Grower Summary

PE 030

An investigation of the current status of tomato leaf mould on UK nurseries: occurrence, disease management and potential for improved control

Final 2017

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GROWER SUMMARY

Headline

- Tomato leaf mould was present on at least six UK tomato nurseries and on 16 different varieties in 2016.
- Disease spread on varieties with no claimed resistance can be very rapid.
- Growers successfully manage the disease by a combination of measures: plant protection products; humidity control; hygiene; de-leafing hard; rotation and floor covering.

Background

Tomato leaf mould caused by *Passalora fulva* (previously *Cladosporium fulvum*) is a destructive foliar disease of increasing importance in the UK. New strains of the pathogen have recently been identified in Japan, China and Korea for which no varietal resistance is in place, the disease is also causing considerable problems in Argentina. Outbreaks have occurred most years over the last decade and affected a range of varieties (Figure 1). Previously well controlled by genetic resistance, the new outbreaks appear to be caused by the cultivation of varieties with no claimed resistance and the emergence of strains capable of overcoming the resistance genes deployed in current varieties. Currently there is no easy method to identify strains; the classical approach is to determine pathogenicity of isolates by inoculation on to a differential set of tomato varieties that possess different resistance genes. This involves testing one isolate at a time on varieties containing known resistance genes, which is both time-consuming and costly. Furthermore, identification of races 1 and 3 is not perfect in this system and no molecular methods to identify different strains have been developed to our knowledge.

Additionally, although Amistar (azoxystrobin) has given good control in some crops, grower reports indicate fungicide resistant strains can develop within a few years. Previous work, PE 018, showed a number of other products including Switch (cyprodinil + fludioxonil) and Signum (boscalid + pyraclastrobin) also give good control when used preventatively. The new product Prolectus (fenpyrazamine) warrants evaluation as the closely related fungicide Teldor (fenhexamid) gave some control in PE 018. Similarly, one or more succinate dehydrogenase inhibitor (SDHI) fungicides submitted for authorisation to use on protected tomato warrant laboratory evaluation as these are generally fungicides with broad spectrum activity.

The disease also affects organic crops, where use of conventional fungicides is not permitted by the Soil Association. Nursery sanitation and hygiene measures between crops, choice of variety and glasshouse environment control are critical in this situation. Spores of *P. fulva* appear to be very resistant to dryness and low temperatures, and are believed to survive in a dormant state from one crop to the next. The fungus can also survive saprophytically in dried leaf debris. A number of disinfectants were shown to be effective against *P. fulva* in PE 018, however effective crop clean up remains problematic on several commercial sites, with re-infection commonly occurring year on year.

Figure 1. Yellow spots on the upper leaf surface are an early symptom of tomato leaf mould infection.

Further effort to identify gaps/weaknesses in current control practices and establish improved targeted, integrated control measures could be beneficial, as incidence of this disease on commercial sites in the UK is increasing, and a number of commercial varieties appear highly susceptible. As the disease has been easily controlled by varietal resistance in the past, it is possible that first symptoms are not recognised quickly, or that actions taken to control early infections are not swift enough to deliver effective results.

Objectives

This project aimed to document disease management practices currently used against tomato leaf mould (*Passalora fulva*) on UK nurseries, determine occurrence of fungicide resistant strains and, based on pathogen biology, and PE 018, propose changes to improve control. The

specific objectives were:

1. Survey and visit nurseries to establish the prevalence of tomato leaf mould infection in the UK, and document treatments and practices currently used to manage the disease;
2. To collect isolates of *P. fulva* from affected crops and determine their sensitivity to current standard fungicides and potentially useful new products;
3. To establish a best practice guide for control of leaf mould in crops based on previous research, grower experience and the results of investigations and tests conducted in this project.

Summary

Objective 1: Current prevalence and management practices

Tomato leaf mould was reported on five of the six nurseries surveyed in 2016, with occurrences on sites in Cambridgeshire, Lancashire, West Sussex and Yorkshire. At least one site which was not monitored during this project also developed a tomato leaf mould infection A total of 16 different varieties were affected at these sites (Table 1), of which ten varieties made no claim of resistance to *P. fulva* and infection on these was not unexpected. Five varieties (Amoroso, Avalantino, Kierano, Piccolo and Sweetelle) that each claim resistance to race groups A to E were affected to some extent. This result provides strong evidence that races of *P. fulva* able to overcome resistance genes *Cf*-1 to *Cf*-5 are present in the UK. There was no information available on the resistance status of the remaining variety, Jester.

Table 1. Tomato varieties reported in grower questionnaires as affected by tomato leaf mould in 2016; several currently claim resistance to *P. fulva*

Variety	Breeder	Listed resistance to *P. fulva*
Amoroso*	Rijk Zwaan	A-E
Angelle	Syngenta	No resistance claimed
Avalantino*	Enza Zaden	A-E
Bamano	Syngenta	No resistance claimed
Campari	Enza Zaden	No resistance claimed
Garincha	Enza Zaden	No resistance claimed
Juanita	Monsanto/De Ruiter	No resistance claimed
Jester	Tozer	Unknown
Kierano*	De ruiter	A-E
Lipso	Clause	No resistance claimed
Papeletto	Rijk Zwaan	No resistance claimed
Piccolo*	Gautier	A-E
Solarino	Rijk Zwaan	No resistance claimed
Sunstream	Enza Zaden	No resistance claimed
Sweetelle*	Syngenta	A-E
Ternetto	Rijk Zwaan	No resistance claimed

*Varieties which claim resistance to *P. fulva* but were reported infected during 2016

The first outbreak of tomato leaf mould was reported to have occurred in May; the final outbreak did not occur until September. Leaf mould had been seen the previous year on five of the six sites. On three nurseries, the level of leaf mould was assessed between three weeks and three months after first symptoms had appeared. At this first assessment, the incidence of affected plants was over 50% on four of seven varieties assessed, with a mean severity of over 50 leaf spots/plant on two varieties. At a final assessment, near to the end of cropping, almost 100% of plants were affected on three varieties. On nursery A, the same variety Ternetto was grown in glasshouses of different ages, leaf mould severity was greatest in the new glasshouse (3 years old) and less in older houses (40 years old). No comparisons of crops in glasshouses of different ages were possible at sites B and C as different varieties were used in each house.

Plant protection products used against leaf mould were Amistar, Signum, Switch, Teldor and Serenade ASO (*Bacillus subtilis* strain QST 713), with Amistar considered the standard product. The total number of sprays applied ranged from zero in organic crops to upwards of ten. Spray volumes ranged from 1250-2500 L/ha. All respondents angled nozzles in order to treat the underside of leaves, the leaf surface with most stomata, through which *P. fulva* infects. In addition to plant protection products, measures used against leaf mould included: maintaining relative humidities below 85%; use of impermeable plastic sheeting rather than Mypex-type matting to cover the floor; removal of fixed plastic energy screens; de-leafing hard at the first sign of infection (combined with a fungicide spray, usually Amistar); removal of affected leaves from the house to a covered skip; use of varieties with claimed resistance to leaf mould; rotation of susceptible and resistant varieties to different locations in a house each year; use of Serenade ASO to extend spray intervals between conventional fungicides; end of season clean-up and disinfection of glasshouse and equipment.

Objective 2: Sensitivity to Plant Protection Products

Seven isolates of *P. fulva* were collected from UK crops and maintained in culture. Several of the isolates were found to carry the naturally occurring hyperparasite *Hansfordia pulvinata*. Attempts to clean these isolates of the hyperparasite were partially successful; any cultures with obvious *H pulvinata* were not used in tests. The isolates were tested for their sensitivity to Amistar, Switch, Prolectus, Reflect (isopyrazam), Mycostop (*Streptomyces griseoviridis)*, Prestop (*Gliocladium catenulatum)* and Stopit (calcium chloride) at label rates in a detached tomato leaf bioassay using benzamidazole agar to delay leaf senescence. Conventional fungicides were applied 3 hours and biofungicides 5 days and 3 hours before inoculation with *P. fulva* spores.

Disease development was poor with most treatments showing <2% leaf area affected at three weeks after inoculation when the experiment was terminated. Even the untreated control leaves had little disease. There was no significant differences between treatments. In a second experiment using a detached leaf bioassay, the fungicides Amistar, Comet (pyraclastrobin), Filan (boscalid) and Switch were each tested at four concentrations (0.1, 1, 10, and 100 ppm a.i.). At three weeks after inoculation, there was <1% leaf area affected on

most leaves, including the untreated control, and there was no significant differences between treatments. Amistar used at the highest rate (100 ppm a.i.) was the only treatment on which no leaf mould developed. No firm conclusions can be drawn from these experiments. It is suggested that in any future work, experiments on product efficacy are carried out on whole plants and/or agar plate inhibition assays rather than a detached leaf assay; or that an improved leaf bioassay is sought which results in higher disease levels, to better allow discrimination between treatments.

Objective 3: Best practice guide

A best practice guide for control of leaf mould has been devised.

Key aspects are:

Preventative spray(s) with suitable plant protection product(s) on varieties with no claimed resistance, and in houses with a history of the disease. If no preventative spray is used, very rapid action is required when the disease is first seen due to its epidemic potential.

Reducing disease risk by careful monitoring of glasshouse relative humidity (RH) and avoiding prolonged periods above 85% RH; especially around the lower leaves where the disease usually starts. Regular de-leafing (weekly when appropriate) can aid air movement around lower leaves.

Angle spray nozzles to treat the underside of leaves; check to ensure good spray coverage is achieved.

Amistar can give good control but a decline in efficacy has been noted by growers with repeated use, likely indicating resistance developing. There is some evidence that Switch may also lose efficacy with time. Serenade ASO is useful, as a preventative, to stretch the interval between sprays of a conventional fungicide and thereby allow construction of a season-long programme, in situations where the disease starts early.

Grower experience indicates there can be a benefit from using an impermeable plastic sheet to cover the soil rather than the Mypex-type matting; and to rotate the location of susceptible and resistant varieties in a house between years (do not grow a variety with no claimed resistance in an area where leaf mould occurred the previous year). One grower also removed all fixed plastic energy screens which they believed helped prevent the disease occurring at their site.

Maintaining a high standard of hygiene: de-leaf hard and promptly when the disease occurs; remove affected leaves and debris to a covered skip outside the glasshouse; undertake a thorough end of season clean-up and treat the glasshouse structure and equipment with a suitable disinfectant.

Financial Benefits

- Knowledge of the frequency of tomato leaf mould strains resistant to Amistar (azoxystrobin) or other fungicides will inform design of plant protection programmes for improved control and prevent wasteful use of products likely to be ineffective.
- Severe infections due to high disease incidence have resulted in crops being removed from glasshouses before end of cropping. Identification of likely gaps/weaknesses in current leaf mould control strategies will enable growers to implement changes with a good chance of improving control.
- Reduction in risk to human health from leaf mould epidemic spore-loads, reducing associated sick leave costs and staff absences.

Action Points

- Prevention of infection by managing the glasshouse environment is easier than eradicating the disease – epidemics can occur quickly given the chance.
- Rectify any leaks or areas in the glasshouse where water pools; this can increase humidity in the area and increase the chance of a hotspot occurring for *P. fulva.*
- Using impermeable plastic to cover soil in glasshouses is likely to prevent moisture escaping the soil, and maintain a cleaner glasshouse environment than permeable Mypex-type matting, providing there is no pooled water due to leaking irrigation/vents.
- Effective clean-up at crop turnaround will lower the inoculum present on site – a thorough clean-up can mean problems begin later in the season, if at all.
- If infection is considered likely, for example if a nursery was infected and/or a known highly susceptible variety is being grown the previous year, aggressive humidity control will reduce the chance of re-infection and spread – monitor relative humidity (RH) around the lower leaves to provide the most relevant information on leaf mould risk.
- Good resistance management is especially important in controlling *P. fulva* – potential resistance to Amistar was already reported by some growers, and in the 2016 season Switch was reported to be less effective than previously
- Use of biological fungicides (e.g. Serenade ASO) to space out conventional sprays can extend a spray programme

- If a variety with no claimed resistance to leaf mould is grown, do not site this variety in areas where leaf mould was observed the previous year.