

University of West-Hungary

a PhD Thesis

**THE EVALUATION OF EXPERIMENTS
IN COMPARING TREE-SPECIES**

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KONDORNÉ, SZ. M. (1992): Investigation results of a comparing tree species experiment. Erdészeti Lapok, Volume CXXVII No 11. pp. 331-333.

KONDORNÉ, SZ. M. (1993): Observations of the Nagylózs comparing tree species experiment. Erdészeti és Faipari Tudományos Közlemények, Volumes 38-39, pp. 43-58.

KONDORNÉ, SZ. M. (1994): Results of the Ágfalva (Sopron-hills) comparing tree species experiment. Erdészeti Lapok, Volume CXXIX, No 5. pp. 145-147

KONDORNÉ, SZ. M. (2005): The results of the 35-year-long Nagylózs (Sopron-hills) comparing tree species experiment. In: Scientific Results in Practice. Alföldi Erdőkért Egyesület, 2005. (Under publication)

KONDORNÉ, SZ. M. – HORVÁTH, T. (2007a): Observations of the comparing tree species experiment found in the Sopron-hills (Ágfalva): Erdészeti Lapok, Volume CXLII, No 2, pp. 38-40.

KONDORNÉ, SZ. M. (2007b): Observations of the 35-year-long Ágfalva (Sopron-hills) comparing tree species experiment. Erdészeti Lapok, Volume CXLII, No 2. pp. 40-42.

KONDORNÉ, SZ. M. (2007c): Results of the 35-year-long Ágfalva (Sopron-hills) comparing tree species experiment. Erdészeti Kutatások, (Under publication)

forest management, exotic species must have their role in plantation tree-growing and in mixed stands.

11. During the investigation of the growing and stand structure factors of admixed tree species (*Acer plantanoides*, *Celti occidentalis* and *kinds of Tilia*) the author found ascertained that these species might as well be planted as unmixed stand. They may play the role of a pioneer forest when renovating or transforming degraded forests. They also may have their role in the afforestation of hilly meadows and territories taken over from the agriculture.

LIST OF PUBLICATIONS

Lectures related to the topic:

KONDORNÉ, SZ. M. (1991): Results of investigation in the 22-year-long comparing species experiment. EFE Scientific Session, 24 October, 1991

KONDORNÉ, SZ. M. (2005): The results of the Nagylózs (Sopron-hills) comparing tree species experiment. Alföldi Erdőkért Egyesület - Research Day: Introduction of the newest results in forestry research. Szeged, 8 November, 2005

Articles related to the topic:

1. THE IMPORTANCE OF THE TOPIC

Forestry research deals with long-lived plant communities. One of the aims of the research is to help choose the proper tree-species. It is also well-known that the long-lived communities can hardly follow the changes of the environment, which are unfavourable nowadays. It is also particularly difficult to adjust the long-cycle growing processes, especially within a short time, to the economic and social changes.

With regard to the above the selection of the tree-species is one of the most significant activities of silviculture, the aim of which is to choose the proper stand suitable for forest site facilities and principles in forestry policy. The stability of the tree stand depends on this and on the other hand the forest must meet the requirements of the primary aim and the multi-purpose functions. The one who would like to make a decision in this field must have special professional knowledge, and experience in the local circumstances. During the time of the decision making the solution can be summarized in three areas: fundamentals in ecology, economic factors and technical possibilities. This also defines the order of the selection process.

2. OBJECTIVES

The author set herself the following aims when analysing the long-lived tree species comparison at the experimental plots of Ágfalva and Nagylózs:

- The definition of site relations at the experimental plots
- The definition and evaluation of the main features of standstructure at the experimental plots in the time of the records following one another
- The investigation of the interconnection between stand structure features
- The definition of rate of growth of tree species one by one at the experimental plot and the comparison of the two sites
- The definition of the litter volume of ten common tree-species found on the experimental plot and their comparison on the two sites
- The comparison of stand structure features of the common tree-species
- The comparison of growth and yield of tree-species at the different sites
- Suggestions for tree species selection at similar sites

3. REVIEW OF SPECIAL LITERATURE

The author has also evaluated the results of tree-species comparison experiments reinforced by concrete yield-data that appeared in special literature earlier. Without the aim at completeness she outlines experimental

defines, particularly when young, the correct time and measure of silvicultural interferences.

8. After examining the distribution of tree stands according to yield growing classification, the author stated that at the experimental plots tree stands of higher yield growing classification are to be found than those of at the settlement borders of the experimental plots. Particularly the ratio of forests with economic classification is higher which means that in the knowledge of the site more valuable stands of proper selection can be brought into life.

9. The examinations of litter approved the fact that the quantity of litter in the case of coniferous species is the multiple of that of the broadleaved species. The quickness of litter decay is influenced by the conditions of microbiology. At a better site a larger quantity of litter comes into being due to the more powerful biological activity. Better species approve better life conditions to the litter-decaying organisms, they are present in a greater number so the process of decay becomes faster. At weaker sites due to the lack of these a bigger amount of litter accumulates.

10. With the analysis of the exotic tree species – *Cedrus atlantica*, *Pinus strobus* and *Pseudotsuga douglasii var.viridis* – the dissertation certifies that these tree species can be planted with good results when using a short rotation period. The species might also be mixed as well. When these species are young, game species mean a lot of danger to them. Later harmful organisms may mean the same. Despite this fact, and besides the natural-like

5. The data of the dissertation confirm the fact that the rate of growth and tree volume of pines when young is significant, but at the age of 35 the emerging of classical home species like *Quercus petraea* and *Fagus sylvatica* is really striking. This shows that these indigenous home species have and will have their role on areas similar to the Ágfalva site. While on areas similar to the Nagylózs plain land it is the *Quercus robur* that feels best. After its initial slow growth by the age of 35 it is growing in a spectacular way and by doing so it also shows its importance as stand-forming species.

6. In the author's opinion the investigation of the rate of growth of tree species gives help for the formation of mixed stands. The data also show that *Carpinus betulus* at the age of 10 grows faster than *Quercus* and *Fagus species*, but they catch up with and outgrow *Carpinus betulus* around the age of 20-25. *Acer platanoides* keeps up with the growth of the main stand-forming species, and even at the age of 35 it outgrows them threatening the life of the main species. *Tilia cordata* endangers *Quercus* and *Fagus species* while growing until the age of 35, in the meantime the growth of *Tilia argentea* lags behind the main species and does not mean any harm after its age of 25.

7. The above sustain the author's opinion of taking the rate of growth and the time of species into consideration to a larger extent than before when producing mixed stands. This is true for the process of growth and development, because it defines the method of mixing, and it also

fields where the growth and yield of some tree-species were examined and compared on the basis of stand structure features.

The candidate has introduced the plantation of some exotic tree species where a detailed evaluation of *Pinus strobus*, *Pseudotsuga douglasii var.viridis* and *Cedrus atlantica* took place.

The data sustained where indigenous species did not grow properly, especially if the site was not known in a suitable way, the non-indigenous species did not give acceptable result either. Some experimental plots of broadleaved species to compare were also mentioned. In relation with this the author focused on the fact how difficult it was to compare the actual growth of different species. This is mostly true if there is a significant dispersion in the recorded data of the plots and if the species to be compared are of different growth, age and demand for site.

The national investigations have proved so far that from the exotic species stands with a short rotation period. A large volume of valuable industrial raw material can be obtained. *Pinus strobes*, *Pseudotsuga douglasii var.viridis* and *Cedrus atlantica* are suitable to transform or change degraded forests in the knowledge of keeping the right ratios and sites.

4. THE METHOD OF INVESTIGATION

The author has dealt with the evaluation of comparing species at experimental plots founded by Professor Majer in 1969. These plots belong to the West-Transdanubian forestry land-group. The Ágfalva 6A forest-part

belongs to the 41st Sopron-hills, the Nagylózs 5F forest-part belongs to the 45th Sopron-Vas-country plain, to the 45a Ikva-Répcse plain land-part.

On the Ágfalva experimental plot 30 species were planted into 42 parcels of 40x40 meters, out of which there were 12 exotic tree species. On the Nagylózs area 22 species were planted into 32 parcels of 50x50 meters. These experimental plots were surrounded with fences against game damage. Unfortunately the fence deteriorated very soon so there was no protection against human theft and game damage. This is why nowadays out of the 74 parcels 20 could be evaluated at the Ágfalva site and 16 of them at the Nagylózs site.

On the experimental plots a detailed climate analysis and site opening took place. The author carried out the forestry climate-diagram for both experimental plots, just like the precipitation and temperature ratio of water-turnover periods. In the areas the opening up of two-two soil profiles took place supplemented by the deepness modelling of pebble-layer at the Nagylózs plot.

The writer of the thesis carried out tree-stand recordings at the experimental plots four times when the tree-stands were 10, 16(17), 22 (23), and 35 years of age. The given data were evaluated with biometric methods; this means that all the stand structure characteristics, their relations and classifications were given in graphs and tables.

The author has compared the stand structure characteristics, growth, classification and litter volume of the common species at the two experimental sites. She completed the comparison of rate of growth, i.e. their interrelation to one another on a certain site, on the basis of rank correlation. The comparison of litter volume was done with the help of

2. The data, given by the author, in the case of both experimental plots show the tendency of natural stem number reduction. At the sites the most powerful reduction in the number of stems occurred by the age 16-17 of the stands, before the first silvicultural interference. The fight to live was going on within and among species during the ensuing phases of growing, too. It is the duty of forest tending to influence this process. In the knowledge of rate of growth of the different species some conclusions can be drawn.

3. The investigation of stand-structure factors at the experimental plots is strengthening the fact that broadleaved species even at the age of 35 grow more slowly on these sites than pine-trees. This fact was well-known earlier, too. The two light-demanding pioneer species, *Pinus silvestris* and *Larix europaea* emerge quickly out of the other pine species, and this rate of growth is kept up to their age of 23. The growth of *Abies grandis* is significant in later years unlike in its younger years. The slow growth of its first ten years changes at the age of 23 and this increase goes on later as well.

4. The author drew a conclusion, when analysing the stands of *Pseudotsuga douglasii* var. *viridis*, saying this kind of species feels very good at the dissimilar sites, where there is a significant difference in terms of climate and soil. This supports the fact that similarly to its natural site it can grow at different and wide choices of site in our country as well. Its demand for site is a lot more suitable for our circumstances than *Picea abies* planted in a general way.

rubra was on the run. The stand-structure of *Tilia platyphyllos* and *Celtis occidentalis* was also favourable.

- By the age of 35, further on, the best stand-structure was produced by the *Pseudotsuga douglasii var.viridis* parcel. However its rate of growth decreased a little, but henceforward it possessed the largest tree volume. At the age of 30-35 the national *Quercus species* started to grow strongly, particularly the growing of tree volume in the case of *Quercus robur* was expressive. *Tilia species* showed equable improvement and good stand structure similarly to *Quercus rubra* planted in different network. By this age the rate of growth and the growing of tree volume of *Pinus silvestris* and *Padus serotina* strongly decreased.

The author, at sites comparable to the Nagylózs experimental plot, suggested that mostly the following species should be grown: Indigenous *Quercus robur*, non-indigenous but evenly growing *Quercus rubra*, and *Pseudotsuga douglasii var.viridis* planted in different networks. The growth of tree-height and diameter at breast of these species is powerful and by the age of 35 they become in possession of meaningful tree volume.

6. SCIENTIFIC RESULTS (THESES)

1. The author, when analysing the soil-investigation results, stated that at the Nagylózs experimental plot a pebble layer, relatively close to the surface, can be found. The position of this is very fluctuating with changing deepness even within the parcels. The shallow solum, which is 35-45 cm at places, on the basis of the compared growing data of parcels, does not influence the growth of species, at least to their 35 years of age.

variance analysis and the demonstration of the largeness of differences with a Duncan-test.

5. THE SUMMARY OF THE RESULTS

The author, when examining the yielding data of *Pinus strobus*, *Cedrus atlantica*, *Pseudotsuga douglasii var.viridis* and *Quercus rubra*, stated that these species can very well be grown within national circumstances and the home selection can preferably be substituted. During the past decades only the successfully adjusted genotypes sustained due to the natural selection. *Pinus strobus* and especially *Cedrus atlantica* can play the role of a pioneer crop because of their adaptation to dryness and general acclimatization. They could also be counted as the alternative species of *Pinus silvestris* and *Pinus nigra*. With regard to the anticipated climate change *Pseudotsuga douglasii var.viridis* may be the alternative species of *Picea abies* since practically speaking its ability to acclimatization and regeneration is a lot better than those of *Picea abies* or even *Larix europaea*.

In the dissertation the author showed a description of stands at the Ágfalva experimental plot, which was of hornbeam-oak, independent of water-losing site and with lassivated brown forest-soil, as follows:

- In the first ten years the best tree-height and diameter-growth at breast was produced by pioneer species, such as *Betula pendula*, *Pinus silvestris* and *Larix europaea* and they generated a close stand. By comparison with these the growing of *Fagus sylvatica*, *Quercus petraea*, *Carpinus betulus*, *Tilia cordata*, *Tilia argentea* and *Abies grandis* was only temperate. The latter was the only one which was not damaged by game.

- At the age of 17 the situation changed from the point of view of growth and stand structure. Here the best stand structure was shown by *Picea sitchensis* and *Pinus ponderosa*. *Pinus silvestris*, *Pinus nigra* and *Picea abies* were also showing a favourable picture. *Fagus silvatica*, *Quercus petraea*, *Acer platanoides* and *Quercus rubra* had good results, too. *Quercus robur* was growing slowly at that time.

- By the age of 23 it was the *Abies grandis* that showed the most powerful growing and it also had significant tree volume. The growing of tree-height and diameter at breast of *Picea abies*, having planted in different networks, was also promising. This was true for tree volume as well. The rate of growth for *Larix europaea* and *Pinus silvestris* slowed down. *Tilia species* were developing quite well, however from the point of view of tree volume their position was in the lower third among tree species.

- At the age of 35 it was *Fagus silvatica* and *Quercus petraea* that showed stronger and stronger growing. The increase of tree-height in the case of *Carpinus betulus* was decreasing and did not mean any kind of further danger to the main stand-forming tree species. Although *Acer platanoides* even at his age has outgrown the stand-forming species.

The author, at sites comparable to the Ágfalva experimental plot, suggested that mostly the following species should be grown: Indigenous *Quercus petraea*, *Abies grandis*, *Picea abies* planted in different networks, *Pseudotsuga douglasii var.viridis*, *Pinus strobus* and *Pinus ponderosa*. The growing of tree-height and diameter at breast of these species is powerful and by the age of 35 they are in possession of significant tree volume.

The author has emphasized that exotic tree species, due to strong game damage, should only be planted with fences. At the Ágfalva

experimental plot only five out of the originally planted twelve exotic species remained appreciable by the age of ten. She added however, that it was not exclusively the exotic species which suffered from game damage but also some broadleaved species like for example *Castanea sativa*, *Fraxinus excelsior*, *Populus tremula* and *Acer pseudoplatanus* etc.

Concerning the stands at the Nagylózs experimental plots the author gave the description of Turkey oak–sessile oak water-losing sites with sessile-soil, medium-deep, sun-dried and half-dried site-type as follows:

- In the first ten years *Padus serotina* and *Pseudotsuga douglasii var.viridis* showed the best growth of tree-height and diameter at breast. In order after that there was *Pinus silvestris*, *Celtis occidentalis* and *Tilia platyphyllos*. These species, by the age of 8-10, created a close stand. The growth of tree-height and diameter at breast was particularly insignificant in the case of national *Quercus species*, *Pinus nigra*, and *Picea abies*.

- At the age of 16 the growth of tree-height and diameter at breast of *Quercus rubra* started in a very powerful way. The results also showed that the basal area and tree volume of species, having planted in a thick network, is a lot more significant than those of the other species like *Quercus rubra*, *Quercus robur* and *Pseudotsuga douglasii var.viridis*.

- By the age of 22 the situation changed a bit from the point of view of stand-structure. The best growth in tree-height occurred with *Pseudotsuga douglasii var.viridis* at the plot. Taking tree-height growth and tree volume into consideration together *Padus serotina* then *Picea abies* and *Quercus*