

Angela Huckle, Sarah Mayne and Chris Creed, ADAS

Rhubarb downy mildew

This factsheet describes the symptoms of downy mildew (Figure 1) and how it spreads in rhubarb plantations. It provides guidance on disease avoidance and summarises both cultural and chemical control measures.



Figure 1. Early downy mildew symptoms displaying angular yellow lesions on rhubarb leaf

Background

Rhubarb downy mildew (*Peronospora jaapiana*) has become an increasing problem in the UK. It was first reported in 1980 on Chinese rhubarb (*Rheum officinale*). In commercial edible harvested rhubarb (*Rheum L.*) crops, yield reductions of up to 30% have been reported. Severe infection can cause leaf death, reducing photosynthetic ability and subsequent

plant vigour and yield the following year. In potted rhubarb plants grown for ornamental production, the leaf spots and subsequently tattered leaves render the crop unsaleable. In cool, humid and wet conditions, the disease can progress rapidly within the dense crop canopy of outdoor crops.

Action points

- Propagate from symptom-free plants
- Maintain weed control and manage irrigation to reduce humidity within the crop
- Consider targeting preventative fungicide applications by monitoring weather conditions favourable for downy mildew
- Be vigilant for early symptoms
- Be aware symptoms can be mistaken for other leaf pathogens therefore microscope confirmation of diagnosis may be beneficial to ensure correct treatment
- Remove infected debris from the field where possible.

Symptoms

Downy mildew may infect seedlings causing complete dieback. On mature plants, infection leads to the development of large, often angular, brown leaf lesions. Seedlings grown in cold frames have also been found to be particularly vulnerable to the disease. In moist conditions, the lesions on the undersides of leaves produce sparse, purple, fawn or grey-coloured fungal spores that are visible with magnification.

Symptoms begin as conspicuous yellowing spots or yellowing areas of 10mm or more on the upper leaf surface (Figure 1 – front cover). These small chlorotic areas are initially delineated by veins and reddened borders, but enlarge across veins in severe attacks (Figure 2). Small areas often become dry and disintegrate causing the foliage to appear ragged and tattered (Figure 3), and this often causes a rough edge to the leaf, where lesions have died and torn away from the remaining healthy tissue. The reddening of the lesion edges is probably as a result of a physiological plant response to the disease.



Figure 2. Developing downy mildew symptoms displaying enlarging lesions across leaf veins



Figure 3. Downy mildew symptoms on rhubarb displaying dry lesions



Figure 4. Physiological stress or injury can give rise to a more intense red colour than that found in downy mildew

Reddening can also occur due to stress, or from physical injury, such as spray damage or high pest infestation. However, these cause a different form of reddening (Figure 4) to that caused by downy mildew. The reddening is more intense with more diffuse edges, and, unlike downy mildew, is not constrained by veins.



Figures 5a (left) and 5b (right). *Ramularia* symptoms on rhubarb leaves showing lesions that are redder when fresh and more rounded, particularly when small, than those of downy mildew

Downy mildew can also be confused with *Ramularia* leaf spot (*Ramularia rhei*). This leaf spot disease has smaller spots of up to 10–20mm diameter, which can affect both stems (petioles) and leaves (Figures 5a and 5b). *Ramularia* leaf spots are red-brown and are not delineated by leaf veins. Early stages may appear as small red spots. It is important to distinguish between the two diseases as each is controlled by plant protection products with different active ingredients.

Figure 6 helps to distinguish clearly between downy mildew, reddening caused by stress/injury and *Ramularia* leaf spot as all three can be found in the plants in the same picture.

Distribution

Downy mildew of rhubarb is caused by the species *Peronospora jaapiana*. This fungus-like Oomycete pathogen has been responsible for severe attacks in the East of England. The first listed records in the UK are of Chinese rhubarb infection in Cambridgeshire and Norfolk. Recent reports in commercial crops of edible rhubarb crops in the UK have been from Yorkshire, Nottinghamshire, Norfolk, Worcestershire, Surrey and Hampshire.

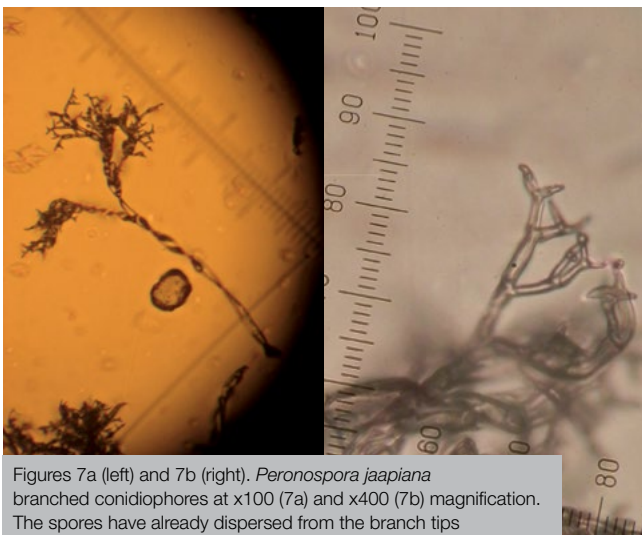
Outside the UK, it has been recorded in gardens in the USA, Poland and Australia. There have been further reports from Asia and across Europe. It is not restricted to commercial vegetable rhubarb. Chinese rhubarb (*Rheum officinale* and *Rheum palmatum*), False rhubarb (*Rheum rhaponticum*) and *R. undulatum* are also reported as being susceptible.

Life cycle

Despite being initially recorded in Switzerland in 1903 and in the UK in 1980, relatively little is known about this pathogen's life cycle and the initial source/s of infection. Downy mildews are obligate pathogens and so infection, growth and sporulation require living host tissue. Spores (conidia) are produced on conidiophores that emerge from the lower leaf surface, usually through open stomata, and are dispersed by air currents, water splash or through contact with people and tools. Conidiophores (Figures 7a and 7b) are produced sparsely by *P. jaapiana*. Conidia are obovoid (28–30 x 14–18µm) and pale violet-brown.



Figure 6. Rhubarb plants exhibiting symptoms of scorch (left), Ramularia leaf spot (middle) and downy mildew (right)



Figures 7a (left) and 7b (right). *Peronospora jaapiana* branched conidiophores at x100 (7a) and x400 (7b) magnification. The spores have already dispersed from the branch tips

Thick-walled resting spores that survive in debris for long periods can be formed by species of *Peronospora*, but have not been found for *P. jaapiana*. Little is currently known about how it survives between seasons, but mycelium is thought to persist in young shoots of propagating roots. In addition, the mycelium of *P. jaapiana* contains unusually large amounts of glycogen, which enables it to overwinter in decaying leaf debris.

Favourable conditions and spread

Rhubarb downy mildew infection and sporulation is favoured by cool, humid conditions, with spore spread assisted by rain splash. Outbreaks are therefore more severe in cold, wet seasons. In the cooler, wetter and also humid UK summers of 2012 and 2015, increasing occurrences of downy mildew symptoms were reported. Initial symptoms are found where humidity in the crop is highest, such as low-lying areas of fields, where severe disease can develop. Plants can become almost completely defoliated in severely affected areas.

The longevity of the conidia of *P. jaapiana* is not known. Information from other related species, suggests that these

spores are likely to be short lived, should humidity and temperature become unfavourable.

Although the thick-walled resting spores (oospores), which allow the pathogen to survive for long periods, have not been found, the survival of fungal mycelium on old plant tissue would explain why infection can re-occur on new plantings in fields previously affected. However, in fields where rhubarb infection has not previously been seen, it would be helpful to understand the distances over which conidia can spread from other locations and remain viable, along with the likelihood of disease movement as mycelium in planting material.

Downy mildew has not been reported on rhubarb grown indoors in the UK in forcing sheds or tunnels. Despite conditions being wet and cool (which would seem favourable for infection), the decrease in leaf canopy reduces humidity. In addition, ventilation is often increased to reduce the occurrence of *Botrytis* grey mould, the key disease issue in forcing sheds. Both these factors could explain the absence of downy mildew in forcing sheds and tunnels.

Integrated disease management strategy

It is important to maintain an integrated approach to the management of downy mildew, to include cultural and biological control measures, in order to reduce the chance of resistance development by the pathogen to the limited chemical control options.

Cultural control

The first consideration is to propagate from disease-free plants and, where possible, consider varietal susceptibility. Variations of tolerance to downy mildew have been seen in the Royal Horticultural Society (RHS) national collection of rhubarb varieties at RHS Wisley. However, the main commercial varieties, including Timperley Early, Reeds Early Superb, Victoria, The Sutton, and Livingstone all seem to be affected by downy mildew. Stockbridge Arrow is the only current commercial variety that appears to have some tolerance to downy mildew.

Control of environmental conditions favourable to disease development should be exercised, where possible. Rhubarb canopies are naturally dense and vigorous in healthy plantations, but wider plant spacing and effective weed control can be utilised to improve ventilation between plants (Figure 8). Humidity can be reduced by the avoidance of overhead irrigation. If this has to be applied, it should be applied earlier in the day to provide sufficient daylight for the leaves to dry.

Infected leaf debris should be removed from the field where possible, and sensible crop rotations implemented with a break between rhubarb cropping.

Biological and chemical control

Fubol Gold WG (metalaxyl-M + mancozeb), is the only crop protection product currently approved (EAMU 2283/13) for use on outdoor rhubarb, which is known to be effective against downy mildew. Care must be taken with its use to prevent the development of pathogen resistance, especially as resistance to metalaxyl-M has occurred in downy mildews specific to other crops.

Ideally, Fubol Gold WG should be applied before symptoms are seen, as it offers protection rather than curative properties. Three applications are permitted per year, used at least seven days apart and up to 21 days before harvest. Monitor for cool, wet and humid weather conditions that may be conducive to downy mildew and consider applying a fungicide if these conditions occur, especially if early symptoms are seen in the crop.

Plover (difenoconazole) also has an EAMU (2786/15) for use in outdoor rhubarb but its activity is primarily against leaf spots and with only one application permitted per season, this fungicide should be targeted towards the control of Ramularia leaf spot.

The biofungicides Serenade ASO (*Bacillus subtilis*) and Prestop (*Gliocladium catenulatum*) are also approved for use on rhubarb under EAMU approvals 0706/13 and 2773/15, respectively, but although these products have efficacy against other Oomycete pathogens (those causing *Phytophthora* root rots), they are not proven to control downy mildews.



Figure 8. The dense canopy of a mature rhubarb crop, showing that good weed control provides gaps for air movement, so making conditions less favourable for downy mildew

Future considerations

There are many gaps in our knowledge of this pathogen and more work is required to understand the life cycle to enable the development of effective control strategies. It is important to determine if the infection becomes systemic, due to the perennial nature of the crop and the potential influence of infection on yield in subsequent years. Systemic and/or non-symptomatic infection would be an important consideration in vegetative propagation.

It is important to maintain an integrated approach to management because chemical control of the disease currently relies on one active ingredient to which resistance has developed in other crops. Varietal tolerance requires further investigation for use as part of integrated disease management.

Further information

Useful AHDB project reports

CP 157 – Aerial Oomycetes: A review of management and control options available for the UK horticulture industry.

Image credits

All images are courtesy and copyright of ADAS.

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.

© Agriculture and Horticulture Development Board 2016. No part of this publication may be reproduced in any material form (including by photocopy or storage in any medium by electronic means) or any copy or adaptation stored, published or distributed (by physical, electronic or other means) without the prior permission in writing of the Agriculture and Horticulture Development Board, other than by reproduction in an unmodified form for the sole purpose of use as an information resource when the Agriculture and Horticulture Development Board or AHDB Horticulture is clearly acknowledged as the source, or in accordance with the provisions of the Copyright, Designs and Patents Act 1988. All rights reserved.



AHDB Horticulture is a part of the Agriculture and Horticulture Development Board (AHDB).

£8.75
where sold

Want to know more?

If you want more information about AHDB Horticulture, or are interested in joining our associate scheme, you can contact us in the following ways...

horticulture.ahdb.org.uk

AHDB Horticulture, Stoneleigh Park,
Kenilworth, Warwickshire CV8 2TL

T: 024 7669 2051 E: hort.info@ahdb.org.uk

[@AHDB_Hort](https://twitter.com/AHDB_Hort)