Grower Summary

CP 158

Application and Management of Biopesticides for Efficacy and Reliability (AMBER)

Annual report 2019

Project title:	Application and Management of Biopesticides for Efficacy and Reliability (AMBER)
Project number:	CP 158
Project leader:	Dr David Chandler University of Warwick Warwick Crop Centre, School of Life Sciences, University of Warwick, Wellesbourne, Warwick CV35 9EF UK
Report:	Annual report, January 2019
Previous report:	Annual report, January 2018
Key staff:	Jude Bennison Clare Butler Ellis John Clarkson Roma Gwynn Rob Jacobson Andy Lane Aoife O' Driscoll Gill Prince David Talbot Erika Wedgewood
Location of project:	University of Warwick Warwick Crop Centre, School of Life Sciences, University of Warwick, Wellesbourne, Warwick CV35 9EF UK
Industry Representative:	Rob James, Thanet Earth Marketing Ltd, Barrow Man Road, Birchington, Kent, UK, CT7 0AX
Date project commenced:	1st January 2016
Date project completed	31st December 2020

DISCLAIMER

While the Agriculture and Horticulture Development Board seeks to ensure that the information contained within this document is accurate at the time of printing, no warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.

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.

Dr D Chandler

Principal Research Leader

University of Warwick, Warwick Crop Centre, School of Life Sciences, University of Warwick, Wellesbourne, Warwick CV35 9EF UK

Signature .... Date ....

Report authorised by:

[Name]

[Position]

[Organisation]

Signature .... Date ....

GROWER SUMMARY

Headlines

- Research on spray application showed that the applied water volumes currently recommended for most biopesticides (1000 L / ha or higher) are unlikely to be helpful in terms of optimizing the quantity and distribution of biopesticide active substance on the plant. Reducing the applied water volumes will be more efficient by reducing the time it takes to spray the crop.
- The persistence of *Ampelomyces*- and *Gliocladium*-based biofungicides on crop foliage was determined, and this information can be used to help schedule spray applications for disease management.
- A mathematical pest control model was developed which can be used to identify optimal biopesticide control strategies.

Background

Pests (including invertebrates, plant pathogens and weeds) have a major impact on crop production, reducing yield and quality (it is estimated that about a third of the potential global crop yield is destroyed by pests before it is harvested). The standard method for pest control has been to use synthetic chemical pesticides. However excessive use is associated with a range of problems including harm to the environment, and concerns have also been expressed about safety to pesticide spray operators. Overuse has also resulted in the evolution of resistance in many pests, which has rendered some pesticides ineffective. In recent years, environmental legislation has resulted in a lot of these pesticides being removed from the market. Alternative pest controls are needed therefore. Many growers already use Integrated Pest and Disease Management (IPDM), in which different crop protection tools are combined, including chemical, biological and cultural methods. IPM is now a required practice under the EU Sustainable Use Directive on pesticides. In order to make IPM successful, it is vital that growers have access to a full range of control agents that can be used as part of an integrated approach. One group of alternatives are ‘biopesticides’. These are pest control products based on natural agents, and there are three types; living microbes, insect semiochemicals and botanical biopesticides. These types of pest control agent are based on living organisms and so it takes more knowledge and understanding to use them successfully compared to traditional pesticides.

AMBER (Application and Management of Biopesticides for Efficacy and Reliability) is a 5-year project with the aim of identifying management practices that growers can use to improve the performance of biopesticide products within IPM. The project has three main parts: (i) to understand the reasons why some biopesticides are giving sub-optimal results in current commercial practice; (ii) to develop and demonstrate new management practices that can improve biopesticide performance; (iii) to exchange information and ideas between growers, biopesticide companies and others in order to provide improved best-practice guidelines for biopesticides.

Summary

Making biopesticide spray application more efficient. The aim of this part of the project is to determine the lowest volume of water required to provide biopesticide efficacy, as this reduces waste and is more efficient, provided that it does not contravene the minimum water volume stated on the label, as this is a legal requirement. At present, the label provided to growers by biopesticide manufacturers / distributors usually contains only general recommendations about spray application. The label specifies the dose to be applied (i.e. the amount of biopesticide per ha), gives a range of water volumes that are permitted on the crop (where water acts as a carrier for the biopesticide), the frequency of applications and the maximum number of applications per crop. Research was done to investigate the effect of different water volumes on the quantity of a tracer dye (used as a proxy for a biopesticide) retained on chrysanthemum plants sprayed using a three-nozzle boom in a track sprayer. The plants were able to retain a significant volume of liquid, such that the relationship between applied volume and quantity retained had only just begun to level off at 1000 L/ha. Thus, when applying biopesticides at a constant concentration, the maximum quantity retained would be achieved at 1000 L/ha. However, when applying at a constant dose, so that concentration reduces as volume increases, there was a clear reduction in deposit as water volume increased. Therefore, the most efficient way to deliver an active substance to this kind of plant is with as low volume and as high concentration as possible. This does not compromise the distribution over the plant. However, in all cases, the quantity of spray liquid reaching the underside of leaves was low – averaging around 5% of the total deposit on a leaf, and also very variable. A similar experiment was conducted with an experimental glasshouse tomato crop and was designed to build on the results from a larger scale HDC study on tomato spray application done about 20 years ago (PC136). Data will be fully analysed in the next financial year but the current indications are that at a constant dose there was no relationship between deposit and water volume, probably because of the complex architecture of the crop and high levels of leaf shielding. In this case application at a low volume would still be preferable because of the time savings it would bring.

Understanding the persistence of biofungicides on crop foliage. There is currently a lack of information on how long microbial biofungicides survive for after they have been sprayed onto crop plants. Biofungicides are recommended for application before, or at the first signs of, disease symptoms. If they do not survive for long, then they will have to be reapplied frequently. In this part of the project, experiments were done to measure the survival of *Ampelomyces quisqualis* (the active agent in the biofungicide AQ10, used against powdery mildew), *Gliocladium catenulatum* (used in Prestop for management of botrytis) and *Bacillus subtilis* (used in Serenade for botrytis management). There was a steep drop in the number of viable propagules of *A. quisqualis* recovered from leaves sprayed with AQ10 after four days. This biofungicide is parasitic on powdery mildew and because it does not survive on the plant for long in the absence of its host, then the correct timing and frequency of application is going to be very important for its efficacy. In contrast, *Gliocladium catenulatum* reproduced on the plant and about twice as many propagules were retrieved 7, 10 and 14 days after Prestop application as on the application day. This biofungicide works as an antagonist and competitor and is applied preventatively. After 7 days from Serenade ASO application, *Bacillus subtilis* bacteria were recovered in similar numbers to within hours of application, again showing good persistence.

A pest control model to help identify optimal biopesticide control strategies. Microbial biopesticides are usually slower acting than conventional pesticides; for example, it takes 5 – 7 days for a fungal bioinsecticide to parasitize its insect host and kill it. During this time, the pest may grow and reproduce. The speed of kill is affected by a wide range of variables including the pest species, its life stage (e.g. larva versus adult), the pest population size, crop type, fungal species, and environmental conditions. This is highly complex, and it means that fungal biopesticides can give variable results depending on the particular situation in which they are used. In this part of the project, a computer model was constructed to simulate pest population dynamics over time and the impact of the biopesticide on the pest population growth. Glasshouse whitefly and entomopathogenic fungi were used as the initial model pest and biopesticide. The model includes the main factors that influence the growth of the pest population (number of eggs laid, length of time spent in each life stage, host crop, temperature and starting population size) as well as factors relating to the ability of the biopesticide to limit pest growth (life stage infected, percentage of population infected, time taken to kill the insect pest). The model allows predictions to be made about how the overall level of pest control is affected by all of these interacting factors. Using the prediction, the model can be used to make practical recommendations about the best ways for growers to use biopesticides. For example, how frequently (and at what time in the crop growing season) the biopesticide should be used. The computer model allows us to provide guidance to growers and identify the areas where future research should be focussed.

Financial Benefits

- When spraying a biopesticide at a constant dose, the most efficient way to apply it is with a low volume and high concentration, as this reduces waste and takes less time, provided that it does not contravene the minimum water volume stated on the label, as this is a legal requirement.
- For biofungicides, savings should be possible by paying attention to the most appropriate timing of spray application. For AQ10, growers should wait to apply it until the first traces of powdery mildew are present. Earlier application is unlikely to be cost effective. Prestop was shown to have a good persistence, multiplying on foliage in the absence of a fungal host in the high humidity conditions provided, and this should give growers with crops in similar environments the confidence to use application intervals of at least a fortnight and probably longer.
- Biopesticides can be more expensive and less forgiving of environmental conditions that conventional pesticides so understanding the optimal way to use them is crucial to maximising efficacy and minimising cost. Computers models are useful for understanding systems that involve complex biological interactions where there are multiple interacting factors. They can be used for rapidly testing a large number of hypotheses to identify those hypotheses that should be further investigated. The model developed here is a valuable research tool that allows different control programmes to be tested. Once optimal control programmes are identified a subset of these will be tested experimentally to assess the accuracy of the model. Attempting to investigate all components of a spray programme in laboratory or grower experiments would be prohibitively expensive and time-consuming.

Action Points

- A good general strategy for constant dose spray applications of biopesticides is to use a low water volume with high concentration, as long as this stays within the minimum water volume on the label.
- Be aware that the survival of the beneficial fungus *Ampelomyces quisqualis* in AQ10 on healthy foliage is short, with few viable colonies after four days, so do not apply either until powdery mildew is seen or conditions are very likely to result in infestation as survival should be greater.

- Good persistence of the beneficial fungus *Gliocladium catenulatum* in Prestop WP can be expected even on healthy foliage for at least 14 days given conditions of high humidity and so reapplication following the recommended three to four week interval is likely to maintain protection of sprayed foliage.
- Applications of Serenade ASO can be expected to result in viable colonies of *Bacillus subtilis* on healthy foliage for at least seven days, but may then need reapplication.
- Remember that good coverage of the products is required and in fast growing crops or during flower production the new tissue will require protection.
- Gain experience of when best to use biofungicide products by keeping records of the environmental conditions (humidity, temperature and sunshine) in which the products were present on the crop and the level of disease control achieved.