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| **Project title:** | Integrated control of Allium white rot |
| **Project number:** | FV 449a |
| **Project leader:** | John Clarkson, University of Warwick |
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| **Previous report:** | February 2020 |
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| **Location of project:** | University of Warwick, Wellesbourne Campus, Warwick. |
| **Industry Representative:** | Phil Langley, G's Growers |
| **Date project commenced:** | 01/03/2018 |
| **Date project completed (or expected completion date):** | 28/02/2022 |

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*The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.*

## AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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## Headline

Experiments showed that commercial garlic products stimulated germination of *Sclerotium cepivorum* sclerotia *in vitro* while one also reduced white rot disease in salad onions in the field. The combined used of such germination stimulants with selected fungicides which also reduced disease shows promise as an integrated strategy for white rot disease.

## Background

*Sclerotium cepivorum* is the causal agent of *Allium* white rot (AWR) an economically important disease of onion (*A. cepa*), garlic (*A. sativum*) and other *Allium* spp. worldwide (Entwistle, 1990). The soilborne fungal pathogen causes estimated losses of 2-15% in UK onion equating to approximately £7M per annum. In addition to this, the heavy infestation of some sites has led growers to abandon onion growing in areas of the East and South East of England with production moved to less infested, but lower yielding areas.

The pathogen infects the root systems of plants from soil-borne sclerotia (resting structures), causing roots to collapse and decay, leading to reduced crop vigour, chlorosis and often plant death. This can result in high levels of physical and marketable yield loss, with the production of further sclerotia allowing the pathogen to proliferate and persist in soil between crops. Relatively small quantities of *S. cepivorum* sclerotia are required for disease to develop with densities as low as 0.1 sclerotia $L^{-1}$ soil leading to economic loss, whilst higher levels such as 10 sclerotia $L^{-1}$ soil can lead to total crop loss (Crowe *et al*., 1980; Davis *et al*., 2007). In addition, sclerotia are able to survive for periods of up to 20 years (Coley-Smith *et al*., 1990).

Currently management options for AWR are limited. Cultural control approaches aim to prevent infestation through practicing good equipment/field hygiene measures (although due to the small and persistent nature of sclerotia, this is challenging), whilst the use of wide rotations aims to prevent inoculum build up. Chemical control is limited in the UK to off label approvals under the HSE Extension of Authorisation for Minor Use (EAMU) scheme. Currently, only Signum (boscalid and pyraclostrobin) and tebuconazole are registered for use against AWR in the outdoor production of bulb/salad onion, onion sets, garlic and shallots. However other fungicides have shown promise elsewhere (Villata *et al*., 2004; 2005; Ferry-Abee, 2014) and were reviewed by Clarkson *et al*., 2016 in AHDB project FV 449.

Other alternative methods of AWR disease management have also been explored, such as biopesticides (Clarkson *et al*., 2002; 2004), biofumigation (Smolinska, 2000), solarisation

 

(McLean *et al*., 2001) and the use of sclerotial germination stimulants (Coventry et al., 2006; Coley-Smith *et al*., 1986) but few of these are currently practiced commercially.

Consequently, the aim of this project was to identify and test a range of treatments for the integrated control of AWR in bulb and salad onions. Two objectives were carried out in the current year (which was highly disrupted due to the Covid-19 pandemic and a member of staff leaving):

- Objective 2: Test *Allium* products for their effect on the germination of *S. cepivorum* sclerotia.
- Objective 4: Test combined treatments for their effect on white rot disease development

## Summary

### Objective 2: Test *Allium* products for their effect on the germination of *S. cepivorum* sclerotia

*S. cepivorum* persists between *Allium* crops as soil-borne sclerotia, which are robust survival structures that remain viable for up to 20 years (Coley-Smith, 1987) and which also constitute the primary inoculum for infection of onion crops. Garlic-based products can be used to reduce the levels of sclerotia by mimicking the natural root exudates of onion, causing them to germinate in the absence of a suitable host and exhaust nutrient reserves. The use of natural and synthetic *Allium* stimulants to control AWR has been reported previously with a particular focus on garlic oils and their constituent chemical compounds such as diallyl disulphide (DADS) or diallyl sulphide (DAS). Consequently, the current objective explored the development of *in vitro* assays to identify commercially available garlic products that could stimulate sclerotia germination.

### Petri dish germination assays

A repeat experiment was carried out to determine the effects of different commercially available garlic products on germination of *S. cepivorum* sclerotia and results were generally consistent with those observed previously. Three NEMguard products (SC, DE, PCN) resulted in very high levels of germination (>86%) while use of the food grade garlic granules was less consistent. Germination of *S. cepivorum* sclerotia in response to DAS (used as a positive control treatment) was poor and has been less consistent throughout such experiments. This could be due to the more volatile nature of this compound resulting in

inconsistent levels over the experiments or perhaps a degradation of the compound while being stored over the duration of the project so far. Nonetheless, the results from these assays clearly indicate the potential of formulated garlic products to successfully stimulate germination of *S. cepivorum* sclerotia.

### Soil based germination assays

A selection of the garlic products used in the Petri dish assays were examined for their effect on *S. cepivorum* sclerotia using a soil-based system under controlled temperature conditions to better replicate a field situation. Here, germination of sclerotia cannot be observed directly but is associated with a low recovery of intact sclerotia. Overall, results from two combined experiments were less clear than observed in the Petri-dish assays although both food grade garlic granules and NEMguard DE resulted in increased germination (non-recovery, >60%) of *S. cepivorum* sclerotia compared to the untreated control (<30% germination).

### Field based germination assay

An extra small field experiment at Wellesbourne assessing selected garlic products for their effect on buried *S. cepivorum* sclerotia (in the absence of a crop) showed that NEMguard SC and NEMguard DE increased apparent germination (as measured by non-recovery) compared to an untreated control (germination 50-60%). Garlic granules had much lower levels of germination in this experiment compared to the soil box assay. As the viability of the sclerotia recovered was high for all treatments, this suggests that the products were not as effective in the field as they are in a controlled enviroment. This emphasises the need to perhaps increase doses of these products or attempt sealing of the soil surface by rolling.

## Objective 4: Test combined treatments for their effect on white rot disease development in the field

Two field trials tested combinations of garlic products with fungicides and biological control agents in comparison with individual treatments for their effect on AWR disease in salad onions. Across both sites, NEMguard SC either alone or in combination with Signum or Trisoil significantly reduced white rot disease while the use of NEMguard DC either alone or in combination was less effective. The fungicides Perseus and Luna Privilege reduced white rot significantly at one site and decreased disease at the other. Their different modes of action and application timings means that they would be good candidates for inclusion in an integrated control strategy for AWR disease alongside NEMguard SC.

## Conclusions

- *S. cepivorum* sclerotia were stimulated to germinate by commercial garlic products in *in vitro* Petri dish assays
- The germination stimulant effect was less clear when garlic products were tested in soil boxes under controlled conditions and in a small field trial
- NEMguard SC alone or in combination with other crop protection products reduced AWR disease in two field trials.
- The fungicides Perseus and Luna Privilege also reduced AWR disease and may therefore be additional useful components in an integrated control strategy.

## Financial Benefits

None to report at this time.

## Action Points

None to report at this time.


# Grower Summary

## FV 499a

## Integrated control of Allium white rot

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