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Natural durability of eucalypt from Italian plantations against fungi and cerambicid *Trichoferus holosericeus* Rossi

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Abstract The natural durability against basidiomycetes fungi and the insect *Trichoferus holosericeus* Rossi of clones *Eucalyptus grandis* and *Eucalyptus x trabutii* coming from an Italian plantation is investigated in this work. The raw material originates from a nine-year old multiclonal plantation located near Battipaglia (SA), Southern Italy. Four clones with better results both in terms of growth rate and resistance to biotic diseases were selected for natural durability tests. The tests were performed in accordance to EN 350-1. The results obtained with fungal tests are promising and encourage further investigations in field tests for clones such as 7 and 329 and for *E. x trabutii*. All the tested clones are resistant to *Trichoferus holosericeus* Rossi.

Natürliche Dauerhaftigkeit von italienischem Eukalyptus-Plantagenholz gegen Pilze und den Käfer *Trichoferus holosericeus* Rossi

Zusammenfassung In dieser Studie wird die natürliche Dauerhaftigkeit von *Eucalyptus grandis* und *Eucalyptus x trabutii* Klonen aus italienischen Plantagen gegen Basidiomyceten und dem Insekt *Trochoferus holosericeus* Rossi untersucht. Die Proben stammen aus einer neun Jahre alten Plantage mit verschiedenen Klonen in der Nähe von Battipaglia (SA) in Süditalien. Vier Klone mit höherer Wachstumsgeschwindigkeit und besserer Resistenz gegen biotische Krankheiten wurden für die Prüfung der natürlichen Dauerhaftigkeit ausgewählt und gemäß EN 350-1 geprüft. Die Pilzversuche ergaben viel versprechende Ergebnisse, die Grund zu Freilandversuchen an den *E. grandis* Klonen 7 und 329 sowie *E. x trabutii* geben. Alle untersuchten Klone erwiesen sich als resistent gegen *Trichoferus holosericeus*.

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1 Introduction

Autochthonous of Australia, the species *Eucalyptus grandis* and its hybrids are the most cultivated ones worldwide thanks to their extraordinary growing features: high growth rate, enhanced by favourable site conditions, columnar shape of the stem, natural ability of auto-pruning, high vegetative propagation capacity by coppice shoots and stem cuttings (Mughini 2001).

In addition to the cultivation properties of *Eucalyptus grandis*, this species generally presents good technological properties of timber making it suitable for multiple purposes: pulp production, wood-based boards, biomass for energy production, sliced veneers, sawn timber, multi-layer particleboards, glue-laminated timber beams, parquet, solid wood furniture (Mughini 2001).

The breeding programmes for the genetic improvement of *Eucalyptus* spp. have expanded the possibilities for utilization of lumber, but at the same time the necessity to characterize the wood material obtained from new genetic sources has increased, in order to orient its use to optimal purposes.

This work is focused on the natural durability against basidiomycetes and the wood-boring insect *Trichoferus holosericeus* Rossi (=*Hesperophanes cinereus* Villiers) of timber of this species grown in Italy, in an experimental field created by the National Research Council (CNR), the Institute for Agro-forestry (SAF) and the cur-

rent Institute for Agro-environmental and Forest Biology (IBAF) in Battipaglia (Salerno district, Campania region, Italy).

The results obtained in this work, together with other data reported in literature on the mechanical and physical properties (Allegretti et al. 2001, Berti et al. 2001, Di Leo et al. 2001, Castro and Paganini 2003), may contribute to the characterization and appreciation of this wood species. The characterization of the wood is important not only for its correct utilization but also for the market promotion that is necessary for wood derived from plantations. For the genus *Eucalyptus* the characterization is even more important because there is a great variability in the natural durability of heartwood among different species and also within the same species. In addition, literature addressing this property is often discordant: for example, Scheffer and Morrell (1998) and also EN 350-2 (1997) state that heartwood of *E. globulus* is not resistant to basidiomycetes, while Lorenzo et al. (2007) have recently obtained a good durability (class 2 according to EN 350-2) of the same species grown in Spain. The authors try to explain the bad classification of the species in EN 350-2 with the inclusion of the data of the subspecies *E. globulus bicostata* having a natural durability much inferior compared to the subspecies *E. globulus globulus* effectively grown and spread in the northwest of Spain and Portugal. An analogous discordance can be found for the species *E. marginata*, which is classified as very durable according to EN 350-2 but it is considered with a great variability by Scheffer and Morrell (1998) according to a classification developed on the basis of previous studies (Clark 1969, Chudnoff 1984, Thornton et al. 1993).

When comparing data, another difficulty is due to the different tests performed, such as field or laboratory tests, and also within the same kind of test, by the different standards adopted (Australian, European or American) that may differ by sample size, duration of tests, fungal strains. Therefore, it is important to test the eucalypt clones grown in Italy using the same standards (European Standards) as is used for the most common wood species.

2 Materials and methods

The raw material originates from a nine-year old multiclonal plantation located near Battipaglia (SA), south of Italy, consisting of 15 clones of *Eucalyptus grandis* and one hybrid of *Eucalyptus x trabutii*. Four clones out of 15 showed better results both in terms of growth rate and of resistance to biotic diseases, and as a consequence, they were selected for wood characterization with respect to natural durability. The clones were identified by the numbers 7, 329, 330, 358.

Wood samples for testing natural durability against wood destroying fungi and *Trichoferus holosericeus* Rossi were taken from three trees belonging to the selected four clones of *Eucalyptus grandis* and one clone of *Eucalyptus x trabutii*.

2.1 Natural durability against wood destroying fungi

Experiments were carried out in accordance with EN 350-1 (1995), except for the number of samples because the wood was not available in such a quantity as required by the standard. However, quality requirements were respected, especially those concerning absence of defects (knots, gums). The sampling was then performed by following the criteria of homogeneity and representativeness of wood material.

From each tree nine samples ($15 \times 25 \times 50\,mm^3$) were taken out from the internal part of the heartwood and the same number was obtained from the external part of the heartwood, for a total of 18 samples per tree. Out of the 18 samples, 12 were reserved for durability tests and 6 were used for calculation of anhydrous theoretical mass (Mto), as indicated in the EN 350-1. The fungi chosen for the tests are *Trametes versicolor* (L.) Lloyd, strain CTB 863 A, *Coniophora puteana* (Schumach.) P. Karst., strain BAM Ebw. 15, *Gloeophyllum trabeum* (Pers.) Murrill, strain BAM Ebw. 109. These strains were selected in accordance with EN 350-1 and EN 113 (1999), which suggested *Serpula lacrymans* to be substituted by *Coniophora puteana.*

Natural durability was evaluated by calculation of a durability index (DI), which is expressed by the ratio of the average mass loss of the wood blocks (*Eucalyptus*) and the control blocks (*Fagus sylvatica*). The durability index (DI) enables each tested clone to be attributed to a durability class in relation to each specific pathogenic agent, as indicated in EN 350-1.

The tested wood species/clone is finally attributed to the natural durability class of the critical fungus, that one causing the highest mean mass loss on eucalyptus wood samples.

2.2 Natural durability against *Trichoferus holosericeus* Rossi

Trials were carried out in accordance with the criteria expressed in EN 46-1 (2005), as indicated in EN 350-1 with some modifications. For each clone, six sapwood blocks ($15 \times 25 \times 50\,mm^3$) were put in contact with ten new-born larvae, totalling 30 samples, for a period of 12 weeks. The larvae were positioned inside small holes excavated into the wood by using an awl. Controls consisted of *Fagus sylvatica* L. wood blocks. At the end of the test, samples were exposed to X-rays in order to detect the presence and distribution of larval galleries from radiographs as well as the

aspect of the larvae that can give informatiom on their health status. Further X-ray analyses were carried out one year after the beginning of the experiment to observe if the insects had or had not completed their life cycle both in the tested wood blocks and in controls.

3 Results and discussion

3.1 Natural durability against wood destroying fungi

Results for each tested clone and test fungus are summarized in Table 1, where the most significant data for the classification of natural durability are reported: the durability index (DI), the relative durability class and also the repartition of data between internal and external heartwood of eucalyptus clones.

The *E. x trabutii* belongs to class 1 (very durable) with DI below 0.09. The 329 and 7 clones belong to class 2 (durable); all the three clones have the same critical fungus, *Trametes versicolor*. The 358 and 330 clones belong to class 3 – moderately durable with critical fungus *Coniophora puteana*. All the clones belong to class 1 – very durable with respect to the fungus *Gloeophyllum trabeum*.

The distinction between results obtained from internal and external heartwood (Table 1) is due to the fact that within the same tree these parts often have consistent different natural durability against fungi. This difference may be correlated with different concentrations of the extractives, which is generally higher in the external part of the heartwood (Giordano 1981). This explanation might also justify the unequal percentages of wood blocks between internal and external heartwood which gave acceptable results according to EN 350-1 and EN 113 (Table 1), such as 20% minimum mass loss of the control and a moisture content in the range of 25% and 80% at the end of the test and their variability among clones and among fungi. Without this information, the different number of wood blocks of internal and external heartwood with acceptable results might create errors in the interpretation of results.

Though a great variability in the natural durability of eucalyptus clones, depending on the genetic diversity and the portion of heartwood tested, all of them were classified durable, and these achievements encourage further studies on the genetic improvement of the species.

In accordance with EN 460 (1994), timber with natural durability class 2 can be utilized in use class 4 according to EN 335-1 (2006), which means in ground contact or in fresh water. The treatment with a wood preservative is indicated only for particular situations when hazard for biological attack is higher than normal. So the 7 and 329 clones of *E. grandis* and the hybrid *E. x trabutii* can be utilized in service conditions where there is a risk of biological attack with respect to basidiomycetes fungi. In addition, the timber of 7 and 329 clones has good workability during industrial processing and good shape of the stem, better than the *E. x trabutii* (Castro et al. 2001, Mughini 2001). Conversely, *E. x trabutii* gave some problems during drying processing (Allegretti et al. 2001). In any case, further studies by means of field tests are needed to also consider the influence of environmental factors on natural durability, which is not controllable with laboratory test.

Table 1 Results obtained by natural durability test on clones of *Eucalyptus grandis* and *Eucalyptus trabutii* (mod. = moderately)
Tabelle 1 Ergebnisse der Dauerhaftigkeitsprüfungen an *Eucalyptus grandis* und *Eucalyptus trabutii* Klonen (mod. = mäßig)

Eucalyptus grandis Hill ex Maiden						
Clone	Fungus	Data obtained by		DI	Mass loss average %	Durability Class
		Internal heartwood	External heartwood			
358	*T. versicolor*	44%	56%	0.13	3.191	1 – very durable
	C. puteana	33%	67%	0.35	10.531	3 – mod. durable
	G. trabeum	43%	57%	0.01	0.297	1 – very durable
330	*T. versicolor*	43%	57%	0.28	7.292	2 - durable
	C. puteana	57%	43%	0.33	10.671	3 – mod. durable
	G. trabeum	50%	50%	0.03	0.795	1 – very durable
7	*T. versicolor*	67%	33%	0.26	6.120	2 – durable
	C. puteana	43%	57%	0.10	3.623	1 – very durable
	G. trabeum	56%	44%	0.03	0.801	1 – very durable
329	*T. versicolor*	86%	14%	0.20	5.033	2 – durable
	C. puteana	71%	29%	0.10	3.548	1 – very durable
	G. trabeum	25%	75%	0.01	0.273	1 – very durable
Eucalyptus x trabutii						
	T. versicolor	60%	40%	0.09	2.449	1 – very durable
	C. puteana	33%	67%	0.03	1.028	1 – very durable
	G. trabeum	67%	33%	0.00	0.120	1 – very durable

3.2 Natural durability against *Trichoferus holosericeus* Rossi

Despite the initial excavation activity of larvae, none of the two radiographic controls performed on wood blocks evidenced any presence of galleries or increments in larvae dimensions from the beginning of the test. From X-ray analyses it seems that the larvae died at the beginning of the test, in fact the galleries are less than 5 mm long, whereas the larvae introduced in the control wood blocks have completed their development cycle to the insect stage after one year. Therefore, it can be affirmed that all the tested clones are resistant to *Trichoferus holosericeus* Rossi.

4 Conclusion

The results obtained with tests to evaluate the natural durability against fungi are promising and encourage further investigations in field tests for some clones such as numbers 7 and 329 and for *E. x trabutii*. The resistance of eucalypt clones and the hybrid *E. x trabutii* against the cerambycid *T. holosericeus* represents an added value to possible uses in class 1 (indoor not exposed to weather and wetting) and class 2 (under cover and not exposed to weather but humidification over 20% can occur occasionally) according to EN 335-1.

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