

## The influence of climatic conditions on the occurrence of powdery mildew attack in oak forests in Mures County, Romania

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**Abstract.** Powdery mildew attack represents an important issue, which must be taken in consideration in forest management. The Transylvanian climate conditions are characterized by major variations induced by the climatic changes of the past decades. Both soil and climate conditions were analyzed, and in the end several statistic analysis were made. It can be observed, from the collected data, that the studied area is characterized by high humidity, a factor that correlated with the drying phenomena presents high risk to the forest, being capable of inducing powdery mildew, a disease that is produced by a fungus, *Microsphaera abbreviata*. The appearance of the disease is favored by climatic factors, the infections happen when the daily temperature reaches values over 15°C and the atmospheric humidity at the level of the leaf is about 80%. The mycelium appears on the upper part of the leaves, and the attack is seen as white spots which are progressively enlarged, and in the end they contribute at the drying of the tree.  
**Key Words:** Forestry, fungus, humidity, drying, *Microsphaera abbreviata*.

**Rezumat.** Atacul făinării reprezintă o problema importantă, care trebuie luată în considerare în procesul de management al pădurii. În zona analizată au fost condiții de umiditate crescută, care împreună cu fenomenul de uscare a crescut riscul de atac a făinării împotriva pădurii. Au fost analizate resursele de sol precum și condițiile climatice și s-a realizat analiza statistică a datelor obținute. Apariția făinării este favorizată de temperaturi medii peste 15°C și de o umiditate atmosferică de peste 80%. Atacul ciupercii apare pe suprafața superioară a frunzei sub aspect de pete albicioase și continuă până în momentul uscării complete a frunzei.  
**Cuvinte cheie:** Fainare, atac, umiditate, uscare, silvicultura, *Microsphaera abbreviata*.

**Introduction.** Powdery mildew attack represents an important issue, which must be taken in consideration in forest management. The most significant factor that increases the attack risk is the drying of the whole tree, present in both types of branches, thin and thick ones (Giurgiu 2004; Marcu 1966).

The Transylvanian climate conditions are characterized by major variations induced by the climatic changes of the past decades. We can observe, from the collected data, that the studied area is characterized by high humidity, a factor that correlated with the drying phenomena presents high risk to the forest, being capable of inducing powdery mildew, a disease that is produced by a fungus, *Microsphaera abbreviata* L. (Badea 2006).

The powdery mildew is affecting large surfaces of wood, being that treatments are rarely performed in the Transylvanian forests, and the predominant natural conditions that induce the disease are darkness and humidity (Badea 2006).

The aims of this study is to analyze the collected data in the oak forests of Mures county and to sum up the level of powdery mildew attack taking into consideration the climatic factors that induce the disease.

**Material and Method.** Before choosing the objectives of the research a series of real problems faced in the forest practice were identified, as the producing of forest material

needed for forestation. The observations and experiences were made during 2 years, 2013 and 2014.

The influence of the various climatic conditions on the development of the powdery mildew at the *Quercus* species, was studied using data collected over a period of 2 years (the average temperature values, the thermal regime of extreme values, the monthly precipitation regime and the values of the thermal and humidity regime). Specific soil parameters were also analyzed (see Table 3).

To find out the way that the powdery mildew fungus's occurrence is favored by climatic factors, periodical observations were made on the appearance and spread of the disease and the climatic conditions.

The soil sampling was made taking into consideration the Order of the Ministry of Agriculture, Food and Forestry (MAFF) no. 223/2002, STAS 7184/1-84, and STAS 7184/12-88. The soil samples were collected from Targu Mures tree nursery at the depth of 0-5 cm, 5-20 cm and 20-55 cm. 0.5 to 1 kg of soil was collected per sample. All soil samples were left to dry at the ambient temperature and were sieved to remove debris, and then mixed to obtain a representative sample.

The following laboratory procedures were used for all soil sample analysis: humidity (SR ISO 11465:1998), soil reaction (pH) (SR 7184-13:2001, using the InoLab Multi 720 multimeter, WTW, Germany), humus content (wet oxidation, method Walkley-Black modified by Gogoasa [SR ISO 14235:2000]), total nitrogen (SR ISO 11261:2000, using Kjeldahl Digestion and Distillation Units – VELP Scientifica, Italy), the soil percentage base saturation, the content of exchangeable bases, total cation exchange capacity (SR EN ISO 11260:2012) and particle size analysis (STAS 7184/10-79). All reagents were of analytical-reagent grade type (Merck) and all solutions were prepared using ultra-pure water with a specific resistance of  $18.2 \text{ M}\Omega \text{ cm}^{-1}$ . Statistical analysis on the data was carried out using IBM SPSS Statistics ver.22. software.

**Results and Discussion.** The influence of temperatures over the attack degree of the fungus *M. abbreviata*, for the analyzed period, the months between April - September 2013 and 2014, that was monitored in the three experimental points of Mures County was shown by calculating the correlations between the temperature and attack degree. In all cases a non-linear dependence was found.

For this reason a non-parametric test was used to show the degree of correlation between the mentioned experimental factors, the Spearman test.

Between the average yearly temperatures and the average attack degree of the fungus *M. abbreviata* in the three monitored experimental fields over the analyzed period the months between April - September 2013 and 2014, weak positive correlations resulted between 0.316 and 0.471 with low representation, the determination coefficients ( $R^2$ ) had values between 9.80-22.10% (Table 1 & 2).

In topsoil, soil reaction varies from 4.57 to 5.62 pH units and the total humus content varies from very low (0.872%) to good (4.236%). Total nitrogen content in the studied plot range from 0.05% to 0.22%, the average being in the low class (0.14%) (Table 3).

Table 1

Correlations, coefficients of determination and their significance for the evolution of powdery mildew attack degree depending on the abiotic factor temperature in 2013, within the monitored fields

<i>Experimental station</i>	<i>Rs</i>	<i>R<sup>2</sup></i>	<i>t</i>	<i>P</i>
Târgu Mureş	0.314	0.098	0.662	0.544
Sighişoara	0.471	0.221	1.424	0.075
Sovata	0.428	0.183	0.396	0.156

Table 2

Correlations, coefficients of determination and their significance for the evolution of powdery mildew attack degree depending on the abiotic factor temperature in 2014, within the monitored fields

<i>Experimental station</i>	<i>Rs</i>	<i>R<sup>2</sup></i>	<i>t</i>	<i>P</i>
Târgu Mureş	0.669	0.447	1.801	0.145
Sighişoara	0.478	0.229	1.091	0.336
Sovata	0.641	0.411	1.672	0.169

Table 3

Results concerning the main soil properties in the studied area

<i>No.</i>	<i>Soil type</i>	<i>Horizon</i>	<i>Level</i>	<i>Humidity</i>	<i>pH</i>	<i>Humus</i>	<i>Bases</i>	<i>Hydrogen</i>	<i>Total</i>	<i>Saturation</i>	<i>Total</i>
				<i>Mean±SEM</i>	<i>Mean±SEM</i>	<i>Mean±SEM</i>	<i>exchange</i>	<i>exchange</i>	<i>exchange</i>	<i>degree</i>	<i>nitrogen</i>
		<i>A,B,C</i>	<i>cm</i>	<i>%</i>		<i>%</i>	<i>%</i>	<i>%</i>	<i>%</i>	<i>%</i>	<i>g%</i>
1	Stagnic luvosol	Ao	0-5	2.49±0.02	1.85±0.03	4.21±0.2	10.95±0.10	7.56±0.04	18.51±0.06	59.15±0.23	0.22±0.02
2		Elw	5-20	1.93±0.02	1.59±0.28	2.76±0.10	5.85±0.06	8.09±0.12	13.96±0.81	41.88±0.78	0.15±0.03
3		Btw	20-55	3.46±1.01	3.65±1.62	0.79±0.26	12.05±3.95	5.30±1.60	17.55±5.58	68.66±21.63	0.04±0.02

Ao - topsoil, Elw - eluviated, Btw - subsoil.

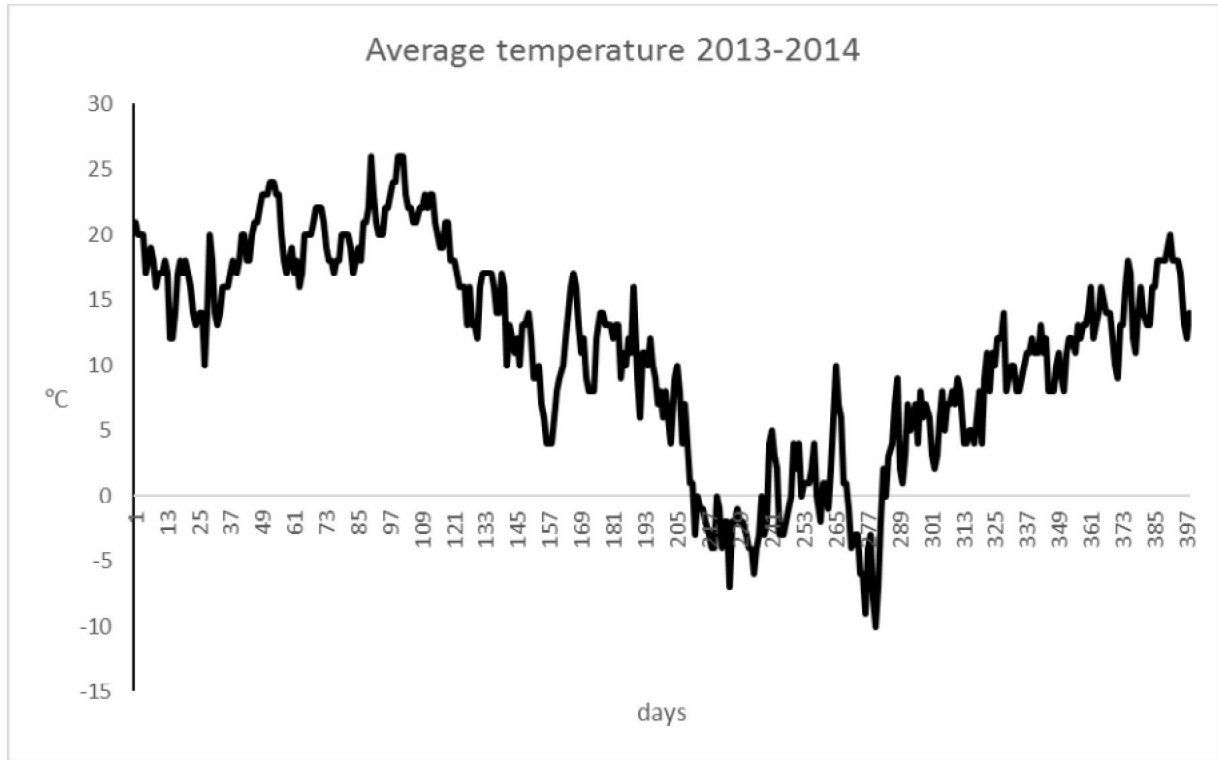


Figure 1. Average daily temperatures recorded in 2013-2014.

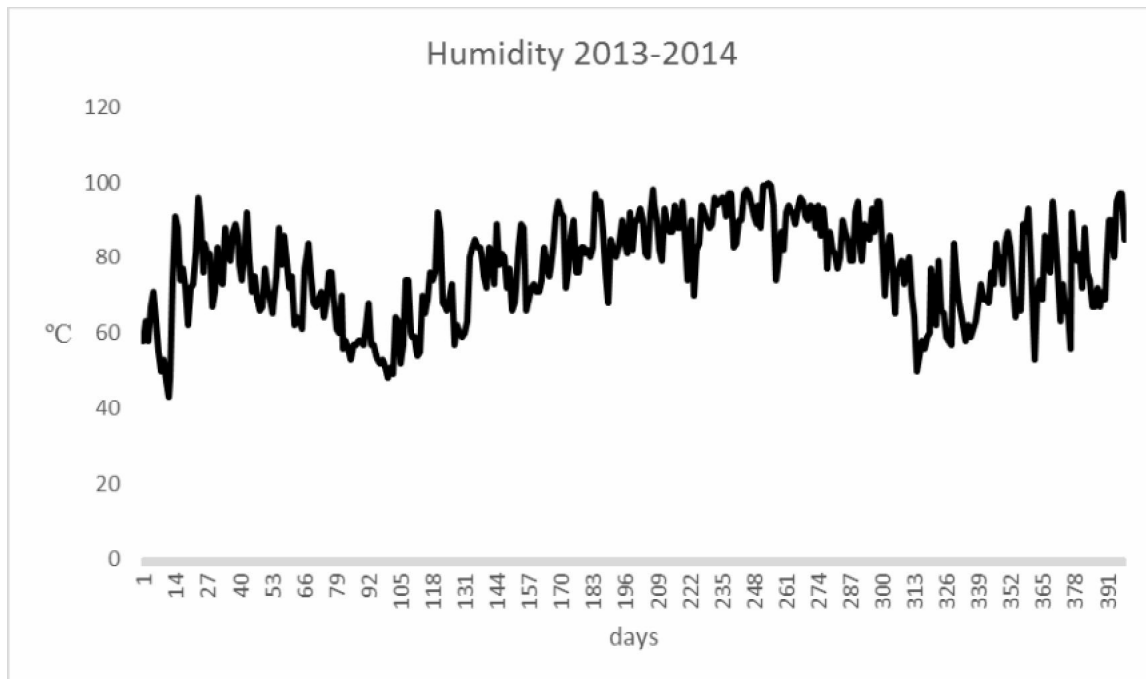


Figure 2. Humidity evolution 2013-2014.

**Conclusions.** The occurrence of the disease is favored by particular climatic factors and the infections occurs when the daily average temperature is above 15°C and air humidity is about 70-80% during summer, followed by short periods of rainy weather, the powdery mildew appears predominantly on the upper leaves as white spots which grow gradually. In the years 2013-2014 there were 205 days with temperatures ranging over 15°C (Figure 1), and were 284 days with humidity reaching over 80% (Figure 2). In

conclusion from the study of the temperature and humidity graphics for the 2 years, we can see that the degree of occurrence for the powdery mildew disease was medium. The appearance of the disease is favored by climatic factors, the infections happen when the daily temperature reaches values over 15°C and the atmospheric humidity at the level of the leaf is about 80%. The mycelium appears on the upper part of the leaves, and the attack is seen as white spots which are progressively enlarged, and in the end they contribute at the drying of the tree.

**Acknowledgements.** This paper was published under the frame of European Social Fund, Human Resources Development Operational Programme 2007-2013, project no. POSDRU/159/1.5/S/132765.

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Received: 01 August 2015. Accepted: 07 September 2015. Published online: 09 October 2015.

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How to cite this article:

Moldovan M. P., Mihaiescu T., Oroian I., 2015 The influence of climatic conditions on the occurrence of powdery mildew attack in oak forests in Mures County, Romania. *AAB Bioflux* 7(3):145-149.