CERCETĂRI PRIVIND MONITORIZAREA ȘI AVERTIZAREA TIMPURIE A ATACULUI DE *MONILIA LAXA* LA UNELE SOIURI DE CIREȘ ȘI PRUN RESEARCHES ON MONITORING AND EARLY WARNING OF BROWN ROT *MONILIA LAXA* ATTACK ON SOME VARIETIES OF CHERRY AND PLUM

Marin Florin Cristian, Călinescu Mirela, Sumedrea Mihaela, Chițu Emil
Research Institute for Fruit Growing Pitesti, Romania

Abstract

Brown rot caused by *Monilia laxa* (Aderh. & Ruhland, Honey) is one of the most damaging fungal disease for stone fruit species, in all European countries and in Romania as well. A great deal effort is done to study its biology and ecology, for disease monitoring and containment. This paper presents the result obtained at RIFG Pitesti Romania during 2018-2020 in monitoring and early warning of the disease attack, using two different weather stations and forecast modules made in Europe and USA. A correlation was found ($R^2=0.0146$, $r=0.1208$, $n=585$), which proves that the microclimate was favorable for stone fruits brown rot infections, for varieties evaluation and classification and to supply data to develop new early warning tools as well. The results obtained with the two forecast systems makes possible the early warning on the attack risk of brown rot, both cherry and plum orchards. In the same period 26 cherry and 22 plum varieties were studied regarding their behavior to the pathogen natural infections. Among the Romanian varieties the ones with the lowest damages degree were: 'George', 'Clasic', 'Daria', 'Negre de Bistrița', 'Roșii de Bistrița', 'Rubin', 'Severin' and 'Uriășe de Bistrița' (DD%=0.13-0.14) on cherry and 'Pescaruș', 'Record', 'Gras ameliorat', 'Romanța', 'Roman', 'Ialomita' and 'Dâmbovița' (DD%=0.03-0.14) on plum. Under long term study, the most sensitives to brown rot attack were 'Lapins' cherry variety (DD%=3.93) as well as 'Stanley' Centenar and 'd'Agen' plum varieties (DD%=4.68-4.72), which can be used as 'indicators', in order to triggers the phytoprotection programs.

Cuvinte cheie: cireș, prun, avertizare timpurie monilioza.

Key words: cherry, plum, early warning, brown rot.

1. Introduction

Cherry and plum. The economic importance of the species

Cherry and plum are two temperate fruit species with economic importance, their fruits being requested by the consumers for fresh consumption or processed worldwide. In Europe, cherry harvested surface is 170,874 ha, with a mean production of 793,466 t / year. In our area, the most important cherry producing countries are Turkey, Spain, Italy, Romania and Greece. Romania is producing 76,292 t / year from 6,393 ha. (Faostat, 2014-2018). At the same time, in Europe the average the average plum harvested surface is 381602 ha, with a mean production of 2,539,868 t / year. In the area, the most important plum producing countries are Romania, Serbia and Bulgaria followed by Turkey. Romania is producing 558356 t plums / year, from 65985 ha. (Faostat, 2014-2018).

Due to the running of the program for fruit growing development, the surface cultivated with valuable cherry and plum varieties, conducted under intensive and superintensive high technology systems, will increase with 860 ha respectively 630 ha in the next years (Coman, 2019).

Brown rot, host plants, biology and main symptoms

The first published description of brown rots on decaying fruit was in 1796 in Europe. It was first noticed in the US in 1807. In Romania, the disease was first described in 1878, and since then spread a lot (Amzăr et al., 2003). *Monilia laxa* menace constantly cherries, plums, apricots, and almond, fruits and wild stone fruit species while *Monilia fructigena* has a broad range of infection targets like stone and pome fruit species and hazelnut as well.

In the case of *Monilia laxa*, the opening blossoms of the host plant species provide the first susceptible tissue for infection in the spring. Spore production begins in the spring at temperatures of 12-25°C. Blossom infection (via anthers and pistils) caused by *M. laxa* depends on the duration of wetness and temperature. For this, 5 to 18 hours of wetness are necessary at 24 and 10-12°C, respectively, for the infection to occur. Very high relative humidity (>94%) is important for infection. The fungus invades the floral tube, the ovary, peduncle, and usually the twig to which the peduncle is attached. The time required for the appearance of symptoms may be only a few days to 1-2 weeks, depending on the

temperature. Secondary spore production begins almost immediately after primary spore infection symptoms occur on the blossoms and stems. Blossoms do not progress into fruit and remain on the tree, brown and wilted (Cannon et al., 2017). Wilting and browning blossoms on twigs and cankers (necrotic areas) on invaded woody parts are typical symptoms of infection by *M. laxa*. A gummy substance usually exudes from the cankers. Under humid conditions, ash-grey-brown sporodochia bearing conidia form on the surface of diseased blossoms and twigs. Stem cankers can eventually girdle diseased stems being additional sources of inoculum. Few blighted blossoms may be enough to cause severe fruit rot if environmental conditions are optimal as fruits ripen. If spores are present during wet and warm conditions, infection of ripening fruits is highly susceptible (Cannon et al., 2017).

Fruit lesions are brown and circular, and eventually the whole fruit decays and turns brown. Tufts of mycelium and conidia (ash-grey-brown in color) sprout from the skin of the infected fruit and are scattered on its surface; later, rotten fruits become "mummies" (Amzar et al., 2003; Linder et al., 2006; Cannon et al., 2017; Veteket et al., 2017; Dubois et al., 2018; Danilovich and Shane, 2018).

Monilia fructigena fungus overwinters mainly in or on diseased mummified fruit either attached to the tree or on the ground. The fungus can survive long periods of adverse environmental conditions as mycelium within mummified fruits, twigs, cankers and other infected tissues and serve as sources of primary inoculum. In the spring or early summer, under favorable conditions, dense bunches of conidiophores (sporodochia) form on the surface of the mummified fruits and infected tissues, occurs and bear chains of conidia. The conidia are dispersed by wind and rain water or by insects to young fruits. Initial infection takes place via wounds caused by pests. Subsequent spread is done by contact between adjacent fruits may also cause infection. Any infected tissue in which the moisture content is sufficient for sporulation may serve as a source of secondary inoculum. Infections of fruitlets during, or shortly after flowering may result in latent infections on green fruits, and become active before or after harvest (Veteket et al., 2017). When continued heavy rainfall is occurring or other conditions are conducive to infection, shorten this interval to 10 days. Immature sweet cherries may show symptoms of small (4.8 mm to 19 mm in diameter), sunken brown spots with a red halo (Cannon et al., 2017). Infection of fruits can occur at any time during fruit development, but the disease is only severe in ripe or ripening fruits. Fruit lesions are brown and circular, and eventually the whole fruit decays and turns brown. Bunches of mycelium and conidia (2-3 mm in diameter) emerges from the skin of the infected fruit, often arranged in concentric rings on pome fruits (however, when the relative humidity is low and/or when the fruits are not ripe, very few or no tufts develop). On some sour cherry varieties, the fruits damages can reach 80-90% (Rădulescu and Răfăilă, 1972; Tomşa, 2003). Rotted fruits may either fall to the ground or dry out and remain attached to the tree, leaving a hard, shriveled "mummy" (Veteket et al., 2017).

Researches regarding brown rot monitoring and containment

Monitoring of the trees. At least 20 trees per block should be checked for fruit mummies and cankers during or after pruning early in the spring (before white bud stage). One to ten mummies and/or cankers per 20 trees is considered a moderate risk level for blossom infection. Greater than 10 mummies and/or cankers indicate a high risk level. During flowers shuck fall, scout ten shoots of 20 trees for blossom infections. A moderate risk level for fruit infection is reached when one to ten blossom infections per 20 trees is present. More than ten blossom infections indicate a high risk of fruit infection. As fruit ripens and becomes softer, the risk for infection increases. Two symptomatic fruit found per 4 ha during scouting before harvest is considered high risk for a brown rot outbreak (Cannon et al., 2016).

Monitoring of weather conditions and key fruit pests (plum curculio, fruit moths, fruit flies, aphids, various bugs), direct into the orchard are important because preventive control measures can be properly applied, agrotechnical ones, the adequate control of pests as well as fungicides can be applied according to weather conditions, and that can cause injuries to fruits may reduce the risk of infection of fruits by *Monilinia* spp. (Danilovich and Shane, 2018; Veteket et al., 2017).

In order to prevent and contain the damages produced by the brown rots on stone fruits species, intensive researches were carried out in Europe and USA, which conducted to the screening and release on the market of more efficient active ingredients and mixtures such as: new formulations of copper and captan), as well as molecules with systemic action like: boscalid; myclobutanil, propiconazol, tebuconazol, fenhexamid, penthiopyrad, pyrimethanil, pyraclostrobin, fluopyram + trifloxystrobin, fluxapyroxad + pyraclostrobin, cyprodinil + difenoconazole; tebuconazole + trifloxystrobin, etc.), biological or biotechnical products were tested and included in integrated phytoprotection programs.

Also, intensive researches were carried out to improve the use of the weather station platforms (Adcon Telemetry, WatchDog, Pessl, Delta T, SysAgria, Enten, etc.) and forecasting software and modules (addVantage 6.4, Specware Pro 9, iMeteo Pro 6.4, DeltaLink 3.2, WD3 WinDIAS, SysWin, etc.), new models and long-term studies on the behavior of valuable stone fruits varieties to brown rots, in order to increase the efficacy of the treatments and reduce the impact of fruit production on the environment. (Cannon et al., 2016; Dubuis et al., 2018).

2. Material and methods

The studies were carried out during 2018-2020 at RIFG Pitesti-Maracineni Romania, and had as objectives the assessment of some valuable Romanian and foreign cherry and plum cultivars, to establish their behavior to brown rot (*Monilia* spp) attack, to classify them accordingly, and use the most sensitive ones as indicators. The assessments were done on 26 cherry varieties (13 from Romania and 13 from abroad) and 22 plum varieties (18 from Romania and 4 foreign ones), conducted in intensive and superintensive experimental orchards belonging to the Institute research platform. The cherries varieties were grafted on 'Gisela-5', 'Gisela-6', 'Gisela-12' and 'Weiroot 2' rootstocks planted at 4.0 x 1.5-2.0 m and trained as spindles or slender-spindles. The plum varieties were grafted on 'Adaptabil' and 'Saint Julien' rootstocks, planted at 4 x 2.25m and trained as slender spindles or 'goblet'. The row data were collected in 4 replicates per variety on at least 5 trees / replicate. After a general evaluation the researches were focused on the most sensitive varieties to highlight the most sensitives and the tolerant ones to brown rot infections. Attack frequency - F [%], attack intensity - I note [0-7], damages degree - DD [%] were calculated every year according the following formulas:

$$F [\%] = (n / N) \times 100,$$

where F [%] = attack frequency; n=number of diseased organs; N=total number of examined organs.

$$DD\% [\%] = ((\text{sum}(f\% \times I \text{ notes}) / n) / 100)$$

where DD [%] = damages degree, f%=class attack frequency; I=attack intensity scored with 0--7 notes; n=number of attack classes.

Another objective was to use two different weather station platforms and forecasting modules to collect data and predict the period of brown rot attack and its severity, aiming to better positioning of preventive chemical treatments diminish and the impact on the environment.

The annual average temperature (1969-2020): 10.0 °C; the absolute maximum temperature in July: 38.8 °C; the absolute minimum temperature in January: -24.0°C; the average precipitation amount (1969-2020): 678 mm / year. First autumn frost occurs at the end of October, and the latest spring frost in the second decade of the April and accidentally in the last decade of the month).

All the data related to the studied biological material were collected using the study methodology for collections and comparative trial (Cociu V. et al., 1989) and international standards as well.

The data related to local microclimate were collected using the semi-automate weather station WatchDog (Spectrum Technologies Inc.), and automate weather station Pessl (Pessl Instruments, Austria), which use the WatchDog and Pessl weather platforms, Specware Pro 9 and iMeteo Pro 6.4 forecasting software and modules. The results were stored, processed and analyzed using the facilities of MS Office Excel 2010, Specware Pro 9.0 and iMetos Pro 6.4 disease modules for early warning.

The experimental data were stored, processed and analyzed, using MS Office Excel 2010 facilities.

3. Results and discussions

3.1. Results on about the infection risk brown rot on plum and cherry and infections early warning

The local microclimate data collected reveal that the years of the study (2018-2020) were very favorable for the brown rots on cherries and plums. Assessment of the figure 1 reveal that the monthly average temperatures ranged between 10.9-15.3°C in April up to 22.0-22.8°C in August to drop at 17.1-18.9°C in September. However, the in October 2018 the monthly average temperature was 20.1°C which insured good conditions to the pathogens inoculum survival and to develop infections in the spring of 2019.

The examination of the figure 2 shows that leaf wetness played an important role for brown rot development on flower clusters, shoots and fruits. On can see the precipitation deficit in April, but leaf wetness was ranging between 79-130 h /month in May, 168.8-188.3 h /month in June, 98.3-139.3 h /month in July which were very favorable for pathogens exponential development and infection. In 2018 and 2020, in August and September, the leaf wetness ranged between 79.2-94.0 and 79.2-81.0 h/month, good conditions to accentuate the diseases symptoms.

Based on collected and processed data, between the monthly average temperatures - higher than 5°C and the air relative humidity values, a correlation was found ($R^2=0.0146$, $r=0.1208$, $n=585$), which proves that the microclimate was favorable for stone fruits brown rot infections and development, for varieties evaluation and as well. The collected data might serve also to improve the forecast done with used models (Figure 3).

Assessment of the figures 4-6, generated by Specware Pro 9.0 software on the data collected by WatchDog system, using Mills Rothwell model, confirmed that during the years of study the brown rot (moniliose) found good microclimate conditions for contamination and infections development, both on stone fruits flower clusters and young shoots, as well as on growing shoots and fruits.

According to the data processed with the software, in 2018 the risk for brown rot attack was medium from the end of April and the month of May (note 4-5), while in 2019 the risk for brown rot attack in May was low (note 2) (Figure 4 and 5). In all three years of study, during June and early of July, the risk of infections on growing shoots and young fruits was medium to very high, (note 4-7) due to the intense rains falling down, increased air humidity and leaf wetness (Figures 4-6).

In all years of study, from mid of July to September the risk of brown rot attack on growing up to full size fruits was medium-high to very high, (note 5-7).

Assessment of the figures 5-6, also reveal that in 2019 and 2020 the microclimate conditions were favorable for brown rot (attack risk note 4-6) and for early infection in the following springs.

Assessment of the figure 7 generated with MS Excel 2020 on the data collected by Pessl system in 2019 and 2020 reveal that, the risk for brown rot attack was medium from March to the end of dormant period of the trees. From the mid of April and the month of May, the attack risk on the growing shoots was medium (note 4-5), and from mid of May till to mid of August the attack risk on the growing and ripening fruits was almost constantly high (note 5-6). The most risky microclimate conditions were the ones from 2020. The results obtained with the two weather platforms and software systems in collecting storing and processing weather data, together with the assessment 'biological reserve from the previous years' established on sensitive varieties, makes possible the early warning on the attack risk of brown rot (*Monilia* spp.), both cherry and plum orchards.

3.2. Results regarding the behavior of valuable plum and cherry varieties on brown rot attack

The assessments done on 26 cherry varieties and 22 plum varieties carried out in the years previous to this study allowed their general classification taking into account their behavior to brown rot attack quantified by overall damages degree DD%.

A deep study of the figure 8 reveal that among the Romanian cherry varieties with the lowest damages degree (DD%=0.13-0.14) were: 'George', 'Clasic', 'Daria', 'Negre de Bistrița', 'Roșii de Bistrița', 'Rubin', 'Severin' and 'Urișe de Bistrița', followed by 'Jubileu 30', 'Simbol' and 'Tendant' (DD%=0.38). Medium damages degrees had the varieties: 'Cerna' and 'Ponoare' (DD%=1.12) and the foreign varieties 'Bigarreau Burlat', 'Areko', 'Belise', 'Fertard', 'Folfer', 'Hertford', 'Merchant', 'Regina', 'Tamara', 'Kordia' and 'Penny' (DD%=1.10-1.13), but were over passed by 'Ferovia', 'Karina', 'Sweetheart' and 'Vanda' varieties (DD%=2.90).

Under long term study the most sensitive cherry variety to brown rot attack was 'Lapins' (DD%=3.93).

Assessment of the figure 9 reveal that among the Romanian plum varieties with the lowest damages degree were: 'Pescaruș', 'Record', 'Gras ameliorat', 'Romanța', 'Roman', 'Ialomița', 'Dâmbovița' (DD%=0.03-0.14), followed by 'Andreea' and 'Agent' (DD%=0.38). Medium damages degrees had the varieties: 'Tita' and 'Carpatin' (DD%=1.11) 'Piteștean', 'Silvia', 'Tuleu gras' 'Valcean' and 'Cacanska rodna' (DD%=1.12). High damages degrees had the varieties: 'Centenar', 'Diana' and 'Tuleu timpuriu' (DD%=2.90). The most sensitive plum varieties to brown rot attack were 'Stanley' and 'd'Agent' (DD%=4.68-4.72).

3.3. Results on brown rot attack on some appreciated plum and cherries varieties grown under superintensive system.

The study conducted during 2018-2020 aimed also to highlight the behavior of some appreciated cherry and plum varieties grown under superintensive system (1904 trees / ha or more) to the attack of brown rot on flower clusters and young shoots and on growing and ripening fruits as well.

Examination of the figures 10 and 11 highlights that during the study period, the year of 2018 was the most difficult (with spring late frost), and the medium attack of brown rot on shoots was registered at the cherry varieties: 'Ferovia', 'Skeena', 'Kordia' and 'Daria', (DD%=1.05-1.80), but the attack on fruits ranged between medium and high (DD%=1.23-2.12).

Assessment of the figures 12 and 13 suggest that, in the year of 2018, the medium attack of brown rot on shoots was registered at the plum varieties 'Stanley', 'Centenar' and 'Piteștean', (DD%=0.82-1.40) but on the plum varieties 'Stanley', 'Cacanska Rodna', 'Centenar' and 'Piteștean', the attack on fruits ranged between (DD%=0.69-1.12). The data obtained suggest that brown rot attack on cherries and plums is rising up exponentially with the late frost occurrence, inoculum reserve from the previous years, rain falls and increased air humidity in first half of the summer and increase sugars content in the ripening period and short periods of yield cooling.

4. Conclusions

Based on collected and processed data, between the monthly average temperatures higher than 5°C and the air relative humidity values, a correlation was found ($R^2=0.0146$, $r=0.1208$, $n=585$), which

proves that the microclimate was favorable for stone fruits brown rot infections and development and for varieties evaluation and classification as well.

Brown rot attack on cherries and plums is rising up exponentially with the late frost occurrence, inoculum reserve from the previous years, rain falls and increased air humidity in first half of the summer and increase sugars content in the ripening period and short periods of yield cooling.

The results obtained with the two weather platforms and software systems in collecting storing and processing weather data makes possible the early warning on the attack risk of brown rot (*Monilia* spp.), both cherry and plum orchards.

Among the Romanian cherry varieties grown under superintensive system, the ones with lowest damages degree (DD%=0.13-0.14) were: 'George', 'Clasic', 'Daria', 'Negre de Bistrița', 'Roșii de Bistrița', 'Rubin', 'Severin' and 'Uriășe de Bistrița', followed by 'Jubileu 30', 'Simbol' and 'Tentant' (DD%=0.38).

Among the Romanian plum varieties the ones with the lowest damages degree were 'Pescaruș' and 'Record', 'Gras ameliorat', 'Romanța', 'Roman', 'Ialomița', 'Dâmbovița' (DD%=0.03-0.14), followed by 'Andreea' and 'Agent' (DD%=0.38).

Under long term study, the most sensitives to brown rot attack was 'Lapins' cherry variety (DD%=3.93), as well as 'Stanley' and 'd'Agent' or 'Andreea' plum varieties (DD%=4.68-4.72), which can be used as *indicators*, in order to triggers the phytoprotection programs.

Using the 'biological reserve' under medium term study, the most sensitives to brown rot attack were 'Lapins' and 'Daria' cherry varieties (F% =36.00--52.97, respectively 35.30--45.40 in 2018). On plums the most sensitives to brown rot attack were 'Stanley' and 'Centenar' varieties (F% =36.08--39.92, respectively 21.30--30.50 in 2018), which caused infection pressure in 2019 and even 2020.

Acknowledgments

This paper was supported by a grant of the Romanian Ministry of Research and Innovation-UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0662, contract 6PCCDI/2018.

References

1. Amzăr Valentina, Ivascu Antonia, 2003. Ghid de identificare al principalelor boli și dăunători la speciile pomicele, București, Editura MEDRO, 200p., ISBN 973-8487-02-1.
2. Braniște N., Amzăr V., 2007. Soiuri de pomi arbuști fructiferi și căpșun, create în România, Editura Paralela 45, 476pp, ISBN-978-973-47-0177-3.
3. Braniște N., și colab., 2006. Fondul de germoplasmă la speciile pomicele, de arbuști fructiferi și căpșun din colecțiile din România.
4. Budan S., Petre L., 2007. Soiuri de cireș pentru plantații comerciale, ICDP Pitești, .pdf, 55 pp.
5. Bulatovic-Danilovich Mirjana, Shan William, 2018. Brown rot in Stone Fruits - *Monilia fructicola*, West Virginia University, Extension Service, pdf, 3pp.
6. Butac Madalina, 2010. Ameliorarea prunului, Editura Universității din Pitești, 2010, 101 pp., ISBN 978-606-560-158-1.
7. Cannon Cami, Alston Diane, Nischwitz Claudia, Spears Lori, Clint Burfitt, 2017. Invazive Fruit Pest Guide for Utah, Insect and Disease Identification, Monitoring and Management, Utah State University, IPM Program, pdf. 106 pp.
8. Cociu V., Oprea Șt., 1989. Metode de cercetare în ameliorarea speciilor pomicele, Editura Dacia Cluj-Napoca, 174pp., ISBN 973-35-0077-1.
9. Coman M., 2019. Actual Tendencies in Fruit Culture in Romania, 4th Balkan Symposium on Fruit Growing 14-18 September, 2019, Istanbul, Turkey, .PPT 20 pp.
10. Dubuis P.-H., Linder Ch., Kehrli P., 2018. Maladies du cerisier, Revue suisse Viticulture, Arboriculture, Horticulture Vol. 50 (1): 39-41, 2018.
11. Gouramanis G.D., 1999. Studies on the control of the apricot brown rot (*Monilia laxa*), Acta Horticulture, 488: 671-674.
12. Gubler W.D., Adaskaveg J.E., Pickel C., Olson W.H., Niederholzer F.J.A., Teviotdale B.L., 2017. *IPM Pest Management Guidelines: Prune*, Agriculture and Natural Resources, University of California, .pdf, 11 pp.
13. Perren Sarah, Peter Jules, Freimoser Florian und Naef Andreas, 2020. Monilia en arboriculture, Fiche technique Agroscope, N° 122 / 2020; 3 pp.
14. Linder Ch., Viret O., Charmillot J-P., Delabays N., Hohn, H., Siegfried W., Ruegg J., Hollinger E., Widmer A., Newweiller R., 2006. Guide de traitements, Cerisier, Griotier et Prunier, Revue Suisse de Viticulture, Arboriculture Horticulture, Vol 38 (1) : 78, 34-38.
15. Pârvu M., 2003. Ghid practic de fitopatologie, Editia a-IIa, Editura Gloria, Cluj-Napoca, 282 pp. ISBN 973-8267-19-6.

16. Rădulescu E., Răfăilă C., 1972. Putregaiul fructelor (*Monilia fructigena*), Tratat de fitopatologie agricolă, vol. IV, p. 56-63.
17. Tamm L., Minder Chr.-E, Flückinger W., 1995. Phenological analysis of brown rot blossom blight, of sweet cherry caused by *Monilia laxa*, Phytopathology, The American Phytopathological Society, Vol. 85, N. 4, p. 401-408.
18. Teodorescu Georgeta, 2000. Prognoza și avertizarea bolilor și dăunătorilor plantelor de cultură, Editura, TIPARG, ISBN 973-8029-16-3.
19. Tomșa M., Tomșa Elena, 2003. Protecția integrată a pomilor și arbuștilor fructiferi la început de Mileniu, Editura Gee, București, 162 p., ISBN 973-85232-9-X.
20. Viret O., Siegfried, 2011. Les monilioses, Fiche 303, Agroscope Changins, Wädenswil, pdf, 3pp.
21. Veteket et al., 2017. Integrated Pest Management of major pest and diseases in Eastern Europe and Caucasus, Food and Agriculture Organization of the United Nations Budapest, 2017, 110 pp. ISBN 978-92-5-109144-9.
22. ***EPPO Standards PP 2/33, Good plant protection practice, Stone Fruits, 2004 OEPP/EPPO, *Bulletin OEPP/EPPO Bulletin* 34, 427–438.
23. ***EPPO Standards PP 1/38(3), *Monilinia spp.*
24. ***FAOSTAT 2014-2018. Crops Data, <http://www.fao.org/faostat/en/#data/QC>.
25. ***Brown rot (*Monilia laxa*), aggressive fungus infecting flowers, shoots and fruits, STIHL, Encyclopedia of Trees <http://www.stihl.com/encyclopaedia-of-trees.aspx>.
26. ***Monilioses, 2017. Epiphytia, INRA, <http://ephytia.inra.fr/fr/C/21500/Prunier-d-Ente-Monilioses-Monilia-spp>.
27. ***Oregon State University 2020. Pest Management Guide for Tree Fruits, pdf, 81 pp.
28. ***Prunier d'Ente - Monilioses (*Monilia spp.*), <http://ephytia.inra.fr/fr/C/21500/Prunier-d-Ente-Monilioses-Monilia-spp>.
29. ***SpecWare 9 User Guide (Pro & Basic) - Product manual, SpecWare Software © 1997-2012 Spectrum Technologies, Inc., IL, USA, 52 pp.
30. ***SpecWare 9 Pro Advanced Features - Product manual, SpecWare Software © 1997-2012 Spectrum Technologies, Inc., IL, USA, 13 pp.
31. ***SysWin Solutions <https://www.syswinsolutions.com/sysagria/>
32. ***SysAgria in brief, brochure, 24pp.

Tables and Figures

Fig. 1. Monthly average temperatures which favored brown rot attack on stone fruits RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 2. Monthly leaf wetness hours which favored brown rot attack on stone fruits RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 3. Correlation between average air temperature and air relative humidity favorable for brown rot attack on stone fruits, RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 4. Brown rot *Monilia* spp. attack risk on stone fruits in 2018
 RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 5. Brown rot *Monilia* spp. attack risk on stone fruits in 2019
 RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 6. Brown rot *Monilia* spp. attack risk on stone fruits in 2020
 RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

**Fig. 7. Brown rot *Monilia* spp. attack risk on stone fruits in 2019-2020
RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m**

**Fig. 8. Overall damages degree determined by brown rot *Monilia* spp. cherry varieties
RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m**

**Fig. 9. Overall damages degree determined by brown rot *Monilia* spp. plum varieties
RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m**

Fig. 10. Damages degree determined by brown rot *Monilia* spp. on cherry flower clusters RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 11. Damages degree determined by brown rot *Monilia* spp. on cherry fruits RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 12. Damages degree determined by brown rot *Monilia* spp. on plum shoots RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 13. Damages degree determined by brown rot *Monilia* spp. on plum fruits
 RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Table 1. Biological reserve of brown rot *Monilia* spp. on cherry assessed in some untreated control variants RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Year	2017		2018		2019		2020		2017		2018		2019		2020	
Organ	Clusters								Fruits							
Variety	F (%)	I (notes)	F (%)	I (notes)	F(%)	I (notes)	F(%)	I (notes)	F (%)	I (notes)	F(%)	I (notes)	F(%)	I (notes)	F(%)	I (notes)
Daria	19,50	3,0	36,00	3,0	11,16	3,0	11,16	3,0	31,80	4,0	52,97	4,0	21,71	3,0	20,58	3,5
Sweetheart	13,40	3,0	26,79	3,0	6,64	2,0	6,64	2,0	27,80	3,5	35,26	3,5	23,03	3,0	25,05	3,0
Skeena	19,50	3,5	31,40	3,5	12,5	3,0	14,50	3,0	29,10	4,0	43,50	4,0	21,75	3,0	22,00	3,0
Lapins	21,65	2,5	35,30	2,5	14,8	3,0	14,80	3,0	31,20	4,0	45,40	4,0	24,10	3,0	24,10	3,0
Kordia	18,15	3,0	35,00	3,0	8,75	3,0	10,65	3,0	17,70	3,5	35,00	3,5	7,00	2,0	11,00	3,0
Ferovia	27,45	4,0	45,00	4,0	18,20	3,0	19,20	3,0	22,60	3,5	40,00	3,5	14,00	3,0	14,00	3,0
Average	19,94	3,17	34,92	3,17	10,15	2,33	12,83	2,83	26,70	3,75	42,02	3,75	14,98	2,33	19,46	3,08
Standard deviation	4,5975	11,9330	5,5130	11,9330	4,6277	0,4472	4,3152	0,4082	5,4962	12,6880	12,2710	12,6880	7,3070	0,4472	5,6898	0,2041
Variation coeficient	0,9168	40,0070	15,7190	40,0070	45,6009	19,1663	0,5534	0,0116	1,4675	32,7130	26,6660	32,7130	48,7785	19,1663	1,1069	0,0063

Table 2. Biological reserve of brown rot *Monilia* spp. on plum assessed in some untreated control variants RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Year	2017		2018		2019		2020		2017		2018		2019		2020	
Organ	Clusters								Fruits							
Variety	F (%)	I (notes)	F (%)	I (notes)	F(%)	I (notes)	F(%)	I (notes)	F (%)	I (notes)	F(%)	I (notes)	F(%)	I (notes)	F(%)	I (notes)
Stanley	36,10	3,5	39,92	3,5	32,20	3,0	36,06	3,5	32,60	3,5	36,08	3,5	29,10	3,0	32,59	3,0
Centenar	27,55	3,0	30,50	3,0	24,60	2,5	27,55	3,0	23,85	3,0	26,40	3,0	21,30	2,5	23,85	3,0
Carpatin	21,75	3,0	24,06	3,0	19,40	2,5	21,73	2,5	17,80	3,0	19,70	3,0	15,90	2,5	17,80	2,5
C. Rodna	14,02	2,5	15,50	2,5	12,50	2,0	14,00	2,0	25,44	3,5	28,14	3,5	22,70	2,0	25,42	3,0
Andreea	19,95	2,5	22,08	2,5	17,80	2,5	19,94	2,5	16,25	2,5	18,00	2,5	14,50	2,5	16,25	2,5
Piteștean	25,31	3,0	27,28	3,0	22,00	3,0	26,65	3,0	20,83	3,0	23,05	3,0	18,60	2,5	20,83	2,5
Average	24,10	2,92	26,56	2,92	21,42	2,58	24,32	2,75	22,79	3,08	25,23	3,08	20,35	2,50	22,79	2,75
Standard deviation	7,5012	0,2739	5,6763	0,2739	4,5791	0,3536	7,5642	0,5244	5,9263	0,3536	4,2970	0,3536	3,4713	0,2236	5,9261	0,2739
Variation coeficient	1.8077	9.3895	21.3743	9.3895	21.3809	13.6859	1.8397	0.0144	1.3506	11.4666	17.0323	11.4666	17.0580	8.9443	1.3506	0.0075

Fig. 14. Damages determined by brown rot *Monilia* spp. on cherry spurs RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 15. Damages determined by brown rot *Monilia* spp. on cherry fruits, RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 16. Damages determined by brown rot *Monilia* spp. on plum shoots, RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287

Fig. 17. Damages determined by brown rot *Monilia* spp. on plum fruits, RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig. 18. Damages determined by brown rot *Monilia* spp. on plum fruits, RIFG Pitești, Romania, Lat. N 44,513; Long. E 24,52; Alt 287 m

Fig 19. *Monilia laxa* micelium and conidia on microscope, 400 x, RIFG Pitești, Romania