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Short Communication

# *Monilinia* SPECIES CAUSING FRUIT BROWN ROT, BLOSSOM AND TWIG BLIGHT IN APPLE ORCHARDS IN BELARUS

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*The aim of the study was to describe the fungi of the genus* Monilinia *and their damages on apple trees. During 2008–2012, surveys of apple orchards in various regions of Belarus were carried out to collect infected material for isolation of pathogens in pure culture. Fungi identification has been made by features of the cultures and morphology. It was found that in Belarus, moniliosis of apple mainly is caused by* Monilinia fructigena*. For the first time, in Belarus the fungus* Monilinia laxa *on apple-tree was recorded. In orchards of Belarus, the most widespread form of apple moniliosis was brown rot. Under favourable conditions for pathogen development, harvest losses of apple due to brown rot can exceed 50%. In recent years, an increase in damage caused by the spring form of moniliosis (monilial blight) has occurred in apple orchards. Monilial blight of twigs and fruit-bearing branches was caused by* M. fructigena *and* M. laxa *fungi. The increasing trend of this form of disease was shown in orchards older than ten years.*

**Key words:** *apple tree, moniliosis,* Monilinia fructigena*,* Monilinia laxa*,* Monilial *blight.*

Phytopathogenic ascomycetes of the genus *Monilinia* (*Monilia* anamorph stage) infect predominantly plants of the *Rosaceae* and *Ericaceae* families, causing brown rot, blossom and twig blight. The genus *Monilinia* includes three widely spread and economically important species: *M. fructigena* Honey, *M. laxa* (Aderh. et Ruhland) Honey and *M. fructicola* (G. Wint) Honey. *M. fructigena* is widespread in Europe and in some parts of Asia. It mainly infects pome and stone fruits, but it can cause blossom and twig blight. *M. laxa* occurs in different environmental conditions and is found in all zones of stone and pome fruit cultivation. The fungus has been known as a blossom and twig pathogen of stone fruit, but has lately also caused damage in apple tree orchards. A specialized form of this species exists, *M. laxa* f.sp. *mali* Harrison, which is thought to be restricted to apple and causes blossom wilt, spur-kill, and canker (Byrde and Willets, 1977; Gril *et al*., 2008).

The third species is *M. fructicola*, which was found for the first time in America, Australia and New Zealand and is subject to quarantine Western Europe. *M. fructicola* is a pathogen of blossom, twigs and fruit, but mainly affects stone fruits (Fulton *et al*., 1999).

Recently, based on morphological, biological and genetic differences between European and Japanese isolates of *M. fructigena* a distinct species named *Monilia polystroma* has been registered. The pathogen infects apple shoots and causes brown rot on infected apple fruits (Côté *et al*., 2004; Petróczy and Palkovics, 2009).

In Belarus, research on brown rot fungi occurrence and the associated damage on apple trees was conducted in 1970–1980. Since then, major changes have taken place in orchard cultivation technology, in apple orchard composition and climate situation, which may have been associated with changes in the danger from these fungi due to alteration of their biology. Taking into account the importance of the diseases caused by brown rot fungi, a survey of their occurrence and the associated damage in Belarus was conducted.

**Plant material.** During 2008–2012, survey was made of apple orchards in various regions of Belarus to determine occurrence of *Monilinia* fungi and the associated damage (Fig. 1). About 350 samples with moniliosis symptoms collected from various apple-tree cultivars were analyzed. Selected cultivars for assessment wereAntey, Antonovka Obyknovennaya, Belorusskoe Malinovoe, Imant, Liberty, Spartan, Vesyalina, Imrus, Zarya Alatau, Zaslavskoe (winter cultivars) and Bely Naliv, Elena, Kovalenkovskoe, Melba, and Orlovim (summer cultivars).

**Isolation and identification by colony morphology.** Fungal isolation in pure culture was carried out from freshly collected-apple fruits, blossoms, short spurs and shoots. The isolates were cultivated on potato-dextrose agar (PDA) at temperature +22.0 °C. Colour and colony margins, formation of rosettes and their lobes, sporulation, conidial dimensions and germ tube features were used for species identification (Van Leeuwen and Van Kesteren, 1998; Lane, 2002).


*Fig. 1.* Map of surveyed regions and collection sites of *Monilinia* fungi isolates (marked with asterisks).

**Fruit evaluation.** Over three growing seasons in 2009–2011, apple losses due to brown rot disease were assessed in four commercial orchards with various fungicide load, located in Kletsk, Uzda, Brest and Hrodno districts. Numbers of fungicide treatments varied between years from 2 to 4 at Kletsk and Uzda orchards and from 7 to 11 in the orchards of Hrodno and Brest. The cultivars grown in the orchards were cv. Belorusskoe Malinovoe, Bely Naliv, Imrus, Kovalenkovskoe, Orlovim, and Zarya Alatau. Disease incidence was assessed as percentage of brown rot at the technical ripeness of fruits.

**Incidence and harmfulness of brown rot fungi in apple orchards.** The phytosanitary inspections of orchards in Belarus showed that *M. fructigena* is the most frequent species on apple-tree among fungi of the genus *Monilinia.* The causal agent occurred in conidial stage and caused brown rot and blossom and twig blight of apple trees (Figs. 2a, b, e, f, j). In integrated apple orchards, brown rot is more widespread and a harmful

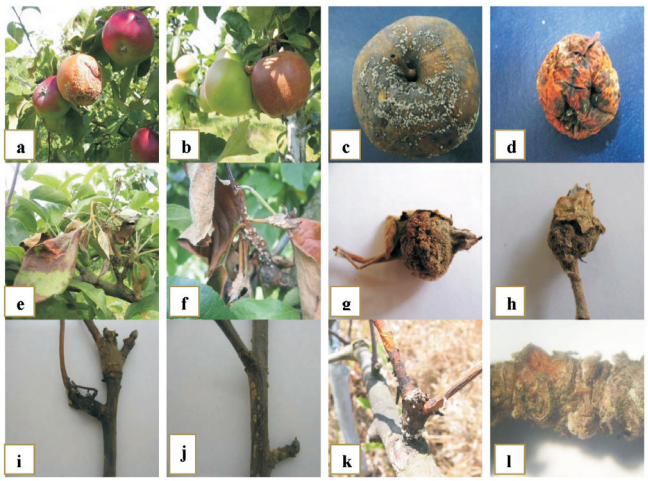


*Fig. 2.* Symptoms of apple moniliosis caused by *M. fructigena* fungus: (a, b) brown rot, (e, f) blossom blight, (j) shoot blight, (i, k) infected short spurs. Symptoms of apple moniliosis caused by *M. laxa* fungus: (c, d) brown rot, (g, h) infected fruit sets, (l) infected short spurs.

Table 1

APPLE YIELD LOSSES CAUSED BY *M. fructigena* IN ORCHARDS WITH DIFFERENT PESTICIDE LOAD, 2009–2011

| Apple tree cultivars | Percentage of apple losses due to brown rot disease | |
|---|---|---|
| | orchard with intensive protection (7–11 fungicide treatments) | orchard with minimal protection (2–4 fungicide treatments) |
| Summer cultivars | 1.5–12.1 | 23.9–62.6 |
| Winter cultivars | 0.9–14.5 | 7.5–41.7 |

form of moniliosis. During the observation period, the disease incidence in orchards of Belarus varied depending on hydrothermal conditions of the vegetation period and the susceptibility of the apple cultivar to the pathogen. Our results also indicate that apple yield losses caused by *M. fructigena* were significantly reduced by protective measures carried out against apple scab (*Venturia inaequalis* Wint.) (Table 1). In the orchards of Kletsk and Uzda district, where 2–4 fungicide treatments during the first part of vegetation season were carried out, apple losses caused by *M. fructigena* varied from 23.9 to 62.6% for summer cultivars (Kovalenkovskoe, Bely Naliv, Orlovim) and from 7.5 to 41.7% on winter cultivars (Imrus, Belorusskoe Malinovoe, Zarya Alatau). In comparison, in apple orchards of Brest and Hrodno, where regular spraying against apple scab (7–11 fungicide treatments) were carried out, apple yield losses due to brown rot during the years of investigation did not exceed 12.1% on those apple summer cultivars and 14.5% on the winter cultivars.

The damage caused by moniliosis is not only limited to loss of yield. The fungus *M. fructigena* can cause blossom and twig blight under favourable conditions. From infected fruits, mycelia of the fungus can also penetrate in short spurs and fruiting shoots, causing partial or full dieback. (Fig. 2i, k). During recent years, increase in incidence of the spring form of moniliosis (blossom and twig blight) has been noted in apple orchards older than ten years. The amount of dead blossoms and shoots on apple trees during a favourable years for the causal agent (*M. fructigena*) can reach 5.1–8.2%. Our observations are in agreement with findings by researchers in other countries. Russian scientists also have recorded an increase in incidence of the monilial blight form in orchards, which recently was observed to infect not only fruits, but also branches (predominantly short spurs, fruiting shoots, 1–3-year-old wood branches), which was not observed 12–15 years ago (Дроздовский Головин, 2006).

Some researchers have also reported the possible involvement of *M. laxa* in causing monilial blight of blossoms and fruit formations on apple trees (Gril *et al*., 2008). Earlier studies on brown rot fungi in Belarus showed that *M. laxa* infected only stone fruit crops (Онуфрейчик, 1974).

In May 2011 in an orchard of the Minsk district, unusual symptoms were observed on ‘Antonovka Obyknovennaya’ apple trees. Brownish die back was present on short spurs. Infected areas were covered with a few stromata (up to 1 mm) with gray colour. Conidia of the fungus (7.7–17.7 × 3.9–9.1 μm) were smaller than the average size for *M. fructigena* (13.2–28.7 × 8.4–15.8 μm). The fungal isolates grown on

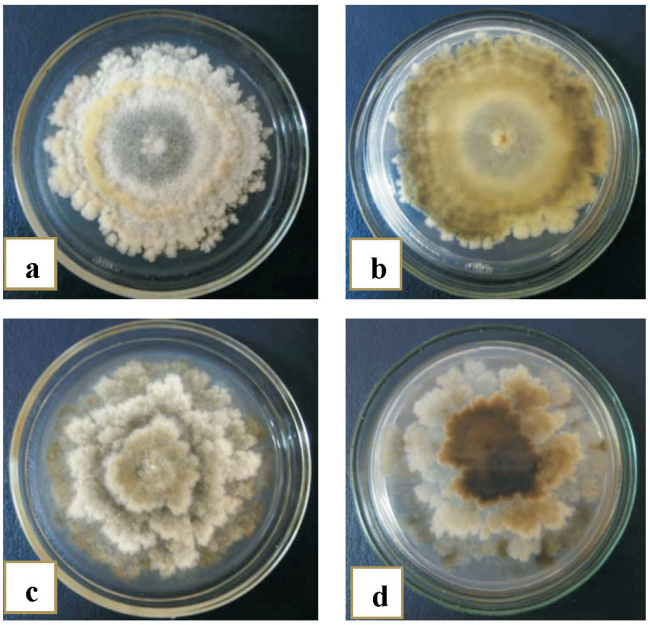


*Fig. 3.* Colonies of *Monilinia* spp. grown on PDA (10 days, in the dark at 22 °C). *M. fructigena* isolate: (a) upper surface; (b) lower surface; *M. laxa* isolate: (c) upper surface; (d) lower surface.

PDA had colonies with gray-olive colour, and a lobed margin. Rosetting occurred in the upper part of the colony (Fig. 3 c, d). *M. fructigena* fungus forms yellow and cream-white colonies with olive-brown or light-sand colour is typical (Fig. 3 a, b). On the basis of conidial dimensions and features of the culture, the fungus isolated from infected apple short spurs was preliminarily identified as *M. laxa*. Specific identification the fungus was also confirmed by PCR analysis in the laboratory of genetics and biotechnology of the Institute of Forest of the National Academy of Sciences of Belarus. During 2011–2012, this fungus was isolated from infected fruits in three apple orchards (cv. Kovalenkovskoe), fruit sets (cv. Elena) and short spurs (cv. Zaslavskoe, Antonovka Obyknovennaya) in Belarus (Fig. 2 c, d, g, h, l).

In the literature, a forma specialis of *Monilinia laxa* f.sp. *mali* Harrison is mentioned, which is thought to be restricted to apple and causes blossom wilt, spur-kill, and canker (Gril *et al*., 2008). Our investigations did not show host-restricted specialisation of isolated fungi. Pathogenicity testing was successful not only apple, but also sweet cherry blossoms and shoots. However, additional study including genetic analysis of *M. laxa* isolates is needed.

Recently, infection of apple shoots was reported by a species described as *Monilia polystroma* (Petroczy 2009). During our investigations we collected 20 isolates from infected apple shoots. On the basis of culture and morphological characteristics, none of the isolates corresponded to the described species. However, accurate delineation between *M. fructigena* and *M. polystroma* can be best achieved using PCR diagnostic methods (Côté *et al*., 2004). Therefore, our further research will include also genetic analysis of collected isolates of *M. fructigena* from apple shoots in surveys.

On the basis of the field observations and laboratory investigations it was found that currently in Belarus, apple tree moniliosis is caused by two species of *Monilinia* — *M. fructigena* and *M. laxa.* The most frequent species is *M. fructigena.* The quarantine-status species *M. fructicola* was not found in Belarus. The fungi *M. fructigena* and *M. laxa* mainly infected apple tree fruits and fruit sets, but also caused blossom and twig blight and fruit wood infection. Ability of these species to infect apple tree blossoms and shoots is not clear but may indicate possible larger potential pathogenicity.

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*Monilinia* SUGAS, KAS IZRAISA AUGĻU PARASTO PUVI, ZIEDU UN DZINUMU BOJĀEJU BALTKRIEVIJAS ĀBEĻU DĀRZOS

Darba mērķis bija izpētīt *Monilinia* ģints sēņu sugu dažādību un to kaitīgumu ābelēm. No 2008. gada līdz 2012.gadam tika apsekoti ābeļu dārzi dažādos Baltkrievijas reģionos, lai ievāktu inficēto materiālu, un veikta patogēnu izolācija tīrkultūrā. Sēņu identifikāciju veica pēc kultūru morfoloģiskajām pazīmēm. Noteikts, ka Baltkrievijas apstākļos ābelēm moniliozi galvenokārt izraisa sēne *Monilinia fructigena*. Pirmoreiz Baltkrievijā uz ābelēm identificēta sēne *Monilinia laxa*. Izplatītākā moniliozes forma ābelēm Baltkrievijas dārzos ir parastā puve. Patogēnu attīstībai labvēlīgos apstākļos ābolu ražas zudumi parastās puves dēļ var pārsniegt 50%. Pēdējos gados ābeļu dārzos atzīmēts pieaugošs postīgums moniliozes pavasara formai, kas izraisa auga daļu bojāeju. Dzinumu un augļzaru bojāeju izraisīja sēnes *M. fructigena* un *M. laxa*. Konstatēta tendence šīs slimības formas pieaugumam dārzos, kas vecāki par desmit gadiem.