Project title:	Optimising the light recipe for maximum photosynthesis, yield and quality in strawberry
Project number:	
Project leader:	Keiri Swann University of Reading
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Location of project:	University of Reading
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AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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GROWER SUMMARY

Headline

Over 100 tonnes of strawberries per hectare is achievable with multi-tiered farming. First fruit can be produced by valentine's day. However, electricity costs are prohibitive without higher yields per unit area and greater efficiencies in the use of artificial light.

Background

There is an expanding market for out of season strawberries in the UK which is, currently met by importation from warmer countries such as Spain or UK glasshouse production under High Pressure Sodium (HPS) lights. LED lighting offers a far more efficient alternative to HPS lights for UK production. My research explores the potential for LEDs in strawberry production and how they could be used most efficiently with regards to light intensity, spectrum and duration.

Summary

Out-of-season production of strawberries is possible using a multi-tiered growing system using supplementary LED lighting. An everbearer cultivar produced a larger overall crop but production was two weeks later that an early season Junebearer. Supplementary LED light increased yield to over 100 tonnes per hectare but with high associated electricity costs. Yields decrease down the tiers with the reduced availability of natural light. Light intensity significantly increases yield at intensities above 227 µmol/m^2/s.

Financial Benefits

Despite high out-of-season yields produced in this experiment the multi-tiered system has not yet been optimised to be cost effective when electricity costs were considered. Table 1 indicates how the different lighting treatments and associated costs relate to the yield and profitability of the system.

Table 1: Cost yield analysis per meter for each cultivar and lighting treatment with an averaged effect of tier. Strawberry price based on early season strawberry prices ((DEFRA, 2020b).

Variety	Photo-duration	Intensity (µmol $m^{-2}s^{-1}$)	Energy Cost (£)	General Cost (£)	Total Cost (£)	Yield (kg)	Price (£/kg)	Income (£)	Profit (£)
Junbearer	11	344	29.43	31.58	61.01	2.908	8	23.27	-37.74
Junbearer	11	227	23.54	31.58	55.12	2.554	8	20.43	-34.69
Junbearer	16	344	42.81	31.58	74.39	3.076	8	24.61	-49.78
Junbearer	16	227	34.25	31.58	65.82	2.886	8	23.09	-42.74
Junbearer	22	344	58.86	31.58	90.44	3.263	8	26.10	-64.34
Junbearer	22	227	47.09	31.58	78.67	2.935	8	23.48	-55.18
Everbearer	11	344	29.43	31.58	61.01	3.321	8	26.56	-34.44
Everbearer	11	227	23.54	31.58	55.12	3.222	8	25.78	-29.35
Everbearer	16	344	42.81	31.58	74.39	3.968	8	31.75	-42.64
Everbearer	16	227	34.25	31.58	65.82	3.193	8	25.54	-40.28
Everbearer	22	344	58.86	31.58	90.44	4.089	8	32.71	-57.73
Everbearer	22	227	47.09	31.58	78.67	4.054	8	32.43	-46.24

Action Points

The use of supplementary light produces higher and earlier strawberry yields. However, a lower light intensity than seen here is likely to be more profitable, due to lower associated energy costs. Furthermore, higher planting densities and the addition of CO_2 could dramatically increase yield and profitability. Also, there is a potential for vertical farms to achieve a higher price for the fruit due to increased consumer demand for a novel product with less pesticide use, low food miles and cleaner production methods.