Factsheet 23/11

Tomato

Horticultural Development Company

Stoneleigh Park
Kenilworth
Warwickshire CV8 2TL
T: 0247 669 2051
E: hdc@hdc.ahdb.org.uk

Grey mould (*Botrytis cinerea*) of tomato

Tim O'Neill, ADAS

Grey mould (Botrytis) of protected tomato (Figures 1 & 2) is a widespread, common and potentially devastating disease. It can affect all parts of the growing crop and is also a cause of postharvest fruit rot. With increasing adoption of measures that reduce heat use during crop production, there is a greater risk of damaging attacks by Botrytis. This factsheet summarises current information on the biology of tomato grey mould in glasshouse crops and gives practical advice on how to minimise losses to the disease with minimal use of fungicides.

Action points

- Pay particular attention to Botrytis control in grafted (vigorous) plants, in varieties with large leaves and in low houses or poorly heated crops.
- Control plant vigour from when the plants arrive to reduce susceptibility to Botrytis.
- Train and supervise staff to deliver a high standard of crop work; simple measures which critically influence Botrytis development are:
  - leaf removal appropriate to the variety so as not to leave a stub or tab
  - care to avoid trapped sideshoots
  - pulling off spent fruit trusses, where required
  - cutting out or treating small Botrytis stem lesions
  - prompt removal of dead stems back to the propagation block
  - prompt removal of crop debris from the canopy and layered stems
  - picking off Botrytis-affected leaves
  - de-leafing regularly
  - keeping layered stems off the ground

1 Botrytis stem rot can result in large gaps in a crop

2 Dense fuzzy grey sporulation is typical of Botrytis

- Promptly remove stem lesions as these are a key source of spores leading to further stem rot.
- Leave a crack of vent in dull conditions to improve air circulation. Windside vent should be employed with caution as it may cause a greater risk of leaf scorch when outside temperatures are low and may also result in a greater reduction in glasshouse CO_2 levels than with leeside ventilation.
- Avoid rapid changes in glasshouse heating and ventilation control that may lead to condensation on the crop. This is most likely to occur after low night temperatures followed by a rapid increase in glasshouse air temperature in the morning from solar gain. Guttation (exudation of free water from leaf margins and cut surfaces) is also most likely to occur after cool nights, especially if they follow a sunny day with high water uptake.
- Monitor glasshouse humidity and adjust settings to prevent frequent long periods (> 6h) of high RH (> 85%).
- Where there is potential for a dense canopy, use leaf-thinning as a tool to help avoid pockets of high humidity and poor air movement. Adjust irrigation carefully according to the light level; stop watering early on a dull day so that slabs are not at a high moisture content overnight and early morning (which may lead to prolonged moisture exudation from deleafing wounds).
- Manage the aerial environment carefully when there is bright sun after prolonged dull weather to minimise leaf scorch.
- Where required, use fungicides and biofungicides preventatively at key times (e.g. early spring) to reduce the risk of a severe disease problem; it is important to use a variety of products with different modes of action.
- Regularly clean and disinfect harvest containers and packing lines.
- Manage the storage and transport of packed fruit so that rapidly changing temperatures do not result in condensation on fruit and calyces.

Background

Grey mould of tomato caused by the fungus *Botrytis cinerea* is found wherever the crop is grown. Damaging attacks, are more commonly seen following persistent wet weather, where the standard of crop work is poor, in unheated or part-heated crops, in older glasshouses with little height above the crop, where there are leaking vents or dripping gutters and towards the end of cropping. Consultation with the industry indicates a UK tomato farm gate value of around £150 million and yield losses due to Botrytis of around 1-5%; losses on individual nurseries can be much higher. Additional losses are occasionally incurred arising from postharvest fruit rot or calyx spoilage due to Botrytis. Additional costs are incurred from the extra crop work required to manage a Botrytis attack.

3 Leaf Botrytis

4 Fruit Botrytis, note the zonate pattern in the lesion

Symptoms

Botrytis can infect leaves (Figure 3), petioles, stems, flowers, fruit and fruit trusses (Figure 4); the fungus has also been recovered from seeds and roots. Leaf and stem symptoms are the most common. These may occur on both young and older growth. Pale to dark brown lesions, often with concentric zones from the leading edge, develop on leaves, petioles and stems. A characteristic sign of the disease is the dense fuzzy grey-brown sporulation that develops on necrotic tissue; under humid conditions, clouds of spores are released if the tissue is shaken. Stem lesions often girdle the stem resulting in death of the parts above.

Where adjacent plants are infected, large gaps can develop in a row. Fruit quality can suffer where plants are exposed in crops with such gaps. This is exacerbated by problems which then occur in irrigating the remaining plants without applying excess water, especially in module-grown crops, unless drippers which supplied removed plants are blanked off.

Stem rot is the most damaging form of the disease, especially when symptoms develop early. A distinctive symptom called 'ghost spot' occurs when spores infect green fruit but do not cause decay (Figure 5). Each spot has a necrotic pinpoint centre surrounded by a pale coloured halo. Occurrence of ghost spotting makes fruit unsightly and unmarketable. Ghost spot occurs when there is condensation on the fruit, typically in the early morning. This is more likely to happen in large-fruited varieties which have a greater thermal inertia and therefore warm up more slowly, which allows dew point conditions to persist for longer. In contrast, smaller fruited varieties, such as cherry and baby plum types, are less susceptible, though the pinpoint spots can sometimes be observed without the halo. Ventilation to avoid condensation is more effective and efficient in these conditions than boosting heat input to try to raise plant and fruit temperatures above their dew point.

5 'Ghost spotting' on fruit

6 Postharvest fruit Botrytis

Fruit damaged by growth cracking at the calyx end is prone to Botrytis rot either in the production house or postharvest (Figure 6); damaged calyces can be infected by Botrytis that may lead to fruit rot. Fruit infection shows initially on the shoulder of fruit as small grey-black, slightly water-soaked, lesions. These develop into large round water-soaked lesions, with fuzzy grey sporulation of the fungus under humid conditions. Botrytis also occurs as a secondary decay organism on tomato tissues damaged by other diseases.

Infection and spread

Sources of inoculum

Infected tomato plants and infected decaying plant debris are the most important sources of inoculum (Figure 7). Although dispersal spores of *B. cinerea* originating from other host plants may infect tomato, recent studies on isolate origin using DNA sequence analysis indicated that infected tomato plants (within the house) were the predominant inoculum source contributing to epidemic development. *B. cinerea* can be seed-borne but this is unlikely to be a common inoculum source; hypochlorite treatment of seed for control of *Pepino mosaic virus* will eliminate external seed-borne infection. The pathogen may also be present as a latent infection in seedlings and rootstocks for transplanting; however the importance of latent infection in disease epidemiology is unknown. Contaminated picking crates may lead to postharvest fruit Botrytis. Contaminated tools and glasshouse structures are potential sources of carryover of the disease from one season to the next.

7 Infection of fallen fruit can lead to stem rot

Fungal survival

Spores of the fungus can remain viable for days or weeks depending on temperature, humidity and exposure to daylight. Survival is greatest at low temperatures and in the dark. Under the normal fluctuating greenhouse conditions, it is likely that spores remain viable for a few days. *B. cinerea* can survive from season to season in plant debris and in the soil. Sclerotia (resting structures) of *B. cinerea* can survive several years and may germinate to produce dispersal spores or fungal strands that may lead to infection.

Fungal spread

B. cinerea is dispersed primarily as spores (conidia) that are carried in air currents and spread by water-splash. Contact spread is important in bundles of layered stems (Figure 8). Insect transmission has been recorded but is not considered important. Transfer on knives used for crop work is possible. Occasionally senescent flowers can lodge on leaves or fruit below them and be a focus for infection.

Infection pathways

B. cinerea enters the plant primarily through wounds and senescent tissues. The fungus is a classic wound pathogen, with the moisture and sugars available in damaged tissues stimulating its growth. Petiole stubs and tabs left after deleafing (Figure 9), are very common pathways to stem infection. Stem rot may develop soon after infection at a deleafing wound site, or up to several weeks later. There is evidence that Botrytis spores can be sucked into the stem in guttation fluid exuding from deleafing wounds and move in the sap stream; stem rot may then develop at a node above the point where infection occurred after a latent period of a few or many weeks. Since there is evidence that the disease can remain quiescent in this latent phase for some time, until conditions allow rapid spread and sporulation, this emphasises the importance of good monitoring, rapid action and preventative control early in the season.

8 Advanced truss Botrytis

9 Deleafing stubs are a common infection point

Leaves with tip scorch, senescent leaves, broken leaves, and trapped sideshoots are other common infection points that can result in Botrytis stem rot (Figures 10 & 11). On some varieties where the fruit are picked loose, the spent fruit trusses turn necrotic and may become infected by *B. cinerea* leading to stem rot. Direct infection of the stem sometimes occurs at the V where an extra head has been taken and the stem has cracked (Figure 12). Leaf trimming debris caught in the plant canopy may become infected by *B. cinerea* with subsequent growth of the fungus into the supporting healthy tissue. Infection of healthy green tissue by conidia of *B. cinerea* is relatively rare. One exception is that of ghost spot when spores infect immature matt-surfaced green fruit but do not cause decay. Fruit rot may develop following infection of damaged calyces, through small cracks in the skin at the calyx end or through harvest injury.

10 Botrytis leaf infection

11 Stem Botrytis arising from an infected leaf

12 Botrytis originating at a stem split

Conditions favouring infection

Infection is favoured by cool temperatures and moisture. Spore germination occurs over a wide range of temperatures from 0 to 25ºC, with 10 - 20ºC being optimum. Spore germination requires free water on a plant surface, or very high humidity, above 90% RH. At 15ºC and 98% RH, a high proportion of spores may germinate within 24 hours. Ghost spotting only develops on fruit that have been wet. On stems however, the occurrence of condensation moisture is not essential for infection. Season-long monitoring of commercial crops in HDC project PC 301 showed that condensation on stems rarely occurred yet in some of the crops severe stem Botrytis developed. Infection occurred on deleafing wound sites, where exudation moisture was likely available, and on senescent fruit trusses, both infection points leading to stem rot.

As with petiole stub wounds, once Botrytis has established itself in a food base such as senescent leaves or necrotic fruit trusses, it can be very aggressive and rot even woody stems. Host resistance mechanisms are unlikely to operate effectively in senescing tissue, another reason that Botrytis can establish readily here. The importance of moisture in the establishment of Botrytis in senescent leaves and necrotic fruit trusses is uncertain.

Stem wounds become less susceptible to infection as they age. Experimental work showed a reduction in susceptibility of leaf scars to a standard inoculum of *B. cinerea* spores of around 50% after 1 day and around 75% after 14 days. The quantity of Botrytis also influences the chance of disease developing. When fresh deleafing wounds on a stem were inoculated with 10 spores of *B. cinerea*, very few stem rot lesions had developed 10 days later whereas inoculation with 1,000 spores resulted in rot at over 70% of wound sites in this time.

Plant age and condition also influence infection. Young plants grown in low light conditions, old plants at the end of a season, and plants infected by another disease (e.g. Verticillium wilt, Figure 13) all appear to be more susceptible. Fleshy leaves and stems, either a varietal trait and/or a result of growing conditions (e.g. inadequate heating resulting in vegetative growth) are also more susceptible. When growing conditions or variety result in a thick stem, the leaf petiole is usually thick also and a tab of tissue is more likely be left at leaf removal; the wound scar on the stem will also be larger. These features increase the risk of stem infection originating at deleafing wound sites.

13 Verticillium sporulation is usually paler and less dense than Botrytis and is mostly confined to the stem base

Conditions favouring sporulation and spore-release

Sporulation by *B. cinerea* on infected tissue has a narrow temperature optimum around 13-17ºC with little spore production below 10ºC or above 22ºC. Profuse sporulation occurs at high humidities, above 85% RH. Epidemic disease development in a crop is more likely when conditions favour both infection and sporulation.

Spores are released into the air from the structures bearing them by air movement or through the effect of changing humidity. They are also spread on the surface of small water droplets by splashing water.

The effects of temperature and moisture on *B. cinerea* spore germination, infection, sporulation and spore dispersal largely explain why grey mould is more troublesome in unheated or part-heated crops, following periods of wet weather and in older glasshouses with poor air movement and dripping water. Infection can also occur in sunny weather in these crop situations, but with low night temperatures, when condensation and guttation may occur during the following morning.

Control

It is difficult to exclude Botrytis from a crop as the pathogen is very common in the environment. The most appropriate and cost-effective course of action is to take measures to prevent stem and fruit infection, the most damaging forms of the disease.

Preventative measures

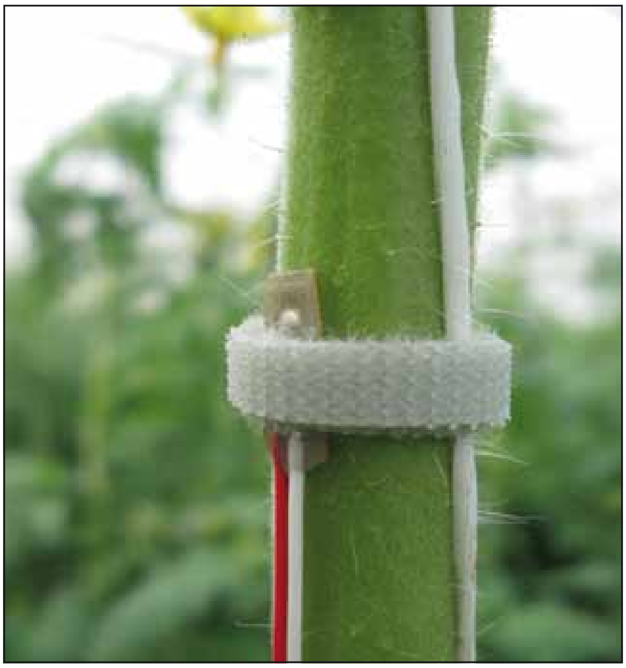
The key preventative measures are glasshouse humidity control, inoculum reduction and good crop management. Reliable control of grey mould requires careful attention to all these aspects.

Humidity control

The aim is to prevent frequent long periods of high humidity in the crop canopy and condensation on plant surfaces. As a guide, seek to avoid successive days with the relative humidity above 85% for more than 6 hours. Although rapid spore germination generally does not occur until the humidity is above 90%, the humidity in the microclimate close to plant surfaces will be greater than that in the measuring box.

Use heat and ventilation to reduce humidity in the glasshouse (see HDC Factsheets 07/09 and 25/02).

Do not allow the air temperature to rise too quickly in the morning, no more than 2ºC per hour, to reduce the risk of condensation on cool plant surfaces (e.g. fruits, stems). Under these conditions it is more effective to use ventilation to limit temperature rise and avoid dew point temperatures being reached than to boost heat input, as mentioned elsewhere. Using computer settings which increase ventilation setpoints in line with increasing solar radiation levels during this period can aggravate the problem.



14 Check for stem condensation: stem temperature sensor from HDC project PC 301

15 Use a fan and duct system or air circulation fans to minimise cold spots in a house

Use air circulation fans and/or a fan and duct system to help give a more uniform temperature across the house and prevent cold spots; Botrytis often starts in cold spots (e.g. close to an outer wall or near the end of a heating system) where condensation is more likely. Where present, ensure that growth tubes, used to provide heat at mid-canopy level, are working. Monitor stem and air temperature (see HDC Project PC 301 - Figure 14) to check if condensation is occurring on stems. Ghost spotting on fruit is a sign that condensation has occurred on them.

Air treatment units that control the temperature of incoming air circulated by a fan and duct system were recently introduced to aid cost-effective glasshouse climate control and are being evaluated in HDC project PC 278 (Figure 15). Results to date indicate a more uniform glasshouse temperature, reduced heating costs and no increase in Botrytis.

A sudden entry of cold or dry air when the vents or thermal screen are opened can result in leaf tip and margin necrosis ('scorch'), increasing the risk of Botrytis infection. Seek to avoid such leaf scorch by using small and gradual changes in the climate control settings. If it occurs, pick off the affected leaves.

Inoculum reduction

The aim is to reduce the quantity of Botrytis in the crop that could lead to further disease through production of air-borne dispersal spores, growth into the stem through a leaf petiole or fruit truss, or by contact spread from infected tissue to healthy tissue. As mentioned previously, Botrytis inoculum produced on tomato tissue within a crop is more likely to lead to further disease in the crop than exogenous spores arriving through the vents. Elimination or reduction of Botrytis inoculum early in the season is therefore particularly important; it will have more effect when levels are low, it will be easier to achieve, and it will delay the disease as several cycles of infection are required for epidemic development.

Inspect all plants for Botrytis when they arrive and inspect the crop regularly (e.g. weekly). Train staff to recognise the disease symptoms. In the first few weeks check for Botrytis on necrotic or damaged cotyledons; occasionally the disease establishes here and subsequently invades the soft stem of young plants. Check for Botrytis lesions on scorched leaf tips, broken leaves and, most especially, on petiole stubs or tabs (ragged pieces of fleshy tissue) left after deleafing. The disease rarely establishes on the stubs left when truss-harvested fruit are cut off. Increase the frequency of inspection in vulnerable areas, where air movement is reduced or crop work is poor, for example.

Where practicable, pick off Botrytis-affected leaves. Cut out small Botrytis lesions from the stem with a sharp knife (do not cut out stem lesions if Didymella stem rot is known or suspected to be present in the crop). Cut beyond the lesion edge by 5-10 mm as fungal growth is likely to be in advance of visible rot. Where a stem lesion has girdled the stem sufficiently to cause wilting, remove the plant and stem back to the propagation cube; where it is an extra head, remove it back to the main stem. Do not leave stem bases to die back; they are susceptible to Botrytis infection and can provide a continual source of spores.

Botrytis-affected leaves which are picked off the crop, stem lesions which are cut out and stems killed by Botrytis should all be removed from the house. Ideally remove them before Botrytis sporulation is obvious. Leaf trimmings from normal deleafing left on the floor under hanging gutters appear not to be a common source of Botrytis.

Crop management

The aim is to grow and manage a crop from when it is introduced to the house so that it is not highly susceptible to Botrytis infection. In particular, seek to maintain balanced growth and avoid fleshy, soft stem and leaf growth, ragged deleafing wounds and senescent leaves. Methods for avoiding soft lush growth include avoiding excess water application, maintaining adequate solution conductivity and balanced nutrition, with adequate potassium but limited nitrogen supplies in particular, removing leaf from the plant head and using generative temperature regimes. If further information is required on how to implement these without adversely affecting the crop, seek advice from a tomato crop consultant.

Interplanted crops appear to be at greater risk of Botrytis, likely from the dense canopy and spread from old to new plants. Overwintered crops are also at greater risk, resulting from low light conditions and soft growth.

Limit irrigation in the first weeks after planting to avoid excessive vegetative growth. Ensure that plants have adequate nutrition; there is some evidence that plants with low calcium levels are more susceptible to Botrytis, possibly because of poorer cell wall strength, which may also increase susceptibility to leaf scorch. Grafted plants may be more susceptible to Botrytis because of the extra vigour from the rootstock; manage growth carefully and seek to avoid producing thick fleshy stems. Varieties that produce large leaves appear to be more susceptible, possibly due to reduced air movement in the dense leaf canopy and the greater risk of leaves being damaged by staff or equipment moving along rows. Use 'leaf pinching' to manage the leaf canopy density (i.e. removing leaves from the plant head in anticipation of a dense canopy developing lower down the plant later on). For other reasons, it is not advisable to remove more than one leaf of the three normally found between successive trusses however. Check that yellowing leaves in the shaded centre of a double row are removed before Botrytis establishes on them. Where varieties are difficult to deleaf cleanly by snapping, use a knife to cut them off but take care to leave a smooth wound as close to the stem as possible (Figure 16). A high standard of trimming has become more important as crops are grown with less heat input.

On some varieties spent fruit trusses remain green for a long period while on other varieties they rapidly become necrotic. Invasion of old fruit trusses by Botrytis can result in stem lesions. For those varieties where truss dieback is common, pull off trusses as they begin to yellow. This may result in epidermal tears along the stem, but these soon dry and are rarely an infection point. Bundles of layered stems should be supported on hoops, or on supports at the side of hanging gutters, so that they do not sit in pooled water on the floor. Where feasible, space layered stems across hoops to allow good air movement around them.

Stem wounds are most susceptible to infection by Botrytis in the first few days after deleafing, before a wound response layer has formed. Seek to avoid prolonged exudation of sap from deleafing wounds (see comments on glasshouse environment control earlier). Deleaf a little and often, rather than removing many leaves at once. Deleaf in the morning, to allow time for stem wounds to dry, but not too early, before the plant has become active, or while the humidity deficit is still very low. It is also easier to snap off leaves cleanly in the morning, when plants are turgid. Twisting plants later in the day when they are more supple helps to avoid damage during this operation however.

Stop irrigation early on overcast days so that the slab is not overwet during the night which can enhance guttation by root pressure, especially at low night temperatures, which also increase the risk of fruit splitting.

The standard of crop work can have a tremendous impact on Botrytis levels. Check that leaf debris is removed from the crop canopy, fallen fruit are picked up, leaves and sideshoots are not trapped by support strings, and that deleafing and spent fruit truss removal are done well and in a timely manner.

Control measures

The basis of effective control is disease prevention as described above. Additionally, the crop should be monitored for Botrytis throughout the season and control measures adjusted where necessary.

16 Consider cutting off leaves where they are not easily snapped off

Disease monitoring

Inspect the crop for Botrytis regularly so that the initial infection, or a sudden increase in the disease, is found at an early stage – once Botrytis becomes well established in a crop it is much more difficult to control. Check deleafing sites, spent fruit trusses, the bundle of layered stems and stem splits. Pay particular attention to any cold areas and the compartment where the hot water pipes are furthest from the heat pump. Where Botrytis is found, identify the infection point(s), then review and adjust the Botrytis control measures to minimise further infection at these points.

Fungicide treatment

Where there is an increased risk of Botrytis, as evidenced from severe attacks on a particular variety, or in a particular glasshouse in a previous year, or where there is reduced heat input into a crop (e.g. boiler breakdown; intensive energy saving measure), or from a period of continuing wet weather, treatment with a programme of fungicides and/or biofungicides is likely to be beneficial. Where the supply of heat has nil or relatively low cost (e.g. waste heat from an associated industrial process or from a CHP generator), the use of extra pipe heat into a crop can greatly reduce further Botrytis development without the need for fungicides.

A range of fungicides and biofungicides are available (Table 1, loose-leaf insert on last page). Experimental work shows that treatment is more effective when applied at or before the start of an outbreak rather than when Botrytis is well established in a crop. Early spring (March – May) is an important period to protect crops with preventative sprays of fungicides because of large variation in day and night temperatures and risk of condensation/high humidities at this time. A treatment programme should be devised using products with different modes of action in alternation in order to reduce selecting resistant pathotypes of *B. cinerea* from the population. An example spray programme is given in Table 2 (loose-leaf insert on last page). It is emphasised that fungicides alone will not necessarily provide effective control of Botrytis; inoculum reduction, humidity control and good crop management are also necessary.

Fungicide spray interval may be 2 weeks initially in early spring, increasing to 3 or 4 weeks as the season progresses and the weather generally improves; but reduce the spray interval in persistent wet weather or if Botrytis levels increase. The recommended spray interval for biofungicides used alone may be shorter. The spray target will depend on the plant parts where infection occurs; it is likely to include de-leafing wounds and the bundle of layered stems and may include the leaf canopy. It is important that good spray coverage is achieved (see HDC Factsheets 20/00 and 14/06). Application of products by a low volume mister will provide some control but a conventional high volume spray is more effective where Botrytis is obvious in a crop.

Fungicide resistance

There is a history of *B. cinerea* developing resistance to fungicides, including those in the MBC, dicarboximide and anilinopyrimidine groups. The development of resistance depends, *inter alia*, on the frequency of use of fungicides in the same mode of action group. It is therefore important to follow product recommendations on how to avoid resistance (see Further information). The example programme is designed to minimise risk of selecting resistant strains by alternating fungicides from different mode of action groups.

The level of Botrytis also affects resistance risk. Follow the disease prevention measures detailed above to reduce Botrytis levels. If fungicide resistance is suspected in a population, this can be examined by a laboratory test on samples of infected tissues collected from throughout the crop (see Further information).

Stem paints and pastes

A number of products have been used to protect fresh wounds on the stem from infection by *B. cinerea* and/or to slow the expansion of small Botrytis stem lesions. Products with a physical mode of action such as silica clay pastes (e.g. Scaniavital Silica clay paste) are exempted from pesticides legislation. Experimental evidence with some treatments indicates they can reduce Botrytis sporulation and slow development from small to girdling Botrytis stem lesions. Treatments are usually applied with a small paint brush. It is impractical to protect all stem wounds but those deemed at high risk of infection (e.g. large wounds on fleshy stems) may warrant treatment (Figure 17). Alternatively, small Botrytis stem lesions may be treated directly, or cut out and the resultant stem wound treated.

17 Non-girdling stem Botrytis treated with a clay paste to delay spread

Further information

Disease diagnosis and fungicide resistance testing is available at Fera, Sand Hutton, York, YO41 1LZ (plantclinic@fera.gsi.gov.uk) and at Stockbridge Technology Centre, Cawood, Selby, North Yorkshire, YO8 3TZ (enquiries@stc-nyorks.co.uk). Information on fungicide resistance is available at: www.frac/info

More information on Botrytis and control of the glasshouse environment is available in the following factsheets and project reports:

- Guidelines for minimising latent grey mould (*Botrytis cinerea*) in cut flowers and pot plants. HDC Factsheet 13/09.
- Energy management in protected cropping: humidity control. HDC Factsheet 07/09.
- Energy management in protected cropping: manipulation of glasshouse temperatures. HDC Factsheet 06/09.
- Guidelines and best practice for pesticide spray application in protected ornamental crops. HDC Factsheet 14/06.
- Controlling humidity to minimise the occurrence of grey mould (*Botrytis cinerea*) in container-grown ornamentals: heated glasshouse crops. HDC Factsheet 25/02.
- Tomatoes: effective use of pipe-rail boom sprayers. HDC Factsheet 20/00.
- Targeting of humidity control, through the use of stem temperature measurements, to reduce stem Botrytis and save energy in tomato production. PC 301 Final report, April 2011.
- Tomatoes: development of biocontrol as a component of an integrated, sustainable strategy for the control of grey mould (*Botrytis cinerea*). PC 174 Final report, March 2004.

Regular changes occur in the approval status of pesticides arising from changes in legislation or for other reasons. For the most up to date information, please check with your preferred supplier, BASIS registered adviser or the Communications Branch at the Chemicals Regulation Directorate (CRD), Tel (01904) 455775, www.pesticides.gov.uk

LIAISON: liaison@fera.gsi.gov.uk Tel (01904) 462612.

This factsheet is based on research projects and may include mention of crop protection ingredients or products. The publication is intended to inform growers about work undertaken by the HDC or other research organisations and is not intended to endorse or recommend the use of any of the products or active ingredients mentioned. Growers should particularly note that the research projects may have included trials of substances which are not registered as crop protection products in the UK or are not approved for commercial use on the crop in question. Only products officially approved as plant protection products should be applied to control pest, disease and weed problems or used as plant growth regulators. Before using any such substance growers should refer to product approval and label recommendations and seek guidance from a BASIS qualified consultant.

Acknowledgements

Chris Durnford, Gerry Hayman and Alan Wright are gratefully acknowledged for useful comments on a draft of this factsheet. All images (apart from Figures 5, 14 & 15) are courtesy and copyright of ADAS. Figure 5 is courtesy and copyright of Gerry Hayman. Figures 14 & 15 are courtesy and copyright of Farm Energy.

Table 1: Fungicides and biofungicides with activity against *B. cinerea* and registered for use on tomato (Dec 2011)

Product	Active ingredient(s) (and FRAC mode of action Group number)	Approval	Max no. treatments	Minimum harvest interval (days)
Agrovista Fenamid	fenhexamid (17)	SOLA 0482/08	3	1
Amistar [a]	azoxystrobin (11)	SOLA 1685/01	4	3
		SOLA 1533/02	3	3
Cercobin WG [b]	thiophanate methyl (1) *	SOLA	1	3
Prestop	*Gliocladium catenulatum* strain 1446 (NC)	Label	none stated	none stated
Rovral WG [c]	iprodione (2) *	Label	5	2
Scala	pyrimethanil (9) *	SOLA0282/11	2	3
Serenade ASO [d]	*Bacillus subtilis* (44) strain QST 713	SOLA 0246/09	20	0
Switch	cyprodinil (9) + fludioxonil (12)	SOLA 0302/11	3	3
Teldor	fenhexamid (17)	SOLA 2087/04	3	1

* Resistant strains will not be controlled.

[a] Do not apply above 30ºC or below 10ºC.

[b] For crops grown in an inert growing medium or NFT.

[c] Not for use on cherry tomato.

[d] Use every 7 days or in alternation with another product.

NC = Not classified

Growers must hold a paper or electronic copy of an Extension of Authorisation for Minor Uses (EAMUs) before using any products under the EAMU arrangements. Any use of a pesticide under EAMU approval is at the grower's own risk. All the conditions of approval must be followed. For all products, check the current approval status before use.

Table 2 Example spray programme for a tomato crop with increased risk of grey mould

Week number [a]	Product	Comment
10	Switch	3 d harvest interval
12	Prestop or Serenade ASO	
14	Rovral WG*	Not on cherry varieties
16	Prestop or Serenade ASO	
18	Teldor	1 d harvest interval
20	Prestop or Serenade ASO	
23	Scala*	Do not spray at >30ºC or high humidity 3 d harvest interval
26	Prestop or Serenade ASO	
30	Rovral WG*	Not on cherry varieties
34	Prestop or Serenade ASO	

* Resistant strains will not be controlled.

[a] Adjust the spray interval according to the weather; a spray interval of 2 weeks is recommended in early spring; if there is prolonged sunny weather in the summer and little visible Botrytis in the crop, consider increasing the spray interval from 3 or 4 to 6 weeks.

January 2012