INFECTIOUS PRESSURE OF THE FUNGUS FUSICLADIUM DENDRITICUM IN APPLE TREES FROM SPONTANEOUS FLORA AND ABANDONED MICRO-ORCHARDS, IN THE HILLY AREA BETWEEN THE RIVER CARAŞ AND THE DANUBE.

A. BORCEAN[1], Simona NIȚĂ[1], F. IMBREA[1]
[1]BUSAMV "King Michael I of Romania" of Timisoara
Corresponding author: florin_imbrea@usab-tm.ro

Abstract: *Fusicladium dendriticum is a very common pathogen in Europe and Romania is no exception. In limiting the losses caused by this pathogen, which affects leaves, fruits and the wood of the young shoots, it is necessary to accurately assess the reserve of the pathogen in order to make decisions on the tree protection strategy. In order to assess as accurately as possible, the infectious pressure of this apple pathogen for the whole area, during last three years we measured the attack degree of the pathogen on groups of apple trees located on significant locations for the limits of the observations defined area. The observations were made in the period 2018-2020, years with a few clear differences in terms of climatic factors. All determinations regarding the pathogen were performed by successive evaluation through 4 determinations during the period between June and September of each year of the time interval between 2018-2020. The locations selected for those determinations to be carried out are grouped in terms of the dominant landforms for the reference area and they are as follows: the first location in Gradinari, the second location around Răcășdia, the third location near Sasca Română and the fourth location near the town of Anina.*

Keywords*: tapple trees, Fusicladium dendriticum, infectious preassure*

INTRODUCTION

Apple scab produced by the fungus *Venturia inaequalis* is a known and very studied affection of the apple trees (BOWEN J. K. ET. AL, 2011) and also it is known that those fungus is widespread in all areas of the temperate and subtropical area (FISHER EILEEN E., 1957). Thus, the attack of this pathogen is common throughout Europe, from Italy and Spain to the Scandinavian Peninsula and Poland.

The limiting climatic factors for *Venturia inaequalis* are very well known. Thus, the reserve of perithecia with axes and ascospores is fundamental for the survival of this pathogen and its ability to infect in the first attacks of the following year. James and Sutton (1982), point out that no perithecia appeared on leaves placed in dry air (FREY C. N., KEITT G. W., 1925). If moisture is not a limiting factor, temperature is a major influence factor on perithecia development phases (GADOURY AND MACHARDY, 1982). Perithecia formation starts as soon as the temperature exceeds 4 ° C. The rainfall must be greater than or equal to 0.1 mm for the ascospores to be released into the air (MACHARDY, 1996; ROSSI et al., 2000, IMBREA 2011).

Later, during the infection phases performed by conidia there are other major climatic influence factors. Taking in consideration that conidia germinate better in the presence of a water film that cover them (SUTTON et al., 1976). it is clear that summer rains and the water present on the leaves early in the morning are the most important climatic factors that could stimulate secondary infections with apple scab (HIRST AND STEDMAN, 1962).

Everyone attaches great importance to combating this pathogen, with wide open debates on very important topics such as:

- genetic analysis of the pathogen (GLADIEUX P., ET. AL., 2010)and how to improve by improving the resistance of varieties but apple varieties with vertical resistance to rotting are few (BURDON, 1993);

- the most effective apple cultivation technologies to avoid the attack of *Venturia inaequalis*;
- strategies for applying treatments against apple blight;

As a general approach, it is recognized that before discussing any protection strategy or the technologies and efficacy of fungicidal or biological products used to stop such a pathogen, the reserve of the pathogen and its infectious pressure must be discussed. The `individual orchard' protection management may vary considerably from one orchard to another, along with the new practice of siting weather stations in production orchards, enabling infection periods to be pinpointed at local level.(LAURENT JAMAR, 2011). Other prediction metods are based on pathogen life cycle (DE WOLF E. D., ISARD S. A. , 2007)

MATERIAL AND METHODS

The observations by which the data for this paper were collected were made during the period 2018 - 2020 and targeted the significant apple populations located in the area between Comorâște and Sasca Montană (figure 1). The apple trees on which we carried out the observations were not located in organized orchards but were arranged alone or in small groups in areas such as forest edges, hilly pastures, roadsides, more or less landscaped parks, etc. The general idea was that the target apple trees must not to be in places where they could be exposed to treatments with phytosanitary products against the fungus *Fusicladium dendriticum* and thus the parameters of the attack of this pathogen could expose the real state of pathogen infectious pressure.

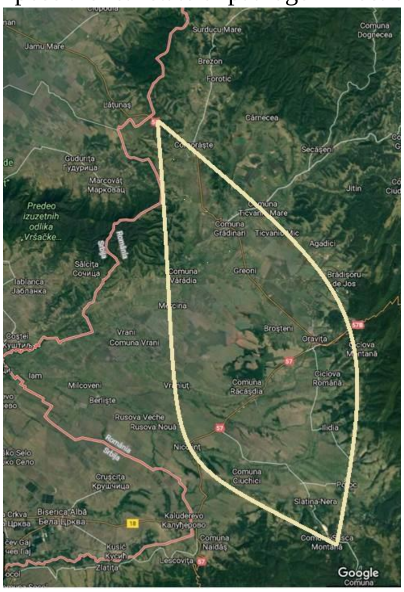

Figure 1. Research area for Fusicladium dendriticum incidence

The decision to apply a treatment against scab (*Fusicladium dendriticum*) in apple orchards is generally take according to the two established models: the preventive model and the economic model. According to the preventive model, the decision to apply the treatment is made according to the evolution of atmospheric precipitation and temperatures. On the other hand, in the economic model applying a treatment is taken according to a more pragmatic model, which takes into account the costs of applying the treatment compared with the potential damage produced by pathogen attack and so it goes to reach the economic damage threshold.

For the present paper we have to collect the data for assessing the apple scab threat assessment on a very wide territory at the geographical level. So it is impossible to assess the threat in real time because climatic data could not be collected in real time because of the high number of the geographical microzones where the apples were located.

This is the reason why we chose to apply the model economic damage threshold. In the case of *Fusicladium dendriticum*, the economic damage threshold is considered reached when the fungus degree of attack (GA) of the pathogen is between 10-20 %, depending on the weather conditions. Thus, if a rainy period is forecast and the degree of attack has exceeded 10%, a treatment can be applied, but if a period of several days without rain is estimated by the forecast, then the degree of attack can be expected to increase up to a maximum of 20%.

The degree of attack was estimated between June and September. Estimates of the aggressiveness (frequency of attack) and virulence (intensity of attack) of the pathogen were made each year in each of the three populations in June, August and September. In each population, the attack parameters represent an average of the readings per 100 trees so that the estimates are representative in order to avoid errors in the statistical calculation. The values of temperatures (figure 2) and precipitation (figure 3) show that from 2018-2020, the most favorable for the development of the fungus between June and September were the years 2018 and 2020.

RESULTS AND DISCUSSIONS

Data on the frequency of attack of the fungus Fusicladium dendriticum show that its aggressiveness increased over time, with the lowest values in June and the highest in August (Table 1). Among the populations, the highest values of the attack frequency were recorded in the population located in the Greoni - Comorăște area and the lowest values in the population located in the Oravița - Ciuchici area, these results being confirmed by statistical calculations (table 1).

The observations on the evolution of the frequency of attack on all three populations in the period 2018-2020 show without a doubt the fact that the lowest values were recorded in 2019 (figure 2). Even if the differences from the average were below the limit of significance, according to statistical calculations, the highest values of the frequency of attack were recorded in 2018.

Table 1

Evolution of fungus Fusicladium dendriticum attack frequency on evaluated apple populations

Factor A - Apple tree population	Factor B - Observation year	Repetition 1 June	Repetition 2 August	Repetition 3 September	Averages of factor A	Difference	Signification
Population of Sasca - Slatina Nera	year 2018	35	40	55	35.56	1.30	-
	year 2019	15	25	30			
	year 2020	25	40	55			
Population of Ciuchici - Oravița	year 2018	25	35	45	27.78	-6.48	○
	year 2019	10	25	30			
	year 2020	15	25	40			
Population of Greoni - Comorâște	year 2018	20	40	75	39.44	5.19	*
	year 2019	15	30	35			
	year 2020	20	55	65			
Area Average	year 2018	26.67	38.33	58.33	34.26	Control	-
	year 2019	13.33	26.67	31.67			
	year 2020	20.00	40.00	53.33			

DL 5%= 4.28 DL 1%= 7.12 DL 0,1 %=11.36

Table 2

Evolution of fungus Fusicladium dendriticum attack frequency between 2018 and 2020

Factor B	2018	2019	2020	Area average
Averages	41.11	23.89	37.78	34.26
Differences	6.85	-10.37	3.52	Control
Significance	-	○	-	-

DL 5%= 8.67 DL 1%= 11.04 DL 0,1 %= 14.34

The attack intensity estimate had similar results to the attack frequency estimate (Table 3). This is because the intensity of the attack registered the highest values in the population located between Greoni and Comorăște localities, while the lowest values were registered in the population located between Oravița and Ciuchici localities. Also, of the three years, the highest value of the average intensity of attack on all three populations was recorded in 2020 (table 4) and the lowest was in 2019, the statistical calculation confirming this.

Table 3

Evolution of fungus Fusicladium dendriticum attack intensity on evaluated apple populations

Factor A - Apple tree population	Factor B - Observation year	Repetition 1 June	Repetition 2 August	Repetition 3 September	Averages of factor A	Difference	Signification
Population of Sasca - Slatina Nera	year 2018	10	15	25	16.67	1.41	-
	year 2019	5	10	15			
	year 2020	15	25	30			
Population of Ciuchici - Oravița	year 2018	10	5	10	10.00	-5.26	○
	year 2019	5	5	5			
	year 2020	10	25	15			
Population of Greoni - Comorâște	year 2018	10	25	35	19.11	3.85	*
	year 2019	2	5	15			
	year 2020	15	25	40			
Area Average	year 2018	10.00	15.00	23.33	15.26	Martor	-
	year 2019	4.00	6.67	11.67			
	year 2020	13.33	25.00	28.33			

DL 5%= 3.36 DL 1%= 6.13 DL 0,1 %= 8.54

Table 4

Evolution of fungus Fusicladium dendriticum attack intensity between 2018 and 2020

Factor B	2018	2019	2020	Area average
Averages	16.11	7.44	22.22	15.26
Differences	0.85	-7.81	6.96	Control
Significance	-	○	*	-

DL 5%= 6.43 DL 1%= 8.52 DL 0,1 %= 11.34

Being an aggregate result of the frequency and intensity of attack, the degree of attack had the same trend of evolution. Thus, among the values of the average degree of attack of the populations, it registered the highest value on all three years of observations in the population located between Greoni and Comorâşte and the lowest value was recorded in the apple population located between Ciuchici and Oravița.

Table 5

Evolution of fungus Fusicladium dendriticum attack degree on evaluated apple populations

Factor A - Apple tree population	Factor B - Observation year	Repetition 1 June	Repetition 2 August	Repetition 3 September	Averages of factor A	Difference	Signification
Population of Sasca - Slatina Nera	year 2018	3.5	6	13.75	6.81	0.32	-
	year 2019	0.75	2.5	4.5			
	year 2020	3.75	10	16.5			
Population of Ciuchici - Oravița	year 2018	2.5	1.75	4.5	2.86	-3.62	○
	year 2019	0.5	1.25	1.5			
	year 2020	1.5	6.25	6			
Population of Greoni - Comorâşte	year 2018	2	10	26.25	9.78	3.30	*
	year 2019	0.3	1.5	5.25			
	year 2020	3	13.75	26			
Area Average	year 2018	2.67	5.92	14.83	6.48	Control	-
	year 2019	0.52	1.75	3.75			
	year 2020	2.75	10.00	16.17			

DL 5%= 2.64 DL 1%= 4.62 DL 0,1 %= 7.16

Table 6

Evolution of fungus Fusicladium dendriticum attack degree between 2018 and 2020

Factor B	2018	2019	2020	Area average
Averages	7.81	2.01	9.64	6.48
Differences	1.32	-4.48	3.16	Control
Significance	-	○	*	-

DL 5%= 2.82 DL 1%= 4.84 DL 0,1 %= 7.72

The calculated mean values of the degree of attack over the three years of observations (Table 6) indicate that the highest degree of attack was recorded in all three populations in 2020 and the lowest in 2019. These results are confirmed and by statistical calculation.

If we consider the appropriate to apply treatments according to the economic damage threshold model, it is clear that some treatment could have become necessary only for short and very varied periods during the annual active part of the apple threes populations on the region. Thus, taking into account an economic damage threshold given by an attack degree between 10-20 % depending on the forecast of the evolution of precipitation and temperatures, it is observed (table 5) that these time intervals are in September 2018 and 2020 for the populations of Sasca - Slatina Nera and Greoni - Comorăşte.

CONCLUSIONS

1. The apple scab produced by Venturia inaequalis is present throughout the analyzed territory, having variable values of the attack parameters depending on the climatic

conditions of the area, but the infectious pressure of this pathogen is significant and continuous.

2. The highest values of the attack parameters (frequency, intensity and degree of attack) register the highest values in the populations located in hilly areas and in the years with the most and best distributed precipitation. This confirms the need to assess the weather forecast for the application of a treatment even in the conditions of an economic damage threshold (PED) located at a degree of attack between 10-15%.
3. For apple plantations established in the area where these determinations were carried out, it is strongly recommended to cultivate varieties which, if not resistant to scab, are at least very tolerant of attack of the fungus Venturia inaequalis

BIBLIOGRAPHY

BORCEAN I, GH DAVID, A BORCEAN, F IMBREA, L BOTOȘ, 2002, On the behaviour of some new maize hybrids in the conditions of brown luvic soils in the hill area of the Banat, Lucrări Științifice Facultatea de Agricultură, USAMVB Timişoara 34, 187-192

BOWEN, J. K., MESARICH, C. H., BUS, V. G. M., BERESFORD, R. M., PLUMMER, K. I. M. M., AND TEMPLETON, M. D., 2011, *Venturia inaequalis* : the causal agent of apple scab, Moecular Plant Pathology, nr. 12, pag. 105–122.

BURDON J.J., 1993, Genetic variation in pathogene populations and it's implications for adaptation to host resistance. pp. 41-56. In: Durability of disease resistance. Jacobs, T.H. Parleviet, J.E., Kluwer Academic Publishers.

DAVID G, P PÎRȘAN, FL IMBREA, 2003, Tehnologia plantelor de câmp, Ed Eurobit, Timișoara

DE WOLF E. D., ISARD, S. A. (2007). Disease cycle approach to plant disease prediction. Annual Rev.of Phytopathoogy,.nr. 45, pag. 203–220.

FREY C. N., KEITT G. W. (1925). Studies of spore dissemination of *Venturia inaequalis* in relation to seasonal development of apple scab. *Jour. Agric. Res.* 30, 529–540

GADOURY D.M., MACHARDY W.E., 1982. Effects of temperature on the development of pseudothecia of *Venturia inaequalis. Plant Dis.* 66: 464-468.

GLADIEUX P., CAFFIER V., DEVAUX M., LE CAM B., (2010). Host-specific differentiation among populations of *Venturia inaequalis* causing scab on apple, pyracantha and loquat, Fungal Genetic Biology nr. 47, pag. 511–521.

HIRST J.M., STEDMAN O.J., 1962. The epidemiology of apple scab (*Venturia inaequalis* (Cke.) Wint.) I. Frequency of airborne spores in orchards. *Ann. Appl. Biol.* 49:290-305.

IMBREA FLORIN, 2011, Cercetarea agricola mai aproape de ferma, Agrobuletin Agir An III, 8

IMBREA FLORIN, 2011 Proiectele de cercetare în domeniul agriculturii în parteneriat public-privat–provocări privind managementul și finanțarea, Agrobuletin Agir An III

IMBREA I, M PRODAN, A NICOLIN, M BUTNARIU, F IMBREA, 2010, Valorising Thymus glabrescens Willd. from the Aninei mountains, Research Journal of Agricultural Science 42 (2), 260-263 9

IMBREA FLORIN, STEFANA JURCOANE, POP GEORGETA, M IMBREA ILINCA, LUCIAN BOTOS, FLORIN CRISTA, LAURA SMULEAC, 2017, Valorising municipal sludge as fertiliser in Camelina sativa (L.) Crantz, Romanian Biotechnological Letters 22 (4), 1276

LEFTER GH., MINOIU N.,1990, Combaterea bolilor şi dăunătorilor speciilor pomicole seminţoase, Ed. Ceres, Bucureşti.

LAURENT JAMAR, 2011, Doctoral thesis, ULg, March

MACHARDY W.E., GADOURY, D. M., 1986. Patterns of ascospore discharge by *Venturia inaequalis.* Phytopathology 76: 985-990.

POPESCU GH., 2001, Patologia plantelor- horticole, Ed. Eurobit, Timişoara

ROSSI V., PONTI I., MARINELLI M., GIOSUE S., BUGIANI R., 2000. A new model estimating the seasonal pattern of air-borne ascospores of *Venturia inaequalis* (Cooke) Wint. in relation to weather conditions. *J. Plant Pathol.* 82: 111-118.

ROSSI V., GIOSUE S., BUGIANI R, 2007, A – scab (Apple-scab), a simulation model for estimating risk of Venturia inaequalis primary infection, EPPO Bull., 37, 300-308

SIMERIA GH., BORCEAN A., MIHUT E., Tehnologii de cultură şi protecţie integrată în pomicultură, 2004, Editura Eurobit, ISBN 973-620-112-0, 230 pag

ŞMULEAC A, C POPESCU, F IMBREA, G POPESCU, L ŞMULEAC, Topographic and cadastre works for the establishment of an animal farm with NPRD funds, measure 121, Vărădia, Caraş-Severin county, Romania, International Multidisciplinary Scientific GeoConference: SGEM 3, 685-692

SUTTON T.B., JONES A.L., NELSON L.A., 1976. Factors affecting dispersal of conidia of the apple scab fungus. *Phytopathology* 66: 1313-1317.