Studentship Project: Annual Progress Report 11/2022 to 10/2023

Student Name:	Sophie Read	**AHDB Project Number:**	CTP_FCR_2019_8
Project Title:	Towards year-round production of UK strawberries		
Lead Partner:	NIAB EMR		
Supervisor:	Mark Else (NIAB EMR), Carrie Twitchen (University of Reading) and Paul Hadley (University of Reading)		
Start Date:	01/10/2019	**End Date:**	30/09/2024

1. Project aims and objectives

- To explore different environmental and cultural growing conditions to develop optimal growing models for winter glasshouse production.
- To investigate the use of new specialist low-chill strawberry cultivars to produce out-of-season UK strawberries in winter glasshouse production.
- To develop chilling models for major Junebearer (JB) and Everbearer (EB) cultivars.
- To carry out an economic study to balance the costs of delivering the environmental conditions required for out-of-season strawberry production including lighting, heating and CO_2 enrichment with the financial returns.

2. Key messages emerging from the project

- JB and EB cultivars can be successfully combined in one growing system to extend the strawberry production season with the focus on the low chill JB for maximising early yields.
- A starting temperature of 22°C which is then lowered to 16°C prior to fruiting is optimal for promoting earlier flowering and fruiting without compromising berry size and yield. Compromised berry size and yield is seen with a higher temperature in the later fruiting growth stages.
- A light duration of 12hrs LED lighting (+4hrs photoperiod extension) over the winter season with continued photoperiod extension in the spring, is beneficial for balancing economic and environmental inputs and outputs for a sustainable growing model. This will be confirmed by the full cost analysis planned for the final project write-up.
- Night-break lighting (NBL) has the potential to be incorporated into an economical and environmental beneficial growing system to bring flowering and fruiting forwards to enable earlier planting and hence earlier fruiting whilst also supplementing some of the higher energy LED lighting if applied early enough to the plant material in its developmental cycle so the LED lighting can be switched on for a shorter duration. NBL can also be used to enhance Class 1 and total yields of a low-chill JB.
- CO_2 enrichment has the potential to reduce the chill requirement of both JB and EB cultivars and promote valuable early season yield.

3. Summary of results from the reporting year

In the fourth year of this PhD project, a winter glasshouse experiment was carried out incorporating the results from the second year and third year experiments, which showed NBL is beneficial in reducing the chill requirement of a specialist low-chill JB and an EB, with CO_2 enrichment to improve strawberry yield and quality. The experiment was conducted in a temperature-controlled glasshouse with two compartments. One compartment was CO_2-enriched (720ppm) and the other, kept at atmospheric CO_2 levels (400-450ppm). In both compartments, there were two photoperiod extension 'garages' which were set to provide +4hrs low intensity photoperiod extension to the 12hrs LED lighting that the plants were under from 6am to 6pm. One garage in each compartment was programmed to provide 7 hours of night-break lighting (NBL) at 10 W/m^{-2} for 15 minutes per hour from 10pm until 4am, whilst the other garage in each compartment had no NBL programmed. Control plants of both the JB and EB cultivars were set up in blocks under ambient lighting in each compartment with different treatment combinations of full/partial/no chill, NBL/no NBL and CO_2-enriched/atmospheric CO_2. The data collected during this experiment included: dates of first open flower and ripe fruit, initial growth measurements at the start of the experiment and a destructive harvest at the end of the experiment, fruit yield sorted into Class 1, Class 2 and waste and Brix measurements. Analysis of the experimental data is still being carried out but the results to date have shown some interesting findings:

- CO_2 enrichment significantly reduced the time to first flower for the EB and although not significant, a similar trend was seen for the JB.
- CO_2 enrichment significantly reduced the time to first fruit for the JB, suggesting that it accelerated the fruit ripening process, and a similar trend was seen for the EB, although this was not significant.
- There was no significant effect of NBL on time to first flower or fruit which is different from what was found in the previous two years of experiments, but this may be due to the plant material being more advanced at the start of the experiment than in the earlier experiments.
- NBL had a strong positive effect on increasing total and Class 1 yield for the JB supporting results from previous years' experiments.
- CO_2 enrichment had no effect on the total yield of the JB or EB which was unexpected and a negative effect on Class 1 yield of the EB was seen. This will be explored further when the yield data from the control plants has been incorporated into the analysis.

4. Key issues to be addressed in the next year

All experimental work has now been completed and the next year will be used for data analysis and writing up my thesis. My plan is to address different environmental factors that I have investigated over the four years of this project in different chapters of my thesis by combining experiments together that have replicated certain environmental treatments e.g. NBL. I plan to look into the economic and carbon footprint costs of various treatment combinations that I have used such as with CO_2 enrichment and LED lighting and incorporate this into each experiment write-up to fulfil the aim of balancing the costs of delivering environmental conditions including lighting, heating and CO_2 enrichment with the financial returns for sustainable out-of-season strawberry production.

5. Outputs relating to the project

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

Output	Detail
Accepted manuscript for the conference proceedings for the International Horticultural Conference 2022 (05/01/2023)	Manuscript entitled "Reducing Chill through Night-Break Lighting and Gibberellic Acid Application to Achieve Year-Round UK Strawberry Production".

Oral presentation for the CTP Student Presentation Winter Event	Recorded presentation presented at the winter event (17th January 2023) summarising my third year experimental results focussing on NBL, LED lighting and GA_3 application to reduce chill.
Oral presentation for the Crops Group Seminar at the UoR	On-line presentation (20th June 2023) giving an update on the results from a third year experiment looking at timing of GA_3 application on time to flowering and fruiting and fruit yield.
Oral presentation for the CTP Student Presentation Summer Event	Recorded presentation presented at the summer event (4th July 2023) summarising the results from a third year experiment looking at timing of GA_3 application on time to flowering and fruiting and fruit yield.
Oral Presentation at the David Miller Awards	Live presentation at the SCI Headquarters in London (10th October 2023) summarising the results from my fourth year experiment looking at the effects of NBL and CO_2 enrichment on reducing chill requirements and improving fruit quality and yields.

6. Partners (if applicable)

Scientific partners	
Industry partners	Richard Harnden and Harriet Duncalfe - Berry Garden Growers Ltd
Government sponsor	AHDB