

Studentship Project: Annual Progress Report 11/2021 to 10/2023

Student Name:	Mengjie Fan	AHDB Project Number:	SF/TF 170a
Project Title:	Optimising photosynthesis performance, marketable yields, and berry quality using blue light		
Lead Partner:	NIAB, University of Essex		
Supervisor:	Prof. Tracy Lawson, Dr. Andrew Simkin, Dr. Mark Else		
Start Date:	15/11/2021	End Date:	1/10/2025

1. Project aims and objectives

This project aims to explore pathways of improving strawberry photosynthesis and to overcome yield bottleneck through understanding plant physiology in response to blue light and using genetic manipulation.

2. Key messages emerging from the project

The impact on yield and the cost benefit of physiological adaption to high percentage of blue light treatment.

3. Summary of results from the reporting year

The experiments herein subjected strawberry plants to a diverse range of blue light percentages within a controlled environmental chamber, employing an array of multiple Light Emitting Diodes (LEDs) as the light sources. Following an initial priming period, these plants were subsequently transferred to standard commercial polytunnels for further cultivation.

My results revealed a noteworthy enhancement in leaf photosynthetic capacity, both under steady-state and dynamic light conditions, for plants exposed to a high proportion of blue light within the spectral composition. This enhancement in photosynthetic prowess was ascribed predominantly to alterations in leaf biochemical and anatomical attributes, concomitant with an intensified gaseous exchange between the external atmosphere and the leaf interior. Notably, the findings illuminated a substantial stomatal limitation within the tested commercial strawberry cultivars, further underscored by the relatively feeble stomatal responses to the presence of blue light.

Furthermore, the results unveiled the dynamic adaptations of various plant traits to shifting lighting conditions and their prospective repercussions on plant physiology. In pursuit of addressing the identified bottlenecks constraining strawberry photosynthesis and acquiring a more profound comprehension of stomatal limitations impacting photosynthetic performance, a series of transgenic plants were engineered, targeting specific stomatal regulators. Including the transcription factor SPECHLESS (SPCH), a guard cell plasma membrane H⁺-ATPase protein pump, as well as a duo of chlorophyll-related enzymes, Chlorophyllase and Chlorophyll a oxygenase, with the latter pair being selectively directed to the guard cells.

The results described in this summary report are interim and relate to one year. In all cases, the reports refer to projects that extend over a number of years.

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Subsequent phases of this investigation entail comprehensive phenotypic assessments of these transgenic specimens are scheduled for the forthcoming years.

4. Key issues to be addressed in the next year

With the completion of the initial work package, spanning the past two years, investigating the impact of high blue light priming, I have amassed compelling data demonstrating a clear enhancement in photosynthesis resulting from this treatment. This comprehensive dataset captures the seasonal fluctuations subsequent to the initial priming phase. Moving forward, my focus will shift towards molecular quantification of the leaf samples collected throughout the growth season. This effort aims to unearth the underlying mechanisms driving the observed phenotypic alterations in response to light. Additionally, I will commence the phenotyping of the transgenic plants cultivated over the years. This endeavor holds the potential to yield novel insights into how plants adapt to light conditions. Lastly, an economic analysis will be undertaken to evaluate the application of high blue light in controlled environments. This analysis seeks to normalize yield against electrical costs, striving to identify the optimal balance point that maximizes both yield and photosynthesis while managing additional expenses.

5. Outputs relating to the project

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

Output	Detail
Presentation at Plastid preview conference 2022 at John Innes Center	Results and methodology on first year experiments
Poster presentation at graduate forum UEssex	Results demonstration of first year outcomes.
Oral presentation at SEB centenary conference	Manipulating Stomatal Density in Bread Wheat: Differential Impacts on Photosynthesis and Blue Light Responses Across Leaf Surfaces
Poster presentation at SEB birthday event	Manipulating Stomatal Density in Bread Wheat: Differential Impacts on Photosynthesis and Blue Light Responses Across Leaf Surfaces
Oral Presentation - Graduate Forum	Photonic Phenotype Induction to Optimise Plant Response to Changing Climate
Submitted Book Chapter	Using Infrared Thermography For High Throughput Plant Phenotyping

6. Partners (if applicable)

Scientific partners	
Industry partners	
Government sponsor	