



Grower Summary 1

CP 085

Securing skills and expertise in crop light responses for UK protected horticulture, with specific reference to exploitation of LED technology (EMT/AHDB Horticulture/HTA Fellowship)

Annual 2014

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Further information

If you would like a copy of this report, please email the AHDB Horticulture office (hort.info.@ahdb.org.uk), quoting your AHDB Horticulture number, alternatively contact AHDB Horticulture at the address below.

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Project Title: Securing skills and expertise in crop light responses for UK protected horticulture, with specific reference to exploitation of LED technology (EMT/AHDB Horticulture/HTA Fellowship)

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GROWER SUMMARY 1

Light spectrum and plant stress.

Headline

Blue light stresses plants more than red or green light. Altering the light spectrum could improve plant growth rates by reducing stress or improving stress tolerance; this could reduce the time required to harden off plants prior to transplanting.

Background

To prevent leaf scorching, plants generally need to be hardened off when they are moved from a protected environment to a field setting. Scorch can be caused by several factors, one of which is light stress (photoinhibition). Plants acclimate to the amount of light they receive; this allows them to photosynthesize at maximum efficiency in a given environment. Part of the acclimation process involves increasing the rate of repair of photoinhibition to match the rate of photoinhibition occurring in the plant. If exposed to a sudden increase in light level, plants may be unable to use all the light for photosynthesis. The excess light energy may then cause photoinhibition and lead to scorching. A sudden decrease in temperature can also cause the same effect because photosynthesis occurs more slowly in lower temperatures.

Different colours of light can result in different amounts of stress. UV light in particular can cause extensive damage when plants are moved outdoors as many covering materials (glass and polythene covers) filter UV light. Plants produce protective pigments on exposure to UV light, but leaves will be damaged if exposure is high before sufficient concentrations of these pigments can be produced.

It is possible to select the colour of light to meet the needs of plants using LEDs. It should, therefore, be possible to select a light spectrum that can reduce light stress and maximise photosynthetic efficiency. Alternatively, a light spectrum could be selected that stresses plants in a controlled manner to help the hardening off process or encourage the synthesis of secondary metabolites such as anthocyanin (the pigment that turns leaves red). A necessary first step in determining the feasibility of these approaches is the determination of the amount of light stress caused by different colours of commercially available LED light. This experiment was performed during a one week visit to Prof Carl-Otto Ottosen's laboratory at Aarhus University, Denmark.

Summary

Experiments were performed to assess how rapidly blue, green, and red light from LED lighting systems cause photoinhibition. To do this, plants were treated with lincomycin, a chemical that prevents plants from repairing the damage caused by light stress. Leaves were then exposed to LED light of different colours and the rate of damage tracked through time. The amount of photoinhibition was measured using a chlorophyll fluorimeter. This instrument measures a parameter referred to as F_v/F_m . When this value is close to 0.84, no photoinhibition has occurred. Values decrease towards zero as photoinhibition occurs. Photoinhibition was found to be greatest when plants were exposed to blue LED light and least when exposed to green LED light. The experiment also assessed the gradient of photoinhibition that occurs between the upper and lower surface of leaves. Light intensity decreases as it passes through a leaf, and more damage should therefore occur near the upper surface. As expected, more damage occurred near the upper surface of the leaves where the light intensity was greatest. The difference between the damage occurring between the upper and lower leaf surfaces was strongly influenced by light colour. The difference was greatest for blue light and least for green light, as would be expected given the greater leaf penetration of green light.

Financial Benefits

It is not possible, as this stage, to assess the potential financial implications of this research. This work would be expected to help the ongoing development of a lighting spectrum designed to maximise plant growth rates and/or to assist the hardening off process.

Action Points

It is too early in this program of research to make recommendations for best practice in use of light spectrum manipulation for improving stress tolerance.