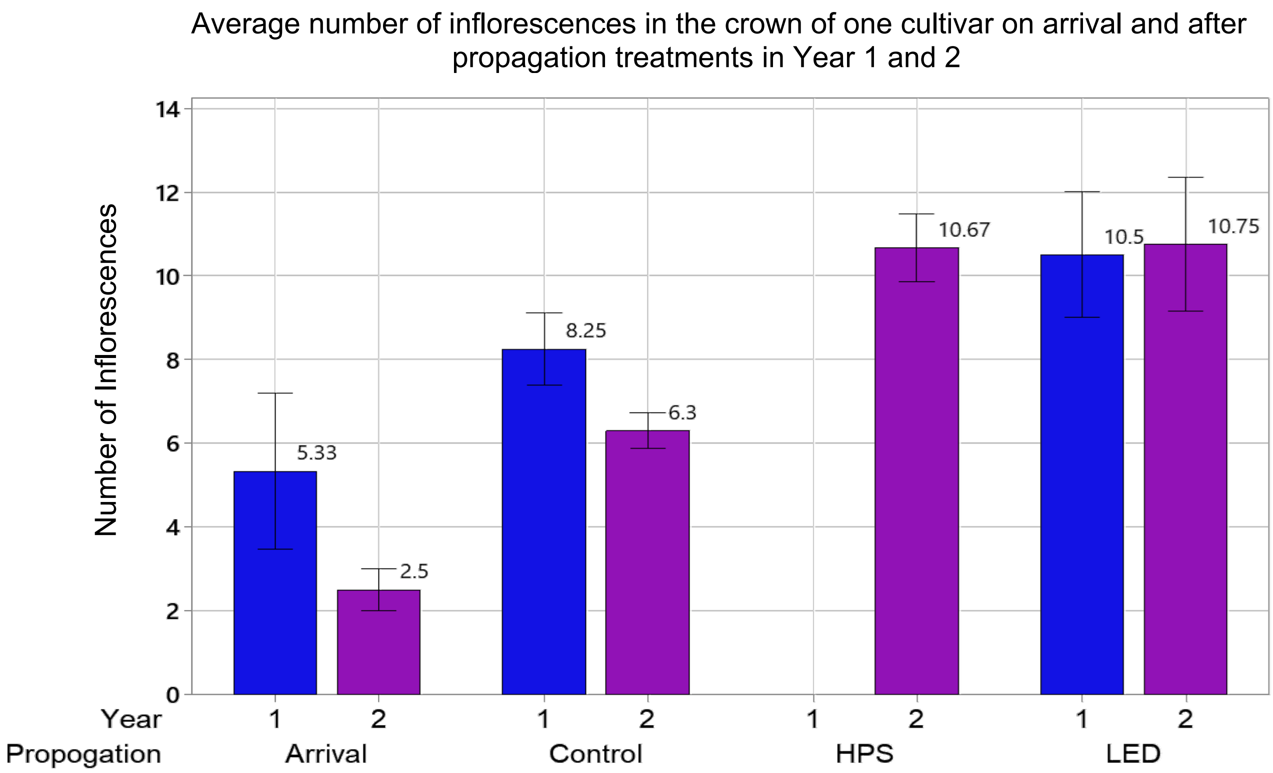

Figure 1. Average number of inflorescences within the crown of one cultivar upon arrival and after propagation treatments over two years. Year 1 plants (blue) were received November 2021 and year 2 plants (purple) were received August 2022.

Fruiting

After propagation plants propagated under control and elite conditions (with LED lighting) were chilled in an unheated glasshouse. After reaching their chill requirement, plants were potted into 2L pots and transferred to a heated glasshouse where the temperature and daylength were steadily increased over two weeks to 17°C and 14 hours respectively. Elite and control plants were then assigned equally to eight treatments and transferred into one of eight growth chambers (Fitotron, Weiss Technik, Loughborough, UK) under the temperatures and CO_2 levels presented in Table 1. All chambers had a 16-hour photoperiod (5am – 9pm, 375μmol m^{-2} s^{-1}) with a night temperature of 12℃ and a constant vapour-pressure deficit of 0.69kPa.

Table 1. Daytime (5am-9pm) temperature and CO_2 level treatment combinations for each of the eight growth chambers.

Temperature/CO_2	400ppm	800ppm	1200ppm	1600ppm
17℃	**X**	**X**	**NA**	**NA**
21℃	**X**	**X**	**X**	**X**
25℃	**X**	**X**	**NA**	**NA**

Figure 2 shows the effect of temperature on average berry weight of both control and elite plants at a CO_2 level of 400ppm. Elite plants had significantly smaller berries than control plants regardless of temperature and as temperature increased average berry weight decreased for both propagation treatments.

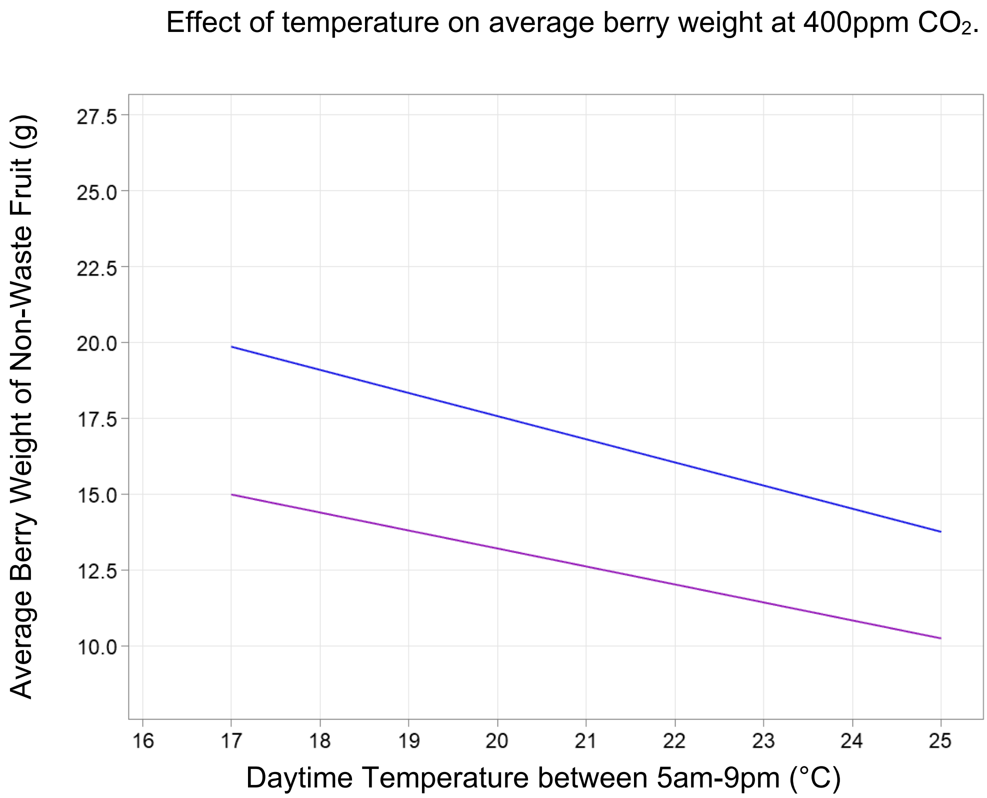

Figure 2.Effect of temperature on average berry weight of all fruit which was marketable quality but not necessarily marketable size (marketable standard is considered 25mm and above) at 400ppm CO_2. The blue regression line represents the control plants and purple represents the elite plants.

Similarly, Figure 3 shows the effect of temperature on average berry weight of plants produced under both propagation treatments at 800ppm CO_2. Regardless of the supplementary CO_2, increasing temperature still caused a reduction in berry size in both control and elite plants. Control plants had significantly bigger berries than elite plants at lower temperatures but as the temperature increased the berry size of both elite and control plants began to converge.

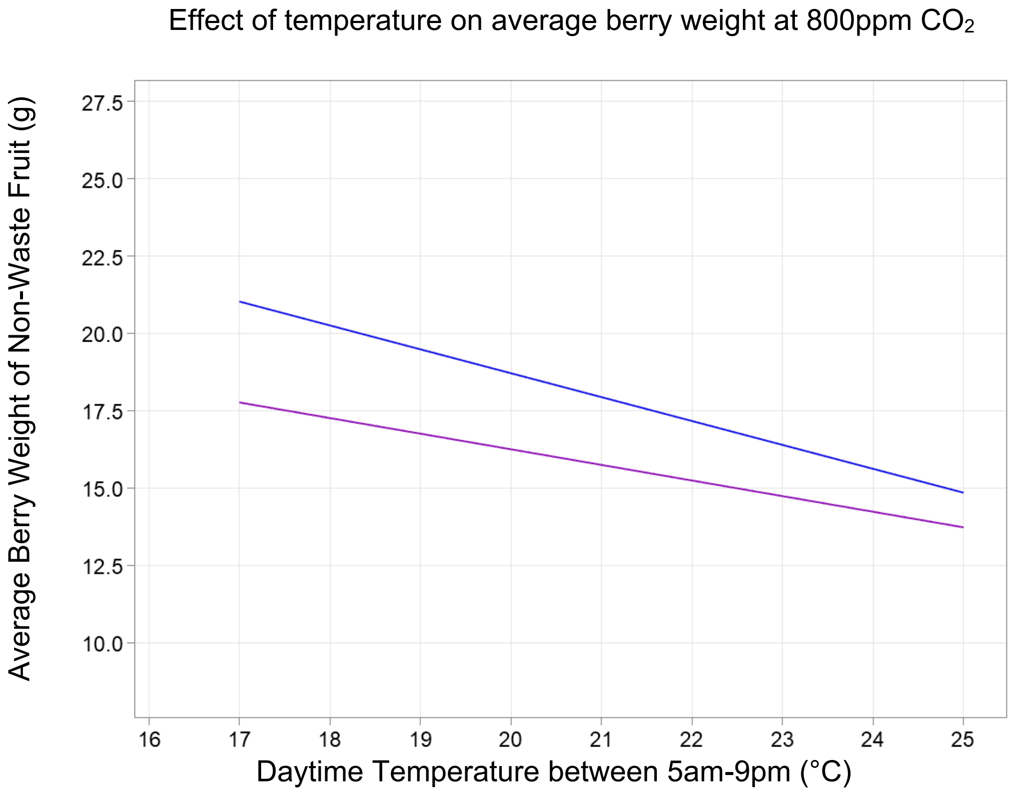

Figure 3. Effect of temperature on average berry weight of all fruit which was marketable quality but not necessarily marketable size (marketable standard is considered 25mm and above) at 800ppm CO_2. The blue regression line represents the control plants and the purple represents the elite plants.

4. Key issues to be addressed in the next year

- The effect of light intensity on floral initiation and expression of inflorescences during propagation
- Whether propagating elite plants under HPS lighting as opposed to LED lighting will affect final marketable yield
- Whether plants propagated under elite and control treatment have different chill requirements and how different levels of chill could impact the cropping profile
- Whether the removal of either primary, secondary or tertiary flowers during the fruiting season would help increase average berry size for the remaining fruit on a fruiting truss and increase overall marketable yield

5. Outputs relating to the project

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

Output	Detail
Presentation	University of Reading Crop Science Student Symposium (01/11/2022)
Presentation	CTP Winter Event (17/01/2023-18/01/2023)
Presentation	CTP Summer Event (04/07/2023 – 05/07/2023)

6. Partners (if applicable)

Scientific partners	
Industry partners	
Government sponsor	