AHDB
HORTICULTURE

Grower Summary

PE 023

Hormetic UVC Treatments for Control of Plant Diseases on Protected Edibles

Annual ***2015***

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.

Project title:	Hormetic UVC Treatments for Control of Plant Diseases on Protected Edibles
Project number:	PE 023
Project leader:	Dr Gilbert Shama, Loughborough University
Report:	Annual report, August 2015
Previous reports:	None
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Location of project:	The University of Nottingham, Sutton Bonington Campus, Plant Science.
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Date project commenced:	1st September 2014
Expected completion date:	31st August 2017

GROWER SUMMARY

Headlines

- Post-harvest treatments of tomato fruit with a high intensity, pulsed UV source show induced disease resistance against *Botrytis cinerea* and delayed ripening. Treatment time is reduced by 98-99 % in comparison to low intensity, conventional UV sources.
- Preliminary studies indicate UV treatments of tomato and lettuce foliage induce resistance against *B. cinerea*.

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 hormesis have been known for over 20 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 UVC sources on post-harvest produce. Commercial application of these treatments has, in part, been prevented due to the lengthy exposure times necessitated. Treatment can require exposure times of several minutes. High intensity, pulsed UV sources, however, have been developed which hold the potential of drastically reducing treatment times and making UV treatment a commercial possibility. However, it is necessary to demonstrate that such sources have the ability to induce disease resistance and delayed 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 UV treatments in commercial situations may allow an alternate 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 UV Source

Tomato fruit of the cv. Meccano were treated at both the mature green and ripe stage. An established conventional UV treatment was performed alongside a number of pulsed treatments. This was to allow comparison of the sources and monitoring of induced disease resistance against *B. cinerea* and demonstrate delayed ripening. Both conventional and pulsed sources successfully induced resistance against *B. cinerea* on mature green and ripe

fruit following artificial inoculation. Ripe fruit showed the requirement for increased levels of UV exposure to effectively induce resistance with the optimal treatment of 24 pulses giving a 37 % reduction in disease, Table 1. Mature green fruit showed a lower optimal treatment of 16 pulses giving a total treatment time of 10 seconds yielding a 97 % disease reduction, Table 2. The ability to induce resistance to *B. cinerea* at both the mature green and ripe stages shows that post-harvest UV 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.

Table 1: The mean area underneath the disease progression curve (AUDPC) and disease reduction for ripe fruit of the cv. Meccano treated with both conventional and pulsed UV.

Treatment	Total treatment time (s)	AUDPC	Disease reduction (%)
Control	0.00	40.62 ±10.47	-
Conventional	370.00	36.99 ±9.04	8.94
8 Pulses	5.00	31.89 ±16.71	21.49
16 Pulses	10.00	30.14 ±15.11	25.81
24 Pulses*	15.00	25.61 ±15.70	36.96

* Indicates a significant difference to the control at the p < 0.05 level by ANOVA

Table 2: The mean area underneath the disease progression curve (AUDPC) and disease reduction for mature green fruit of the cv. Meccano treated with both conventional and pulsed UV.

Treatment	Total treatment time (s)	AUDPC	Disease reduction (%)
Control	0.00	73.24 ±10.54	-
Conventional*	370.00	51.08 ±18.98	30.25
8 Pulses*	5.00	59.87 ±11.72	18.26
16 Pulses*	10.00	41.95 ±15.33	42.72
24 Pulses*	15.00	42.49 ±21.62	41.98

* Indicates a significant difference to the control at the p < 0.05 level by ANOVA

The effects of UV treatment on ripening were only monitored for mature green fruit. Fruit colour measurements were taken from tissue directly facing the UV sources and at 90 degrees from the source to assess the requirement for complete surface exposure. Delayed ripening was most efficiently induced with a 16 pulse treatment giving a 41 % difference in tomato colour index, Table 3. Tomato colour index increases with ripening. Little change was observed for tissue at 90 degrees from the source and thus it can be concluded that the tomato requires direct exposure for delayed ripening, Figure 1.

Table 3: The change in tomato colour index (TCI) and percentage difference from control of mature green fruit from the cv. Meccano after ten days of storage following treatment with conventional and pulsed UV sources.

Treatment	Direct		90^{0}	
	Change in TCI	Difference (%)	Change in TCI	Difference (%)
Control	259.22		267.51	
Conventional	174.73	- 32.60	268.32	+ 0.30
8 pulses	235.85	- 9.02	326.86	+ 22.18
16 pulses	155.15*	- 41.15	271.85	+ 1.62
24 pulses	182.78	- 29.49	257.10	- 3.75

* Indicates a significant difference to the control at the $p < 0.05$ level by ANOVA

We have shown here that the use of a pulsed source rich in UV can induce disease resistance against *B. cinerea* on both mature green and ripe tomatoes. Furthermore, a delay in ripening on mature green tomatoes was also observed. The use of a high intensity pulsed source can reduce treatment time by 97-99 %.The use of such a source has the potential for integration into post-harvest production lines to reduce losses through disease. Moreover, the observed delayed ripening would allow increased storage or transportation times.

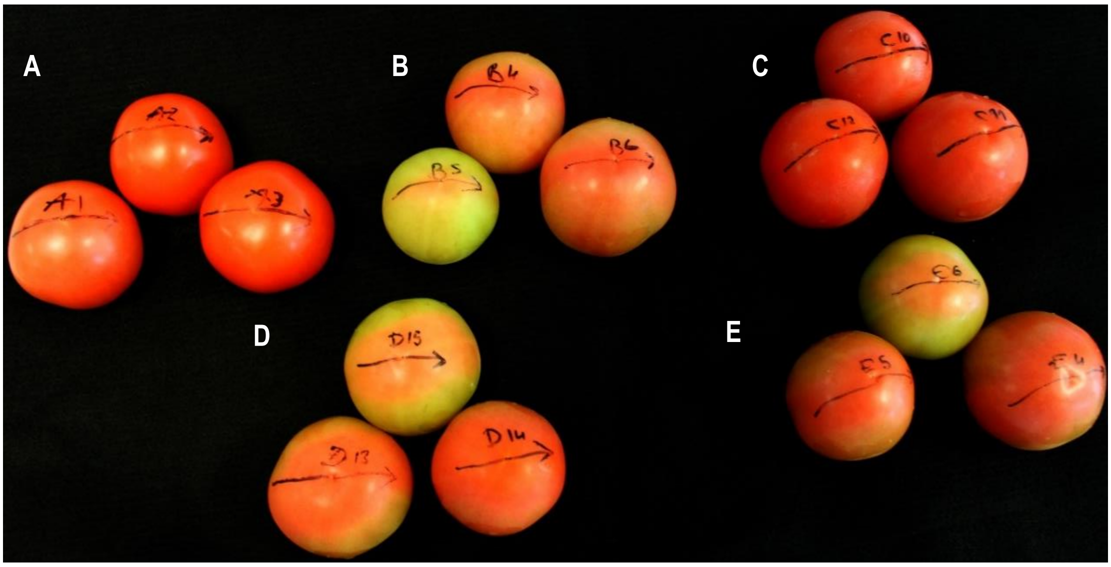

Figure 1: A representative sample from the fruits treated post-harvest showing: **A)** Control fruit. **B)** Conventional treatment with the low pressure mercury source. **C)** An 8 pulse treatment. **D)** A 16 pulse treatment and **E)** A 24 pulse treatment. Black lines on the fruit run parallel to the direction of UV source exposure which highlights the dependency of full surface exposure for delayed ripening.

Objective 2 - Foliar UV 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. During preliminary studies we have shown induced resistance against *B. cinerea* on a number of occasions. Further research, however, is required before the level and longevity of resistance can be determined.

Objective 3 - Foliar UV treatments of Lettuce

Damage assessments for lettuce were carried out at the 3-5 true leaf and early head formation developmental stages. Damage was observed above 2.25 kJ/m^2 and 45 pulses for the conventional and pulsed sources, respectively. Early indications also point towards the successful induction of disease resistance against *B. cinerea.*

Financial Benefits

Calculation of financial benefits are not possible at this time.

Action Points

There are no immediate action points.