Grower Summary

CP 085

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

Annual 2013

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GROWER SUMMARY

Using LEDs to control plant morphology and reduce the need for PGRs.

Headline

Increasing the percentage of blue light reduced plant height, while addition of far-red light increased crop height. With careful selection of the light recipe plant height can be controlled reducing or potentially removing the need for plant growth regulators. In some crops far-red light will be beneficial and may increase harvestable yield.

Background

The use of plant growth regulators (PGRs) are required to keep commercially grown crops within the strict retailer set specifications. Growers are under increasing pressure to decrease the use of chemical inputs to reduce chemical residues and environmental impacts. If PGRs are banded it will be difficult to grow many plants to sufficient quality. In addition PGRs cannot be used on all crops (e.g. most food crops) and alternative methods must be used if crop morphology is to be controlled. A number of non-chemical approaches for controlling crop heights have been developed, including reduced watering strategies, increased EC values and temperature manipulations (negative DIF or DROPS and JUMPS: see HDC research project PC 41). While these approaches can be effective for some crops they are often used to counteract plant stretching that has been caused by poor light quality during growth. Spectral manipulation via LED lighting or spectral filters will improve crop quality and reduce the need for PGR applications.

To extend the growth season or increase productivity crops are often lit with high pressure sodium lighting. While HPS light is good for driving photosynthesis and crop growth the spectrum of the light often results in plants becoming stretched. This is because HPS light is deficient in the blue light that helps keep plants compact. The introduction of LED lighting for horticulture has provided the opportunity to design light mixtures or recipes that have the correct spectral mix to both drive efficient photosynthesis and control plant height. In this initial study we have examined the influence of the red:blue and the red:far-red ratios on the height of a range of crops with the aim of improving our understanding of how crops respond to LED lighting.

Summary

A series of small pilot scale trials were performed in the LED4CROPS growth facility at STC to examine the influence of light spectrum on plant height and yield in a range of crops species

in the absence of background sunlight. The influence of three colours of light were tested: blue (430 nm); red (660 nm); and far-red (735 nm).

Controlling plant height

Tomato, Sweet Pepper and a several microherbs (Basil, Red Amaranth, Coriander, Watercress, Red Veined Sorrel, Red Perilla and Parsley) were grown as young vegetative plants under four different red and blue light recipes (no far-red was included). In each treatment the light intensity was kept constant at 200 μmol m^{-2} s^{-1}. As the proportion of blue light was increased plants became more compact and had a smaller leaf area. The most desirable plants (plants with shorter internodes) tended to be those where there was a higher incidence of blue light relative to red light.

Harvestable Yield

Dwarf bean plants demonstrate large responses to different light recipes and therefore are a good crop to demonstrate the effect of changing the light recipes.

Bean plants were grown under four different red and blue light recipes (no far-red was included). In each treatment the light intensity was kept at 150 μmol m s^{-1} but the blue proportion was changed.

As found with the other crops investigated bean stems were shorter resulting in more compact plants when blue light formed a higher proportion of the total light intensity. However, the more compact plants had a lower bean yield so plants grown under a low proportion of blue light were more desirable. A second experiment was performed on bean plants to examine the influence of far-red light on plant height and yield. In each treatment plants were provided with 186 μmol m^{-2} s^{-1} of photosynthetically active radiation (16% blue) and four different far-red intensities (0, 9, 24, 48 μmol m^{-2} s^{-1}). Increasing the far-red light resulted in taller plants with a larger leaf area and larger bean yield. The largest plants were those produced with the highest far red light (48 μmol m^{-2} s^{-1}) but this treatment also had the highest electrical inputs.

Conclusions

These experiments demonstrate that light can be used to control plant morphology in crops that can't be treated with plant growth regulators. The consistency of the responses between the different species examined suggested that the results will be applicable to all species and that spectral manipulation will be a useful tool for the reduction of plant growth regulators in the ornamental sectors. The data also indicate that the best light regime will differ between crops depending on the qualities desired from the crop and what part of the crop is harvestable/saleable. It is also possible that the lighting regime may need to be changed during different crop stages e.g. vegetative and reproductive stages.

Financial Benefits

It is currently too early in the project to assess the financial implications of the research, or to make recommendations as to the best practice for LED lighting systems. The current high initial investment cost associated with the LED systems is perceived as inhibitory. The prices of LEDs are anticipated to decrease in the coming years and improve the economic case. As energy prices continue to rise this will bring the increased efficiency of LED light relative to HPS/HID lights into more focus. Understanding the plant light responses will be key to making the best of LED lighting and help define when the economics merit investment.

Action Points

It is too early in the project to make suggestions as to the best use of LED lighting systems.