Crop Walkers' Guide

AHDB

Mushrooms

HORTICULTURE

Unless mushroom growers can recognise, diagnose and deal with crop problems promptly, the crop can be quickly rendered unsaleable. Often, such problems are linked to pests and diseases, but nutritional and cultural-related disorders may also be involved.

This AHDB Horticulture Crop Walkers' Guide is designed to assist growers, supervisors and staff in the vital task of monitoring crops.

It is designed for use directly on site to help with the accurate identification of economically important pests, diseases and disorders. Images of the key stages of each pest or pathogen, along with typical symptoms, have been included, together with bullet-point comments to help identification.

This guide presents the most commonly occurring pests, diseases and disorders in mushroom (*Agaricus bisporus*) crops. Growers are advised to familiarise themselves with the variety of symptoms that can be expressed and be aware of new problems that may occasionally arise.

This guide does not offer advice on available control measures because these frequently change. Instead, having identified a particular pest, disease or disorder, growers should acquaint themselves with the currently available control measures.

Some of the best safeguards for a mushroom grower to stay free of diseases are:

- A reliable compost supplier that abides by strict hygiene protocols
- A reliable casing soil supplier that abides by strict hygiene protocols
- Keep growing rooms closed, so no flies, which can carry fungal spores, can get in or out
- Adhere to strict hygiene protocols on the farm
- Cover any diseases that occur with salt, at the regulated rate and as soon as possible, to avoid spore spreading

Following these safeguards does not guarantee disease-free mushroom growing, but – if carried out well – are strong influencing factors on good yields and good quality product.

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BACTERIAL DISEASES

FUNGAL DISEASES

VIRAL DISEASES

Pests

Cecid flies

Mycophila speyeri

- Cecids are rarely identified from the fly stage. Flies are small (1 mm) and seldom seen.
- Cecids are identified from their larvae. The maggots are orange in colour and about 1 mm long. There is no discernible head. Larvae are legless but move by flexing and straightening their bodies. Larvae are typically seen below the mushroom cap at the top of the stem.
- Female larvae can produce daughter larvae, without an adult stage.
- The main damage caused by cecid larvae is that they are very difficult to remove from the mushroom, making the mushroom unfit to sell.

Phorid flies

Megaselia halterata

- Mushroom phorids are 2–3 mm long; smaller than sciarid flies. They are brown-black in colour and have no clear or distinctive antenna.
- The adult flies usually are attracted by light and are less likely to crawl over the mushroom beds.
- The larvae are creamy-white and legless, reaching a size of 1–6 mm in the mature stage. The head is pointed and not black.
- Females can lay up to 50 eggs and, at a compost temperature of 24°C, the life cycle from egg to adult is only around 17 days. At 18°C, the life cycle takes about 45 days.
- Larvae can damage mushrooms by feeding on mushroom mycelium, but they never enter mature mushrooms. Adult flies can be a nuisance to pickers as they swirl around the lights.
- Uncontrolled spreading of fungal disease spores can cause indirect damage.

Red pepper mites

Pygmephorus selnicki

- The mites are tiny, 0.20–0.25 mm in diameter and are orange-brown in colour. They can be seen grouped together in large numbers, usually on the highest point of a mushroom or casing on the mushroom beds.
- They appear to be moving when watched and always rapidly return to the highest point after being blown off.
- Females can lay up to 150 eggs over a period of 4–5 days. The life cycle from egg to adult mite is only 4–5 days at 20–25°C.
- Red pepper mites do no direct damage, but make the crop unfit to sell.
- These mites are known to be associated with *Trichoderma* spp., which causes green mould, so they are considered an indicator for an underlying problem.

Sciarid flies

Lycorella auripila or *Lycorella solani*

- Mushroom sciarids are 3–6 mm long. They are black gnat-like flies with long thread-like antennae, facing upwards from the head of the fly.
- The adult flies are typically slow and walk over the mushroom beds more than they fly.
- The larvae are white and legless, reaching a size of 6–12 mm in the mature stage and usually have a black head.
- Females can lay up to 170 eggs and, at a compost temperature of 24°C, the life cycle from egg to adult is only 18–22 days. At 18°C it takes 35–38 days.
- Direct damage to the crop is usually limited, unless the population is extremely large; in this case, larvae can chew their way through the stems of the mushrooms.
- Indirect damage is more significant. The adult flies are attracted to fresh phase III compost, so they leave the old and diseased growing rooms for new rooms, spreading fungal diseases when spores stick to their legs and bodies.

Spider mites

Parasitus fimetorum

- The adult mites are orange to dark red in colour. They can move very fast over the beds, but cannot fly.
- This mite is around 1–2 mm in size and is often seen running over the casing soil and the sides of the beds – even across the floor. It only attacks mobile prey, such as nematodes and insect larvae.
- Spider mites, even in larger numbers, do no direct damage to the crop. However, people can find them a nuisance as the mites run over their hands. They are said to be a cause of skin irritation for pickers.
- Spider mites probably spread disease by spores.

Beneficials

Entomopathogenic nematodes

Steinernemae feltiae

- *Steinernemae feltiae* nematodes are microscopic non-segmented worms and are an effective way to biologically control populations of mushroom flies. They are very effective for the treatment of sciarid flies, but less effective against phorid flies.
- Produced in special fermenters, they come with a carrier – usually in bags of 250,000,000. After application, the nematodes enter the larvae of the sciarid fly via mouth, anus or respiratory openings and start to feed.
- Bacteria emerge from the intestinal tract of the nematode. These spread inside the insect and multiply very rapidly, converting host tissue into products that can be easily absorbed by the nematodes. The sciarid larva dies within a few days.
- Application rate is 2,000,000 nematodes per square metre of growing surface. This can be a split application. Make sure the equipment used is fit for purpose. The nematodes are dissolved in water and applied.

Diseases

BACTERIAL
FUNGAL
VIRAL

Bacterial blotch

Pseudomonas tolaasii or *Pseudomonas gingerii*

- Brown or bacterial blotch appears as brown patches on the mushrooms, in both white and brown crops.
- Ginger blotch appears in a similar way, but with a different, more reddish-ginger colour.
- Sometimes, the caps are partly affected; in severe cases, the whole mushroom cap and even stem can be coloured brown. Cap spotting also occurs, but this should not be mistaken for *Trichoderma* infection.
- Bacterial blotch will never grow inside a mushroom; it remains superficial. Affected mushrooms are also slimy.
- The bacteria causing blotch issues are present in all crops, but high levels cause discolouration. When beds stay damp and wet after watering, blotch can become a major problem.
- Blotch can grow very fast on dead mushroom material, or on stems left on the beds.

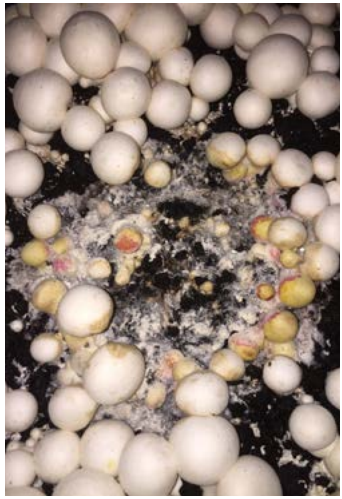
Mummy disease

Pseudomonas spp.

- Affected mushrooms become dry and rubbery on the beds. The caps are distorted and are commonly tilted, with curved stems. Infected mushrooms are usually small and become mummified at an immature mushroom stage.
- When picked, the mushrooms are hard to remove from the casing soil and a lot of casing will stay attached after picking.
- The affected mushrooms are grouped together with no healthy mushrooms found in the middle.
- Fast growth is a typical feature of this disease. Typically, the first sign is a round spot of dying, rubbery mushrooms on the beds. This spot may spread by up to 20 cm a day.
- The disease is caused by *Pseudomonas* bacteria, which are related to the bacteria that cause bacterial blotch. It can only be spread by physical contact of mycelium. Wet compost seems to trigger Mummy disease.

Cobweb

Dactylium dendroides syn. *Cladobotryum dendroides*



- The main symptom of the parasite Cobweb disease is the spiderweb-like growth of mycelium over the surface of the mushrooms and beds. It appears to be 'eating' the mushrooms.
- When left on the beds, the diseased mushrooms turn a yellow or red colour. They eventually turn black and rot away. Cap spotting also occurs and can cause large crop losses. When the disease stays on the bed, it can appear purple.
- The spores, which are produced in large numbers, are airborne and therefore spread extremely easily, making this disease potentially very harmful.
- The time from spores landing on the mushrooms or beds to the development of symptoms is only 3 days.
- The three parasitic fungal diseases, cobweb, wet bubble and dry bubble, are not known to develop before pins of mushrooms appear on the beds. This means they are formed in the casing soil and not in the compost.

Dry bubble

Verticilium fungicola

- This parasitic disease shows itself in many ways, depending on the development stage of the mushroom at the time of infection. It can cause large losses in yield.
- At an early stage, small, undifferentiated masses of tissue occur that are generally up to 3 cm in diameter – sometimes larger. When affected at a later stage, mushrooms are often imperfectly formed with distorted stalks and malformed caps.
- Later on, these dry 'bubbles' turn grey or brown in colour. Spores landing on healthy mushrooms can cause cap spotting, turning from grey to brown.
- Spores are sticky; therefore, the disease is spread very easily by flies, people, dust and all equipment traveling through the farm.
- The time from spores landing on a healthy crop to showing symptoms, such as cap spotting, is only about 4 days.

Green mould

Trichoderma spp.

- *Trichoderma* species are known to produce enormous amounts of spores that vary in shades of green; hence the name ‘green mould’.
- *Trichoderma* causes the most damage when colonisation of the disease occurs in compost. The disease is first seen at spawn-running stage and looks like a dense mass of white mycelium. When the disease develops, visible green spores are being formed and the mushroom mycelium is being pushed out. *Trichoderma* is a so-called ‘competitor mould’.
- *Trichoderma* can do a lot of damage, depending on the time of infection on the compost facility. An infection at spawning of *Trichoderma aggresivum* will reduce yields to zero. When entering the growing room, there is a typical metallic smell.
- In later flushes, *Trichoderma harzianum*, a species that causes milder green mould, can be seen as green spots on top of the casing soil. This causes mushrooms to turn brown and rot.

Ink cap mushrooms

Coprinus spp.

- Ink cap mushrooms are clearly visible, individual mushrooms, which grow on mushroom beds. In the first stage of their development, they appear as white, oval-shaped mushrooms with a rough surface.
- The development of ink caps is very rapid; they soon turn into a slimy stem with a disintegrating cap that spreads black spores. They usually show up before or during the first flush.
- Ink caps are an indicator of a flawed composting process: too much nitrogen, or a compost not totally cleared of ammonia (NH_3).

Wet bubble

Mycogone perniciosa

- This parasite disease shows itself by forming distorted, undifferentiated mushroom tissue. These so-called 'bubbles' give the disease its name. Very commonly, amber drops of liquid can be found on top.
- These bubbles are often very large, 10 cm, or even larger if untreated. In cases of infected casing soil, they sometimes show themselves coming out of the casing soil with an already large and shapeless appearance.
- The disease spreads through spores, which are carried by flies, people, boxes or equipment. The spores are not airborne.
- The time from infection with spores to the development of the disease is approximately 10 days. The disease needs mushroom tissue to develop.
- *Mycogone perniciosa* may also appear as small, fluffy, white patches of mycelium.

Mushroom virus X

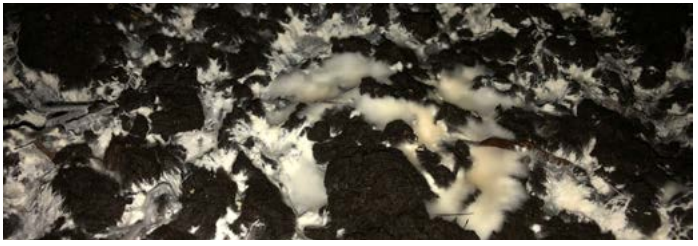
MVX

- One of the first symptoms to be noticed is patches of non-productive bed. These patches are usually circular or have strange patterns throughout the beds. Sometimes, these patches show delayed cropping, but sometimes cropping is not delayed at all. Delayed mushrooms from the patches open prematurely.
- In white strains, pale brown mushrooms can grow, with no distinguished pattern. One mushroom may be white, while the neighbouring mushroom may develop a typical pale brown colour. Usually, the whole cap is brown and anywhere between 5 and 80% of the total crop may be affected.
- It is said that MVX is caused by mushrooms that contain double-stranded RNA, which has the genetic appearance of a virus, and influences the cells of the mushroom. An early infection, for example on that occurs on the compost yard because of poor hygiene practices, can have devastating effects on yield.

Cultural disorders

- Clusters are groups of mushrooms that grow together and look like a cauliflower. They are fused clumps with deformed shapes. There are two types.
- The first type is a cluster of deformed pieces of mushroom, which cannot be broken apart into individual mushrooms. This type of clustering is now very rare, but is usually caused by degeneration of the mushroom spawn.
- The second type of clustering contains mushrooms grown together as a clump. They are easily separated into individual mushrooms. This type of clustering is a typical for the first mushrooms of a first flush and is seen, in lower counts, quite often. It is caused by high CO_2 concentrations used to try and keep pin numbers at a reasonable level.

Stroma



- Stroma is seen in vegetative stages, when mycelium grows through the casing soil and forms a thick white mat on the surface. No pinning takes place in that area.
- A milder variation of stroma can be called ‘overlay’. Overlay is usually caused by high CO_2 concentrations when the mycelium surfaces; this mycelium will not start pinning straight away when the room is shocked. After a couple of days, pins appear through the overlay.
- Real stroma is caused by a mild mutation in the spawn, which occurs due to improper spawn storage. To avoid this, spawn must be kept in a coldstore at around 2°C for no longer than 3 months.

References

AHDB Horticulture is very grateful to independent mushroom consultant John Peeters for writing this Mushroom Crop Walkers' Guide.

We very much hope that it proves to be a helpful aid to your businesses.

Photographic credits

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Section 1 – Pests

1.1 Cecid fly larvae – Oscar Lahmann
1.2 Phorid fly larva – Matt Bertone
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4.1 Cluster – Mushroom Office
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