Neck rot of onion - *Ciborinia allii*

Neck rot of onion occurs on the vegetative organs of onions including the bulbs and are known especially at the vegetative stage and as a post-harvest disease. Confusion exists about the causal organism thus it is unclear how widespread is this pathogen in the United States and Europe. Based on recent understanding of the *Botrytis*-like species on *Allium*, *Ciborinia allii* is known primarily from Asia. The anamorph *Botrytis allii* has since been shown to be a natural hybrid resulting from a cross of *B. byssoidea* with *B. aclada* (Nielsen et al., 2002; Staats et al., 2005) but it is unclear if this is the asexual state of *C. allii*.

*Ciborinia allii* L.M. Kohn 1979

**Apothecia** arising from sclerotia, disc-shaped, stipitate, pale brown, nearly glabrous. Paraphyses filiform, hyaline, septate, with 2-3 branches. Asci cylindrical asci, 184–212 x 12–18 µm (136–190 x 10–16 µm fide Yamamoto et al., 1956), with eight ascospores.

**Ascospores** hyaline, ellipsoid, 17–21 x 7–11 µm (15–23 x 8–12 µm fide Yamamoto et al., 1956).

**Sclerotia** blackish-brown to black, subepidermal, densely pitted on upper surface, 1–7 x 0.5–2 mm, 0.3–0.7 mm thick, outer layer pseudoparenchymatous, interior hyaline.

**Microconidia** globose, 3–4 µm diam. Cottony white mycelium, sclerotia and sparse conidia develop in culture.

**Major hosts**: *Allium cepa* L. (onion), *Allium fistulosum* L. (Japanese onion), *Allium porrum* L. (leek), *Allium sativum* L.(garlic),

**Geographic Distribution**: Known primarily from Asia. Occasional reports from Europe and the United States may or may not be accurate.

**Notes on taxonomy and nomenclature**: There has been a certain lack of clarity in the literature about the species of *Botryotinia* and *Botrytis* causing neck rot on onion. *Sclerotinia allii* was described without a conidial form by Sawada in 1919, while Jarvis (1977) recognized a conidia-producing onion pathogen, *Botrytis allii*. The fungus mainly referred to in the literature is the anamorph *Botrytis byssoidea*, which was described by Walker (1925). Most authors do not refer to the teleomorph of *B. byssoidea*. A teleomorph for *B. byssoidea* was described in Japan as *Botryotinia allii* (Yamamoto et al., 1956), although the new combination based on Sawada’s species was invalidly published according to International Code of Botanical Nomenclature. Kohn (1979) transferred the teleomorph name to *Ciborinia*, noting that no sporulation of the *Botrytis*-type could be obtained in culture. *Botrytis byssoidea* has been found to sporulate on infected plants when it would not do so on standard media (Shirane et al., 1989). Furthermore, an investigation of the phylogeny of some species placed in *Ciborinia* (not including *C. allii*) has shown the genus to be polyphyletic, and its restriction to species affecting woody dicots has been suggested (Holst-Jensen et al., 1997).

Jarvis (1977, 1980) did not address the question of the anamorph-teleomorph connection. Some authors cite a report that *B. byssoidea* is the anamorph of *Botryotinia porri* (Moore, 1959; Smith et al., 1989). However, this would imply that *B. byssoidea* is synonymous with *Botrytis porri*, which is mistaken, at least according to the authoritative views of Hennebert (1973) who placed *B. allii* in synonymy with *B. aclada* Fresen.

Lacy and Lorbeer (1995) have suggested that *B. byssoidea* may be conspecific with *Botrytis allii*, which has no known teleomorph. *Botrytis allii* has since been shown to be a natural hybrid resulting from a cross of *B. byssoidea* with *B. aclada* (Nielsen et al., 2002; Staats et al., 2005); the hybrid has 32 chromosomes while each parent species has 16 (Shirane et al., 1989). Thus, the relationship of these three species is clarified, although the identities of the various organisms reported or collected from onions worldwide (CMI 1980, 1987) may not be.

**Notes on host range**: Sawada (1919) reported *Sclerotinia allii* as a pathogen of onions (*Allium cepa* and Welsh onions (*A. fistulosum*; also called Japanese onion). Yamamoto et al. (1956) were able to obtain infection by inoculation with mycelium on “garlics, *A. fistulosum* var. caespitosum, *A. Bakeri, A Ledebourianum, A. tuberosum,* and A. grayi”. *Botrytis byssoidea* has been recorded on onions from most continents (CMI, 1980; BPI, 2009). Presly (1985) obtained isolates identified as *B. byssoidea* from leeks (*A. porrum*) in the UK, but it is not clear what disease they caused on that crop. In Japan, Takakuwa et al. (1974) also found *B. byssoidea* on leeks; sclerotia of *Sclerotinia allii* were also reported present. Cho et al. (1995) reported that *B. byssoidea* was the cause of a storage rot of garlic bulbs (*A. sativum*) in Korea. Disease on *A. fistulosum* in Taiwan (Leu and Wu, 1985) and Japan (Tamura et al., 1982) was attributed...
to *Ciborinia allii*, with accompanying descriptions of the teleomorph but no mention of a conidial form. Zhang (2006) reports *B. byssoidea* on onion, garlic and *Aloe vera var. chinensis*, but, except for *A. tuberosum*, not on the other primarily Asian *Allium* spp. tested by Yamamoto et al. (1956)

**BIOLOGY AND ECOLOGY**

The biology and ecology of *B. byssoidea* is similar to that of *B. allii*. Infection of the leaves and flower stems results in pale water-soaked spots that spread longitudinally toward the tips and base (Yamamoto et al., 1956). The relative roles of ascospores and conidia in initiating infections have not been investigated. Leaves wilt and turn yellow, then brown (Leu and Wu, 1985). The fungus infects the neck of the bulb from the leaves, and sporulation occurs on dead or dying tissues under moist cool conditions. Production and spread of airborne conidia results in secondary infections under humid conditions in the field and in storage (Maude and Presly, 1977a; Lacy and Lorbeer, 1995).

The cardinal growth temperatures for *Ciborinia allii* were found to be 2, 24, and 28 C (Leu and Wu, 1985). Sclerotia are produced in the leaves (Yamamoto et al., 1956) and at the neck of the bulb (Lacy and Lorbeer, 1995). These can survive in and on the soil through the summer in Taiwan, germinating at 8-26 C in 10-15 days to produce apothecia (Leu and Wu, 1985). In the cooler climate of Europe, the sclerotia of *Botrytis allii* were found to persist for two years in soil (Maude et al., 1982).

**MORPHOLOGY**

Tamura et al. (1996) reported the apothecia of *Ciborinia allii* (Sawada) Kohn, obtained in culture on PDA under continuous light, to be pale yellow and 1–2.5 mm in diameter, with clavate asci 198–257 x11–13 µm (longer than those in Yamamoto et al.), the larger ascospores 19–22 x9–11 µm. Leu and Wu (1985) described the larger spores in Taiwan as 20 x10 µm; the smaller ones were 12 x10 µm and did not germinate. Ascospores of differing sizes in the same ascus are not mentioned in Sawada’s description, but are shown in one of the accompanying illustrations (Sawada, 1919).

Erect conidiophores of *B. byssoidea* arise directly from a hyaline septate mycelium. They are light to dark brown, septate and thick-walled, with a swollen base and occasional branches that are constricted at their bases. Branches at the apex themselves bear round-ended shorter branches (“ampullae”) which produce conidia; these shorter branches die and collapse after sporulating. Conidia are obovoid, smooth, one-celled, initially colorless, becoming pale brown and appearing grey in mass, 8-19 x 5-11 µm, mostly 10-14 x 6-9 µm (Walker, 1925). Walker’s description also included microconidia and sclerotia; sclerotia were reported to germinate by means of hyphae or by producing conidiophores.

Hennebert (1973) recognized *B. byssoida* as distinct from *B. allii*, which he considered synonymous to *B. aclada*. Presly (1985) described *B. byssoidea* as producing conidia 13.0 x 7.5 µm, larger than those of *B. allii* (10.2 x 5.25 µm) but smaller than those of *B. porri* (15.7 x 9.6 µm). *B. byssoidea* was distinguished from *B. allii* in culture by its growth as white fluffy sterile mycelium, not producing abundant conidia. It also differed from *B. porri* and *B. squamosa* by not producing sclerotia in culture (Presly, 1985). Shirane et al (1989) distinguished *B. byssoida* by conidium size, L/W, and number of nuclei, but also noted its inability to sporulate on the culture media utilized for obtaining sporulation of other *Botrytis* species, so that the conidia examined had to be obtained from inoculated onions.

The relationships among three of the *Botrytis* species on *Allium* have been elucidated through examination of molecular biology. Comparison of DNA sequences revealed that *Botrytis allii* is a hybrid of the two other species, *B. aclada* and *B. byssoidea*, and bears alleles of genes from each. Each of the parents has 16 chromosomes, while the hybrid has 32 (Nielsen et al., 2001, 2002; Staats et al., 2005).

**SIMILARITIES TO OTHER SPECIES**

All the *Botrytis* species that cause disease on *Allium* spp. produce globose/ovoid/elliptical conidia on apically branched brown conidiophores. Conidial dimensions have been used to distinguish them (Ellis, 1971):

*B. aclada* 8-9 × 4-5 µm (see Shirane et al., 1989)

*B. allii* 7-11 × 5-6 µm

*B. byssoida* 10-14 × 6-9 µm

*B. cinerea* 8-14 × 6-9 µm

*B. porri* 11-14 × 7-10 µm

*B. squamosa* 15-21 × 13-16 µm

*Botrytis byssoida* is almost exclusively mycelial in culture, while *B. allii* sporulates readily and profusely (Owen et al, 1950). *Botrytis squamosa* readily produces thin black sclerotia in culture on PDA, but *B. allii*
and *B. byssoidea* do not, according to Walker (1925). On the other hand, Yamamoto et al. (1956) found that *Botrytinia allii* readily produced sclerotia in their cultures. *Botrytis porri* may be distinguished in culture by its large, irregular, cerebriform sclerotia (Ellis, 1971).

**MEANS OF MOVEMENT AND DISPERAL**

Natural dispersal (non-biotic): *Botrytis byssoidea* is principally dispersed by wind or rain movement of its conidia (Stewart and Franicevic, 1994; Lacy and Lorbeer, 1995).

Seedborne spread: Though *B. allii* is definitely seed-transmitted (Maude and Presly, 1977a), there is no specific evidence that this is the case for *B. byssoidea*. Stewart and Franicevic (1994) isolated *B. byssoidea* from onion seeds, although at a much lower rate than *B. allii*. They then obtained transmission to seedlings only with *B. allii* when both fungi were present in one seed lot.

Movement in trade: *Botrytis byssoidea* is principally moved in infected onion bulbs, for planting or consumption (Lacy and Lorbeer, 1995).

**Plant parts liable to carry the pest in trade/transport**

Bulbs/tubers/corms/rhizomes: borne internally; borne externally; visible to naked eye.

**Plant parts not known to carry the pest in trade/transport**

Fruits, growing medium accompanying plants, flowers/inflorescences/cones/calyx, seedlings/micropropagated plants, roots, stems above ground)/shoots/trunks/branches, and wood.

**IMPACT**

*Botrytis byssoidea* is associated with the same serious neck-rot disease of onion as *B. allii*. In general, *B. allii* is considered to be the more important of the two (Presly, 1985; Stewart and Francisovic, 1994; Lacy and Lorbeer, 1995). Losses of up to 50% have been reported due to neckrot of onions in storage (Kritzman and Netzer, 1978).

**PHYTOSANITARY SIGNIFICANCE**

It is doubtful whether *B. byssoidea* is sufficiently important to present a phytosanitary risk, especially since the more important *B. allii* is very widespread. The sclerotial form of *Botrytinia allii* has been intercepted in international trade in the past (BPI, 2009) but the hybrid *Botrytis* species already in existence may represent the actual fulfillment of the threat of genetic recombination posed by the existence of a sexually reproducing form of the fungus.

**SYMPTOMS**

Infection of the leaves and flower stems of *Allium* spp. by *Botrytinia allii* results in pale water-soaked spots that spread longitudinally toward the tips and base (Yamamoto et al., 1956). Leaves will and/or turn yellow, brown and/or grayish white, and collapse (Leu and Wu, 1985). Sporulation occurs on dying or dead tissue and black sclerotia are formed in the leaves.

*Botrytis byssoidea* causes a neck rot of onion similar to that caused by *B. allii* (Lacy and Lorbeer, 1995). Scale tissue becomes soft, water-soaked and translucent, beginning in the neck area and continuing down into the bulb. However, Dixon (1981) and Presly (1985) distinguish the neck rot caused by *B. byssoidea* as “mycelial neck rot”, referring to the visible presence of mycelium without conidia or sclerotia, in contrast to “grey mould neck rot” due to *B. allii* and with abundant conidia and “sclerotial neck rot” due to *B. squamosa*, which produces many sclerotia.

**DIAGNOSIS**

Nielsen et al. (1999) obtained a PCR primer specific for *B. allii*; DNA from *B. byssoidea* or *B. squamosa* was not amplified. A real-time PCR assay for only the three *Botrytis* species causing neck rot has since been developed (Chilvers et al., 2007), as well as a serological ELISA test specific to *B. allii* (Linfield et al., 1995). Shirane et al. (1989) showed that, in addition to the size and length/breadth ratio of the conidia, the species could be distinguished by the mean number of nuclei in each conidium: 1.3-1.5 for *B. allii*, about 5 for *B. byssoidea*, and about 18 for *B. squamosa*. However, they note that conditions of growth can affect the number of nuclei. In the absence of sophisticated instrumentation, *B. byssoidea* could be distinguished by its failure to sporulate in culture on PDA and the size of conidia obtained on infected plants (Yohalem et al., 2003).

**CONTROL**

Good agricultural hygiene will prevent the persistence of sclerotia or infected crop debris in the soil (Maude et al., 1982). Leu and Wu (1985) found that sclerotia of *Ciborinia allii* could survive at some level in the soil through the summer in Taiwan. Agricultural practices that would create cool moist conditions,
favourable to the fungus, in the upper layers of the soil should be avoided, in particular in relation to irrigation (Moore, 1959, Crowe et al., 1995). No particular chemical control is recommended, but treatments developed for control of *Botrytis allii* should be effective (Smith et al., 1988; Chilvers et al., 2006). In storage, leeks should be kept at a sufficiently low temperature. Alternatively, increasing the carbon dioxide content of the storage atmosphere, and decreasing the oxygen content, will prevent development of the fungus (Hoftun, 1978).

Neck rot of onions in storage can be controlled in part with cultural practices that encourage “curing” of the neck, such as planting at a proper density, restricting use of nitrogen fertilizer, and undercutting to remove roots in the field. However, warm air drying of bulbs may still be required before storage, and proper ventilation should be maintained during storage (Lacy and Lorbeer, 1995), since neck rot incidence increases in years of wet or humid weather (Maude and Presly, 1977b; Maude, 2006).

References


Use this link to revisit SMML website
Developing conidiophore of Botrytis-like asexual state.

Conidia forming in a cluster at apex of conidiophore.

Thin-walled conidia of Botrytis-like asexual state.