Grower Summary

CP 105

Integrated protection of horticultural crops through enhancing endogenous defence mechanisms

Annual 2014

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Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Project Number:	CP 105
Project Title:	Integrated protection of horticultural crops through enhancing endogenous defence mechanisms
Project Leader:	Professor Adrian C Newton
Contractor:	The James Hutton Institute
Industry Representative:	Neal Ward, Cantelo Nurseries Ltd
Report:	Annual 2014
Publication Date:	18th November 2014
Previous report/(s):	None
Start Date:	1st September 2013
End Date:	31st September 2016
Project Cost:	£67,650.00

Headline

Resistance elicitors enable tomatoes to better defend themselves against Botrytis. Protection can be long-lasting but such products must be used as components of an IPM programme tailored to tomato cultivars.

Background

Many of our crop protectants either become ineffective as pathogens develop resistance, products are removed from the market for regulatory reasons, new pathogens emerge, or we need to grow varieties that are susceptible for market reasons. New active ingredients in crop protection products permitted for horticultural crops are all too rare and late, and for bacterial and viral pathogens there are few options available anyway. However, the plants themselves have highly effective resistance mechanisms that if primed and expressed in a focussed, specifically-targeted way, could not only lead to better crop protection, but also substantially reduce the need for toxic crop protectant interventions. This can be done with resistance ‘elicitors’. Resistance elicitors 'prime' plant defence mechanisms and enable the plants to respond to actual pathogen threats faster.

The underlying mechanism is mainly based upon a more effective induction and expression of defence mechanisms. However, being mediated through the plant's complex metabolic pathways where many feedback and trade-off mechanisms operate, the result of resistance priming and induction can potentially affect non-disease resistance mechanisms too. These may result in either positive or negative effects on yield quantity, quality and its components. To develop resistance induction crop protection approaches, a detailed knowledge of the timing and amplitude of defence induction as well as the consequences on target and non-target end-products is required. The molecular tools for such studies and our understanding of the mechanisms in model and crop systems have advanced considerably in recent years. In particular we will use these approaches to determine both the phenotypic and molecular profiles of defence activator combinations that should prove synergistic. This will give crucial information about how key signalling pathways interact in various crops and the mechanisms of trade-offs associated with disease reduction. The work can be seen as under-pinning crop protection mechanisms.

In particular, the project aims to (i) establish a robust and reproducible beneficial effect with an elicitor regime on a 'model' plant pathogen system; (ii) to investigate the molecular basis to the plant defence response elicited by the treatment regime and (iii) to test whether this

same response is triggered in different plant species. The project will focus on a single plant-pathogen system: *Botrytis cinerea* on tomato plantlets, testing a range of treatment types and regimes. Once effective treatment components and combinations have been established and the response characterised, the treatments will then be tested on other plant species that are also infected by *B. cinerea* to determine whether there are similarities in the mode of elicitor action. We will also determine what the effects are on non-target organisms, and here we will focus on bacteria with the potential to a pose food safety risk.

Summary

Resistance elicitors are able to reduce disease in tomatoes caused by botrytis (*Botrytis cinerea*). Long-lasting defence is induced by B-amino-butyric acid (BABA), methyl jasmonate (MeJA), “Chitosan 23” and “ChitoPlant”. These substances can significantly reduce necrotic lesion expansion and tomato cultivars differ in their response. “ChitoPlant” defence induction is characterised by callose deposition in tomato cotyledons before pathogen challenge.

Elicitors that trigger one of the main defence pathways, the jasmonate-signalling pathway (i.e. MeJA and the chitosans) are able to provide long-lasting defence and limit *B. cinerea* infection progress in both cultivars. BABA is more effective in one tomato cultivar than another and is long-lasting but the level of protection is dependent on the pathogen inoculum concentration and aggressiveness. The cultivar difference is seen clearly in the amount of callose deposition induced. There is also a cost in plant fitness after elicitor-induced resistance, particularly with BABA.

The other main defence pathway, the salicylic acid (SA)-signalling pathway, is also involved in basal defence of tomato against *B. cinerea*, however its effect and efficacy in long-lasting resistance is still unclear. Further experiments with SA elicitors will be needed.

In summary, it has been demonstrated that both SA- and the JA-signalling pathways are involved in tomato resistance against *B. cinerea*. However, their efficacy may vary depending on the pathogen strain, tomato cultivar and infection time point.

A summary of some of the main findings are presented in the landscape figure below.

Financial Benefits

Outcomes of this project will be in the form of knowledge that enables product replacement with more benign alternatives, and principles for their use. We see this as maintaining profitability by providing the tools to continue to achieve effective crop protection that might

otherwise be compromised by loss of crop protection products or their reduced efficacy. Any specific knowledge that identifies either improved crop protection over conventional approaches or results in increased marketable or quality crop will be calculated in terms of financial benefit on a case-study basis as appropriate.

Action Points

There are few resistance elicitors currently licenced for use on horticultural crops and experimentation to determine which of these are effective for particular crops is being carried out in another project. This PhD project will help determine the principles whereby such products can be used, and particularly how they might be combined effectively. The latter will be as much about avoiding detrimental combinations and practices as identifying those that might be additive or synergistic.

Effectiveness of elicitor-IR in tomato Vs the necrotrophic fungus *Botrytis cinerea*

Long lasting defence induction (15 days prior infection)

Benefits of elicitor-Induced Resistance (IR)

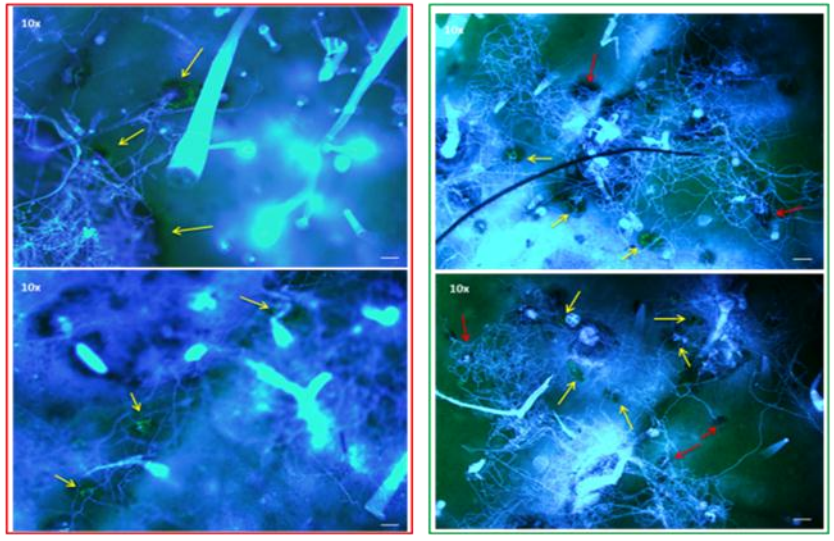
Jasmonic acid (MeJA and Chitosan) triggering elicitors

Salicylic acid (BABA) and Jasmonic acid (MeJA, Chitosan) elicitors

Costs of elicitor-Induced Resistance (IR) in plant fitness

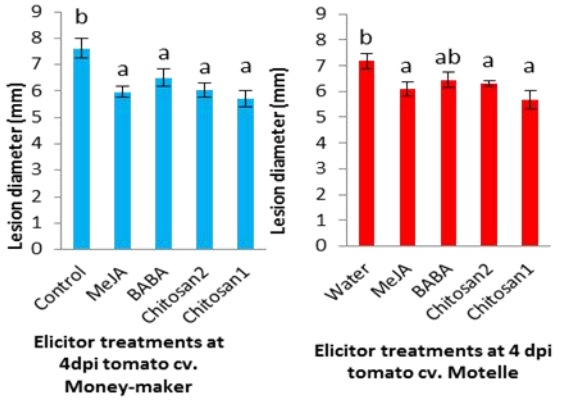
Elicitor-induced growth reduction

Cell-wall defences: Callose-rich papillae deposition

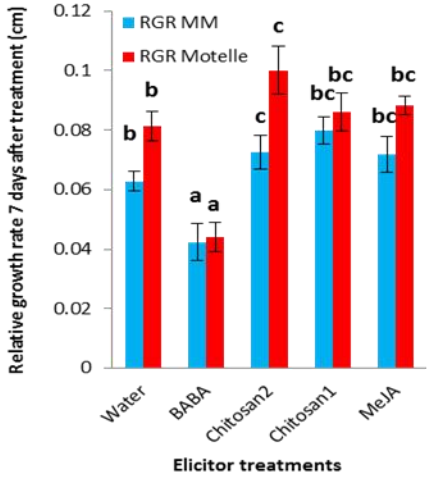


Mainly Jasmonic acid-dependent elicitors (**MeJA and Chitosan**) were able to **induce callose papillae deposition** before and **upon pathogen challenge** in both tomato cultivars (Money-maker and Motelle). Yellow arrows indicate callose papillae deposition surrounding pathogen mycelia penetration sites. Red arrows indicate fungal penetration sites without callose deposition.

Necrotic lesion reduction



BABA, MeJA and Chitosan can significantly reduce *B.cinerea* lesion growth



Quantification of relative growth rate (RGR) of 2 tomato cultivars after elicitor treatment. **BABA** caused the greatest growth inhibition of all elicitors.

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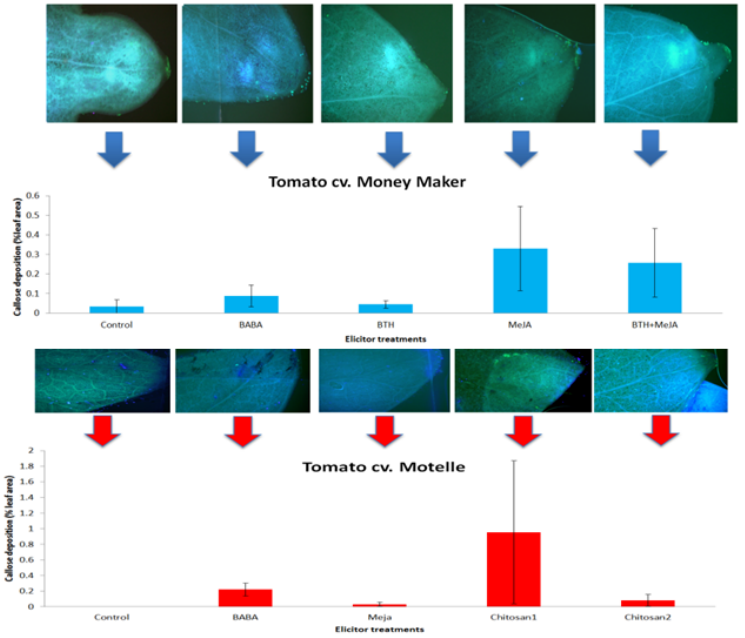
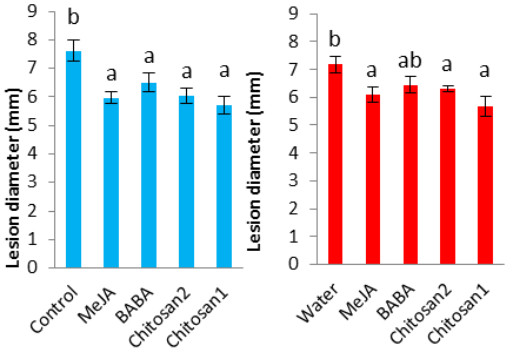


Jasmonic acid-dependent elicitors (**MeJA and Chitosan**) were able to **induce callose papillae deposition before** pathogen challenge in both tomato cultivars (Money-maker and Motelle).

Necrotic lesion reduction



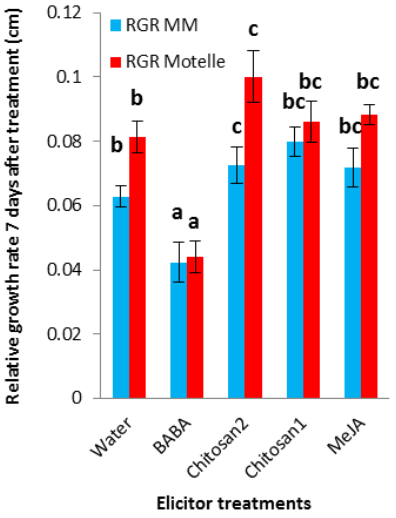
Elicitor treatments at 4dpi tomato cv. Money-maker

Elicitor treatments at 4 dpi tomato cv. Motelle

BABA, MeJA and Chitosan can significantly reduce *B.cinerea* lesion growth.

Costs of elicitor-Induced Resistance (IR) in plant fitness

Elicitor-induced growth reduction



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