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Monilinia vaccinii-corymbosi on Highbush Blueberries (*Vaccinium corymbosum* L.): Also in Europe!

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Summary

Monilinia vaccinii-corymbosi (Monilinia blight, mummy berry disease) is one of the most important plant pathogenic fungi on blueberries in America and was not detected in Europe until now. In the years 2002 and 2003, in Styria (Austria), a fungus was isolated from blueberries (*Vaccinium corymbosum* 'Berkeley') and identified morphologically as *Monilinia vaccinii-corymbosi* through appearance on shoots and fruits, the asco- and conidiospores and the overwintering structures. As known so far, this is the first verified occurrence of *M. vaccinii-corymbosi* in Europe.

Zusammenfassung

***Monilinia vaccinii-corymbosi* auf Kulturheidelbeeren (*Vaccinium corymbosum* L.): Jetzt auch in Europa!** *Monilinia vaccinii-corymbosi* (Monilinia-Spitzendürre, mummy berry-Krankheit) zählt zu den wichtigsten Schadpilzen im amerikanischen Heidelbeeranbau und wurde in Europa bisher noch nicht nachgewiesen. In den Jahren 2002 und 2003 konnte in der Steiermark (Österreich) von Kulturheidelbeeren (*Vaccinium corymbosum* 'Berkeley') ein Pilz isoliert und morphologisch aufgrund des Schadbildes an Trieben und Früchten, den Asko- und Konidiosporen sowie den Überwinterungsorganen als *Monilinia vaccinii-corymbosi* identifiziert werden. Nach bisherigem Wissensstand ist dies das erste nachweisliche Auftreten von *M. vaccinii-corymbosi* in Europa.

Key words. ascomycete – ascospores – conidiospores – epidemiology – fungal disease – microconidia

Introduction

The ascomycete *Monilinia vaccinii-corymbosi* (Reade) Honey (Monilinia blight, mummy berry disease) is one of the most important fungal diseases on blueberries in America and can cause major fruit yield losses on susceptible cultivars (Eck 1988). Comparable with the in Europe widely spread pathogen *Monilinia laxa* on cherries, *M. vaccinii-corymbosi* also infects young vegetative and floral shoots, as well as fruits. Beside the highbush blueberry (*Vaccinium corymbosum*), further *Vaccinium*-species like *V. ashei* (rabbiteye blueberry) and the European bilberry (*V. myrtillus*) are more or less susceptible for this pathogen (Ehlenfeldt and Stretch 2001). Furthermore, the susceptibility is cultivar specific (Pepin and Toms 1969; Stretch et al. 1995; Ehlenfeldt et al. 1996; Ehlenfeldt and Stretch 2000; Stretch and Ehlenfeldt 2000). According to Milholland (1977), the disease cycle of the fungus is represented as follows: *M. vaccinii-corymbosi* overwinters in dark, thick-walled pseudosclerotia (mummified fruits), from which apothecia emerge during the springtime. The sexually formed, wind borne (Cox and Scherm 2001) ascospores, infect young developing tissue via stomata or the cuticula and lead to wilting symptoms (Monilinia blight) of young shoots and floral clusters. On infected, grey to black coloured tissue, masses of conidia are formed, which are mostly distributed by pollinating insects (Batra and Batra 1985) onto the stigmas of the blossoms. The fungus invades the ovary through the pistil and remains in the young berry, which develops without any outward differences compared to non-infected fruits. In the late stage of the berry formation, infected fruits shrink, get cream to salmon pink coloured, and build mummified pseudosclerotia with a pumpkin like shape. These mummy berries drop to the soil and serve as overwintering structures and further on as primary source of infection in the next year. Therefore, the disease management is focussed mainly on the prevention of the infection through ascospores in spring with appropriate fungicides. Alternatively, pseudosclerotia can be removed or covered by mulching. Whereas the occurrence of Monilinia blight is well known and investigated in America, the disease was not verified in Europe until now.

Materials and Methods

Material from the fungus was collected from approximately 25 years old, yearly pruned highbush blueberries (*Vaccinium corymbosum* 'Berkeley') for commercial fruit production. The plantation is located in a small valley, which favours high humidity and is surrounded by forest. The soil of the orchard is covered wholly with partially rotten spruce bark. The bushes already showed symptoms of infection with *M. vaccinii-corymbosi* in 2001, the same year when spring frost occurred. Ascospores were isolated from naturally developed apothecia, conidiospores from infected vegetative shoots. The spores were examined with a light microscope.

Results

Black, solid, pumpkin shaped, approximately 1 cm big, and more or less cavernous pseudosclerotia (Fig. 1) were found in spring 2002 and 2003. These overwintering structures of the fungus, mostly covered with soil, germinated in spring (2002) with several, up to 4 cm long, trumpet to cup shaped, brown to blackish apothecia (Fig. 2) with sometimes over 1 cm in diameter. Apothecia formation could also be observed on overwintered pseudosclerotia, when incubated at wet conditions and room temperature (Zinkernagel, Chair of Plant Pathology, Freising, pers. comm.). In 2003, germinated pseudosclerotia could be found already at the end of February under a 20–30 cm thick layer of snow. Hyaline, ellipsoid ascospores (Fig. 3) were isolated from the apothecia. Microconidia were found on the hyphae braid of apothecia stems. From infected vegetative shoots, hyaline, lemon shaped conidiospores (Fig. 4) were isolated. Young vegetative and floral shoots, infected with the ascospores, showed heavy wilting symptoms (Fig. 5) followed by a dark greyish to black colouration of the shoot stems and leaf tissue, starting at the midrib and lateral veins of the leaves. Masses of conidiospores were found on a greyish, downy layer especially located on the stem base of the infected shoots. Non-infected shoots obviously grew more vigorous compared with healthy shoots from wholly non-infected bushes. Infected berries were not distinguishable visually from healthy fruits while the berries were green coloured. Later on, fruits turned cream to pink, shrunk (Fig. 6) and dropped to the soil at slight vibrations. When the skin of these fruits was abraded, a brownish to black, hardened structure of fungal tissue remained (Fig. 7). Moreover, a fungus could be isolated from infected overwintered twigs, cultivated in vitro and identified macroscopically as *M. vaccinii-corymbosi* (Speakman, BASF AG, Limburgerhof, pers. comm.).

Discussion

In 2001–2003, *Vaccinium corymbosum* 'Berkeley' showed distinctive symptoms of *Monilinia vaccinii-corymbosi* as described from Milholland (1977). The morphological traits of the asco- and conidiospores agreed with the findings of Milholland (1977), as well as Mims and Richardson (1999). In contrast to Milholland (1974) and Bristow and Byther (1992), even pseudosclerotia covered with more than 2.5 cm soil germinated and formed apothecia, probably due to the fluffy, humus rich soil (rotted spruce bark and peat). The yearly development of the fungus starts earlier than those of

Fig. 1. Black, solid, pumpkin shaped, approximately 1 cm big, and more or less cavernous pseudosclerotia.

Fig. 2. Germinated pseudosclerotia with apothecia.

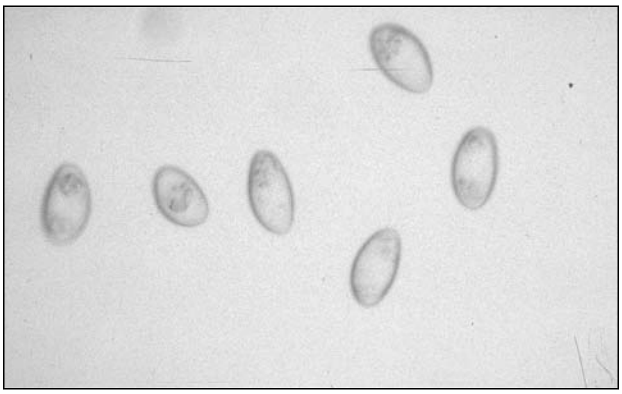

Fig. 3. Ellipsoid ascospores, isolated from apothecia.

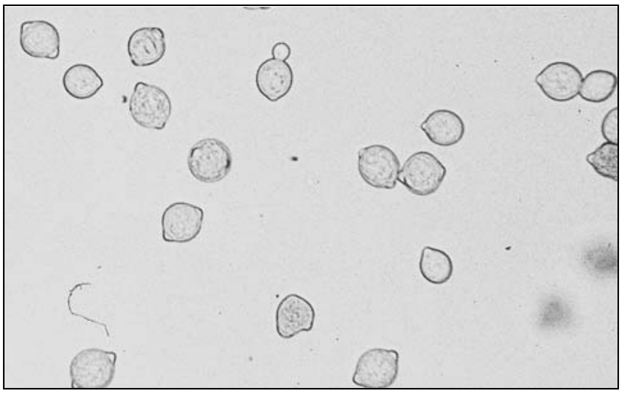

Fig. 4. Lemon shaped conidia from infected vegetative shoots.

Fig. 5. *Monilinia* blight after infection of young shoots.

Fig. 6. Shrunk, cream to pink coloured blueberries.

Fig. 7. Infected fruit with partially abraded skin, whereby brownish to black, hardened fungal tissue remained.

the blueberry (MILHOLLAND 1974), so that germinated pseudosclerotia could already be found at the end of February (unperceived probably earlier) under a cover of snow. Due to this competitive edge, ascospores were already present when the buds of the blueberry started to swell. The more vigorous growth of uninfected shoots could be explained by the reduction of vegetative and floral clusters concerning the whole bush, leading to an effect comparable with pruning. Summarised, the distinct disease symptoms on vegetative and floral shoots, as well as the characteristics of the fungal structures refer to an infection with *M. vaccinii-corymbosi*. An infection of blueberries with other *Monilinia*-species seems to be impossible (see below). The origin of the first inoculum in the respective orchard in Austria is not known yet, since no plant material was obtained from outside of Europe, and there is no other documented appearance of this disease in Europe. However, *Monilinia*-like symptoms on blueberries were reported from other blueberry orchards in Austria, but a false specification cannot be excluded, since the symptoms are similar to other diseases like *Botrytis cinerea*. It seems more probable that *M. vaccinii-corymbosi* was introduced years ago to Europe and is already present but not determined in other blueberry orchards maybe due to unfavourable conditions for the fungus. The findings that spring frosts enhance the susceptibility of blueberries to *M. vaccinii-corymbosi* (HILDEBRAND and BRAUN 1991), could be the reason of the massive, and therefore for the first time conspicuous, occurrence of the fungus in 2001. Only after the coincidence of appropriate conditions like foggy or rainy weather, spring frost, wind protected valley site, optimal temperature for fungal development, susceptible cultivar, etc., a noticeable infection could occur. Another possibility, why *M. vaccinii-corymbosi* was not detected in other European orchards, is the strong dependence of the fungal disease cycle to the host´s phenology: EHLENFELDT et al. (1997) showed that the susceptibility of vegetative shoots, in general, decreased as shoots elongated, representing some kind of age-effect. This leads to a "phenological window of susceptibility", in which an inoculum has to be present for a successful infection. Moreover, LEHMAN and OUDEMANS (1997) found that populations of *M. vaccinii-corymbosi* have distinct developmental phenologies, which correspond to the cultivar specific phenology of the hosts (early vs. late start of growth), leading to the formation of apothecia and release of ascopores when susceptible tissue is present. Therefore, the newly introduced fungus may have had to adapt through selection to the phenological development of the blueberries of European orchards which was not fulfilled until now. This high pathogen-host dependence also seems to exclude the possibility that other *Monilinia*-species, which are already found on other fruit crops in Europe, are responsible for the Monilinia blight on blueberries. All together, the climatic factors and the pathogen-host interactions, as well as the relatively small acreage of blueberries in Europe may have repressed a devastative spread of the fungus in Europe over years. Especially for organic farming blueberry growers, *M. vaccinii-corymbosi* is an alarmingly peril, which emphasises the importance of a good selection of the planted cultivars and orchard sites. Additionally, it remains to be seen how this disease will affect the low susceptible European bilberry (*V. myrtillus*). Until now, it has not been proven either, that the infected and dead overwintered twigs can serve as inoculum in the following year, as it is the case for *M. laxa* on cherry trees.

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