Grower Summary

CP 099c

Evaluation of an integrated disease management system to ascribe risk of downy mildew disease on commercial salad and bulb onion crops in the UK

Final 2016

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Further information

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GROWER SUMMARY

Headline

- This project has successfully demonstrated the huge potential of using an integrated disease management approach to reduce crop protection inputs to control downy mildew in onion crops, whilst maintaining or even improving yields.
- In four out of six field trials carried out at commercial grower sites between April 2014 and October 2015 crop protection inputs were reduced and provided either similar or improved levels of onion downy mildew disease control. Whilst these results are promising, the system was not fully robust over the period.
- In the system trialled, the application of fungicide (oomyceticide) treatments was timed according to predicted 'potential disease thresholds' determined using weekly measured bio-aerosol concentrations of onion downy mildew inoculum above crops combined with environmental measurements (parameters) in a computer model (MILIONCAST).
- This study showed that there are still refinements needed in the calibration of downy mildew inoculum detection to take environmental, annual and seasonal changes in spore maturation, viability and diversity of responsiveness into account.

Background

Onion downy mildew (*Peronospora destructor*) is geographically widespread and is a serious disease in bulb onions, salad onion sets and in seed production. Downy mildew infects all of the main onion types grown in the U.K. including the common onion (*Allium cepa*), shallots (*A. cepa* var. a*scalonicum*) and Welsh onion (*A. fistulosum*). Welsh onion is particularly susceptible to downy mildew infection. Many commercial varieties of salad onion are crosses between *A. cepa* and A. *fistulosum* types. Yield losses in bulb onions of 60 to 75% have been recorded. These losses mainly result from severe infections causing early defoliation, reduced bulb sizes and poor storage quality of bulbs. In salad onions, yield losses can be as high as 100%, with whole crops being discarded as downy mildew symptoms on the plant make them unmarketable. Losses to seed production are frequently caused by the collapse of infected seed stalks and poor germination of seeds collected from infected stalks.

The onion downy mildew pathogen can overwinter as mycelium in onion bulbs and sets and, as oospores in debris from diseased foliage. It has also been shown to be seed-borne. When either sets or seeds are transplanted the mycelium grows within the foliage of the plant. Under favourable conditions onion downy mildew will produce large numbers of infective spores. This is a diurnal process requiring periods of both light and darkness. Spore production is mainly during the night under high relative humidities (> 94 - 95%) at temperatures of 6 - 22°C provided there is no rainfall. However, high day temperatures (> 24°C) have been found to inhibit sporulation during subsequent nights. Spore discharge is triggered when relative humidity falls below 59%. These spores can be transported by the wind over considerable distances and have been detected at heights of >450 metres. Once deposited on susceptible host leaf surfaces, they can germinate and infect within hours, and, under favourable conditions, disease symptoms are visible within 7 to 10 days.

The control of downy mildew in onions relies mainly on the frequent prophylactic application of fungicides (every seven to ten days), since fungicides are only effective if they are applied before or immediately after the first appearance of symptoms in a crop. To reduce the impact of fungicides on the environment, integrated disease management (IDM) approaches have been developed using predictive models run with climatic data to time sprays. Of these models, MILIONCAST (an acronym for 'MILdew on onION foreCAST'), is probably one of the best of this type of model for predictions of onion downy mildew. However, forecasts based on environmental factors alone are unable to take the presence/absence of the pathogen in the crop or locality into account and so are likely to over-estimate potential disease risks. To overcome this, methods of detecting and quantifying downy mildew spores in crop aerosols have been developed (AHDB Horticulture FV 356). Information on pathogen inoculum concentration within cropping systems can be used in conjunction with environmentally-based forecasting models to improve the precision of fungicide application and disease control. The purpose of this study was to evaluate this combined approach, as an integrated disease management system, to control downy mildew in UK commercial onion cropping systems.

Summary

The timed application of downy mildew control regimes according to bio-aerosol concentration reduced crop protection inputs by 50% and provided either similar or improved levels of disease control in four out of the six field trials assessed.

Field bio-aerosol testing was carried out using two air sampling systems:

- A Microtitre immunospore trap (MTIST), available from Burkard Manufacturing (http://www.burkard.co.uk) at a cost of approx. £2,300 + VAT, provides a weekly field air sample for risk of downy mildew disease. However, samples require laboratory processing by ELISA (enzyme-linked immunosorbent assay). By postal delivery the results can be available within several days. Results indicate that a downy mildew bio-aerosol disease risk warning is provided when ELISA results of ≥ 0.6 optical density are recorded. However, doubts over the robustness of the MTIST ELISA were raised in this study when the test failed to identify risk of downy mildew disease during the final weeks of one field trial in salad onions.
- A weekly multivial air field sampler (daily air samples provided in seven tubes for testing on-site by lateral flows) can also be used to collect field bio-aerosols. This field ready air sampler with a timer can be purchased from Burkard Manufacturing for an approx. costing of £1650 + VAT. Daily air samples are assessed once weekly by an agronomist or grower using on-site field tests (lateral flows). The test is semi-quantitative and measurement of inoculum has been made using a lateral flow test reader (approx. Cost £1000 + VAT) with a standard curve. The standard curve is generated at the time of the weekly test using known spore concentrations of *P. destructor*.

Information on the presence or absence of a critical downy mildew spore threshold in bio-aerosols would provide growers with the capability to identify periods when crops are at risk from the disease. Disease onset and intensity are affected by three factors: disease, host and environment. The timed application and fungicide applied will also be important in control of the disease. In this study, field trials were carried out over two years and across the seasons. This was to reflect the varied climate of the UK and all the year round production of onion crops. Different salad and bulb onion varieties were assessed. Bio-aerosols were evaluated for downy mildew spores using a monoclonal antibody diagnostic probe. The application of fungicides to control downy mildew were applied to crops based on the diagnostic test result and an environmental downy mildew forecast (MILIONCAST). Areas within the crop remained

unsprayed to assess disease development in the absence of control measures. Also, an area was treated for control of onion downy mildew according to the grower schedule.

Based on results in Year 1, a downy mildew lateral flow test reading for predicting disease was proposed. This value was developed in conjunction with the use of an environmental downy mildew forecast model (MILIONCAST). In this way, assessment of the host, disease concentration and environment had been considered. The timed application of downy mildew control regimes according to bio-aerosol concentration reduced crop protection inputs in each of the field trials of 2014 by 50% and provided either the same or improved levels of disease control to that of the grower schedule. In Year 2, three further field trials were assessed in the same way. The disease threshold calculated in Year 1 for the lateral flow test worked well for that season. However, in the following year inoculum potential (capacity of downy mildew spores to initiate infection) appeared greater and so a lower threshold may be required to retain test accuracy. The final trial in 2015 provided environmental conditions very favourable for disease over an extended time period. Identified disease thresholds may not transpose accurately over time i.e. different cultivar type, environment and pathogen. The laboratory test (MTIST ELISA) also failed to identify risk of onion downy mildew spores in the collected bio-aerosols during the final weeks of the trial.

Whilst promising, use of each test should be with caution as downy mildew population structure, spore maturation, viability and the environment will vary. These factors may influence the accuracy of the tests to accurately quantify disease risk. The contamination of air samples with soil may have an inhibitory effect on the immunoassay process. In wet conditions the tubes can fill with water compromising the trapping efficiency of the test.

Financial Benefits

The main financial benefits would be in the use of these tests to reduce unnecessary crop protection inputs to onion cropping systems. Fungicide usage is costly and is one of the major inputs in crop production. Using the lateral flow device the grower/consultant would be able to check for the presence of onion downy mildew in the air and better time the first fungicide application. The cost of these tests must be compared with a typical spend of £260/ha for fungicide treatment. In high risk years it is common to spend in excess of £300/ha on fungicides in a bulb onion crop. However savings will be variable between years and depend on the overall reductions in sprays achieved.

Producers are required under the European Union Sustainable Pesticide Use Directive (2009/128/EC) to apply the general principles of integrated pest and disease management from January 2014.

Action Points

- Disease onset and intensity are affected by three factors: disease, host and environment. The timed application and fungicide applied will be important in control of the disease.
- whilst promising, each test should be used with caution as downy mildew population structure, spore maturation, viability and the environment will vary. These factors may influence the accuracy and robustness of each test especially in salad crops where high crop losses can result from low levels of disease. Reliable disease thresholds for each test cannot be confirmed.
- the use of these tests with environmental models may provide an improved accuracy to identify onion downy mildew infection and sporulation periods. As an integrated disease management approach, information on airborne disease load and environmental data has the potential to assist growers to schedule fungicide applications to crops more effectively and reduce crop protection inputs whilst making cost savings.
- The European Union sustainable pesticide use directive (2009/128/EC) states that professional users will have to apply general principles of Integrated Pest and Disease Management from 1 January 2014.