# 11 Common diseases of some economically important crops

In this section the common diseases of a range of vegetable crops and one field crop are recorded to illustrate the diversity of diseases in Vietnam. The diseases listed in each table also provide a checklist to help with observations in the field. The pathogens responsible for many of these diseases can only be diagnosed accurately in the laboratory.

Accurate diagnosis is essential before recommendations can be made on an integrated disease management strategy. For example, fungal root rots can be caused by many pathogens such as species of *Pythium, Phytophthora, Rhizoctonia* and *Phoma*. The appropriate disease management strategy differs between these genera.

A diagram of each crop plant is included to assist the reader in learning where to look for symptoms of each disease.

A thorough understanding of these diseases will assist the reader in their diagnosis of diseases in many other crops.

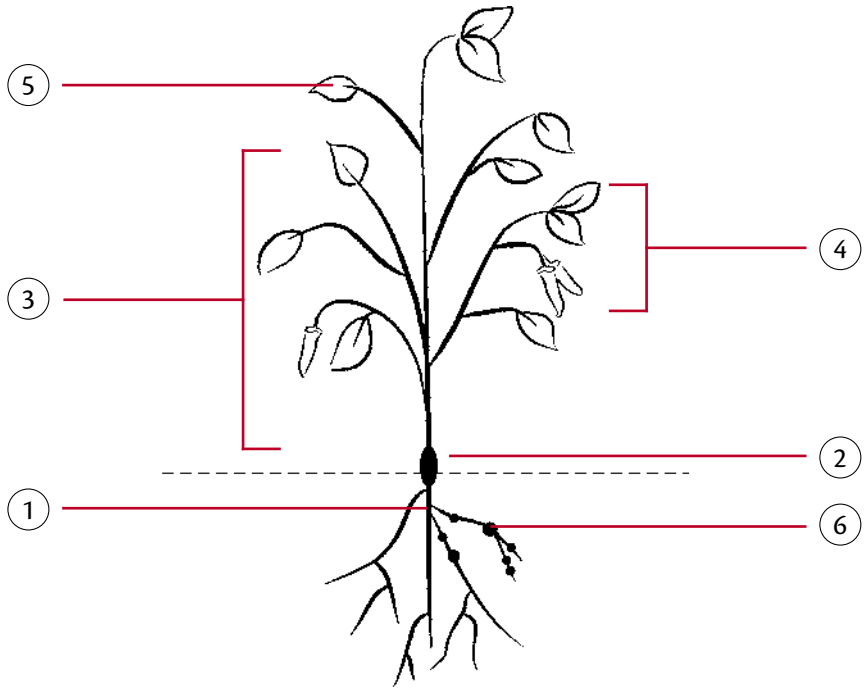
## 11.1 Common diseases of chilli

Table 11.1 provides a list of the common diseases of chilli in Vietnam (numbers refer to diagram). All diseases may be present in a single crop, and one plant can be affected by one or more of these diseases (Figure 11.1).

Phytophthora root rot, basal stem rot, bacterial wilt, root knot nematode and stem boring insects all cause similar wilting symptoms.

**Table 11.1** Common diseases of chilli

| Disease | Pathogen | Key diagnostic sign |
|---|---|---|
| 1 Phytophthora root rot | *Phytophthora capsici* | Root rot and wilt |
| 2 Basal stem rot | *Sclerotium rolfsii* | Small brown round sclerotia and white mycelium on stem base |
| 3 Bacterial wilt | *Ralstonia solanacearum* | Bacterial ooze in stem, stem browning |
| 4 Anthracnose | *Colletotrichum* sp. | Black sunken lesion |
| 5 Viral disease | Plant virus | Dwarfing of younger leaves |
| 6 Root knot nematode | *Meloidogyne* sp. | Galls on roots |



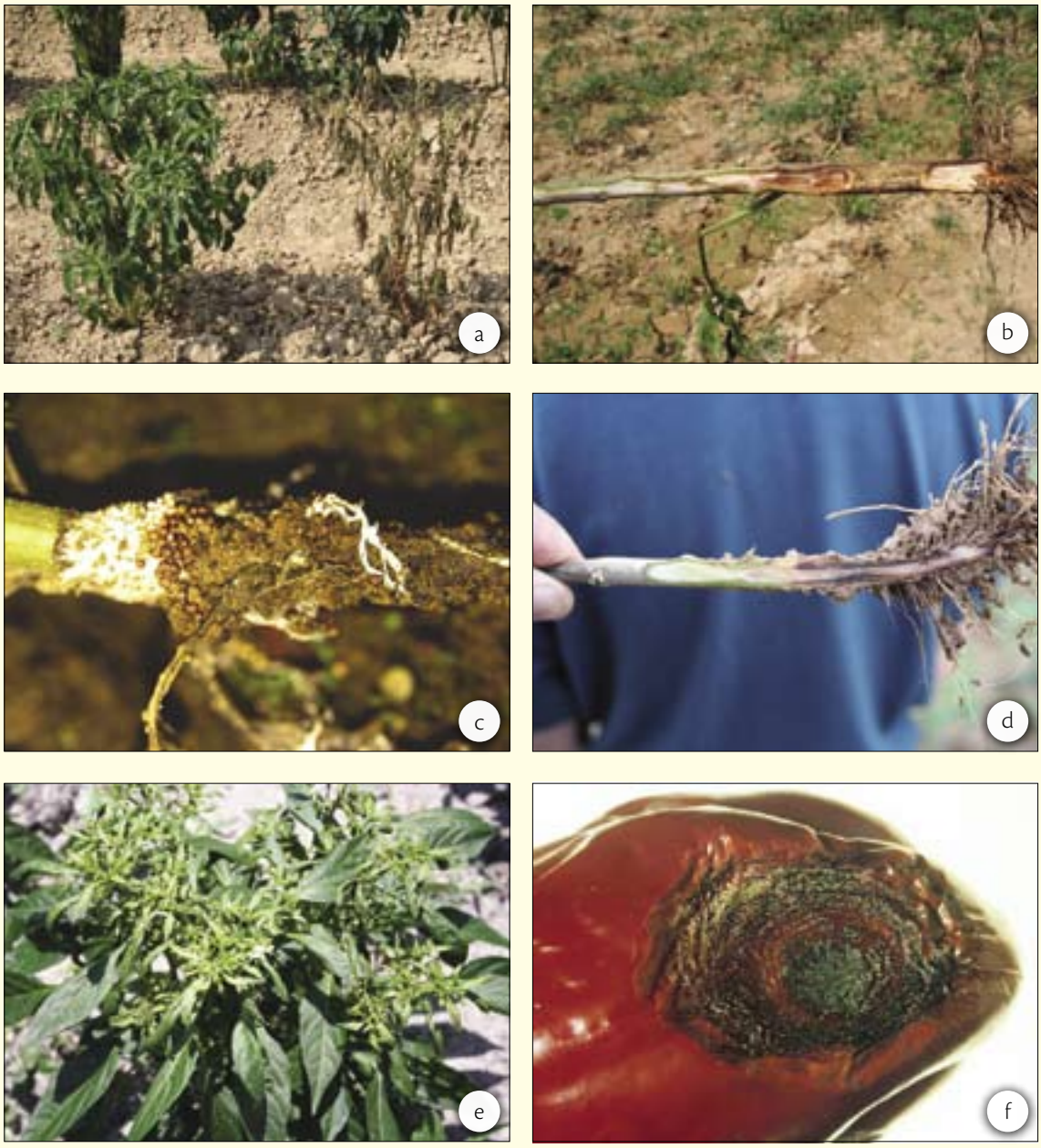



**Figure 11.1** Diseases of chilli: (a) healthy chilli plant (left) and wilted (right), which can be caused by several diseases, (b) stem browning, a typical symptom of bacterial wilt caused by *Ralstonia solanacearum*, (c) basal rot caused by *Sclerotium rolfsii*, (d) Phytophthora root rot caused by *Phytophthora capsici*, (e) chilli affected by tomato spotted wilt virus, (f) chilli fruit affected by anthracnose, caused by *Colletotrichum* sp.

## 11.2 Common diseases of tomato

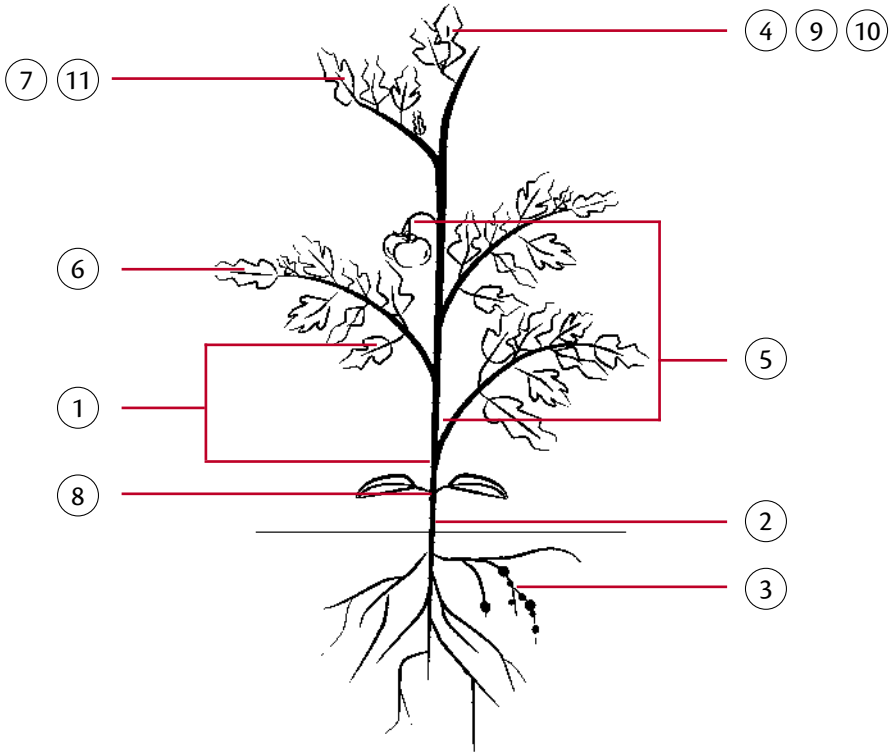
Tomato is susceptible to a very wide range of diseases (Table 11.2). There is a need for more disease surveys of tomatoes in Vietnam to identify all the serious diseases present. In particular, diagnostic studies are needed on the viruses and bacterial pathogens on tomato.

Tomato crops in Vietnam are commonly affected by several diseases. Individual plants can be affected by more than one disease, which can make diagnosis difficult (Figure 11.2).

**Table 11.2** Common diseases of tomato

| Disease | | Pathogen | Key diagnostic sign |
|---|---|---|---|
| 1 | Bacterial wilt | *Ralstonia solanacearum* | Wilt, bacterial ooze in stem, stem browning |
| 2 | Basal stem rot | *Sclerotium rolfsii* | Small brown round sclerotia and white mycelium on stem base |
| 3 | Root knot nematode | *Meloidogyne* sp. | Wilt, galls on roots |
| 4 | Late blight | *Phytophthora infestans* | Grey fungal growth on underside of leaf |
| 5 | Bacterial canker[a] | *Clavibacter michiganensis* | Leaf yellowing, wilting, stem browning, fruit spotting |
| 6 | Bacterial speck[a] | *Pseudomonas syringae* | Necrotic spots on leaves |
| 7 | Tomato spotted wilt virus[a] | Virus | Small areas of browning (bronzing) on young leaves, dark spots or rings on old leaves |
| 8 | Fusarium wilt[a] | *Fusarium oxysporum* f. sp. *lycopersici* | Wilt, vascular stem browning |
| 9 | Target spot/early blight | *Alternaria solani* | Concentric circular black lesions on leaves |
| 10 | Leaf mould | *Cladosporium fulvum (Fulvia fulva)* | Grey/purple fungal growth on underside of leaf |
| 11 | Yellow top virus | Virus | Small yellow curled leaves |

a The presence of these pathogens in Vietnam needs to be confirmed.



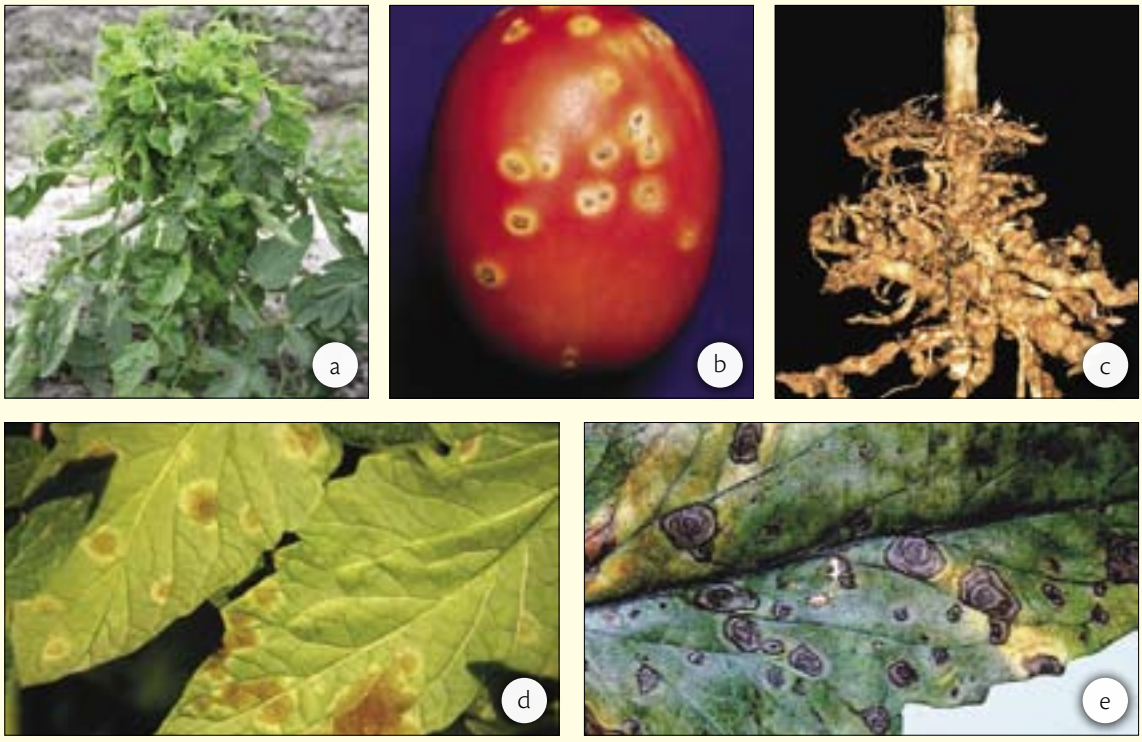



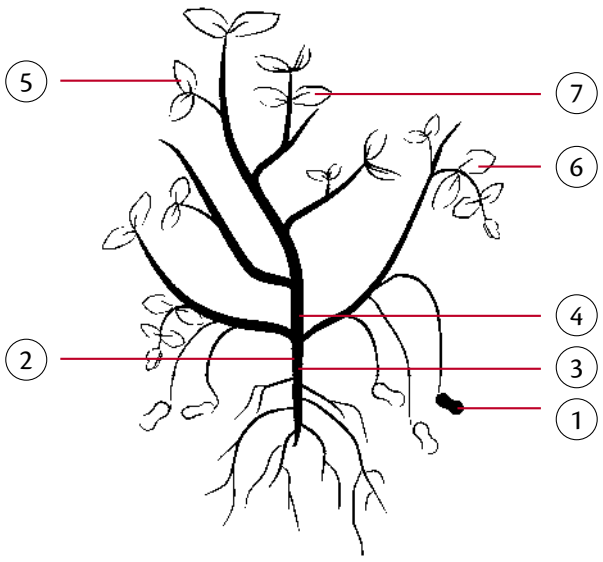

**Figure 11.2** Tomato diseases: (a) tomato showing symptoms of yellow leaf curl virus in new growth, (b) tomato fruit showing bacterial speck lesions caused by *Pseudomonas syringae*, (c) root knot nematode caused by *Meloidogyne* sp., (d) velvet leaf spot caused by *Cladosporium fulvum*, (e) target spot caused by *Alternaria solani*

## 11.3 Common diseases of peanut

Peanuts are susceptible to root, pod, stem and leaf diseases (Table 11.3 and Figure 11.3). The root and pod rot diseases need more diagnostic research to determine the key pathogens involved.

**Table 11.3** Common diseases of peanut

| Disease | Pathogen | Key diagnostic sign |
|---|---|---|
| 1 Root and pod rot | *Pythium/Rhizoctonia* | Seedling death/root rot<br>Yellowing and wilting<br>Stunting<br>Browning of lateral roots mid-season<br>Tap-root rot late in season and pod rot |
| 2 Basal stem rot | *Sclerotium rolfsii* | Small brown round sclerotia and white mycelium on stem base |
| 3 Crown rot | *Aspergillus niger* | Stunting and wilting<br>Black mycelium and spores on stem base and cotyledons |
| 4 Stem rot | *Sclerotinia sclerotiorum* | Wilting, wet rot of stems and leaves, large black sclerotia |
| 5 Rust | *Puccinia arachidis* | Reddish rust pustules on leaves |
| 6 Cercospora leaf spot | *Cercospora arachidicola* | Dark chocolate brown lesions |
| 7 Mosaic virus | Virus | Mosaic, laboratory diagnosis required |



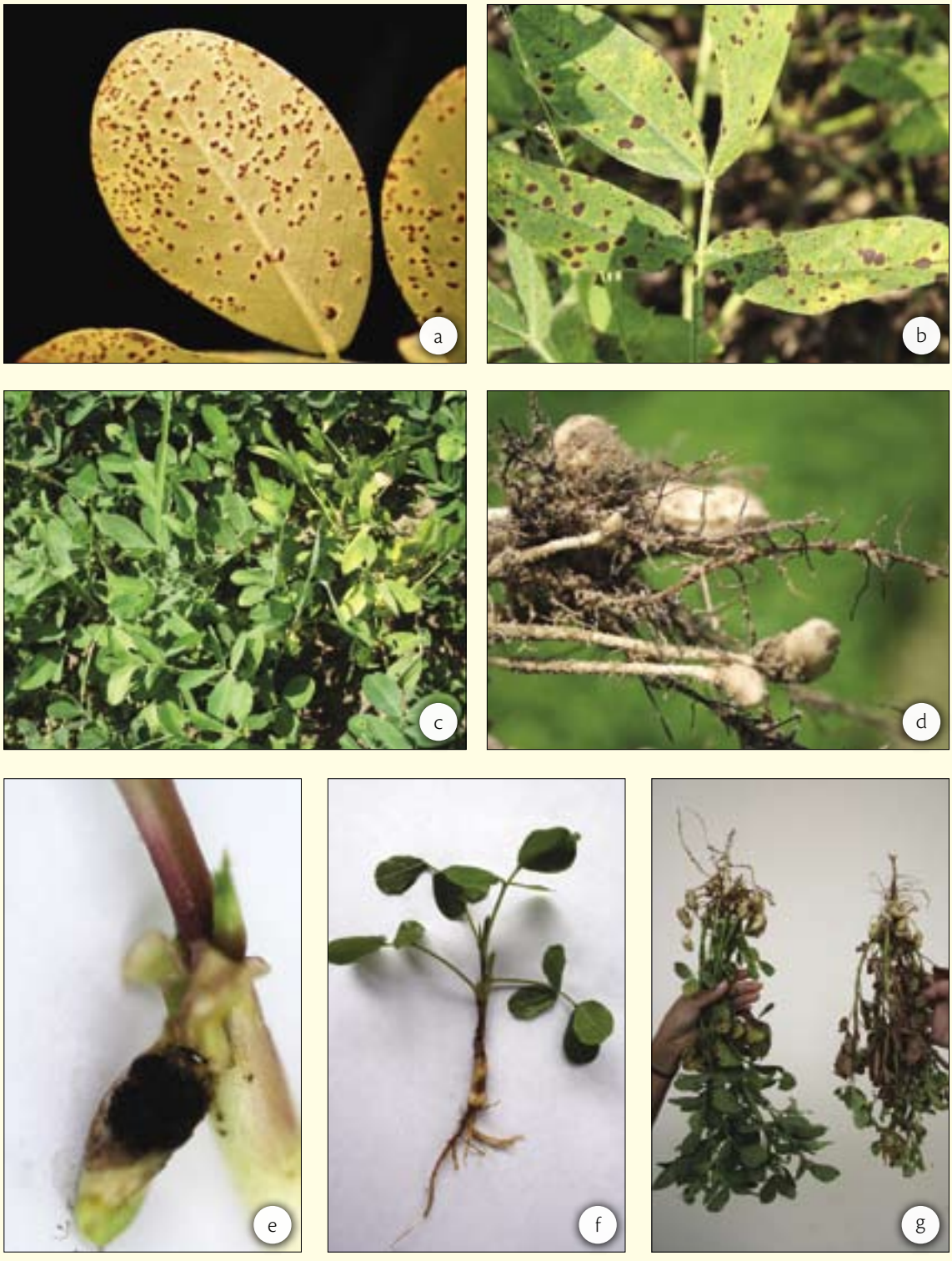



**Figure 11.3** Peanut diseases: (a) peanut rust caused by *Puccinia arachidis*, (b) Cercospora leaf spot (*Cercospora arachidicola*) and rust, (c) peanuts affected by root rot showing yellowing and stunting symptoms, (d) feeder root rot and pod rot caused by *Pythium* sp., (e) necrotic peanut cotyledon showing abundant sporulation of the pathogen *Aspergillus niger*, (f) Pythium root rot on peanut seedling, (g) healthy peanut plant (left) and stunted root rot affected plant (right)

## 11.4 Common fungal diseases of onions

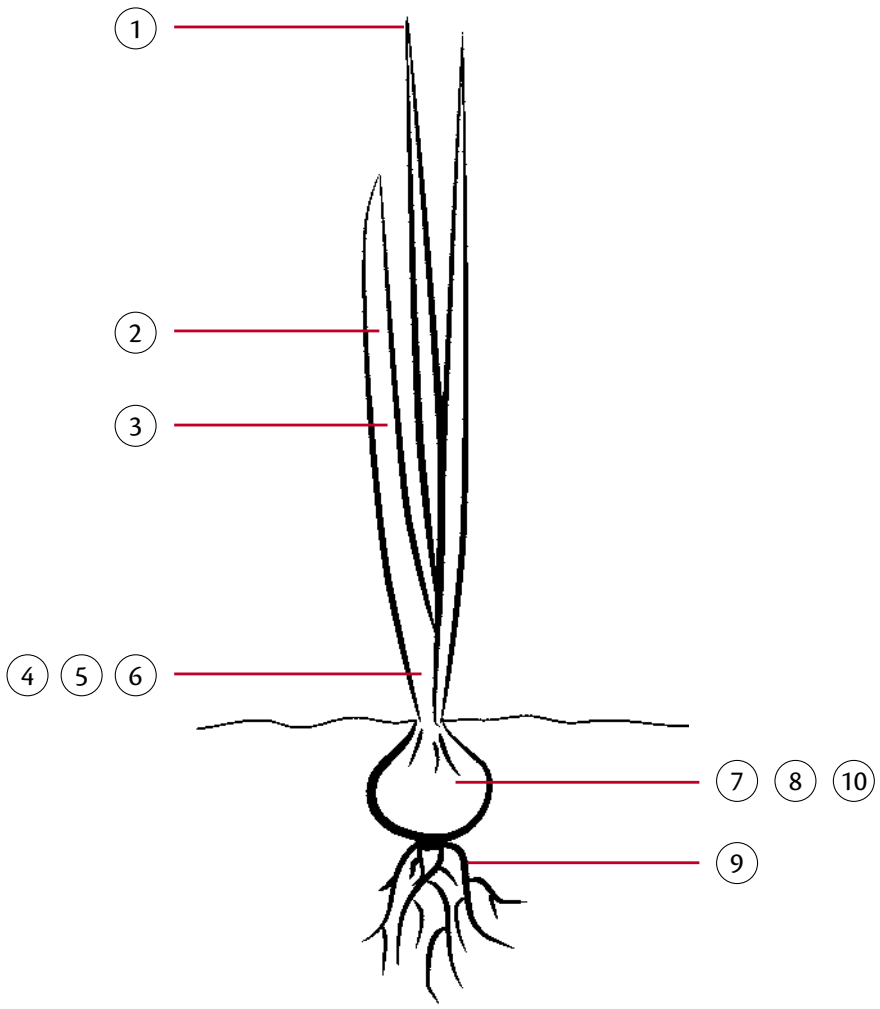
Onions are affected by a wide range of fungal diseases of the leaves, bulb and roots (Table 11.4). Most of the fungal pathogens can be isolated on culture media relatively easily. Note that downy mildew is an obligate fungal pathogen and cannot be grown on artificial culture media.

The diseases listed in Table 11.4 have distinctive symptoms and can usually be distinguished readily in the field, and then confirmed in the laboratory. The fungi which cause bulb rots can continue to cause problems during storage.

**Table 11.4** Common fungal diseases of onions

| Disease | Pathogen | Key diagnostic sign |
|---|---|---|
| 1 Tip blight | *Colletotrichum* sp. | Brown-white tip, acervuli present |
| 2 Downy mildew | *Peronospora* sp. | Grey fungal growth |
| 3 Stemphylium leaf spot | *Stemphylium* sp. | Target-like leaf spot |
| 4 Neck rot | *Botrytis byssoidea* | Grey-brown fungal growth and spore masses on bulb |
| 5 White rot | *Sclerotium rolfsii* | White mycelium and brown sclerotia on stem base |
| 6 Leaf base (wet) rot | *Sclerotinia sclerotiorum* | White mycelium, large black sclerotia |
| 7 Fusarium rot | *Fusarium* spp. | White to pale violet mycelium, no sclerotia |
| 8 Black mould (bulb rot) | *Aspergillus niger* | Black powdery spore masses (also a storage rot) |
| 9 Pink root rot | *Phoma terrestris* (*Pyrenochaeta terrestris*) | Pink roots and pink outer scales |
| 10 Bulb rot | *Rhizopus stolonifer* (*R. nigricans*) | Extensive cottony fungal growth with obvious black sporangia |

Onions are also affected by bacterial leaf blights, bacterial bulb rots, a number of plant viruses, and several nematode diseases of the roots (Figure 11.4). Nematode diseases mainly cause stunting and rarely lead to plant death, so these are commonly overlooked.



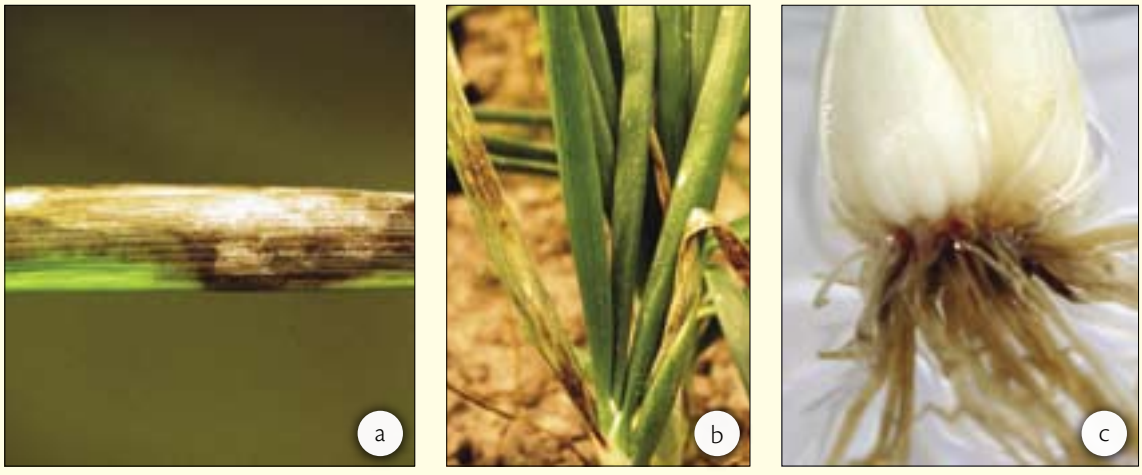




**Figure 11.4** Diseases of onion: (a) Stemphylium leaf spot, (b) downy mildew caused by *Peronospora* sp., (c) symptoms of pink root rot caused by *Phoma terrestris*

## 11.5 Common fungal diseases of maize

Maize is strongly recommended for rotation with vegetable crops for the control of many pathogens which survive in soil. Maize is resistant to bacterial wilt (*Ralstonia solanacearum*), *Sclerotinia sclerotiorum*, most common *Phytophthora* species, and root knot nematode. However, it is susceptible to common species of *Pythium* and moderately susceptible to *Sclerotium rolfsii* and *Rhizoctonia* spp. (Table 11.5 and Figure 11.5) Maize is also susceptible to stalk and cob rots caused by several *Fusarium* species but these do not normally affect vegetable crops. A more exhaustive list of maize diseases can be found on the internet (http://www.cimmyt.org/english/docs/field_guides/maize/diseases.htm).

**Table 11.5** Common fungal diseases of maize

| Disease | | Pathogen | Key diagnostic signs |
|---|---|---|---|
| 1 | Common (boil) smut | *Ustilago maydis* | Large white galls replace kernels, black spore masses; can also infect the tassel and stalk. |
| 2 | Fusarium stalk, cob and root rots | *Fusarium graminearum* | Stalks rot internally usually with 'shredded' appearance of pith. Pink to red pigments and hyphal growth may be present in rotted stalks and cobs. |
| | | *Fusarium verticillioides*<br>*Fusarium sublutinans*<br>*Fusarium proliferatum* | Stalks rot internally usually with 'shredded' appearance of pith. Pith usually pigmented violet to purple. White mycelium develops on diseased cobs under hulls. |
| 3 | Common rust | *Puccinia sorghi* | Elongated necrotic pustules forming on leaves. |
| 4 | Rhizoctonia leaf, stalk and root rots | *Rhizoctonia* spp. | Causes large irregular pale-brown lesions on leaves and stalk. Brown irregular-shaped sclerotia usually present on diseased areas. |
| 5 | Southern leaf blight | *Bipolaris maydis* (*Cochliobolus heterostrophus*) | Necrotic lesions form on leaves. |
| 6 | Turcicum leaf blight | *Exserohilum turcicum* | Small oval water-soaked lesions on leaves changing to larger necrotic lesions. |
| 7 | Pythium stalk and root rot | *Pythium* spp. | Wet rot of stalk tissues and brown lesions on roots. |
| 8 | Downy mildews | *Peronosclerospora* spp.<br>*Sclerospora* sp.<br>*Sclerophthora* spp. | Grey fungal growth (sporangiophores) on underside of leaf. |

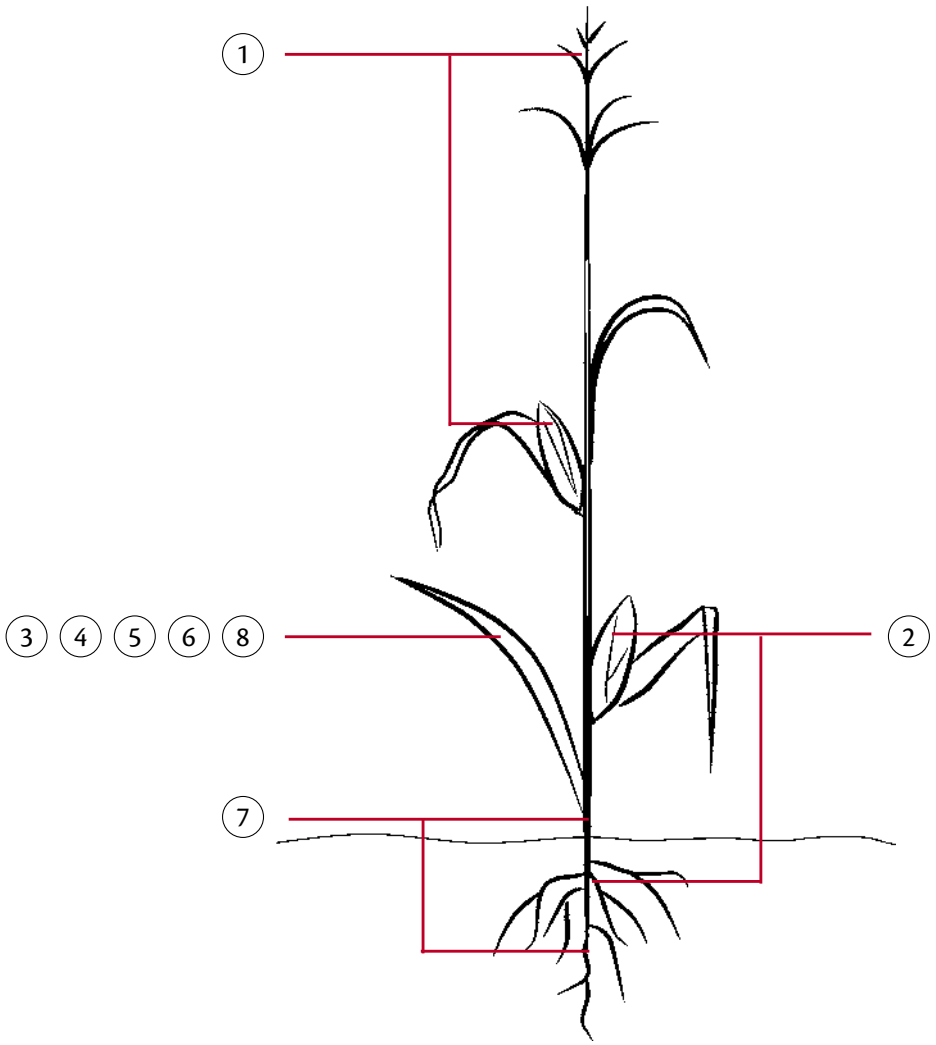




**Figure 11.5** Diseases of maize: (a) common (boil) smut on maize cob caused by *Ustilago maydis*, (b) banded sheath blight caused by *Rhizoctonia solani*, (c) white mycelial growth on infected cob caused by *Fusarium verticillioides*

# 12 Fungi, humans and animals: health issues

Some fungi cause diseases of humans and other animals—these diseases are called mycoses. For example, *Aspergilllus flavus* can infect the human lung, causing chronic respiratory disease. Therefore, it is important to take great care with cultures of *A. flavus* (see Section 12.2.1). *Fusarium oxysporum* and *F. solani* have been associated with diseases of the eye and of the fingernails and toenails.

Some fungi which infect plants also have the ability to produce toxic secondary metabolites called mycotoxins. Mycotoxins can contaminate human food or animal feed and cause mycotoxicoses. For example *A. flavus* produces aflatoxins, one of the most important group of mycotoxins. Aflatoxins are found in a range of products such as peanuts and corn.

Mycotoxins are produced by fungal hyphae and diffuse into the substrate (e.g. grain, hay or fruit, see Figure 12.1).

Mycotoxins can be produced and contaminate the substrate before harvest or during grain storage after harvest (post-harvest). It is important to store grain under dry conditions to minimise post-harvest growth of fungi and mycotoxin contamination.

Mycotoxin production varies between species. *Fusarium graminearum*, for example, produces zearalenone in corn grain but not in wheat grain. *Aspergillus flavus* prefers hot, humid conditions for growth and production of aflatoxins in corn and peanuts (Figure 12.2). Even within a species, mycotoxin production can differ significantly. Within the species *F. graminearum,* isolates can either be deoxynivalenol or nivalenol producers. These differences are very important, as their toxicities and effects on animal species are significantly different.

Some mycotoxogenic fungi produce toxins in fungal structures such as ergots (sclerotia) and spores. Such structures may contaminate grains or hay and so affect humans or animals that eat the contaminated food. Ergots of *Claviceps purpurea*, for example, are quite toxic.

Many mycotoxins are not affected by heating, and can therefore survive cooking in processed foods such as grain (cereal) and nut products. Some mycotoxins in farm animal feed can also pass into meat, milk and eggs. Humans ingest mycotoxins in food from contaminated grains, nuts, or other processed foods.

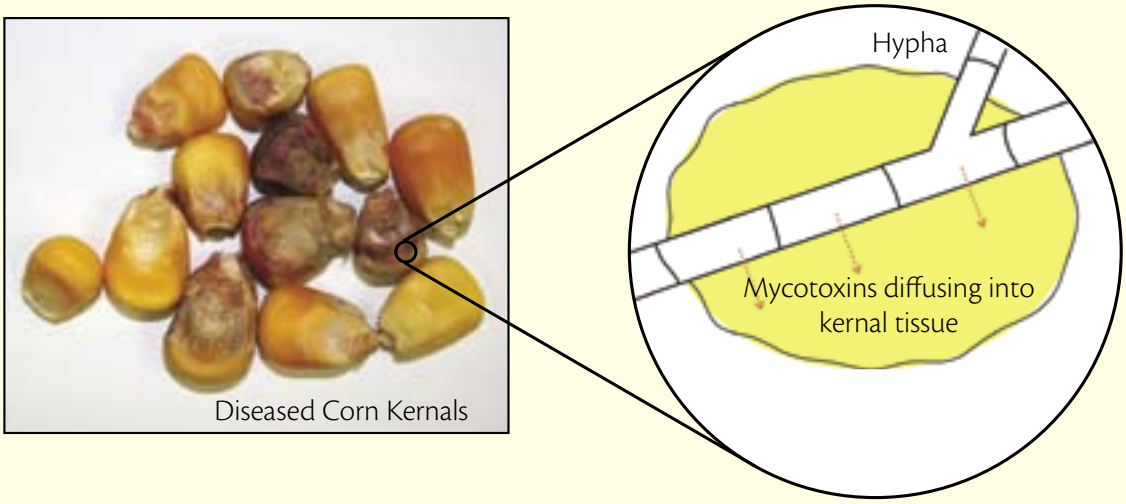



**Figure 12.1** Corn kernels infected with *Fusarium graminearum* and a diagrammatic illustration of the diffusion of mycotoxins from fungal hyphae into kernel tissue

**Figure 12.2** *Aspergillus flavus* sporulating on infected peanut seeds on isolation medium

## 12.1 Key mycotoxigenic fungi in Vietnam

Table 12.1 provides a list of key mycotoxigenic fungi in Vietnam, along with the toxins they produce and the crops and animals they affect.

**Table 12.1** Key mycotoxigenic fungi in Vietnam

| Species | Toxin | Crop | Animal |
|---|---|---|---|
| *Aspergillus flavus* | Aflatoxins | Peanuts, corn | Many species |
| *Fusarium verticillioides* | Fumonisins | Corn | Horse, pigs |
| *Fusarium graminearum* | Deoxynivalenol | Wheat, barley, corn | Pigs, poultry |
| | Nivalenol | Wheat, barley, corn | Pigs, poultry |
| | Zearalenone | Corn | Pigs |
| *Penicillium* | Cyclopiazonic acid | Cereals | See literature |
| | Patulin | Fruit | See literature |
| | Ochratoxin A | Fruit | See literature |

Mycotoxin production by a fungus is influenced by a number of factors including:

- substrate
- temperature
- moisture levels in the substrate
- strain of the fungus.

## 12.2 Mycotoxigenic *Aspergillus* species

### 12.2.1 *Aspergillus flavus*

#### Sources

*Aspergillus flavus* is common in peanuts and maize grain in tropical regions. It can also be found in other stored commodities including spices.

#### Plant pathogenicity

*Aspergillus flavus* colonises peanut plants, but does not appear to be pathogenic to the growing plant. *A. flavus* is associated with cob rot in maize under hot, humid conditions.

#### Mycotoxins

*Aspergillus flavus* can produce aflatoxins and cyclopiazonic acid. Some isolates are highly toxigenic. Aflatoxins are potential carcinogens and can cause liver cancer.

#### Precautions

This species grows at 37 °C and can be pathogenic to humans, causing lung infections. The conidia may contain aflatoxins. Care should be taken in handling cultures of this species (Figure 12.3). Avoid inhaling spores (conidia).


**Figure 12.3** *Aspergillus flavus*, three colonies on Czapek yeast autolysate agar (left), conidia produced abundantly on heads on conidiophore (centre), conidia (right)

### Description

*Aspergillus flavus* produces yellow-green colonies which grow well, especially at 30–37 °C. Some isolates produce dark brown to black sclerotia. *Aspergillus* heads are yellow-green and mop-like when viewed under the stereomicroscope. The heads are usually biseriate, but some only have phialides.

Do not open plates containing *Aspergillus flavus*. This fungus is pathogenic to humans, causing serious lung infections.

## 12.2.2 *Aspergillus niger*

### Sources

*Aspergillus niger* is one of the most common *Aspergillus* species. It is common in peanuts, and can be isolated from almost any durable commodity (e.g. grains, legumes, pulses, spices) as well as dried fruit (Figure 12.4).

### Plant pathogenicity

*Aspergillus niger* causes a wide range of plant diseases, including crown rot of peanuts, damping off and seedling rots, vine canker, bunch rot in grapes, black rot of onions and garlic, as well as a range of post harvest rots in fruits and vegetables.

### Mycotoxins

A small number of *A. niger* strains can produce ochratoxin A. The similiar species *A. carbonarius* is an important producer of ochratoxin A and is probably the primary source of ochratoxin in grape products and in coffee.

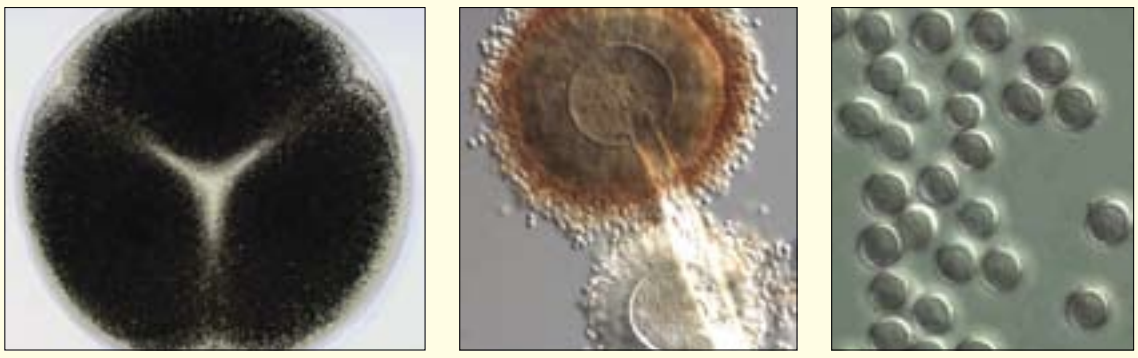


**Figure 12.4** *Aspergillus niger*, three colonies on Czapek yeast autolysate agar (left), conidia produced abundantly on heads on long conidiophore (centre), conidia (right)

#### Precautions

*Aspergillus niger* and other black Aspergilli grow well at 37 °C and are potentially pathogenic to humans. They are quite commonly isolated from human ear infections. Care should be taken in handling cultures of this species. Avoid inhaling spores (conidia).

#### Description

Colonies of *A. niger* are chocolate brown to black and grow well, especially at 30–37 °C. Several different species are included in the *A. niger* complex (aggregate). The heads of this species are generally dark brown to black, produced on long stipes and are mop-like when viewed under the stereomicroscope. Most species produce biseriate heads which have large metulae.

### 12.2.3 *Aspergillus ochraceus*

#### Sources

*Aspergillus ochraceus* is essentially a storage fungus. It has been reported from a wide variety of stored commodities, particularly in tropical areas. *A. ochraceus* and other related species are thought to be responsible for ochratoxin A contamination in coffee, cocoa, and stored oilseeds and nuts.

#### Plant pathogenicity

Not pathogenic under normal weather conditions.

#### Mycotoxins

Ochratoxin A was first discovered in cultures of *A. ochraceus*. This mycotoxin is produced by a number of species in the *A. ochraceus* group.

#### Precautions

*Aspergillus ochraceus* has rarely been reported to be pathogenic to humans. However, as with all fungi, care should be taken to avoid inhaling spores (conidia).

#### Description

Colonies of *A. ochraceus* are pale yellow brown (ochre) coloured, often with a pinkish-brown reverse. Many strains also produce pinkish-brown sclerotia. There are a number of similar species within the *A. ochraceus* group (Figure 12.5). *A. ochraceus* grows more slowly than *A. flavus* and *A. niger*, especially at 37 °C. Some species within this group do not grow at 37 °C.

The authors wish to thank Dr Ailsa Hocking for her contribution of species descriptions and images for this section.

**Figure 12.5** *Aspergillus ochraceus*, three colonies on Czapek yeast autolysate agar (left), conidia produced abundantly on heads on conidiophore (centre), conidia (right)

## 12.3 Mycotoxigenic *Fusarium* species

*Fusarium verticillioides* and *F. graminearum* are the two most common toxigenic *Fusarium* species on maize in Vietnam. These species can occur in the same areas. Other *Fusarium* species occur in maize, but usually are less common than the two species discussed here.

### 12.3.1 *Fusarium verticillioides*

#### Sources

Mainly associated with maize but is occasionally isolated from other plants.

#### Plant pathogenicity

Causes root, stalk and cob rot in maize. Most common in warm to hot, dry conditions, when plants are drought stressed. Cob rot is also more severe in cobs damaged by insects. This fungus can cause symptomless infection of maize stalks under good growing conditions.

#### Mycotoxins

*Fusarium verticillioides* produces the fumonisin group of mycotoxins in corn. Fumonisin B1 is the most common and most toxic of the group. Fumonisin B1 causes pulmonary oedema in pigs and liquefaction of the brain of horses. Fumonisin B1 has also been associated with oesophageal cancer in humans. There are restrictions on the trade in corn contaminated by fumonisin B1.

### Description

Produces white mycelium on PDA and violet pigment in the agar (Figure 12.6). On water agar containing sterile carnation leaf or green rice stem pieces, *F. verticillioides* produces long, thin and relatively straight macroconidia in sporodochia in the leaf/stem pieces, and long chains of oval microconidia from monophialides. It does not produce chlamydospores.

**Figure 12.6** Fusarium cob rot caused by *Fusarium verticillioides* (left), and pure cultures on potato dextrose agar (right)

## 12.3.2 *Fusarium graminearum*

### Sources

In Vietnam, *Fusarium graminearum* most commonly occurs on maize. In Sapa region, it has also been observed on some grasses.

### Plant pathogenicity

Causes stalk, root and cob rot in maize in warm temperate growing conditions. It also causes head blights of wheat and pearl millet.

### Mycotoxins

Produces trichothecenes, especially deoxynivalenol and nivalenol. These can be found in animal and human food made from contaminated maize grain. Deoxynivalenol (sometimes shortened to DON) is also known as 'vomitoxin', as it causes feed refusal or vomiting in pigs depending on the concentration in the feed. *F. graminearum* also produces zearalenone, an estrogenic mycotoxin. This mycotoxin causes infertility especially in pigs, but may also affect cattle and other animals.

### Description

Produces rose to burgundy ('red') mycelium on PDA and burgundy pigment in the agar (Figure 12.7). There can be some pale yellow mycelium. It produces slightly curved macroconidia of medium length in small sporodochia in CLA or green rice stem pieces in water agar. Does not produce microconidia or chlamydospores. Produces abundant black fertile perithecia homothallically on CLA or other water agar medium containing a suitable plant material, at 20–23°C under lights. Perithecia do not usually form above 25°C in culture. Perithecia are also produced on old maize stalks and old hulls under cool humid conditions.

**Figure 12.7** Fusarium cob rot caused by *F. graminearum* (left), and pure cultures on potato dextrose agar (right)