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PRELIMINARY REPORT OF A FORECAST SYSTEM TESTED IN QUINCE TO PREDICT FIRE BLIGHT SYMPTOM OCCURRENCE

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Abstract
Erwinia amylovora is known since 1996 in Hungary, it is the most important bacterial disease of fruit crops belonging to subfamily Maloideae, Rosaceae. The pathogen has quarantine status in propagating material production. It is overwintering in cancerous wounds in the woody parts of the host. The diseases progresses in several steps and can lead the total destruction of the plant. Since antibiotics are banned in field use, protection of the crop must be based on prevention. Symptom appearance and pest occurrence data were collected in 2011 and 2013 in a quince orchard in Lajosmizse, Hungary. Simultaneously weather data and plant phenology were entered in MARYBLYT 4.3 program and results were compared. Based on the results properly parameterized MARYBLYT can be used to forecast fire blight in quince.

1 Introduction

Quince (*Cydonia oblonga* Mill.) is an important fruit bearing crop in Hungary. The estimated growing area was around 150 ha in 2014 [21]. Majority of the plantations are near Siófok, Kecskemét and Szeged, where processing facilities and export companies are located. Quince is a versatile fruit [18], it can be eaten raw, cooked for soup, preserved as compote or Membrillo, processed for juice, pulp, pectin or fermented to beer, cider or brandy. The fruit is mainly exported to Germany for further processing or fermentation.

It is the member of *Maloideae* subfamily, so the essentials of its pest management are basically the same as for apple or pear [18].

Fire blight is one of the most important diseases of pome fruits and ornamentals [1]. Its causative agent is *Erwinia amylovora* BURR. (WINSLOW) – a bacterium – which was first found and reported in Hungary from Nyárlőrinc at the 25th of April 1996 from two neighboring apple orchards [6]. MÁRIA HEVESI published her findings of the first report of the pathogen in 1996 [12]. At the time the authorities tried to eradicate the pest by cutting down and burning the affected orchards and all the host plants in the 3 km wide zone of the orchards [6]. Despite the strict quarantine measures the disease occurred in 297 more sites in 1996 at a total of 242 ha [7]. In 1997 the disease spread further to a total of 1195 ha, which devastated both growers and hobby gardeners [8]. Plant pathologist assumed at the time – because of the sudden explosion-like spread of the disease – that the pathogen was carried in and distributed with the dirty secateurs of migrant workers from neighboring countries where the disease was already present. Today the pathogen is widespread in the country, and it has been identified from almost all countries where apple is grown (*Figure 1.*) [5].

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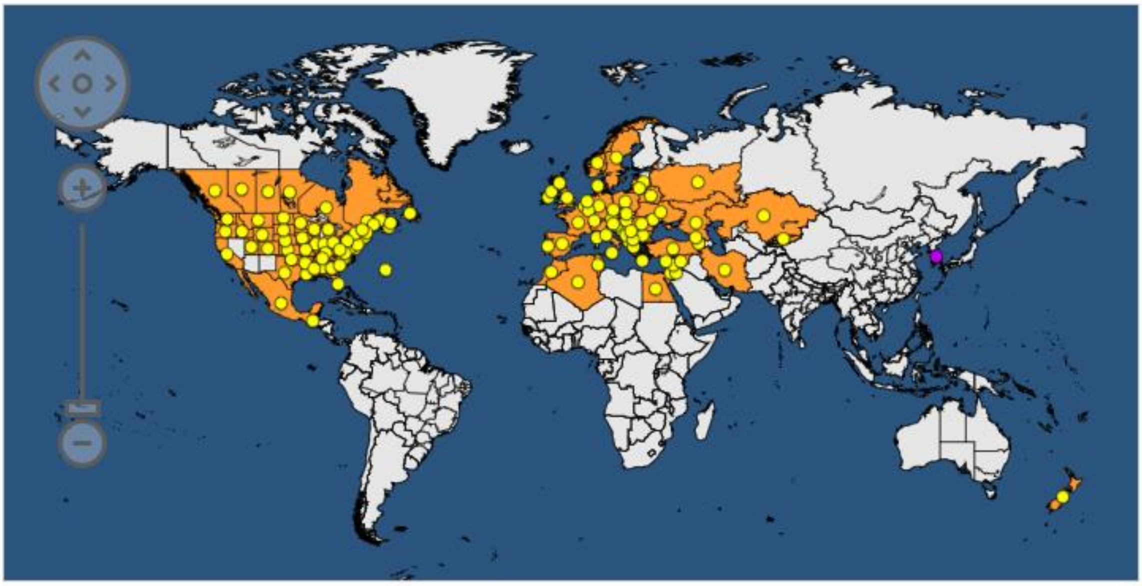

Figure 1. Distribution map of Erwinia amylovora
(Image downloaded from: https://gd.eppo.int/taxon/ERWIAM/distribution, 2020-04-10)

Erwinia amylovora today is still a quarantine pathogen of pome fruit and ornamental propagating material [26] in Hungary, it is on the A2 list of quarantine pests in the EPPO region. In fruit producing orchards it is a Regulated Non-Quarantine Pest (RNQP), which means growers must protect their crop against the disease and prevent its dispersal [5, 26].

The pathogen is a Gram-negative, facultative anaerobe bacterium with no pectolytic properties [1, 11]. It has a wide range of host plants. According to FLECK it causes diseases on 174 different species of plants [9]. The bacterium infects mainly *Maloideae* hosts, but lately it has been described from stone fruits (*Prunoideae*) [24, 25] and from *Rosoideae* [22]. Important hosts from a horticultural and forestry point of view includes: *Amelanchier ovalis, Armeniaca vulgaris, Aronia melanocarpa*, *Cerasus avium, Chaenomeles* spp., *Cotoneaster* spp., *Crataegus* spp., *Cydonia oblonga, Eryobotria* spp., *Fragaria* spp., *Malus* spp., *Mespilus germanica, Photinia* spp., *Prunus domestica, Prunus serrulata, Prunus triloba, Pyracantha* spp., *Pyrus* spp., *Raphiolepis* spp., *Rubus* spp., *Sorbus* spp., *Spiraea* spp. and *Stranvaesia* spp. [2, 5, 13].

Host plants are infected systemically, causing tracheobacteriosis, a sudden necrosis of foliage, flowers and fruits. Infection can occur in several phenology phases, mostly it starts as an infection of flowers. The bacterium multiplies in the intercellular space, which later causes the typical “shepherd’s crook” symptom of young shoots. As the bacterium progresses downwards it causes branch-, trunk- and root collar canker. Fruit rot occurs seldom. Cancerous wounds play a major role of the overwintering of the pathogen [1, 9, 10, 13, 23]. The main fruit bearing crops can be ranked by susceptibility of fire blight in the following ascending order: apple (*Malus domestica* Borkh.), pear (*Pyrus communis* L.), quince (*Cydonia oblonga* Mill.), medlar (*Mespilus germanica* L.). This is more or less the order in which the trees flower in spring. While pear appears to flower at the same time or earlier than apple, the flowers of pear are open almost 50% longer, making it more susceptible. Medlar is considered extremely susceptible, as under Hungarian conditions it flowers in the period from beginning to mid-May, which also coincides with more precipitation.

Resistance genes present in the apple gene pool are hard to combine with traditional breeding techniques to maintain good appearance, tasty fruits with good shelf life and good storing abilities. Commonly used dwarfing rootstocks (like M9, M26) are also very susceptible to the pathogen. According to US research after an epidemic year – where the vast majority of flowers and spurs destroyed – the orchard needs 4 years to fully recover [9].

There are several methods to forecast fire blight. Manual forecast is labor intensive, while semi-automated forecast systems only need temperature, precipitation and plant phenology to be entered, examples are COUGARBLIGHT and MARYBLYT [4, 15].

MARYBLYT calculates the epiphytic infection potential (EIP), which is an indicator of infection risk, it also gives information of the potential risk (L: low, M: medium, H: high, I: infection) for infection [3, 14, 15, 19]. Generally an EIP of 100 means there is a risk of infection, as a rule of thumb about 10% of the open flowers may become infected. Besides flower blight, the program can predict the development of other symptoms like shoot-, canker- and trauma blight [20].

2 Methods

Investigations were made from 2011 and 2013 at a quince orchard near Lajosmizse. The orchard was planted in 1990, the main grown cultivar was 'Leskovacka', the pollinator partner was 'Vranja', and the rootstock was BA-29 in spacing 6×4 meters and the trees were trained to bush form.

Fire blight first appeared in 1997 in this orchard, and is present ever since. The orchard has a good general condition with reasonable integrated pest management practices and good fertilizing technology. Infected tree parts are regularly removed and burned. Trees are sprayed regularly with copper salts as a preventive treatment.

The orchard was scouted and assessed in every 2 weeks before flowering for symptoms from beginning of April, at least every 2 days from white petal to petal fall, and at least weekly after petal fall to mid-June. Meteorological data were collected daily (temperature, precipitation), plant phenology was observed at each visit. Meteorological events which may influence infection and symptom development (storm, hail, frost) were also collected.

The trial was set up according to "General test methodology" [16] and each assessment was carried out according to 2.3.4.1.1. point of "Fungicide and bactericide test methodology" [17]. The final assessments were carried out by counting and assessing the total number of disease occurrence of all the branches of 100 trees.

For forecasting and testing MARYBLYT v4.3 was used with settings for pear. Data from the forecast, symptom occurrence and date have been compared.

3 Results

EIPs over 100 and dates of possible infection predicted by the program are shown in *Tables 1 and 2.*

Table 1. EIPs and possible infection days in 2011.

Date	EIP	Potential Infection Risk
2011-04-24	121	high
2011-04-25	121	medium
2011-04-26	145	high
2011-04-27	158	medium
2011-04-28	133	high
2011-04-29	121	high
2011-04-30	109	high
2011-05-01	145	infection

Table 2. EIPs and possible infection days in 2012.

Date	EIP	Potential Infection Risk
2013-04-29	121	high
2013-04-30	218	high
2013-05-01	364	high
2013-05-02	461	high
2013-05-03	448	infection
2013-05-04	424	infection
2013-05-05	315	high
2013-05-06	376	infection
2013-05-07	339	infection
2013-05-08	267	infection
2013-05-09	242	infection
2013-05-10	242	high
2013-05-11	230	high
2013-05-12	218	infection
2013-05-13	194	high

The predicted and observed dates of blossom-, shoot- and trauma blight are shown in *Table 3*.

Table 3. Dates of blossom-, shoot- and trauma blight symptoms observed and predicted

<table>
<tr><th rowspan="2">Year</th><th colspan="2">Blossom blight</th><th colspan="2">Shoot blight</th><th colspan="2">Trauma blight</th></tr>
<tr><th>observed</th><th>predicted</th><th>observed</th><th>predicted</th><th>observed</th><th>predicted</th></tr>
<tr><td>2011</td><td>2011-05-18</td><td>2011-05-20</td><td>2011-05-26</td><td>2011-05-27</td><td>n/a</td><td>n/a</td></tr>
<tr><td rowspan="7">2013</td><td>2013-05-12</td><td>2013-05-13</td><td rowspan="7">2013-06-01</td><td rowspan="7">2013-05-31</td><td rowspan="7">2013-06-13</td><td rowspan="7">2013-06-12</td></tr>
<tr><td>2013-05-15</td><td>2013-05-17</td></tr>
<tr><td>2013-05-17</td><td>2013-05-19</td></tr>
<tr><td>2013-05-18</td><td>2013-05-20</td></tr>
<tr><td>2013-05-19</td><td>2013-05-21</td></tr>
<tr><td>2013-05-20</td><td>2013-05-23</td></tr>
<tr><td>2013-05-29</td><td>2013-05-30</td></tr>
</table>

In 2011 the disease occurrence was low, only 6 branches were infected in 100 trees at 2011-05-31.

In 2013 the disease occurrence was much higher 2381 branches were infected in 100 trees at 2013-06-13.

4 Discussion

In each tested year the MARYBLYT model predicted shoot and blossom blight. Symptoms were observed within ± 24 to 48 hours to the predicted date. Trauma blight were only observed in 2013, where the model predicted the symptom occurrence 24 hours sooner than the symptom was observed.

5 Conclusions

According to the results, MARYBLYT v4.3's prediction was accurate in 48 hour interval, which can be a useful information for the prediction of blossom-, shoot- and trauma blight. This can be a valuable tool for quince growers as formerly no prediction model was available for fire blight in this crop.

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