Grower Summary

FV 402

Pre-adaptation of vegetable seedlings to increase their resistance to pest attack

Final 2013

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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 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:	FV 402
Project Title:	Pre-adaptation of vegetable seedlings to increase their resistance to pest attack
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Headline

- By using a controlled stress technique, growers will be able to potentially reduce the use of chemical treatment in intensively raised plants before transplanting into the field.

Background

Two of the biggest issues facing propagators and growers are downy mildew and cabbage root fly. Control of downy mildew in young plants in propagation, particularly early spring sowings or those grown overwinter, is extremely difficult and recent approval losses mean fungicide options are limited. These problems impair optimum growth which results in a non-uniform crop, unmarketable produce and plant losses.

With typically 3-4 overlapping generations a year CRF is a perennial problem affecting all Brassica plantings from March to early October. Current CRF control on leaf and flowerhead Brassicas relies largely on insecticide module drenches at propagation of either spinosad (Tracer™) or more commonly chlorpyrifos (Dursban WG™). However, with the chlorpyrifos drench approval likely to be revoked in the near future (classed as a priority substance under the Water Framework Directive) alternative controls are therefore being actively sought to reduce the dependency on chemical control of pest and disease. The focus of the current project is to explore the potential of a non-chemical method to exploit the natural defence mechanisms of the plant and to explore whether this 'internal resistance' has a similar impact on CRF and downy mildew attack.

This project evaluates a brief period of stress that pre-adapts cauliflower plants to pest and disease attack; not all stress which plants experience is 'bad'; the internal 'natural' response of the stressed plant can be harnessed to repel pest and disease attack. The approaches adopted in the project are short periods of pre-adaptive stress with an application window of days, which is distinct from longer term 'hard raising' that can lead to poor quality 'woody' plant material. A key part of the production cycle is to confer resistance established in propagation to the main growth phase. To evaluate NaCl treated propagated material performance at maturity, pre-adapted module raised seedlings were grown on and monitored under commercial conditions in the field.

Expected deliverables

The expected deliverables for this project are:

(i) Project aim: To reduce the use of pesticides on Brassicas by increasing the host resistance of young plants.

(ii) Project objectives:

- To summarise current approaches to cabbage root fly (*Delia radicum)* and downy mildew (*Hyaloperonospora parasitica*) control;
- To explore the physiological and growth response of untreated and pre-adapted plants to pest challenge;
- To quantify the pest resistance of pre-adapted seedlings to selected inoculum levels of cabbage root fly and downy mildew.

Summary of the project and main conclusions

- Experimental data suggest that a moderate concentration of salinity (60 mM for Chassiron and 90-120 mM NaCl for Skywalker) applied in a solution to the roots, in the last week of the plug production cycle improved plant survival when attacked by CRF.
- Leaf expansion and root biomass was increased in cauliflower plants at 60 - 90mM NaCl compared with the zero salt control. The work highlighted a dual benefit of increased growth and pest resistance.
- Plants grown on to harvest that had been treated with salt, demonstrated a larger marketable curd compared with the control which had not been given additional salt. The size of the curd plus leaves was larger in plants that had not been salt treated. Salinity applied to seedlings may confer a favourable shift during crop maturation towards generative compared with vegetative growth.
- Whilst 'stressing' plants may appear at odds with the Horticulture business case of maximising productivity, improving our understanding and application of this research will ultimately lead to a reduction in the use of chemical application alone for pest control during plant propagation.

The data suggests that the cauliflower cultivars Chassiron and Skywalker can be pre-adapted by a brief period of NaCl solution feeding to the root-zone. Misting application to the foliage at the same dose provides less robust effects. Chassiron produced an increase in leaf expansion and a larger root system at 60 mM NaCl, whereas Skywalker exhibited enhanced growth at 90-120 mM NaCl compared with the zero NaCl control. Resistance to CRF damage was evident at 60 mM NaCl in Chassiron and 90-120 mM NaCl in Skywalker. In contrast NaCl had little impact on resisting infection by Downy mildew and in fact there was

weak evidence to suggest that at high levels of NaCl feeding concentrations (240 mM NaCl) then infection was increased. In summary:

- Skywalker and Chassiron show enhanced growth response to NaCl during propagation to a 5 day feeding window immediately prior to dispatch.
- Skywalker can beneficially utilise salt at higher concentrations (90-120mM NaCl) to promote growth compared with Chassiron (60 mM NaCl).
- The cultivar enhanced growth response to NaCl feeding coincides with a marked increase in the resistance or pre-adaptive potential of young plants to withstand CRF attack.
- The resistance of plants appears to be strongly linked with the ability to transport water from the root system and to drive cell expansion in the leaves.
- Transpiration is more markedly reduced in CRF attacked plants compared with photosynthesis alone.
- Growth responses under protected growth conditions appear to correspond with Chassiron and Skywalker performance in the field.
- Pre-adaptation appears to have promise for use with Brassica transplant crops and is a technique that has the potential to reduce chemical control dependency in production.
- Further field-scale trials that build upon this preliminary study will give the industry a clearer understanding of the benefits of pre-adaptive stress conditioning of Brassica transplants

Table 1 below can be used to convert the units used in this report (mM) to g/l.

Table 1: Salinity conversions

NaCl Solution Concentration		**EC Solution**	**EC Seawater ~54dSm^{-1}**
mM	**g/L**	**dS m^{-1}**	**Rel Strength**
60	3.5	5.5	0.1
120	7.0	11	0.2
240	14.0	22	0.4

Financial Benefits

The commercial objective of this project is to provide vegetable growers with guidelines on plant stress manipulation for control of CRF control in Brassicas species. This will allow growers to mitigate against the current level of chemical usage and reduce the costs of production and minimise the risk environmental pollution.

The potential benefits to the industry are:

- To understand and incorporate the practice of pre-adaptation treatments into plug raised Brassicas that confer pest resistance.
- Increased confidence in using the natural stress response functioning of plants to improve resilience to pest attack.
- To potentially reduce the dependence of chemical use to control pest attack.
- Increased profitability by decreasing the level of chemical control of CRF in Brassica plug plant production.
- To maintain productivity and minimise wastage whilst reducing chemical use.
- The current cost of Dursban (chlorpyrifos) is around £12/kg and Tracer £236/L. The rate of Dursban WG is 30g/5000 modules which = £0.36/5000 modules compared to Tracer which has a rate of 60ml/5000 modules which = £14.16/5000 modules. With chlorpyrifos likely to be revoked in the near future, this leaves growers with a treatment that is nearly 40 times more expensive for the control of CRF.
- If a suitable level of NaCl can be found, which will enhance the plants defence mechanisms, building resistance to cabbage root fly, then the total amount of Tracer can be reduced with direct replacement by pre-adaptation.
- In further experiments a combination of treatments could be evaluated to reduce direct chemical use. Either way the aspiration of the work is to produce the best quality plugs for transplant to the field at lowest plant raising cost and if residue free, lowest environmental impact.

Action points for growers

- NaCl fed to the root-zone as a controlled dose can enhance root growth and increase leaf expansion; pre-adaptation at known doses can also confer resistance to CRF.
- Pre-adaptation with NaCl at seedling stage can promote a shift from vegetative to generative growth and promote larger curd size at harvest.

- Very high salt levels can weaken growth by restricting water uptake and promote Downy mildew infection.
- Pre-adaption by using controlled stress offers the propagator an alternative technique to chemical treatment alone, which may prove cost effective and produce more robust and productive plants in the field.

Suggestions for further work

- Pre-adaptation with NaCl can be evaluated for an extended range of Brassica and other crop types.
- Combination doses of NaCl stress combined with Tracer could be evaluated to understand potential beneficial interactions on plant growth and resistance to CRF attack.
- Other stresses could be considered e.g. temperature combined with water / salt stress in combination or alone (see Dutch grower report).
- A greater emphasis on crop performance to maturity would give both propagators and growers more confidence to adopt pre-adaptation techniques for industry practice.
- Further work could be carried out to refine the pre-adaptation ‘window’ to evaluate the potential for non-chemical control of Downy mildew.
- At a fundamental level the work carried out could be extended to gene exploration and identification of specific mechanisms that trigger plant resistance to infection or attack.