FACTSHEET 15/16

Field Vegetables

AHDB HORTICULTURE

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Onion neck rot

First described in the USA in 1917, neck rot can be a major source of losses in stored bulb onions in the UK. The extent of losses is variable. Losses of over 50% were reported in the late 60s and early 70s and, more recently, losses of up to 40% have been reported in individual crops. This factsheet draws together recent results from several AHDB Horticulture projects, together with historical information from the UK and the worldwide scientific literature.

Figure 1. Typical neck rot symptoms are not apparent until bulbs are cut open

Action points

For growers

- Request information from seed suppliers on their neck rot seed testing programme and policies.
- Request seed that has been physically treated with hot water or steam, to control neck rot.
- Do not assume that fungicide-treated seed is free from neck rot.
- Do not assume that fungicide treatments will be fully effective against neck rot.
- Do not leave topped crops in the field for more than 48 hours.
- Use initial drying temperatures of 25–30°C.
- Accurately control and monitor store temperatures.

For seed suppliers

- Test all onion seed for the presence of neck rot.
- Reject seed with high levels of infection.
- Treat infested seed with a physical treatment (hot water, steam) to control neck rot.
- Retest physically treated seed after treatment to confirm efficacy.

Symptoms

Typically, neck rot symptoms only become apparent after onion bulbs have been harvested and stored for some time (2–3 months). Symptoms are not generally seen in the field, so that bulbs which appear sound and healthy (but nevertheless latently infected) at harvest may be rotten/unmarketable when stores are opened. As the name implies, neck rot infection results in a light-brown to brown wet rot that normally begins in the neck area of the bulb (Figure 1) and progresses downwards into the scale tissues (Figure 2), with no external symptoms. Eventually the infection can spread to the entire bulb. Whitish fungal mycelium develops on infected tissues and between the scales, producing dense masses of grey fungal spores (conidia) (Figure 3). Black sclerotia (hardened resting bodies consisting of a mass of fungal mycelium) may develop under the outer skin of the decaying bulbs (Figure 4). Infections may develop in any part of the bulb as a result of damage.

As well as the obvious losses in storage, neck rot may also reduce emergence and kill seedlings, reducing plant populations. Infection may affect seedling vigour.

Figure 3. Whitish mycelium and masses of grey spores (conidia) develop on infected tissues

Figure 2. Light brown rot develops downwards from the neck

Figure 4. Black sclerotia developing on rotten tissue under the outer skin

Pathogens

The disease can be caused by three different species of Botrytis: *B. aclada*, *B. allii*, and *B. byssoidea. B. byssoidea* is thought to be less important (but this may be due to the fact that it is more difficult to isolate and identify). Prior to 2002, *B. allii* and *B. aclada* were lumped together as a single species, (usually called *B. allii*), hence the vast majority of the literature and reports of the disease during the 20th century refer to neck rot as being caused by *B. allii*; we should now interpret these reports as referring to either *B. allii* or *B. aclada* or both.

The two species are very similar in appearance. *B. aclada* has smaller spores than *B. allii* (Figure 5), although there is some overlap in dimensions. They can be reliably distinguished using relatively straightforward molecular methods. A number of historical isolates of the pathogen from the UK originally identified as *B. allii* have been shown to be *B. aclada*. More recently, both *B. aclada* and *B. allii* were detected in commercial UK onion seed marketed for the 2015 season, including from fungicide-treated seed, and in stored bulbs with neck rot symptoms (2014 seed) (results from AHDB Horticulture Project FV 423a). Some seed lots contained one or the other species, but some contained both.

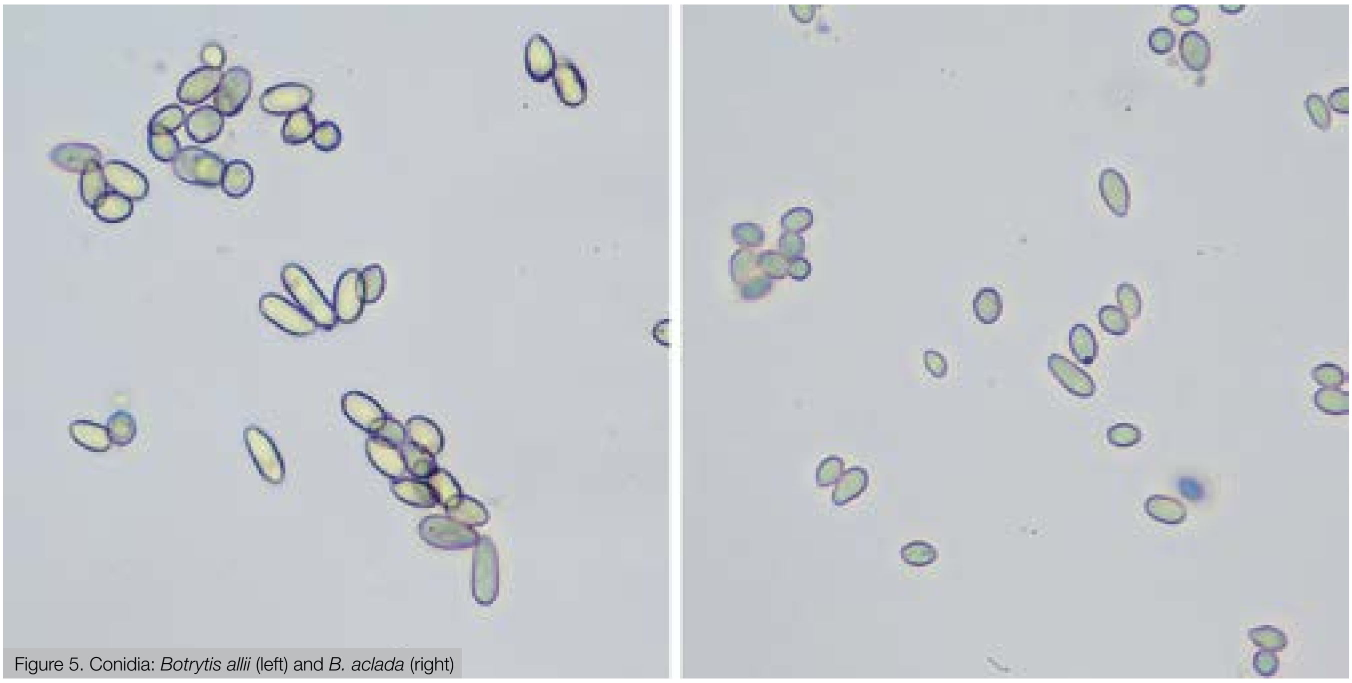

Figure 5. Conidia: *Botrytis allii* (left) and *B. aclada* (right)

Both *B. allii* and *B. aclada* are present and have been present in commercial onion seed and bulbs for some time: *B. aclada* is not a new pathogen, but a new name for one that has likely been around for some time.

In this factsheet we will refer to *Ba* to represent both/either of the two main neck rot pathogens, *B. allii* and *B. aclada*.

Biology/epidemiology

Neck rot is primarily seed-borne. Infested seed (Figure 6) can be contaminated externally and/or internally and the pathogen may survive on seed for several years. Infested seeds give rise to infected seedlings as a result of direct infection of the tips of the cotyledons from spores or mycelium on or within the seed coat during germination and emergence. Within a plant, *Ba* then infects successively produced leaves and only sporulates when the leaves senesce and die (Figure 7).

Figure 6. Neck rot fungi growing out of infested onion seeds on selective agar

Figure 7. *B. allii* sporulating on the cotyledon of a dying seedling

Infection of newly produced leaves may occur as a result of growth of mycelium within an individual plant (growing down to the base of one leaf and up the next) or via spores produced on necrotic tissues.

For crops grown from sets, it is likely that the sets could be a source of neck rot infection. However, there is no definitive information on this aspect and, in a recent AHDB Horticulture Project, FV 392, *Ba* was not detected in sets.

During the growing season, the fungus spreads between plants within a crop and possibly to a limited extent locally between neighbouring crops via airborne spores. The extent of and rate at which spread occurs in the field has not been well studied, but will inevitably depend on a number of agronomic and weather-related factors. In addition, due to the differences in spore size, the rate of spread may also differ between the two main pathogen species.

Once infected leaves have died and decayed, the pathogen may remain present in the leaf bases which form the wrapper leaves of the bulb. Infection of the fleshy neck and bulb tissues results from growth of the fungus down the green leaves and into the bulb tissues. There is little or no spread between bulbs once in store: increases in disease over time are due to increasing levels of expression in latently infected bulbs.

Ultimately, whether or not neck rot develops in store and its level will depend on a number of factors:

- Seed infection level and inoculum load (spores per seed)
- Efficacy of any seed treatments, and presence of resistant/tolerant pathogen strains
- Rate of spread between plants (affected by weather, agronomy, fungicides)
- Rate of spread/infection at harvest (affected by topping, timing, weather)
- Rate of drying of neck (affected by crop maturity, weather, store regime).

Control/management options

Seed testing

As the disease is primarily seed-borne, control of seed-borne inoculum should be the main target for control. Infestation levels in untreated seed lots can be relatively high (>90%). Seeds may be infested with the pathogen(s) both externally and internally. Ideally, all seed should be tested and only healthy seed should be used.

However, there is no formal standardisation of the seed test method used for *Ba* or the health standard that needs to be achieved. There is also no assessment of inoculum load. Therefore, although seed may have been tested/treated, what is considered as ‘clean’ or ‘healthy’ may differ depending on the source of the seed and the test laboratory, and the methods and standards applied. It is, therefore, important to ask suppliers not only if the seed has been tested, but also to request information on the detection limit, implied seed health standard, and/or the number of seeds tested. For example, a negative test on 200 seeds means that the infestation level is likely to be below 1.5%, but with a drilling rate of 500,000 seeds per ha, this means that there could still be 7,500 infested seeds per ha, despite a negative test result.

Some seed suppliers operate their own in-house seed testing laboratories, alternatively independent seed health testing laboratories are available.

For seed that is destined for use in set production, more stringent seed health standards should be applied, as the higher plant density will facilitate greater plant-to-plant spread than in ware crops.

Chemical seed treatment and limitations

The use of benomyl seed treatments in the 1970s was highly effective, but was discontinued in 1997. Until recently, the industry standard seed treatment for neck rot has been HyTL (thiabendazole + thiram), but the registration has now expired. The efficacy of more recent chemical treatments has been the subject of some debate, with varying claims and different levels of efficacy reported in different studies. At least in part, this is due to different assessment methods used in the different studies but, in addition, the initial infestation level of the seed, location of the inoculum (surface and/or internal) will also be a factor in the apparent efficacy achieved. In Project FV 423a, it was also clear that sensitivity to some fungicides varied between the two main species and also between different isolates of the same species. Thus, different conclusions may be drawn depending on the particular seed lot(s) used in the study, and the pathogen species and strains present on them. Necessarily, most studies have used only a limited number of seed lots. Some selected and interpreted (to provide a consistent measure of efficacy) results from some recent studies are shown in Table 1. It should be noted that most of these are not approved for use in the UK.

A list of currently approved seed treatment fungicides are listed in Table 2 (insert).

It should be noted that in FV 423a, a number of fungicide-treated commercial seed lots tested positive for neck rot, emphasising that chemical treatments alone should not be relied on to eliminate neck rot.

Biological seed treatments

A number of biological seed treatments using fungi or bacteria have been examined in recent work. Some of these appear to be as effective as chemical fungicides in reducing seed-to-seedling transmission, but, at the time of preparation of this factsheet (2017), they have not been approved for use as seed treatments.

Physical seed treatments

Several studies have shown that a number of different hot water temperature/time treatment regimes and proprietary steam treatment can give better control than chemical treatments without any significant impact on germination. It is important to check the efficacy of the treatment by retesting treated seed after treatment.

Table 1. **Selected examples of onion seed treatment studies targeting neck rot. Note that most of these treatments are not approved for use in the UK (for a list of approved seed treatments, see Table 2)**

Product/treatment (AI)	Rate (ml or g/kg)	Range[1] of efficacy (% reduction in seed infestation)
Single seed lot (98% infestation) du Toit *et al* (2008)[2]		
Farmore D300 (mefenoxam + fludioxonil + azoxystrobin)	0.53	47
Coronet (pyraclostrobin + boscalid)	5	94
Rovral (iprodione)	10	97
Thiram	3.9	69
Two seed lots (25% and 5% infestation) Green (2006) FV 263		
Hy-TI (thiabendazole and thiram)	1.8	62 to 93
Wakil XL (fludioxonil, cymoxanil, metalaxyl-M)	1.25	38 to 42
Wakil XL (fludioxonil, cymoxanil, metalaxyl-M)	1.88	53 to 96
Wakil XL (fludioxonil, cymoxanil, metalaxyl-M)	2.5	34 to 99
Mix of lots (66% infestation) Green (2006) FV 263		
Hot water 45°C	15 minutes	>99
	30 minutes	>99
	45 minutes	99
Hot water 45°C with pre-soak	15 minutes	>99
	30 minutes	>99
	45 minutes	99
Single seed lot (1.6% infestation) Lane (2013) FV 423		
Thiram	?	>86
Topsin M (thiophanate-methyl)	?	0
Hy-TI (thiabendazole and thiram)	?	>86
Fludioxonil	?	>86
Four seed lots (100% infestation) Roberts (2016) FV 423a		
Maxim 480 FS (fludioxonil)	1	28 to >99
Thiram	5	18 to 69
Apron XL (metalaxyl-M)	0.5	0
Hot water 50°C	30 minutes	0 to >99

Notes:
[1] The range of efficacy obtained for the seed lots tested.
[2] The number of seed lots tested (their levels of infestation) and the author(s) of the report.

Set treatments

There appears to be no information on the treatment of sets to control neck rot. It is possible that fungicide treatments to control Fusarium and heat treatment may also have an effect on neck rot.

Crop sprays

It is possible that some fungicides (ie that have activity against Botrytis spp.) applied to the growing crop may have an impact by reducing the rate of spread in the field (and so contribute to control of disease in store) but there is little information on this aspect. Studies in the USA and Canada have suggested that products containing boscalid + pyraclostrobin (Signum), cyprodinil + fludioxonil (Switch), azoxystrobin + difenoconazole (Amistar Top) may have a benefit, but results from different studies are inconsistent, therefore there is no basis to recommend them for control of neck rot. A list of currently approved fungicides that may have an effect are shown in Table 3 (insert), but it is important to note that there is no definitive evidence that they will be of any benefit.

Pre-harvest risk assessment

An ELISA-based antibody test to detect latent infection was developed at Wellesbourne in the 1990s. The test could be used to test samples of bulbs at, or prior to, harvest and so predict the risk of neck rot developing in store. High-risk crops can then be marketed quickly, avoiding losses that might occur in long-term storage. Kits are available in the UK, it is not known if they have been evaluated against both of the main pathogen species.

Harvesting and high temperature curing

Neck rot is likely to be most active and sporulate during periods of wet/humid weather, therefore it makes sense to harvest crops during dry weather, whenever possible.

Work done in the late 1970s demonstrated that topping followed by drying at ambient temperatures increases the risk of neck rot development in store. This increased risk results from exposure of a damaged cylinder of susceptible neck tissues and local redistribution of inoculum (spores) to infect those tissues. To counter this risk, topped crops should be removed from the field as soon as possible and should not be left in windrows for more than 48 hours before transport to store and initial (stage 1) drying using forced air at 30°C for several days. At this temperature, the growth rate of *Ba* is severely limited and the neck dries faster than the fungus can grow down into the fleshy tissues. The preceding temperature recommendation is based on the work done in the late 1970s, and more recent work in Australia. However, it is more common to use lower temperatures in the range 25–30°C, due to concerns about the increased risk of Aspergillus spp. and bacterial rots caused by Burkholderia spp.

High temperature curing will have no effect on established neck rot infections that have been initiated prior to topping.

Rotation

Work done at Wellesbourne in the 1980s indicated that the pathogen does not survive for longer than two years in soil. Therefore, normal onion rotations of 3–4 years to reduce the risk of other soil-borne pathogens and nematodes will prevent carry-over of neck rot.

Good hygiene

Clean up cull piles and dispose of pack house waste promptly. Clean all machinery and equipment that may have come into contact with infected bulbs. Avoid planting crops near to stores and pack houses, which could be a source of inoculum.

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Further information

AHDB project reports

FV 134 – The rapid detection of *Botrytis allii* causing latent neck rot infection of onion bulbs.

FV 263 – Bulb onions: Evaluation of alternative seed treatments for the control of neck rot (*Botrytis allii*).

FV 392 – Onions: relationship between disease incidence in stored bulb onions and first year sets.

FV 423 – Determining the effectiveness of seed treatments on the occurrence on neck rot disease in onions caused by Botrytis spp.

FV 423a – Onion neck rot: seed infection, pathogens and treatments.

Other useful publications

du Toit, L.J., Derie, M.L. and Brissey, L.M. (2008) Evaluation of fungicide seed treatments for control of seedborne neck rot fungi of onion, 2007. Plant Disease Management Reports 2: ST002.

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...

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Table 2. **List of currently (2017) approved onion seed treatments**

Product	Main supplier	AI	Rate	Approval type	Approval expiry	Notes on efficacy
Agrichem Flowable Thiram	Agrichem	thiram	5ml/kg	Label	10/2020	Variable results. Inhibitory but not eradicating
Apron XL	Syngenta UK	metalaxyl-M	0.5ml/kg	Label	12/2019	Not effective
Maxim 480FS	Syngenta UK	Fludioxonil	1ml/kg	Label	09/2018	Variable results. Inhibitory but not eradicating. Some evidence for resistance in some strains of *B. aclada*
Hot water	–	–	50°C 30 minutes. 45°C 15–45 minutes.	Not required	–	Highly effective. Post-treatment testing should be done to confirm efficacy
Steam treatment	–	–	Proprietary	Not required	–	Highly effective. Post-treatment testing should be done to confirm efficacy

Table 3. **List of currently (2017) approved fungicide sprays and set treatments that may have an effect on neck rot, but note there is no definitive evidence of any benefit in the UK**

Product	Main supplier	AI	Rate	Approval type	Approval expiry	Notes on efficacy
Foliage sprays						
Switch	Syngenta	cyprodinil + fludioxonil	1kg/ha	EAMU 20122285	10/2020	Variable results in USA and Canada. Some strains of *Ba* may be resistant to fludioxonil
Signum	BASF	boscalid + pyraclostrobin	1.5kg/ha	EAMU 20102108	07/2019	Approval is for control of white rot. Variable results in USA and Canada
Unicur	Bayer Crop Science	fluoxastrobin + prothioconazole	1.25L/ha	Label	01/2021	Main target is downy mildew, but may have some benefit against Botrytis spp.
Set treatments						
Signum	BASF	boscalid + pyraclostrobin	136g/ha	EAMU 20103122	07/2019	Approval is for application on bulb onion sets pre-planting

This factsheet includes information available on the Health and Safety Executive (HSE) website (pesticides.gov.uk), on product labels and in supplier technical leaflets. Please check the HSE website or with an appropriate adviser before using the information as regulations may have changed.

EAMU – Extension of Authorisation for Minor Use.

Growers must hold a paper or electronic copy of an EAMU before using any product under the EAMU arrangements. Anyone using a plant protection product with an EAMU should follow EAMU (or label) recommendations.

Use is carried out at the grower's own risk. If specific crop safety information is not available, consider undertaking small-scale tests and/or obtain professional advice before widespread commercial use.

If in doubt about which products are permissible, or how to use them correctly, seek advice from a BASIS-qualified consultant.

Details of compatibility of plant protection products with biological control agents are available from biological control suppliers or IPM consultants.