Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 19, Issue 3, 2019
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE INCIDENCE OF APPLE "*VENTURIA INAEQUALIS*" IN TRADITIONAL ORCHARDS OF FÂNTÂNELE VILLAGE, SIBIU COUNTY, ROMANIA

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Abstract

Venturia inaequalis is a known pathogen for long time as causing apple scab disease or black spots. The extent of the disease expression highly depends on apple cultivars, the presence in orchards of host plants of the pathogen, climatic conditions and agricultural practices. Today it becomes more important to broaden the access to more diverse genetic resources in order to improve the breeding programs including for apple varieties. The scope of this article is to analyse how much are affected apple trees by apple scab in the traditional orchards of Sibiu, Fântânele. These orchards are maintained without any pesticides, only traditional practices being applied for more than 30 years. Therefore, we consider that this hot-spot of apple diversity can be a valuable pool gene for further breeding programmes in Europe. Based on our results we can conclude that 'Belle de Boskoop', 'Winter Pearmain', 'London Pepping', 'Batul Alma', 'Edelborsdorfer', 'Boiken', 'Yellow Bellflower', 'Reinette Ananas' and 'Reinette Baumann' are among the best resisting cultivars against this disease. 'Golden delicious' is obviously the most susceptible apple cultivar against V. inaequalis.

Key words**:** *apple scab, Venturia inaequalis, traditional orchards, varieties under conservation*

INTRODUCTION

Venturia inaequalis causes important economic losses in apple production all over the world [3; 8; 19; 27]. In this regard we mention that according to FAOSTAT data, Romania provided official data to the FAO since 1961 and the today apple production is alike that of 1976. This is lower compared to official data collected in 1989 (i.e. the year when Romania entered democratic countries area) that was the highest in terms of trade and production, as well as the reference year for climate change. After 1989 the apple productivity and cultivation area in Romania continuously decreased [1]. Thus, it can be considered that apple production is today half of that of 1989 (i.e. from 697,400 kt to 339,570 kt) for an area that constantly diminished (i.e. from 84,864 ha to 55,600 ha). However, apple fruit is among the most important fruits in the world ranked the thirds at the global level. In this regard the EU production is covering almost all needs [2]. The external imports are around 493 kt for last year for the EU (USDA, 2018) [1]. In Romania case even nearly half (47.9 %) of those orchards' holdings were situated in three countries: Romania (18.7 %), Spain (16.5 %) and Poland (12.7 %) however Romania has no export market [1]. However, researchers are more interested in finding new tools and methods for improving the quality of apple genetics [6; 9; 20]. In the European Union is a group of specialists named: 'Malus Group' working on the inventory of apple collections in certain parts of Europe [18]. We consider that it is relevant for the scientists in Romania to provide a scientific background for our *on farm* collection of fruit trees that should be in line with the *Malus group* proposals, which is open for cooperation. We consider that the remains of traditional orchards inside the arch of Carpathian Mountains are valuable gene pools for apple breeding programme in Europe as it is considered in other studies [10]. The scope of this article is to analyse the presence and degree of infection of *Venturia inaequalis* into the traditional orchards from Sibiu, Fântânele in order to consolidate

scientific data for the recognition in Romania of traditional orchards as hotspot's habitats important for agro-biodiversity [1].

MATERIALS AND METHODS

Place of investigations: Fântânele (45°45'23" N and 23°55'28" E) is a small village positioned in Sibiu county which integrates in the rural area and agricultural land area traditional orchards for four types of landscape sub-units (Fig. 1).

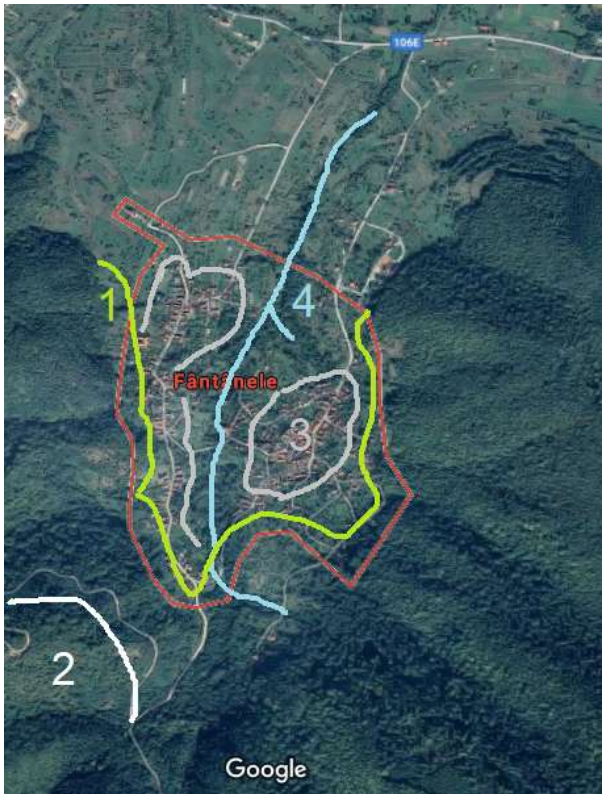

Fig. 1. Traditional orchards distribution within the landscape sub-units of Fântânele: 1- along the forest canopy area, 2- in the mountain at 1,000 m, 3 – inside the village and 4 – along the creek
Source: Image processed from *www.google.map* and modified by authors.

Methods of investigation

Venturia inaequalis is a fungal disease that can be observed as black / brown spots on the leaves and apple fruits.

Two field missions have been conducted in two consecutive years: 2016-2017 during September and covering 937 apple tree specimens into all four subunit-landscapes. Each mission duration took at least 7 full days.

Leaves infestation was realized by direct observation of the leaves into the trees (Fig. 1, upper image).

Degree of infection of apple fruits was realized in accordance to that described by Schwabe and collaborators (1984) such as following: 0 for no lesion; 1 for one lesion; 2 for 2 up to 5 lesions; 3 for 6 up to 10 lesions; 4 for 11 up to 20 lesions and 5 over 20 lesions. The calculation followed the mathematical formula developed by Townsend–Heuberger and adapted by Tinivella and collaborators [25] for fruits such as the following equation:

$$[\%\text{infection}] = \sum((n * v)/(i * N)) * 100$$

where:
v=class of infection defined as the degree of symptoms,
i=highest class of infection (5 in this case),
n=number of plants or fruits in this case,
N=no of total number of investigated fruits or 200.
The fruits were observed *on spot* without harming the trees (Fig. 2, bottom image).

Fig. 2. Jonathan' *Venturia inaequalis* attack on leaves of 'Jonathan' (upper image) and fruits of 'Poynik Alma' (bottom image)
Source: Original.

RESULTS AND DISCUSSIONS

The analysis of data recorded for 937 specimens belonging to 22 old apple varieties are discussed below, for each of the cultivars

'Batul-Alma', the second most popular apple tree of the region (i.e. 155 specimens recorded), presented an infestation percentage for the trees of 37%. However, only 5,25% of the infested fruits manifested a degree of infection of 1.06%. The cultivar is original from Transylvania and the long installation in the same ecosystem may further be relevant for the low fruits' infestation rate. These results are in line with other observations [13, 23].

'Belle de Boskoop' 38% of the investigated trees presented scab infection signs and 3.95% of the fruits were infested with a degree of infection of 1.86% (Table 1). They seem to be resistant towards this disease except for those trees located in the creek area where humidity is much higher during all year. From our investigations only 32 of the 84 specimens were infested and from 200 investigated apple fruits. It can be considered that these results are in line with previously published that stated among others that 'Belle de Boskoop' is less susceptible to infections [12].

'**Boiken'**, it is not a very often found cultivar as only 18 specimens have been recorded. All trees presented signs of leaves infestation and a media of 9.43% of the fruits are infested for an infestation degree of less than 2% (i.e. 1.88%). We mention that this variety is scattered over all landscape units and probably because it was popular in former times. As a novelty, the variety is rare in Europe and only few studies reported the degree of resistance against pests and not against scab [14].

'Edelborsdorfer' All 29 specimens were infected and 9.41% of the apple fruits. However, in terms of infestation degree this cultivar proved to be 1.17%. Some of the fruits were clean (0 degree of infection for 28%) and only 3% of the fruits presented a 2% degree of infection. The rest of the fruits presented a single up to 3 maximum spots of infestation. These results are supported by other studies published in the field [14].

'Golden delicious' is not very often found in orchards. All 21 specimens were infested with scab and all fruits expressed a maximum degree of infection of 5%. It can be considered that it is the most susceptible variety to scab in agreement with other authors [12].

'Gustav'. All 28 specimens identified in the field presented scab infection on their leaves. It appears to be susceptible to the infection even it was recorded in all landscape units from the mountain area (i.e. 1,000 m altitude) to the crick (i.e. 500 m altitude). However, when the fruits were analysed only 21% of them presented an infection degree of 2.01%. This may position the cultivar in the class of moderate susceptible cultivars to the scab [24].

'**Jonathan'** is the most appreciate cultivar in the region and all 205 specimens were infested. Over 45% of the fruits present a degree of infection of 5% proving that the cultivar is very sensitive to the scab [12; 26].

'**Local Baia Mare**' is a vigorous tree and 10 specimens have been recorded all infested with scab. 90% of the fruits expressed an infection degree of 5%. This cultivar is the most sensitive local cultivar to scab in Fântânele.

'**Local Cacova**' is considered as a rare and specific variety of the place. Only 2 specimens located in the village, both infested with scab expressed for more than 63% of the apples a media degree of infection of 2.03%. It can be considered that this red apple variety is susceptible to scab.

'**Local Florin**' All 29 recorded specimens were infested with scab. Over 57% of the fruits expressed a media degree of infection of 2.56%. The cultivar can be considered as susceptible to scab considering similar data for other cultivars such as 'Jonathan' or 'Starkrimson'.

London Pepping All tree specimens were infected and 4.25% of the fruits were infested with a degree of infection of 1.43% (Table 1). This result is relevant for the good quality of apple fruits compared to the rest of the fruits even all three trees were infected. Also, such an observation may further support that this variety may be relevant for further studies

regarding their resistance towards this disease. We also mention that the cultivar found in Serbia was also recently considered as moderate resistant [7].

'Nemes Sovari Alma' or **'Noble de Sovar'** is an old variety that is very often found in Transylvania. All specimens are infected no matter of the position into the landscape and 14 of the 49 specimens (i.e. 28.57%) also expressed the infestation at the fruits level with a degree of infection of 4.03%. These results are supporting other studies realized in Transylvania [16].

'Ponyik Alma' All recorded 86 specimens were infected with the scab at the leaves level. Also, 32% of the fruits were infected with a degree of infection of 3.23%. These are also very popular for this area and they are also vigorous trees. This variety is susceptible to the scab but at the fruit level it can be considered that there is a resistance against this fungus.

'Red Astrachan', is rare old variety for Romania territory, only one infected specimen with apple scab was found inside the village. The fruits analysis showed that infection was recorded for 21.25% that is around 2 the degree of infection (1.95). The variety is considered as moderate susceptible [21].

'Red Delicious'. All 27 analysed specimens presented signs of infestation at the leaves level. However, 26% of the apples were infected with a degree of infection of 5% (i.e. more than 20 spots/apple fruit). These results are further supporting other researchers results [4].

'Reinette Ananas'. This cultivar is present only in two exemplars. Both specimens were infected with scab and 14% of the fruits presented a degree of infection of 3.26%. However, 25% of the fruits presented a degree of infection of 1. This is a susceptible cultivar for the infestation with scab [17].

'Reinette Baumann' is also susceptible to this disease all 61 recorded trees presenting infestation signs on their leaves and fruits. However, only 15% of the apple fruits presented more than on single infestation spot on their surface. The infestation degree is likely to be 2.03% for the rest of the fruits. This variety was used for apple breeding studies in our country due to its potential in proving some resistance against this pathogen [22].

Table 1. Degrees of apple trees infections with *Venturia inaequalis* for different cultivars from Fântânele, Sibiu county Romania

Apple cultivar	Infested trees (%)	Infested apples (%)	Degree of apple fruits infestation (%)
Batul Alma	37	5.25	1.06
Belle de Boskoop	38	3.95	1.86
Boiken	100	9.43	1.88
Edelborsdorfer	100	9.41	1.17
Golden Delicious	100	100	5.00
Gustav	100	21	2.01
Jonathan	100	45	5.00
Local Baia Mare	100	90	5.00
Local Cacova	100	63	2.03
Local Florin	100	57	2.56
London Pepping	100	4.25	1.43
Nemes Sovari Alma	100	28.57	4.03
Poynic Alma	100	32	3.23
Red Astrachan	100	21.25	1.95
Red Delicious	100	26	5.00
Reinette Ananas	100	14	3.26
Reinette Baumann	100	15	2.03
Reinette Canada	100	40	3.24
Strakrimson	100	45	5.00
Winter Banana	100	46	4.41
Winter Pearmain	100	4.05	1.23
Yellow Bellflower	100	12.45	2.13

Source: original data.

'Reinette Canada' All 13 recorded specimens are infected with scab at the leaves level. The degree of infection of the fruits is 3.24 and covers 40% of all investigated fruits. This should be also due to ecosystems conditions as well as dur to the climatic conditions of the year. It is known also that this variety showed a moderate susceptibility towards scab [22].

'**Strakrimson'** is 100% infested for the 21 specimens recorded. 45% of the fruits are infected with a degree of 5. This was already described as a sensitive cultivar [5, 24].

'**Winter Banana'** is a rare cultivar found in orchards and all of them expressed the scab infestation at the leaves level. Over 46% of the apples were infected with a degree of infection of 4.41 proving that the cultivar even is susceptible however can be resistant at the fruit level [23].

'Winter Pearmain' All 44 specimens were found infested even they are occupying all

types of landscape units in Fântânele. However, only 4.05% of the apple fruits presented specific spots for a media of infestation of 1.23% per fruits. The cultivar it is recognized as susceptible to the infestation [11]. However, the low degree of fruit infestation may be considered that this variety can further hamper the pathogen development for each of the biological cycle step for a certain environmental condition.

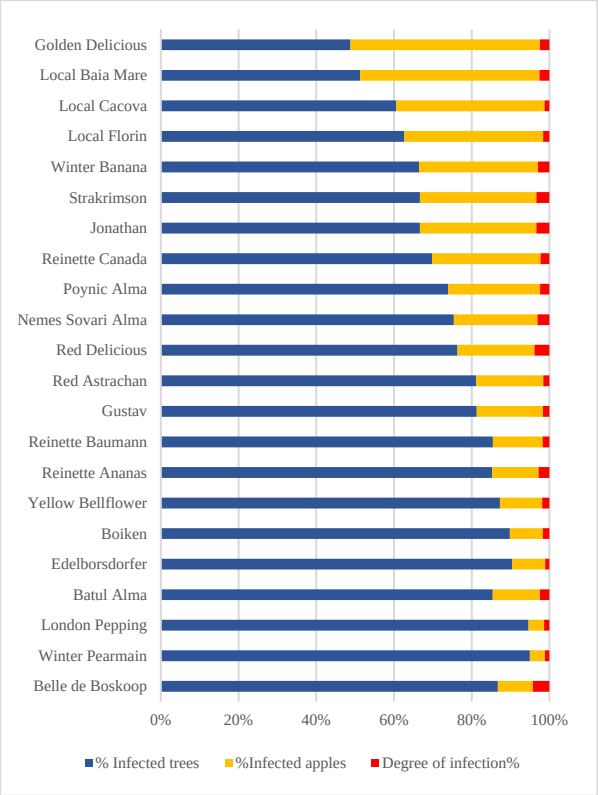

Fig. 3. Graphic representation of the degrees of apple trees infections with *Venturia inaequalis*. Recorded data are presented in the order of increasing resistance towards the apple scab.
Source: original data.

'Yellow Bellflower'. All 10 specimens were found infected with scab. 12.45% of the fruits presented a degree of infection of 2.13% (i.e. most of the fruits presented 4 or 5 scab spots). The cultivar was long time before considered as susceptible to this disease [15]. However, it can be considered that the installation of the cultivar in different landscape units, can rise some questions related to the degree of resistance and the evolution of this process during time.

It can be considered that at least four cultivars present only 5% scab infections for the fruits: 'Belle de Boskoop', 'Winter Pearmain', 'London Pepping' and 'Batul Alma'. They are followed by 'Edelborsdorfer' and 'Boiken' under 10% and up to 15% by 'Yellow Bellflower', 'Reinette Ananas' and 'Reinette Baumann'.

All these cultivars are very old and may represent for the future valuable genetic resources for improving the apple resistance against scab. On contrary the most susceptible to scab are 'Jonathan', 'Strakrimson' and 'Winter Banana' (i.e. over 45%) followed by local cultivars (i.e. 'Local Florin', 'Local Cacova', 'Local Baia Mare') and 'Golden Delicious' with the highest possible sensitivity to scab.

CONCLUSIONS

The analysis of these results showed that scab is present in all orchards of Fântânele and it is expressed on the leaves and /or the fruits. The scab is more active in the area of the creek and old varieties such as 'Belle de Boskoop', 'Winter Pearmain', 'London Pepping', 'Batul Alma', 'Edelborsdorfer', 'Boiken', 'Yellow Bellflower', 'Reinette Ananas' and 'Reinette Baumann' are among the most resistant cultivars towards this disease. However, the most susceptible cultivar remains 'Golden Delicious'. These results encourage us to consider that traditional orchards in Transylvania are relevant genetic pools for being accessed for the future breeding programmes in apple at the European level.

ACKNOWLEDGEMENTS

This paper was supported by the Research Center for Agricultural Sciences and Environmental Protection of the University Lucian Blaga from Sibiu.

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