PhD THESIS

Solutions for fighting against *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000 attack in *Quercus robur* L. in climatic conditions of Căpușarea, Cluj County

SUMMARY OF Ph.D. THESIS

PhD student **Ovidiu Daniel Ștefan**

Scientific coordinator **Prof.univ. dr. Antonia ODAGIU**

CONTENTS

INTRODUCTION

Forest ecosystems have a special role in ensuring the natural balance, being the most important terrestrial carbon deposits, storing about 50% of the total quantity and, consequently, play an important role in climate control. The change in these regimes can lead to significant changes in the viof by pests and pathogens, as well as increased risk of fire (EGGLESTON ȘI COLAB., 2008).

1. General considerations concerning *Querqusrobur* L. species and the impact of the powdery mildew

The common oak, or European oak (*Quercus robur* L.) is a species that has a wide spread, with its own systematics, being originating mostly from the northern hemisphere, represented by the area of Europe located in west of the Caucasus. It is widely cultivated in temperate regions, but has also penetrated Asia or America, where at present there are representatives of the species adapted to these regions (DENK ET AL., 2017). Globally, more than 600 species are currently known, the genus *Quercus* being subdivided into sub-genuses, and these, in turn, into sections.

2. The effects of the climate and climate changes on powdery mildew attack in *Querqus robur* L. species

More than half of the world's forests are found in just five countries (Brazil, Canada, China, Russia and the United States). Almost half of the forest area (49%) is relatively intact, while 9% is found in fragments with little or no connectivity. More than a third (34%) of the world's forests are primary forests, defined as regenerated natural forests containing native tree species where there are no clearly visible indications of anthropogenic activities and ecological processes are not significantly disturbed (FAO, 2009, 2010, 2011).

3. Research objectives

The objectives of the doctoral thesis concern the identificationb of solutions for the fight against the attack of *Erysiphe alphytoides* (Griffon & Maubl); U.Braun & S.Takam. 2000 in *Quercus robur* Lduring two experimental years 2019 and 2020, testing phytosanitary solutions detined to fight against *Erysiphe alphytoides* Griffon & Maubl); U.Braun & S.Takam. 2000, identification and quantification of the influence of the climatic factors that influence the attack degree of the pathogen in *Quercus robur* L. species in Căpuș area, Cluj County, during 2019 – 2020.

4. Environmental peculiarities of the experimental site

The experiments developed within the present doctoral thesis were placed in a *Quercus robur* L. forest located on the territory of the Căpuș area, Cluj County, in the Agârbiciu Composesorate (46°47'26''N și 23°17"32"E). The Căpușu Mare commune has in componence 8 villages: Agârbiciu, Bălcești, Căpușu Mare și Căpușu Mic, respectively, to which are added the rural communities Dângău Mare and Dângău Mic, and also Dumbrava, Păniceni and Straja village (Fig. 4.1). The Căpușu Mare commune is characterized by an average altitude of 468 m, laying on an area of about 60 km^2.

5. Material and method

The biological material consisted of *Querqus robus* L. oak trees, located on the experimental site. Oaks are trees belonging to the genus *Quercus* from the beech family, Fagaceae. There are about 500 existing species of oaks. The chemicals used are represented by the phytosanitary products used to combat the attacin the experimental site: Sulf micronizat 80%, Topas 100 EC, Mimos Zn, Score 250 EC, Systane Forte și Riza 250 EW, respectively. The physical materials used in the experiment are represented by the PortLog portable monitoring weather station, as well as by the tools needed to apply phytosanitary treatments. The experiments were performed in the experimental field, and the observations and determinations made refer both to climatic parameters and to the intensity and frequency of the attack of the *Erysiphe alphytoides* (Griffon & Maubl); U.Braun & S.Takam. 2000 and subsequently calculating the degree of attack according to its frequency and intensity. Climate parameter observations were made using a PortLog portable weather monitoring station. Also, the efficacies of the phytosanitary treatments administered by calculating the degrees of attack were determined.

6. Results and discussions

The study on the identification of solutions to fight against the attack *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000 in the oak species (*Quercus robur* L.) in the climatic conditions of the Căpuș area, Cluj county, was performed by testing conventional and unconventional fungal control products under the registration of climatic parameters specific to the experimental site, considered to have the potential to influence the fungus attack and the manifestation of the disease produced by it, respectively the powdery mildew. Analysis of the attack degrees of *Erysiphe alphit*oides (Griffon & Maubl.) U.Braun & S.Takam. 2000, carried out in the time interval of manifestation of the disease (oak powdery mildew), April - September, respectively, corresponding to the two experimental years 2019 and 2020, depending on the phytosanitary treatment, highlights similar evolutions, but of different intensities. Thus, in 2019, compared to the untreated control variant for which the highest degree

of attack equal to 24.78% is reported, the highest efficiency is reported in the case of using the phytosanitary treatment with Microthiol Special for which the lowest is reported. degree of attack equal to 7.45% (Tabelul 4.36).

Table 4.36

The basic statistics for the attack degrees of *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000 recorded in *Quercus robur* L., when different phytosanitary treatments are applied, and in lack of these, during April - September 2019 and 2020 (%)

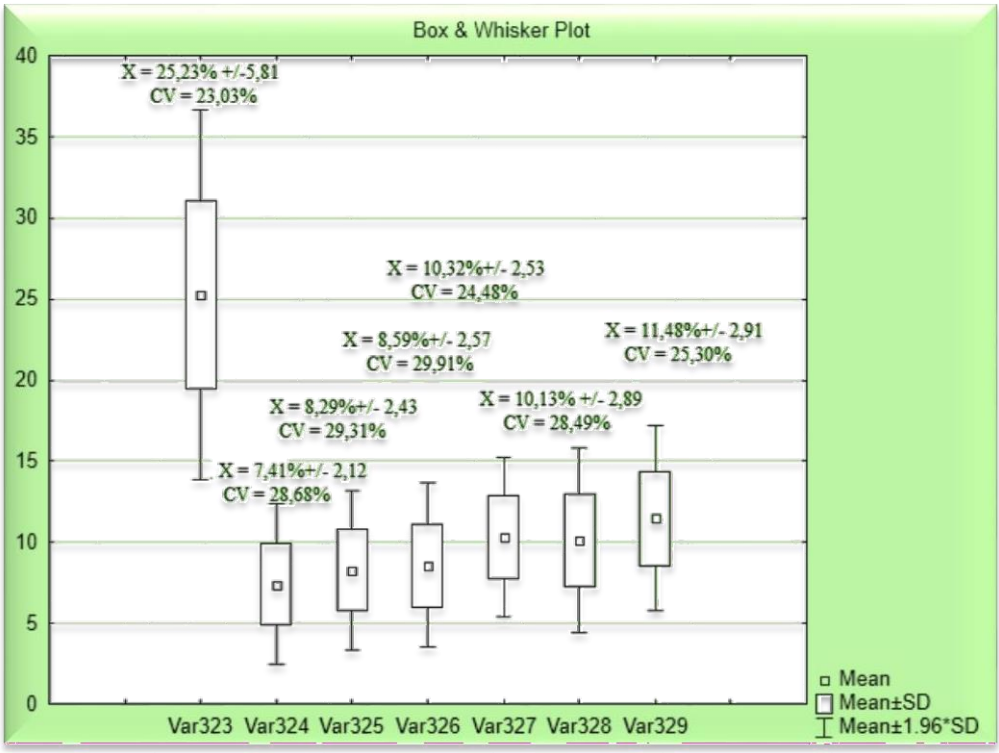
Year	Treatment	N	X	Minimum	Maximum	s	CV%
2019	Control	10	24.78[a]	19.20	40.00	5.16	20.81
	Microthiol Special	10	7.45[a]	3.10	12.60	2.30	30.90
	Topas 100 EC	10	8.64[a]	4.90	14.00	2.30	26.58
	Mimos Zn	10	8.97[a]	5.00	14.20	2.38	26.49
	Score 250 EC	10	10.32[a]	6.10	16.20	2.78	26.52
	Systhane Forte	10	10.13[a]	4.00	16.60	3.26	31.38
	Riza 250 EW	10	12.19[b]	6.80	18.00	3.16	25.92
2020	Control	10	25.69[a]	18.90	42.00	6.44	25.07
	Microthiol Special	10	7.38[a]	2.90	12.30	2.75	37.27
	Topas 100 EC	10	7.94[a]	3.60	13.00	2.69	33.84
	Mimos Zn	10	8.21[a]	3.90	13.50	2.73	33.25
	Score 250 EC	10	10.15[a]	7.00	15.00	2.27	22.37
	Systhane Forte	10	9.87[a]	6.20	16.00	2.48	25.09
	Riza 250 EW	10	10.78[b]	6.40	17.00	2.48	22.98

N – no. of cases; X – mean; s –standard deviation; coefficient of variation.

Analysis of attack degrees of *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000, carried out in the time interval of manifestation of the disease produced (oak powdery mildew), respectively April - September, on the whole experimental period 2019 - 2020, depending on the phytosanitary treatment applied highlights the fact that the highest degree of attack of fungal pathogen on oak equal to 25.23% corresponds to the untreated control variant against powdery mildew, and the lowest average degree of attack equal to 7.41% to the experimental variant treated with the Microthiol Special product. The highest degree of attack of the pathogen studied, in the conditions of application of phytosanitary treatments equal to 11.48% corresponds to the application of phytosanitary treatment with the product Riza 250 EW. For all experimental variants, the distribution of attack degrees is normal, and the variability expressed by the values of the coefficients of variation in the range CV = 23.03% - 29.91%, although high, does not exceed 30% threshold, thus confirming the representativeness of the averages (Fig. 4.1).

The cluster analysis applied to the study of attack degrees of *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000, on the whole experimental period 2019 - 2020 highlights their grouping in two clusters. One, consisting of a single branch, corresponds to the highest average degree of attack reported for the untreated experimental control variant, and the other cluster consisting of two sub-branches, corresponds to the experimental variants treated phytosanitary against powdery mildew. Each of these sub-branches is subdivided, in turn into two other sub-clusters corresponding to the degrees of attack of the pathogen. According to the linkage

distance, the smallest difference between the degrees of attack is reported between the experimental variants treated. (Fig. 4.2).



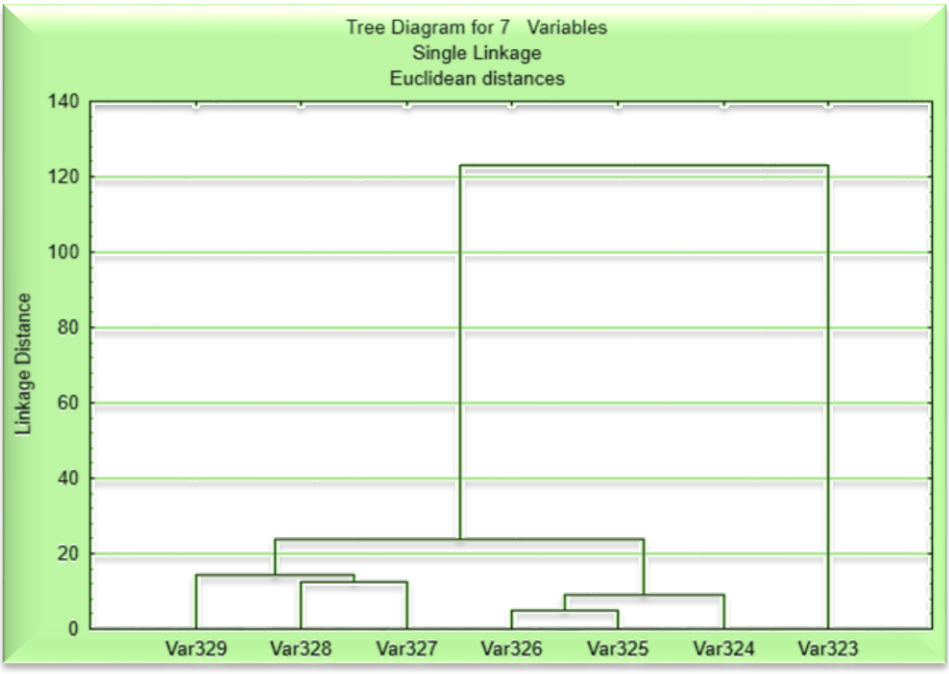
AD – attack degree; Var 323 – AD% untreated control; Var 324 - AD% treatment with Microthiol Special; ; Var 325 - AD% treatment with Topas 100 EC; AD% treatment with Mimos Zn; Var 327 - AD% treatment with Score 250 EC; Var 328 - AD% treatment with Systane Forte; Var 329 AD% treatment with Riza 250 EW.

Fig. 4.1. The Box-Plot diagram for the mean attack degrees of *Erysiphe alphitoides* (Griffon & Maubl.)U.Braun & S.Takam. 2000 recorded in *Quercus robur* L., when different phytosanitary treatments are applied, and in lack of these, 2019 – 2020 (%)

The cluster analysis applied to the study of attack degrees of *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000, by the whole experimental period 2019 – 2020, highlights their grouping in two clusters. One, consisting of a single branch, corresponds to the highest average attack degree reported for the untreated experimental control variant, and the other cluster consisting of two sub-branches, corresponds to the experimental variants treated phytosanitary against powdery mildew. Each of these sub-branches is subdivided, in turn, into two other sub-clusters corresponding to the attack degrees of the pathogen. According to the linkage distance, the smallest difference between the degrees of attack is reported between the experimental variants treated (Fig. 4.2).

The best results correspond to phytosanitary treatments with Microthiol Special products, but also Topas 100 EC and Mimos Zn, which constitute a subcluster (Var 324, Var 326, Var 326). For the other experimental variants, according to the

grouping in subclusters, lower performances, respectively higher attack degrees. In the case of this subcluster characterized by attack guards of the pathogen that produces oak powdery mildew, its constituent is represented by a single branch (Var 329) which corresponds to the highest degree of attack in phytosanitary treatments, for the variant treated with Riza 250 EW, respectively (Fig. 4.2).

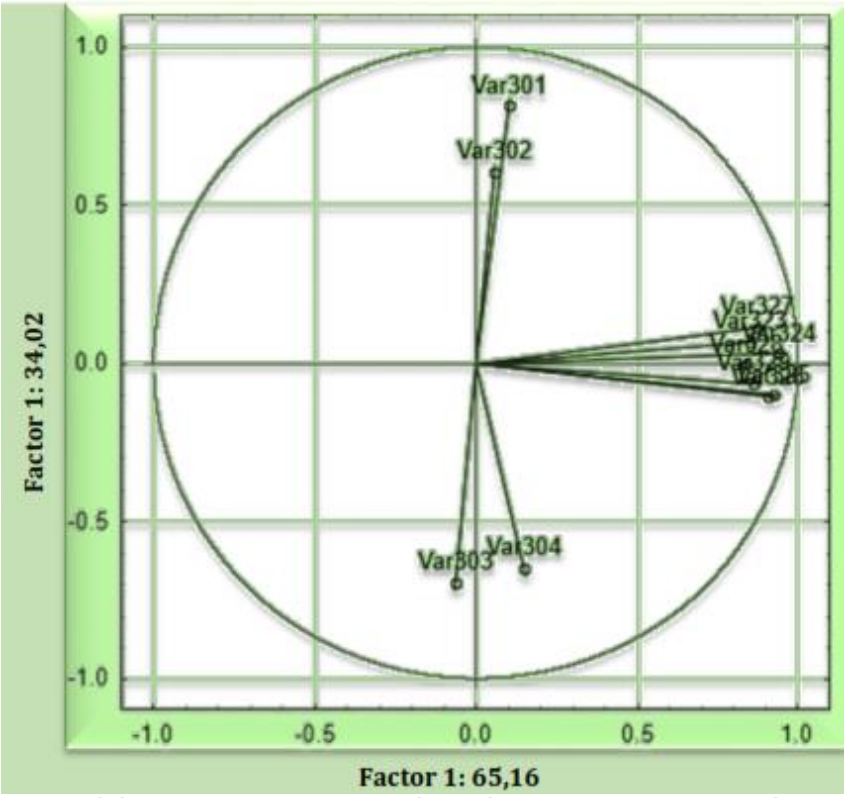


AD – attack degree; Var 323 – AD% untreated control; Var 324 - AD% treatment with Microthiol Special; Var 325 - AD% treatment with Topas 100 EC; AD% treatment with Mimos Zn; Var 327 - AD% treatment with Score 250 EC; Var 328 - AD% treatment with Systane Forte; Var 329 AD% treatment with Riza 250 EW.

Fig. 4.2. The cluster analysis for the mean attack degrees of *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000 recorded in *Quercus robur* L., when different phytosanitary treatments are applied, and in lack of these, 2019 – 2020 (%)

Following the highlighting of the simple correlations between environmental factors and the attack degrees of *Erysiphe abbreviata* (Peck) Braun & Takam. 2000, recorded according to the phytosanitary treatments applied, it is found that between the degrees of attack on the one hand, ambient temperature and relative humidity on the other hand, average and medium to strong correlations are reported, while between the degrees of attack of the pathogen that produces oak powdery mildew recorded according to the phytosanitary treatments applied and the environmental factors mean and mean to strong correlations between the environmental factors represented by the ambient thermal regime and that of the relative humidity, made it possible to take into account the fact that the conditions for applying the factorial analysis by its component represented by the Principal Components Analysis. The application of this analysis led to the identification of three main factors: the phytosanitary treatments administered

in order to control *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000 in oak (with the seven experimental variants, the untreated control variant and the six phytosanitary treatment variants, respectively), the climatic conditions (with the components represented by the environmental temperature, the relative humidity, the wind speed and the precipitation regime) and the age of the trees, respectively (Fig. 4.7, Tabelul 6.38).



AD – attack degree; Var 323 – AD% untreated control; Var 324 - AD% treatment with Microthiol Special; ; Var 325 - AD% treatment with Topas 100 EC; AD% treatment with Mimos Zn; Var 327 - AD% treatment with Score 250 EC; Var 328 - AD% treatment with Systane Forte; Var 329 AD% treatment with Riza 250 EW; Var 301 – environmental temperature (°C); Var 302 – relative himidity (%);Var 303 –wind velocity (m/s); Var 304 – rainfall regimen (mm).

Fig. 4.7. The variables (attack degrees of *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam.2000 recorded in *Quercus robur* L., in climatic conditions of the experimental site) projection of factors F1 and F2

Table 6.38

The cumulative variance and Eigenvalues for principal components

Factor	Eigenvalue	Total variance	Eigenvalue cumulativ	Total variance cumulativ
1	5.5177	65,1600	5.5177	65,1600
2	2,8808	34,0200	8,3985	99,1800
3	0,0694	0,8200	8,4679	100

7. CONCLUSIONS AND RECOMMENDATIONS

Analysis of the attack degrees of *Erysiphe alphytoides* (Griffon & Maubl); U.Braun & S.Takam. 2000, carried out in the time interval of manifestation of the disease produced (oak powdery mildew), respectively April - September, by the whole experimental period 2019 - 2020, depending on the phytosanitary treatment applied highlights the fact that the highest degree of attack of fungal pathogen in oak equal to 25.23% corresponds to the untreated control variant against powdery mildew, and the lowest mean attack degree equal to 7.41% in experimental variant treated with the Microthiol Special product. The highest attack degree of the pathogen studied, in the conditions of application of phytosanitary treatments equal to 11.48% corresponds to the application of phytosanitary treatment with the product Riza 250 EW. For all experimental variants, the distribution of attack degrees is normal, and the variability expressed by the values of coefficients of variation in the range CV = 23.03% - 29.91%, although high, do not exceed 30% threshold, thus confirming the representativeness of the averages. The cluster analysis applied to the study of attack degrees of *Erysiphe alphytoides* (Griffon & Maubl); U.Braun & S.Takam. 2000, by the whole experimental period 2019 - 2020 highlights their grouping in two clusters. One, consisting of a single branch, corresponds to the highest average degree of attack reported for the untreated experimental control variant, and the other cluster consisting of two sub-branches, corresponds to the experimental variants treated phytosanitary against powdery mildew. Each of these sub-branches is subdivided, in turn, into two other sub-clusters corresponding to the attack degrees of the pathogen. According to the linkage distance, the smallest difference between the attack degrees is reported between the treated experimental variants. The best results correspond to phytosanitary treatments with Microthiol Special products, but also to Topas 100 EC and Mimos Zn, which constitute a subcluster (Var 324, Var 326, Var 326). For the other experimental variants, according to the grouping in subclusters, lower performances are reported.

The implementation of the Principal Components Analysis led to the identification of three main factors, the phytosanitary treatments administered in order to control *Erysiphe alphytoides* (Griffon & Maubl); U.Braun & S.Takam. 2000 for oak (with the seven experimental variants, the untreated control variant and the six phytosanitary treatment variants, respectively), the climatic conditions (with the components represented by the environmental temperature, the relative humidity, the wind speed and the precipitation regime) and the age of the trees, respectively. The three main factors identified in the present study are responsible for 100% of the variance. Factor 1, the phytosanitary treatments administered in order to control *Erysiphe alphytoides* (Griffon & Maubl); U.Braun & S.Takam. 2000 in oak, respectively, is responsible for 65.16% of the variance, Factor 2, represented by climatic conditions is responsible for 34.02% of the variance and Factor 3, represented by the age of the trees is responsible for 0.82% of the variance. Because the latter factor has a subunit value, it can be considered negligible and consequently only the first two factors are

analyzed. It is recommended, in the context of the practice of phytosanitary treatments in oak against powdery mildew, that before undertaking the practical approach, a phytosanitary treatment strategy to be established, taking into account the effectiveness of existing products on the market, as well as the forecast of climate developments in the area, so that the treatments lead to their maximum potential, in the process of fight against the disease and reducing the damages created by it, at the level of the oak trees in the studied area. Also in this context, the aspects related to climate change must be taken into account, given that they play an increasingly important role in resizing the host/pathogen interaction, through the components that affect the changed behavior of the two components involved, under conditions of altering the eco-climatic context.

SELECTIVE BIBLIOGRAPHY

1. DENK T., G.W. GRIMM, P.S. MANOS, M. DENG, A.L. HIPP, 2017, An Updated Infrageneric Classification of the Oaks: Review of Previous Taxonomic Schemes and Synthesis of Evolutionary Patterns, In: Gil-Pelegrín, E., Peguero-Pina, J., Sancho-Knapik, D. (Eds.) Oaks Physiological Ecology. Exploring the Functional Diversity of Genus Quercus L., *Tree Physiology, 7. Springer, Cham. https://doi.org/10.1007/978-3-319-69099-5_2.*
2. EGGLESTON H.S., K. MIWA, N. SRIVASTAVA, K. TANABE (Eds.), 2008, IPCC Guidelines for National Greenhouse Gas Inventories – A primer, Prepared by the National Greenhouse Gas InventoriesProgramme, *https://www.ipcc-nggip.iges.or.jp/support/Primer_2006GLs.pdf.*
3. **ȘTEFAN O., ANTONIA ODAGIU, P. BURDUHOS, I. BRAȘOVEAN, 2020, Testing phytosanitary solutions destined to fight against *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000 in *Quercus robur* L., Căpuș area, Cluj County, 2019, *ProEnvironment, 13(42), 430-436.***
4. **ȘTEFAN O., ANTONIA ODAGIU, P. BURDUHOS, C. BRAȘOVEAN, 2021, Comparative study concerning the performances of the phytosanitary solutions tested for fighting against *Erysiphe alphitoides* (Griffon & Maubl.) U.Braun & S.Takam. 2000 in *Quercus robur* L., Căpuș area, Cluj County, 2019 – 2020, *ProEnvironment, 14(43), 39-43*.**
5. **ȘTEFAN O., ANTONIA ODAGIU, P. BURDUHOS, C. IEDERAN, 2021a, Study Concerning the Evolution of Wood Used as Biofuel and in Industrial Aims. Note 1: Report Performed Worldwide, and by Continents, *ProEnvironment, 14(44), 57-56*.**
6. **ȘTEFAN O., ANTONIA ODAGIU, P. BURDUHOS, C. IEDERAN, 2021b, Study Concerningthe Evolution of Wood Used as Biofuel and in Industrial Aims. Note 1: Report Performed bu EU, and Main Producer Countries, *ProEnvironment, 14(44), 57-62*.**