AHDB

HORTICULTURE

# Grower Summary

## PE 023

Hormetic UV-C Treatments for Control of Plant Diseases on Protected Edibles

Annual 2016

## Disclaimer



The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

## Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

## Further information

If you would like a copy of the full 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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AHDB Horticulture is a Division of the Agriculture and Horticulture Development Board.

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| **Project title:** | Hormetic UV-C Treatments for Control of Plant Diseases on Protected Edibles |
| **Project number:** | PE 023 |
| **Project leader:** | Dr Gilbert Shama, Loughborough University |
| **Report:** | Annual report, August 2016 |
| **Previous reports:** | Annual report, August 2015 |
| **Key staff:** | George Scott, Loughborough University<br>Matevž Rupar, The University of Nottingham<br>Professor Matt Dickinson, The University of Nottingham<br>Dr Gilbert Shama, Loughborough University |
| **Location of project:** | The University of Nottingham, Sutton Bonington Campus, Plant Science. |
| **Industry Representative:** | Philip Pearson, APS Salads, Aston Way, Middlewich, Cheshire, CW10 0HS.<br>Nigel Bartle, North Bank Growers Ltd., Tees Valley Nursery, Billingham, TS23 4ED.<br>James Bean, Crystal Heart Salads, Eastrington Road, Sandholme, Brough, North Humberside, HU15 2XS. |
| **Date project commenced:** | 1st September 2014 |
| **Expected completion date:** | 31st August 2017 |

# GROWER SUMMARY

## Headline

- Post-harvest treatments of tomato fruit with a high intensity, pulsed polychromatic source, rich in UV-C, show induced disease resistance against *Botrytis cinerea* and delayed ripening. Treatment time is reduced by 97.3 % in comparison to low intensity, conventional UV-C sources.
- Post-harvest treatments of tomato fruit from the side with high intensity, pulsed polychromatic or conventional UV-C sources elicit a local response and full surface exposure is, therefore, required.
- Post-harvest treatments of tomato fruit with a high intensity, pulsed polychromatic or conventional UV-C sources induce resistance to *B. cinerea* on both mature green and ripe tomatoes.

## Background

Hormesis is a dose-response phenomenon where low doses of a stressor bring about a positive response in the organism undergoing treatment. The benefits of UV-C hormesis have been known for nearly 30 years. A broad range of benefits are observed from increased nutritional content to disease resistance and reduced chlorophyll degradation. To date, the majority of studies have been performed using conventional low pressure mercury UV-C sources on post-harvest produce. Commercial application of these treatments has, in part, been prevented due to the lengthy exposure times necessitated. Conventional treatments of tomato fruit take in excess of six minutes. High intensity, pulsed polychromatic light sources, rich in UV-C, however, have been developed which hold the potential of drastically reducing treatment times and making UV-C treatments a commercial possibility. However, it is necessary to demonstrate that such sources have the ability to induce disease resistance and delay ripening on tomato fruit through post-harvest treatments (Objective 1).

Recently, exposure of foliage to UV has been shown to induce resistance against downy mildew and grey mould on *Arabidopsis thaliana*. The horticultural application of such treatments, however, have not been explored. We, therefore, aim to research pre-harvest UV treatments to induce resistance on both tomato and lettuce crops (Objectives 2 & 3). Utilisation of such UV treatments in commercial situations may allow an alternative to traditional chemical-based disease control and provide a residue-free alternative to other inducers of disease resistance.

## Summary

***Objective 1 - Validation of the High Intensity Pulsed Polychromatic light Source***

Tomato fruit of the cv. Meccano were treated at both the mature green and ripe stage. An established conventional UV-C treatment was performed alongside a number of pulsed polychromatic treatments. This was to allow a comparison of the sources' ability to induce both disease resistance against *B. cinerea* and delay ripening. Both conventional and pulsed sources successfully induced resistance, to comparable levels, against *B. cinerea* on mature green fruit following artificial inoculation. Disease progression on ripe fruit, however, was inhibited to a greater extent on ripe fruit treated by the pulsed source. Furthermore, ripening was delayed by the pulsed source to comparative levels of that observed for the conventional source. Both ripe and mature green fruit showed optimal treatment of 16 pulses giving a total treatment time of 10 seconds yielding a 97.3 % reduction in treatment time. The ability to induce resistance to *B. cinerea* at both the mature green and ripe stages shows that post-harvest UV-C treatment could be adopted by growers who harvest at differing fruit maturities. The majority of previously published research was focused only on fruit at the mature green stage.

Further investigation has highlighted that both the conventional UV-C and pulsed polychromatic sources elicit a local response in tomato fruit. Fruit would, therefore, require full surface exposure to the optimal dose to effectively induce the hormetic benefits. The local response is seen for both disease resistance and delayed ripening. To assess the need for direct tissue exposure to induce resistance, fruit were treated on a single side and then inoculated at either the directly exposed tissue or unexposed tissue. Unexposed tissue gave results homologous to those observed for the control, figure 1. An example of the local delayed ripening response to treatment can be seen in figure 2 where the uneven ripening in treated groups B, C, D and E is caused by only partial exposure to UV-C or polychromatic light.

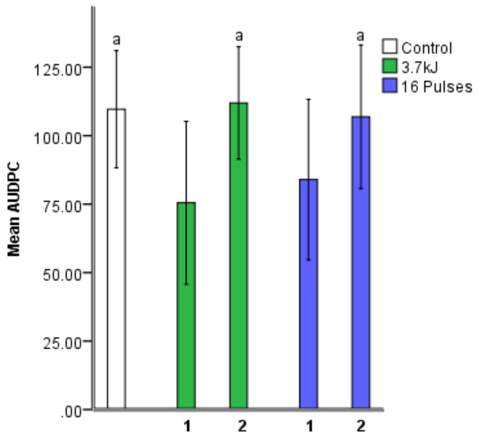


**Figure 1.** Area underneath the disease progression curve (AUDPC) of tomatoes, cv. Mecano, treated on a single side and inoculated with *B. cinerea* at 10 d post treatment. Fruit were treated with an established low intensity UV-C treatment of 3.7 kJ/m$^2$and a high intensity pulsed polychromatic treatment of 16 pulses. (**1**) Exposed tissue and (**2**) unexposed tissue. Error bars show ± 1 standard deviation; n = 20. Labelling denotes a statistically significant result at $p < 0.05$. Means sharing the same superscript are not significantly different from each other at $p< 0.05$. (Scott *et al.,* 2016)

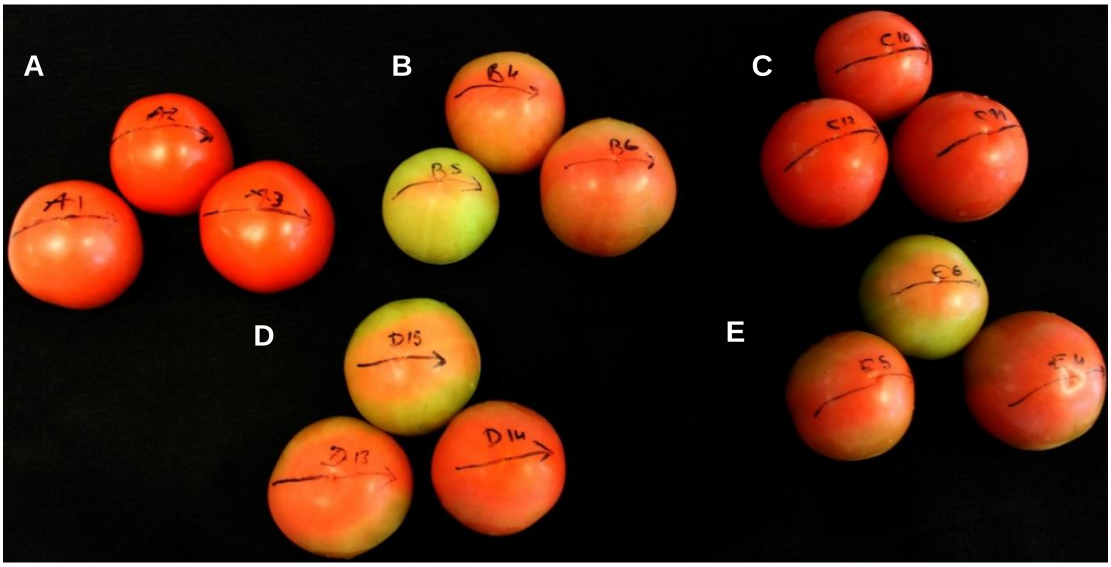


**Figure 2.** A representative sample from the fruits treated post-harvest showing: **A)** Control fruit. **B)** Conventional treatment with the low pressure mercury source. **C)** An 8 pulse treatment. **D)** A 16 pulse treatment and **E)** A 24 pulse treatment. Black lines on the fruit run parallel to the direction of UV source exposure which highlights the dependency of full surface exposure for delayed ripening. (Scott *et al.,* 2016)

### *Objective 2 - Foliar UV-C and Polychromatic Treatments of Tomato*

No previous work has been carried out on the induction of resistance on tomato through exposure of the foliage to UV. The first step was, therefore, to find the point at which damage was observed on plants exposed to both conventional and pulsed UV sources. This was performed at two developmental stages; early vegetative and early flowering. Damage was observed above 0.5 kJ/m$^2$ for the conventional source and at 20 pulses. Hormetic treatments will, therefore, fall below these thresholds.

***Objective 3 - Foliar UV-C and Polychromatic Treatments of Lettuce***

Damage assessments for lettuce were carried out at the 3-5 true leaf and early, mid and late head formation developmental stages. The point at which damage was caused to the plant following UV-C and polychromatic treatments varied across the year. Within the middle of the growing season damage was caused at pulsed treatments above 60 pulses and conventional treatments above 1.5 $kJm^2$. At the end of the season, however, damage was observed at pulsed treatments of 16 pulses and conventional treatments of 0.35 $kJm^2$. In preliminary studies the treatments for which reduced levels of disease was observed also showed variation across the year. Furthermore, in preliminary work the optimal treatment also varied depending on the pathogen undergoing investigation and the cultivar being used.

## Financial Benefits

Calculation of financial benefits are not possible at this time.

## Action Points

There are no immediate action points.