Comunicación invitada

REVIEW OF THE FAST GROWING FOREST TREE SPECIES IN TURKEY

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Summary

The fast growing species have 50 year-old political and 35-40 year-old scientific background in Turkey. *Eucalyptus camaldulensis Dehn., E. grandis W.Hill., Pinus pinaster Ait., P. radiata D. Don*., hybrid poplars, some clones of *Populus deltoides Bartr. ex Marsh. and P. nigra L.* are the most important species for obtaining a great deal of progress in species and origin experiments and starting the plantation phase in Turkey. In fast growing species process; although the American species and origins are mostly used, the desired outcomes could not be achived because of establishing the experiments with few number of clones and origins, which didn't represent the natural distribution area. Along with these species, studies should be focused on *Pinus brutia Ten*. which has broad natural distribution area in Turkey, improvement potential and fast growing character. Furthermore, *P. brutia* is evaluated as a species which will close the supply deficit in long run. Also, studies should be performed on *Fraxinus angustifolia Wahl. subsp. oxycarpa Bieb ex Willd., Salix excelsa J. F. Gmelin., S. alba L., Pterocarya fraxinifolia Spach. and Alnus glutinosa Gaertn. subsp. barbata* (C. A. Mey.) Yalt. which was experimented in regional base and showed the faster growing character than the other indigenous alder species and native species.

Keywords: *Plantation, Industrial wood, Fast growing species, Origin, Indigenous*

Resumen

Revisión de especies de crecimiento rápido en Turquía

Los antecedentes de la utilización de especies de crecimiento rápido en Turquía tienen se remontan a 50 años y en los últimos 35-40 años se ha abrodado desde un punto de vista científico. *Eucalyptus camaldulensis Dehn., E. grandis W.Hill., Pinus pinaster Ait., P. radiata D. Don.*, chopos híbridos, algunos clones de *Populus deltoides* Bartr. ex Marsh. y *P. nigra* L. son las especies más importantes por su mayor utilización en ensayos de especies, orígenes y en plantaciones. Aunque las especies y orígenes americanas son los más usados en los ensayos, los resultados esperados no han podido ser alcanzados debido al bajo número de clones y orígenes, establecidos en los experimentos que no representan el área de distribución natural. Junto con estas especies, los estudios deberían centrarse en *Pinus brutia* Ten. que tiene una amplia área de distribución natural en Turquía, elevado potencial y caracteres relacionados con el crecimiento rápido. Además, *P. brutia* esta considerado como una especie que podría cubrir el déficit de suministro a largo plazo. También, los estudios deberían ocuparse de *Fraxinus angustifolia* Wahl. subsp. oxycarpa Bieb ex Willd., *Salix excelsa* J. F. Gmelin., *S. Alba* L., *Pterocarya fraxinifolia* Spach. y *Alnus glutinosa* Gaertn. subsp. *barbata* (C. A. Mey.) Yalt que fueron probados en varias regiones y mostraron mejores características de crecimiento rápido que otras especies de aliso indígenas.

Palabras clave: *Plantación, Madera industrial, Especies de crecimiento rápido, Origen, Indigenas*

INTRODUCTION

The total area of Turkish forests is 21.2 million ha and this area occupies 27.2 % of whole country area. Half of Turkey's forests which are quite rich in point of biological diversity consist of conifer species and the rest of broadleaved species. Overall tree volume, the mean annual volume increment and the annual allowable cutting amount of the Turkish forests are 1.3 billion m^3, 36.3 million m^3 and 16.3 million m^3, respectively (Anonymous, 2006).

In Turkey, 60-65 % of the industrial wood and 85% of the fire wood are obtained from state forests. The supply deficit which is due to low proportion and low standard of quality-log in industrial wood-assured in state forests is suppressed by means of imports (Fig.1). It was claimed that the wood obtained from the native forests would not be enough to meet wood demand (Birler, 1998). The fruition values of industrial wood consumption in last two decades as expressed in supply-demand projections of 9^{th} Development Plan Period (2007-2013) are the indication to climb tendency, from 1970s to the present, in industrial wood consumption, along with population increase (Anonymous, 2006).

The major proportion of the industrial wood assurance outside the state forests has been fulfilled in poplar (over 90%) and *Eucalyptus* plantations. According to some calculations and projections, supported by some researches, the annual industrial and fire wood amounts provided by private sector outside the forest area (poplar, willow, fruit trees etc.) are 3.3 and 1.4 million m^3, sequentially (Anonymous, 2006; Birler, 1998). As to different supply sources, approximate wood consumption for 2005 is pointed in Fig.1.

From Fig 1, it's seen that, 16% and 10 % of Turkey's wood consumption are supplied by means of unregistered wood (as fire wood, at large proportion) and imports, respectively. If these values were taken into consideration as the basis, for saving Turkey's wood consumption from external addiction and unregistered supply, 26 % of total yearly consumption (25 410 million m^3) had to be provided from fast growing plantations, in the short run.

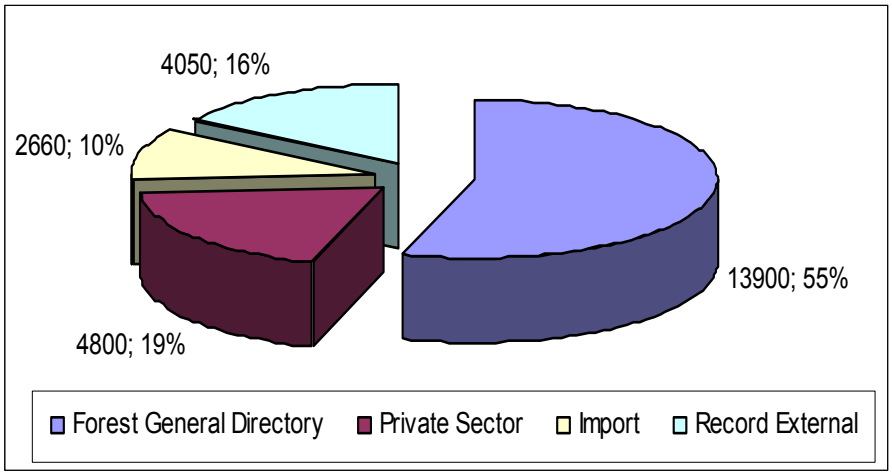

Figure 1. Consumption rates of Industrial and Fire Wood for 2005 as to the Supply Source in Turkey (1000 m^3)

The production capability of Turkey forests declines gradually. Furthermore, in 2000s, some forest areas will probably turn from the production forest into the external-production forests due to the increasing in conservation and environmental sensivity. Thereby, in due course, the decrease in the amount of production forests is inevitable. In developed countries, the conservation areas occupy 10 % of whole country area. But, this rate is 5-6% in Turkey (Anonymous, 2006). So, enlarging the number and size of conservation areas is one of the priorities of country.

In Turkey both the supply deficit at present and politics, aiming at increase of the number and the size of conservation areas, will increase the wood deficit. To overcome this deficit, tree improvement is the first of the two alternatives. But, this method requires selection-trial-evaluation process in the long run. So, establishment of fast growing plantations in suitable sites should be appreciated as a way of solution of the wood deficit in short term.

In this study, by investigating the brief history of Turkey's fast growing plantations, obtained experiences, established plantation/potential areas, experimented species/origins/clones and conclusions, suggestions are stated on import trials and plantations of fast growing species for following years.

BRIEF HISTORY OF FAST GROWING PLANTATIONS

Introduction of fast growing species to Turkey was started in 1880's with *Pinus pinaster* and in 1939 with *Eucalyptus camaldulensis*. In 1946, some *P.* x *euramerican* poplar clones were introduced. Later, in 1950's, there have been demonstrative plantations and comperative experiments of exotic coniferous species at various levels conducted by several different organizations.

Poplar and Fast Growing Forest Trees Research Institute-İzmit, Eastern Mediterranean Forestry Research Instıtute (the old name is Eucalyptus Research Station) and other research institutes/organizations have taken active part in fast growing species import practises. The scientific studies were started on fast growing species by the organizations mentioned above in 1968 (Tunçtaner, 1998). The beginning of the researches on fast growing American species was attributed to the year 1940 (Yaltırık *et al.,* 1994).

Together with the species and origin trials enforced by different organizations, the studies were fulfilled on native and exotic fast growing species in the extend of a project entitled "TUR/71-521 Industrial Forestry Plantations" in 1972-1977 (Tunçtaner, 1998). Also, in 1969-1976, in the extent of the "Arboretum of Conifer Species" project, trials on various American originated species were carried out (Boydak *et al*., 1995).

Species and origin trials were established at coastal regions as Black Sea, Marmara, Aegean and Mediterrenean, intensively. The experimented species in these regions are given on Table 1.

Table 1. Exotic fast growing species experimented in Turkish Forestry (Boydak *et al*. 1995; Tunçtaner, 1998; Atasoy, 1998; Üçler, 1998; Eyüboğlu and Atasoy, 1988) *

Number	Scientific Latin Names of Species	Provenance
1	*Picea pungens* Englemann	Colorado
2	*Abies amabilis* (Lood) Forb.	Darrington Washington
3	*Abies concolor* (Gord.) Hoopes	Colorado
4	*Abies concolor* var. *lowiana* Lemn.	Shady Cove-Oregon
5	*Abies magnifica* Murr.	Klamath-Oregon
6	*Abies balsamea (L.)* Mill.	Penobscot-Maine
7	*Pinus contorta* var. *latifolia* Eng.	Tillamook-Oregon
8	*Pinus banksiana* Lamb.	Marquetle-Michigan
9	*Pinus virginiana* Mill.	Prince Georgia-Maryland
10	*Pinus attenuata* Lemm.	Josephine-Oregon
11	*Pinus echinata* Mill.	Buckingham- Virginia
12	*Pinus pungens* Lamb.	Grant-W. Virginia
13	*Pinus rigida* Mill.	Burlington-New Jersey
14	*Pinus monticola* Dougl.	Klamath-Oregon
15	*Thuja pilicata* Donn.	Colville/Stevens Cob-Wash.
16	*Juniperus virginiana* L.	Adiron Dock Mt-New York
17	*Chamaecyparis lawsoniana* (A. Murr) ParI.	Germany
18	*Tsuga heterophylla* (Raf.) Sarg.	Mt. Vermon-Washington
19	*Cupressus arizonica* Greene	Arizona
20	*Larix occidentalis* Nutt.	Okanogan-Washington
21	*Larix lariciana* (Du Roi) K. Koch.	Hampshire-Graftan
22	*Pinus glabra* Walt.	Jones-Missisiphi
23	*Pinus serotinia* Michx.	Craven-North Carolina
24	*Pinus resinosa* Ait.	Forest-Pennsylvania
25	*Pinus balfouriana* A. Murr.	Siskiyou-California
26	*Pinus palustris* Mill.	Nansemond-Virginiana
27	*Abies lasiocarpa* (Hook) Nutt.	Yakima-Washington
28	*Abies fraseri* (Pursh) Poir.	Mitchel-North Carolina
29	*Picea engelmanii* (Parry) Eng.	Clackomas-Oregon
30	*Picea rubens* Sarg.	Penobsccot-Maine
31	*Taxodium distichum* var. *nutans* (A) Swe.	Baker -Florida
32	*Tsuga mentensiana* (Bong.) Carr.	Klamath-Oregon
33	*Picea abies* (L.) Karst.	Germany
34	*Chamaecyparis thyoides* (L.) B.S.P.	Bladen-North Carolina
35	*Abies grandis* (Dougl.) Lindl.	Deschuters-Oregon
36	*Picea breweriana* S. Watc.	Siskiyou-California
37	*Picea mariana* Mill. B.S.P.	Nortstar -Arkansas
38	*Sequoia sempervirens* (D. Don) EndI.	Blue Lake-California
39	*Pinus lambertiana* Dougl.	California
40	*Acer saccharum* Marsh.	Canada
41	*Pinus strobus* L.	Wisconsin
42	*Pinus jeffreyi* Grev. Balf.	California
43	*Pinus ponderosa* Laws.	California
44	*Sequoiadendron giganteum* (Lindl.) Buchh.	California
45	*Alnus cordata* (Loisel.) Duby	Italy
46	*Alnus rubra* Bong.	USA
47	*Alnus incana* (L.) Moench.	Norway
48	*Alnus sinuata* (Vill.) Lam.&DC. (Regel)	USA
49	*Robinia pseudoacacia* L.	Romania, USA
50	*Acer pseudoplatanoides* L.	Italy
51	*Larix decidua* Mill.	Germany
52	*Larix leptolepis* Gord.	Germany
53	*Larix x eurolepis* A. Henry.	Germany
54	*Acer negundo* L.	USA

55	*Picea sitchensis* Bong. Carr.	USA
56	*Pinus radiata* D. Don.	USA
57	*Pinus pinaster* Ait.	France
58	*Pinus densiflora* Siebb.&Zucc.	Japan
59	*Pinus caribaea* Morelet.	New Zealand, Australia
60	*Pinus canariensis* Chr. Sm. ex DC.	Canary Islands
61	*Pinus elderica* Medw.	Iran
62	*Pinus nigra* var. *corsicana*	Corsica
63	*Cedrus deodara* Loud.	China
64	*Cedrus atlantica* Manetti.	Morocco, Italy, France
65	*Pseudotsuga menziesii*	USA
66	*Pinus taeda* L.	USA
67	*Pinus elliotti* Engelm.	USA
68	*Cryptomeria japonica* (L. f.) D. Don.	Japan
69	*Pinus excelsa* Wall. Ex D. Don.	Central and Northern Europe
70	*Pinus muricata* D.Don.	USA
71	*Eucalyptus camaldulensis* Dehn.	Australia, Lake Albacutya, Willuna
72	*Eucalyptus grandis* W. Hill ex Maiden	Australia
73	*Populus x. euroamericana*	Italy
74	*Populus deltoides* Bartr. ex Marsh.	USA
75	*Quercus rubra* L.	USA
76	*Alianthus altissima* (P. Mill) Swingle	China
77	*Pseudotsuga menziessi* (Mirb.) Franco.	Washington, France
78	*Paulownia elongata* S. Y. Hu.	China
79	*Paulownia tomentosa* (Thunb.) Sieb.& Zucc. ex Steud.	China
80	*Paulownia fortunei* (Seem.) Hemsl.	China
81	*Paulownia tomentosa x fortunei*	China

*Some of the species in the table disappeared in nursery stage.

As to the Table 1, the conifer species were used commonly (app. 80 %). Also, while some of the broadleaved species as *Populus x euroamericana P. deltoides, Eucalyptus camaldulensis, E. grandis, Alnus incana, A. sinuata, A. robusta, A. cordata, Acer saccharum, A. pseudoplatanoides, Acer negundo, Robinia pseudoacacia, Quercus rubra* and *Ailanthus altissima* were experimented. For *Paulownia* Sieb.& Zucc. (Ulu *et. al.,* 2002; Ayan *et al*., 2006a) which was recognized by the Turkish forestry as plantation goals in 1990s, the studies could be expressed as openning stage. In addition, about two decades ago, it was stated that the studies on fast growing species in Turkey should also be focused on native broadleaved species such as *Fraxinus, Alnus* sp. *Populus tremula*, *Ulmus* etc. (Çiçek and Yılmaz, 2002).

POTENTIAL AREA OF INDUSTRIAL PLANTATIONS

It was expressed by Boydak *et al.* (1995) referred to Saatçioğlu (1969) that at the first stage, 5% of the degraded forests which are comprised of 10 million ha and need rehabilitation, then 10 % of these forests as to the accurate results, even 15 % of them would be allocated for the fast growing exotic species. In Turkey, as Zoralioğlu (1990) stated, there was 1.5 milion ha of area suitable for industrial plantations by using intensive cultural methods. Öztürk (1998) confirmed above-mentioned 1.5 milion ha of area as potential site for fast growing plantations in degraded forest, state and agricultural lands. In Turkey, Boydak and Dirik (1998) referred to Birler alleged that, it was possible to establish 1 840 000 ha of industrial plantations consist of 455 000 ha of poplar, 1 385 000 ha of

other native and exotic fast growing species.

2.2 million ha of land was identified as feasible for industrial plantations from technical and social aspect in 2006's inventory (Anonymous, 2006). If, 1 million ha (roughly) of state potential land and forest areas, mislayed the natural regeneration conditions and have to be planted, were added to 2.2 million ha, the area requiring plantation would be extremely large in above-mentioned area.

Currently, apart from poplar, the total area of established fast growing plantations is about 80 000 ha allover Turkey (Asan, 1998; Günay, 1998). This area is expressed as 120 000 ha by Aydın (1998). That 60 000 ha of exotic conifer plantations were only established in Black sea and Marmara Region, was stated by Kahveci (1998). There still are 53 901 ha of *Pinus pinaster*, 140 ha of *Pseudotsuga menziessi*, 1 692 ha of *Pinus radiata*, 17 ha of *Pinus taeda* (Çalışkan, 1998), 20 000 ha of *Eucalyptus camaldulensis* (Özkurt, 2002) plantations in Turkey (Çalışkan, 1998). Although there exist no clear record about poplar plantations owing to private sector investment character, 145 000 ha of established area is thought to be found (Anonymous, 2006).

PERFORMANCE OF SOME FAST GROWING EXOTIC SPECIES

American Originated Species

American originated species experimented in Turkey spread on the coastal zone of Atlantic and Passific (Boydak *et. al*. 1995). These are;

Pseudotsuga menziesii Mirb. Franco.; The use of this species which was firstly experimented in 1951 for aestatic and industrial goals is recommended for the plantation areas on Castanetum-Fagetum zone at the rate of 20%, in Eastern and Western Blacksea regions by 1250 m altitude. The origins are stated to reach to 10 m in height, 18 m^3/ha in volume increment at the age of 16 (Şimşek, 1987; Üçler, 1998; Tunçtaner, 1998). In this species which show faster growing at advanced years, no series insect harm and disease has been detected (Boydak *et. al*., 1995).

Sequoia sempervirens (Lamb.) Endl.**:** As to the observations in the experiment areas on Western Blacksea region, this species is a promising one on the coastal zone. But, in point of growing, important differences were determined among the individuals on the same area and at the same age. The change of diameter between 20-75 cm, and height between 11-25 m were found out among the equal individuals (Eyüboğlu *et al*., 1995). So, in this species, by selecting the origins with the help of the preliminary explorations on native spreading areas and systematically experiments on the individuals, selecting among the resistant ones against to the frost and capability of fast growing from industrial/ornamental aimed plantations, positive results could be attained. In other words, the experiments should be enforced together with the origin and clonal-based.

Picea sitchensis (Bong) Carr.**:** According to the 13rd years results of experiments established in Trabzon-Maçka region, this species shows growth as fast as 3 times than *Picea orientalis* that is indigenous for the region. So, Üçler (1998) and Boydak *et. al.* (1995) emphasize the utilization of this species in plantations of Eastern Blacksea at 700-1000 m elevations, at the rate of 10-15%.

Pinus contorta Dougl.**:** In respect of the results of the experiments conducted at the high region of Eastern Blacksea, planting of this species is suggested at

1200-2000 m elevations (even, above the timber line by 2500 m) at the rate of 10-15% (Eyüboğlu, 1986).

Pinus ponderosa Laws**.:** This species has an important advantage owing to the suitability to experimental studies in the high region. Boydak *et al.* (1995) suggested that this species should be experimented with convenient origins at Blacksea, Western and Southern Marmara, inner part of Aegean, Westhern Mediterrenean regions after having reliable preliminary studies.

Pinus radiata D. Don**.:** This species reaches the fastest growth, in Western and Eastern Blacksea region and Eastern Marmara. So, this one is the most investigated species. (Tunçtaner, 1998). But, because of *Evetria buoliana* (Schiff.) harm, this species is the most controversial one, in point of passing to limited plantations stage (Boydak *et al.*, 1995). The harm of *Evetria buoliana* on *Pinus radiata* intensifies on the unsuitable ecological conditions, as stated by Öztürk (1998). Toplu *et al*. (1987), in their study on resistance to the insect harm, determined Cedros-12785 as the most resistance origin. Also, It was explained the origins of this species on the northern and coastal zone, showed much better height- diameter growth and survival rate in Marmara (Kandıra-Sarısu) experimental area. Firstly, the utilization of Guadalupe, Monterey and Ano Nuevu origins are suggested for industrial plantations (Toplu *et al*., 1987).

Cupressus arizonica Greene**:** This species which is represented with quite a few, even with a single origin in some region, is mainly used for ornamental goals in Mediterrenean, Aegean, Marmara and inner Anatolia region. Owing to the height and volume growth in some experiments, this species should be utilized in all suitable lands in Turkey after a conclusive testing of the convenient origins (Boydak *et al.*, 1995). Tunçtaner (1998) clarified that this species has the most successful performance in Aegean region together with *Pinus pinea.*

In the fast growing trials and plantations at Marmara and Western Blacksea region, no or too little snow damage was perceived for the USA-originated species such as, *Pinus banksiana, P. monticola, P. contorta, P. ponderosa, P. muricata* and *P. radiata.* However, *Pinus taeda* and *P. elliottii* affected from the intensive snowing (Boydak *et al*., 1995).

European Originated Species

Hybrid poplar and *Populus deltoides*: Introduction of some poplar species and clones to Turkey have been made since 1940's. *P. deltoides* has a very large natural range in USA. It was introduced to Europea and Turkey as seed-lots and cuttings. *P.x euramericana* clones were mostly important from European countries as cutting material. The meaning of hybrid poplars refers intraspecific and interspecific hybrid clones of some poplar species. *P.x euramericans* are hybrids between *Populus deltoides* and *Populus nigra* (Tunçtaner, 1989; Tunçtaner *et al*., 1992).

Poplar is broadleaved species, the most extensively studied species in Turkey. Both the plantation area broadness (145 000 ha) and the important role of them on wood supply (app. 3.3 milion m^3/year) increase their importance. In Turkey, more than 90% of wood assurance outside the state forest are composed of poplar production (Anonymous, 2006). 55% of this production is ensured by means of fast growing plantations established with the clones of *Populus euramericana* (Hybrid poplar) and *Populus deltoides.* The clones of *Populus euramericana* named "I-214" and "45/51", and *Populus deltoides*'s clone

named "Samsun" are mainly used in the temperate region of Turkey. These clones have a rotation of 12-13 years and annual volume increment of 15-36 m^3/ha/year (Tunçtaner *et al*., 1994). In the studies, the superiority of 77/51 which is one of the *P. deltoides* clone than 45/51, 177-3 and I-214 clones in point of wood technologic characters was determined. Moreover, as an outcome of poplar breeding works, the clones of *Populus nigra* named "Gazi, Anadolu, Kocabey, Geyve and Behiçbey" were selected for continental regions of Anatolia. These clones are widely used in the gallery poplar plantations and other plantations (Tunçtaner *et al*., 1994; 2004). Under the Middle Anatolia conditions, Kocabey clone showed superiority than Gazi, Geyve and Behiçbey clones with respect to growth, physical/mechanical characters and resistance to the frost harms (Tunçtaner *et al*., 1998).

Picea abies L. Karst.: In the trials, since 1978, at 700-1500 m altitudes, in Eastern Blacksea region (Üçler, 1998), It was determined that this species showed as big as 2 times growth than the region's native species (*Picea orientalis* L. Link.). So this species should be used in the plantations at the rate of 10-15%, in the regions represented by experimental area (Ayan, 1990). Yahyaoğlu (1988) stated that for using of the convenient origins of this species on the wider areas, observations have to be continued, minimally by the half of rotation period.

Pinus pinaster Ait. This species was initially used in Turkey at Terkos dune plantation in 1880. It is grown especially in the north region of Turkey. Provenance trials for the species were established by Poplar and Fast Growing Forest Trees Research Institute in 1974-1979 (Özcan, 2002). In Turkey, *Pinus radiata* had a serious insect (*Evetria buoliana* Schiff.) problem and *Pinus pinaster* had some snow/wind damage and displayed many broken branches due to the weight of early snowfalls (Erkan, 2002; Özcan, 2002). It was determined that *Pinus pinaster* (provenance from Corsica and Morocco) grows successfully in Marmara, Blacksea Region and that it is more resistant to insect, disease, snow and wind damages (Tunçtaner *et al*., 1985;1988; Tunçtaner, 1998; Özcan, 2002). Also, Tunçtaner (1998) stated that this species would be used widely in some parts of Aegean region.

Robinia pseudoacacia L.**:** Together with multiple purpose uses, on the loose and deep soils which have good humidity, the black locust shows fast growing character for industrial plantations. More than 10 m^3/ha yield could be gained in this species, at the areas having high site index and unlimited humidity together with intensive soil cultivation and maintenance (Kızmaz, 1998). Rédei (2002) reported that the black locust stands of yield class I-II have a rotation of 35 – 40 years and an annual increment of total volume of 12 – 14 m^3/ha/year. The stands of yield class III-IV have a rotation of 30 years an annual increment of 8 – 9 m^3/ha/year. Finally, the poorest sites (Yield Class V-VI) have a rotation of 20 – 25 years and an annual increment of 4 – 6 m^3/ha/year.

Also, about black locust, Rédei (2002) stated that in the future there would be two regions, where the fast spread of black locust could be expected. In Europe and in Mediterranean countries (Italy, Greece, Spain and Turkey), in Asia (China, Korea) may be the most prominent black locust growers.

Australian Originated Species

***Eucalyptus* sp.**: This genus was firstly introduced to Anatolia in 1885 as an

ornamental plant for parks, gardens and edges of railroads (Özkurt, 2002). The first plantation of this species with economical mean was established in Tarsus-Karabucak in 1939. Now, the important part of the present amount of this species (20 000 ha) is owned by private sector. Since 1967, 609 origins of 191 *Eucalyptus* species were experimented in point of rising by Eastern Mediterrenean Forestry Research Intitute (Gürses, 1990). In experiment conclusions, *E. camaldulensis* Dehn and E. *grandis* W. Hill ex Maiden were determined as the fastest growing species in Turkey (Avcıoğlu and Gürses, 1984; 1986; 1988, Avcıoğlu and Acar, 1984). At the results of origin trials, an annual increment of total volume of 35 m^3/ha/year for *E. camaldulensis* and 50 m^3/ha/year for *E. grandis* was obtained (Avcıoğlu and Gürses, 1988). In conclusion of clonal trials after origin trials, the mean volume increment of the best clone reached to 49 m^3/ha/year for *E. camaldulensis* (Gülbaba, 2002) .

PERFORMANCE OF SOME FAST GROWING NATIVE SPECIES

Fraxinus angustifolia Wahl. subsp. ***oxycarpa*** Bieb. Ex Willd.**:** This species is a fast growing and indigenous tree species for Turkey. The mean annual icrement at the age of 30 and 3x3 m intervals for good, medium and poor site are 20.7, 14.2 and 9.1 m^3/ha/year, respectively (Yavuz and Mısır, 2002). Also, Kapucu *et al.* (1998) stated that the normal yield table for *F. a.* subsp. *oxycarpa* stands of Middle and Western Black sea Region in Turkey shows that mean annual increment reaches to 23.1 m^3/ha in plantation and 15.3 m^3/ha in natural stands in site I class. Çiçek and Yılmaz (2002) stated that *F. angustifolia*, particularly, a suitable tree for lowland and sub-mountain areas, is a fast growing tree species.

Pinus brutia Ten.: According to FAO's definition for fast growing species, Turkish red pine can be considered as fast growing species (Boydak and Dirik, 1998). Also, this species is evaluated as one of the species to close the anticipated future wood deficit in average term (Birler, 1998; Anonymous, 2001; Boydak, 2001) As to the recent years' studies, the annual volume increment and mean volume increment of natural forest of this species are 14.8 and 11.4 m^3/ha/year, respectively (Erkan, 1996). These increments can be promoted in an order by 27.8 and 15.4 m^3/ha/year in plantation areas at site class I (Usta, 1991). In natural forest and plantation in good site of Turkish red pine, mean annual increment can reach 10,5 m^3 at the age of 30 and 15,4 m^3 at the age of 27, respectively (Erkan, 2002). However, it is clear that the production could considerably be increased by tree breeding studies, because of the fact that the wide genetic base of this species gives an indication of the improvement potential. Many researchers and scientists reached an agreement on red pine's native and fast growing character and on the necessity of establishing the plantations, even on agricultural areas by using improved material (Tunçtaner 1998; Boydak *et al*., 2006; Usta 1991). Also, quite wide potential area and improvement potential of this species, signifies its value for Turkish Forestry.

Alnus glutinosa Gaertn **subsp. *barbata*** (C. A. Mey.) Yalt.**:** Owing to faster growing character than other six *Alnus* taxa, *A. glutinosa* subsp. *barbata* is an economically valuable one among the other naturally distributed black alder taxa in Turkey. In Eastern Black Sea Region, the pure forests of this taxon cover an area of 43853 ha;

mixed forests also cover an area of 63694 ha. In spite of little proportion (app. 1%) of this taxon's forest in Turkey's forest area (Saraçoğlu, 1998), fast growing character, high biological regeneration ability raise its importance, especially for the region. Also, this taxon is used in the region predominantly by the local public. At the same time, there are vast suitable potential plantation areas in the region (Çetin, 1988; Ayan *et al.,* 1998, 2006b). As to the study results, general mean volume increment of this species is 21 m^3/ha, at the age of 20, in site I class (Batu and Kapucu, 1995).

***Salix sp.* L.:** The growth performance and adaptation capability of 27 clones of *S. excelsa*, 26 clones of *S. alba* and 3 clones of *S. acmophylla* were investigated by Tunçtaner (1990, 2002). In the tested clones, the clones of *S. excelsa* (Akyazı/8408-8409, Çarşamba/8428-8429) and the clones of *S. alba* (Kırşehir/8211) showed growth performance as 54,9-67,2 m^3/ha. Moreover, these clones showed much better volume growth than I-214 clone in İzmit region.

On the other hand, the streamsides in Turkey, which have big potential sites for fast growing broadleaved species such as *Prunus sativum*, *Acer* sp., *Tilia*, *Pterocarya fraxinifolia*, *Ulmus* sp., *Populus tremula* and *Platanus* sp. should be tried with suitable origin in the rich sites (Çiçek and Yılmaz, 2002).

CONCLUSION AND SUGGESTIONS

In the light of data, observations and experiences obtained over 50 years, especially in the last 25-30 years, the below results and suggestions can be listed about the fast growing species in Turkey.

In American originated species exception of *Pseudotsuga menziessi, Pinus radiata, P. taeda* and *P. contorta*, the experiments were carried out with few number, even 1-2 of origin/clone, which didn't represent the distribution area. Also, the studies were performed without reliable preliminary explorations and systematic researches (Boydak *et al.*, 1995). Owing to above mentioned reasons, the desired outcomes about the American-originated species could not be achived. So, the real performance of these species should be investigated again by selecting the origins representing the distribution area, and by relying on reliable preliminary explorations.

When compared the potential area with the poplar area (145 000 ha) and plantation area of the other fast growing species (total 80 000-100 000 ha), the low rate (7.5 %) is seen. Therefore, Turkish Foresters have to progress much on fast growing species.

In 1950s, in spite of determining the establishment policy of fast growing species plantations, the desired still haven't been achived from many numbers of fast growing species. Because of this, if the industrial plantation investments were not encouraged with the new approaches and legal arrangements, the wood deficit would be increase as time passes.

When 50 year-old experiences, research findings and evaluations are taken into the consideration about fast growing species, the species that may be used in fast growing plantations in respect of the region, are listed in Table 2.

The most convenient regions for fast growing plantations are Marmara and Blacksea in Turkey. And, the most successful and widely used exotic species are *Populus x euramericana, P. deltoides, Eucalyptus camaldulensis, E. grandis, Pinus pinaster* and *P. radiata.*

It's agreed by many scientists and researchers that advanced improvement

studies should be carried on *Pinus brutia, Alnus glutinosa* subsp. *barbata,* some clones of *Salix excelsa, S. alba, Fraxinus angustifolia* subsp. *oxycarpa, Pterocarya fraxinifolia* species and the clones of *Populus nigra* which are native in Turkey.

Table 2. The promising species/origins/clones in fast growing plantations for Turkey.

REGION	SPECIES	ORIGIN	CLONE	LITERATURE
Eastern Black Sea	*Alnus glutinosa subsp. barbata*	Turkey	-	Pamay 1967 Ayan *et al.* 2006b
	Fraxinus angustifolia subsp. *oxycarpa*	Turkey	-	Pamay 1967 Kapucu *et al.* 1998 Yavuz and Mısır 2002
	Pinus radiata	Spain, New Zealand	-	Çiçek and Yılmaz 2002
	Pinus pinaster	Corsica	-	Birler 1998; Özcan 2002
Middle & Western Black Sea and Marmara	*Populus deltoides*	USA	Samsun	Tunçtaner *et al.* 1994
	Populus deltoides	USA	İzmit	Tunçtaner *et al.* 2004
	P. x. euroamericana	Italy	I-45/51	Birler 1998
	P. x. euroamericana	Italy	I-214	Birler 1998
	S. excelsa	Turkey (Akyazı)	8408-8409	Tunçtaner 1990;2002
	S. excelsa	Turkey (Çarşamba)	8428-8429	Tunçtaner 1990; 2002
	S. alba	Turkey (Kırşehir)	8211	Tunçtaner 1990; 2002
	Fraxinus angustifolia subsp. *oxycarpa*	Turkey	-	Kapucu *et al.* 1998 Yavuz and Mısır 2002 Çiçek and Yılmaz 2002
	Pterocarya fraxinifolia	Turkey	-	Çiçek and Yılmaz 2002 Kantay 2002
	Pinus pinaster	Corsica, Morocco	-	Tuçtaner *et al.*1985; 1988 Özcan 2002
	Pinus radiata	New Zealand, Spain	-	Birler 1998 Tunçtaner&Tullukçu 1991
Aegean	*Pinus brutia*	Turkey	-	Boydak and Dirik 1998 Erkan 2002
	Pinus pinea	Turkey (Kozak)	-	Birler 1998
	Cupresus arizonica	USA	-	Birler 1998
	Pinus pinaster	Corsica	-	Birler 1998
	P. x. euramericana	Italy	I-214	Birler 1998
Mediterranean	*Pinus brutia*	Turkey	-	Boydak and Dirik 1998 Erkan 2002
	Pinus pinea	Turkey (Kozak)	-	Birler 1998
	Eucalyptus camaldulensis	Australia	-	Birler 1998
	Eucalyptus camaldulensis	Lake Albacutya (6845)	-	Birler 1998
	Eucalyptus camaldulensis	Willuna (7046)	-	Birler 1998
	Eucalyptus grandis	Australia	-	Birler 1998
	P. x. euroamericana	Italy	I-214	Birler 1998
Middle, Eastern and Southeastern Anatolia	*Populus nigra*	Turkey	Anadolu	Tunçtaner *et al.* 1994;1998
	Populus nigra	Turkey	Gazi	Tunçtaner *et al.* 1994;1998
	Populus nigra	Turkey	77/10	Birler 1998
	Populus nigra	Turkey	67/1	Birler 1998
	P. x. euroamericana	Italy	I-214	Tunçtaner *et al.* 1994
	P. x. euroamericana	Italy	I-45/51	Tunçtaner *et al.* 1994

References

Anonymous, 2001. Supply-Demand Relationships in Forest Products, 8th Five-Years-Old Development Plan, Report of Forestry Private Specialty Commission, Publication of State Planning Organization, Num.:2531/547, p.57-115, Ankara.

Anonymous, 2006. Report of Forestry Private Specialty Commission, 9th Five-Years-Old Development Plan (2007-2013), Publication of State Planning Organization, Ankara.

Asan, Ü. 1998. Endüstriyel Plantasyonlar ve Türkiye'deki uygulamalar, Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop) s. 25-37, Ankara.

Atasoy, H. 1998. Hızlı Gelişen Türlerler İlgili Olarak Doğu Karadeniz Bölgesinde Yapılan Çalışmalar, Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop) s. 209-222, Ankara.

Avcıoğlu E.;Acar O., 1984. Eucalyptus camaldulensis (Dehn.) Orijin Mukayese Araştırması, Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Yıllık Bülten No: 20, İzmit.

Avcıoğlu, E.;Gürses, M.K.1984. Türkiye Oryantasyon Okaliptetumları Kuruluş Projesi Sonuçları, Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Yıllık Bülten No: 20, s. 113-168, İzmit.

Avcıoğlu, E.;Gürses, M.K. 1986. Türkiye Mukayese Okaliptetumları Araştırma Sonuçları, Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Yıllık Bülten No: 22, s. 67-113, İzmit.

Avcıoğlu, E.;Gürses, M. K. 1988. Eucalyptus grandis Orijin Denemesi, Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Teknik Bülten No: 142, 50 s., İzmit.

Ayan, S. 1990. Appreciation on Height Growth of Ten - Year Old Norway Spruce (Picea abies L. Karst.) Origins in Eastern Black Sea Region, Blacksea Technical University, Institute of Science and Technology, Forest Engineering Department, Master Thesis, 55. p, Trabzon-Turkey

Ayan, S.; Ulu, F.; Gerçek, V.; Ölmez, Z. 1998. Potential Areas Suitable for Alder Plantations on Alluvial, Colluvial Soils and Flood Veins in Middle and Western Blacksea Region (Poster Proceeding). Symposium on Forest Possession Problems in Western Blacksea Region, Proceedings, p.453-461, 8-10 September 1998, Trabzon-Turkey.

Ayan, S.; Sıvacıoğlu, A.; Bilir, N. 2006a. Growth Variation of Paulownia Sieb. & Zucc. Species and Origins at the Nursery Stage in Kastamonu-TURKEY, Journal of Environmental Biology, 27 (3): 499-504.

Ayan, S.; Yahyaoğlu, Z.; Gerçek, V.; Şahin, A.; Sıvacıoğlu, A. 2006b. The Vegetative Propagation Possibilities by Soft Stem Cutting of Black Alder [Alnus glutinosa subsp. barbata (C. A. Mey.) Yalt.]. Pak. Journal of Biological Sciences, 9 (2): 238-242.

Aydın, S. 1998. Hızlı Gelişen türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar, Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop) s. 203-207, Ankara.

Batu, F.; Kapucu, F. 1995. Doğu Karadeniz Bölgesi Kızılağaç Meşçerelerinde Bonitet Endeks ve Hasılat Tablosunun Düzenlenmesi, I. Ulusal Karadeniz Ormancılık Kongresi, 23-25 Ekim 1995, Bildiriler 4. Cilt, p. 349-362, Trabzon-Trabzon.

Birler, A.S. 1998. Çevre ve İnsan: Endüstriyel Plantasyonlar (Orman Ağaçları Tarımı); Ed: Kıvanç, M. and Yücel, E., Anadolu Universitesi, Açıköğretim Fakültesi Yayınları, No:1017/560, Bölüm:9, s.174-189, Eskişehir.

Boydak, M. 2001. Continual Forestry in Turkey, "Continual Forestry" Discussion Meeting, (7 November 2001, Ankara), Turkey Environs Wakf Publication, p.59-77, Ankara.

Boydak, M.; Oliver, C. D., Dirik, H. 1995. Introduction possibilities of some native fast growing coniferous forest tree species of the USA to Turkey. Poplar and Fast Growing Forest Tree Species Research Institute, Misselenous publications, Num.7, İzmit-Turkey.

Boydak, M.; Dirik, H. 1998. Ülkemizde Hızlı Gelişen Türlerle Bugüne Kadar Yapılan Çalışmalarda Ulaşılan Aşama, Uygulanan Politika ve Stratejiler, Buna Bağlı Olarak Uygulanabilecek Strateji ve Politika Önerileri. Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop),s.13-25, Ankara.

Boydak, M.; Dirik, H.; Çalıkoğlu, M. 2006. Kızılçamın (Pinus brutia Ten.) Biyolojisi ve Silvikültürü, OGEM-Vakfı Yayınları, ISBN:975-93943-4-0, s. 364, Ankara.

Çalışkan, T. 1998. Hızlı Gelişen Türlerle İlgili Rapor, Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop), s.109-130, Ankara.

Çetin, N. 1988. Doğu Karadeniz Ormancılığının Özellikleri, Doğu Karadeniz Ormancılığı Sempozyumu Tebliğ Metinleri, 12-13 Ekim 1988, Orman Mühendisleri Odası Yayın No:14, s. 7-12, Trabzon.

Çiçek, E.;Yılmaz, M. 2002. The Importance of Fraxinus angustifolia subsp. oxycarpa as a Fast Growing Tree for Turkey. Management of Fast Growing Plantations (IUFRO Meeting), Proceedings, DIV. 4.04.06, p. 192-200, 11-13 September 2002, İzmit-Turkey.

Erkan, N. 1996. Stand simulation for Pinus brutia Ten. Southeastern Anatolia Forestry Reaearch Directorate, Technical Bulltein, No:1, 147 p. Elazığ.

Erkan, N. 2002. Growth Performance of Turkish Red Pine (Pinus brutia Ten.) in Natural Forest and Plantation in Turkey. Management of Fast Growing Plantations (IUFRO Meeting), Proceedings, DIV. 4.04.06, p. 67-74, 11-13 September 2002, İzmit-Turkey.

Eyüboğlu, A. K. 1986. Pinus contorta var. latifolia Engelm. Provenances Trials in Trabzon-Meryemana District, Forestry Research Institute Publication, Technical Bulltein, No:162-163, p.7-28, Ankara-Turkey.

Eyüboğlu, A. K.; Atasoy, H. 1988. Doğu Karadeniz Bölgesinde Hızlı Gelişen Alternatif Türlerle İlgili Çalışmalar, Doğu Karadeniz Ormancılığı Sempozyumu Tebliğ Metinleri, 12-13 Ekim 1988. p. 45-58, Trabzon.

Eyüboğlu, A. K.; Atasoy, H.; Küçük, M. 1995. Doğu Karadeniz Bölgesi'nde Tür Adaptasyon ve Orijin Denemeleri, KTÜ, Orman Fakültesi, I. Ulusal Karadeniz Ormancılık Kongresi, Bildiriler, 4. Cilt (Orm. Müh.) 23-25 Ekim 1995, s. 73-79, Trabzon.

Gülbaba A.G. 2002.Ökaliptüs'de Genetik Islah Çalışmaları: Klon Denemesinin 6 Yıllık Sonuçları, DOA Dergisi, Sayı:8, s.19-32, Tarsus.

Günay, T. 1998. Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarında Yetişme Ortamı Etüdü Konusu ve Önemi, Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop), s. 335-345, Ankara.

Gürses, M.K. 1990. Dünya'da ve Türkiye'de Okaliptüs. Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü Dergisi 1990/1, s. 1-19, İzmit.

Kahveci, O. 1998. Türkiye'de Hızlı Gelişen Yabancı Orijinli Plantasyonların Bugünkü Durumu ve Geleceğine Dönük Silvikültürel ve Ekolojik Değerlendirmeler, Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop), s.103-108, Ankara.

Kantay, N. M. 2002. The Technological Properties and Industrial Use of Wingnut (Pterocarya fraxinifola (Lamb.) Spach.) Wood, a Fast Growing Tree Species. Management of Fast Growing Plantations (IUFRO Meeting), Proceedings, DIV. 4.04.06, p.281, 11-13 September 2002, İzmit-Turkey.

Kapucu, F.; Yavuz, H.; Gül, A. U. 1998. Dışbudak Meşçerelerinde Hacim, Bonitet Endeks ve Normal Hasılat Tablosunun Düzenlenmesi. KTU Araştırma Fonu Başkanlığı, Sonuç Raporu, Proje Kod No. 96.113.001.4, Trabzon.

Kızmaz, M. 1998. Macaristan'da Yalancı Akasya Yetiştiriciliği ve Türkiye'de Yetiştirme İmkanları, Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop), s. 295-301, Ankara.

Özcan, B. G. 2002. Growth and Yield of Pinus pinaster Ait. Management of Fast Growing Plantations (IUFRO Meeting), Proceedings, DIV. 4.04.06, p. 84-95, 11-13 September 2002, İzmit-Turkey.

Özkurt, A., 2002. Eucalyptus plantations in Turkey: Problems, Management and Opportunities, Management of Fast Growing Plantations (IUFRO Meeting) Proceedings, DIV. 4.04.06, p. 297-302, 11-13 September 2002, İzmit-Turkey.

Öztürk, O. N. 1998. Ülkemizde Hızlı Gelişen Türlerle Yapılan Çalışmaların Değerlendirilmesi, Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop), s. 91-101, Ankara-Turkey.

Pamay, B. 1967. Demirköy-İğneada Longos Ormanlarının Silvikültürel Analizi ve Verimli Hale Getirilmesi İçin Alınması Gereken Silvikültürel Tedbirler Üzerine Araştırmalar. Orman Genel Müdürlüğü Yayını No. 451/43, s. 174. Ankara.

Rédei, K. 2002. Improvement of Black Locust (Robinia pseudoacacia L.) in Hungary. Management of Fast Growing Plantations (IUFRO Meeting), Proceedings,, DIV. 4.04.06, p. 166-173, 11-13 September 2002, İzmit.

Saraçoğlu, N. 1998. Stem volume table of alder (Alnus glutinosa Gaertn. subsp. barbata (C. A. Mey.) Yalt.) Turkish J. of Agriculture and Forestry. 22:215-225, Ankara.

Şimşek, Y. 1987. Karadeniz Bölgesinde Yapılacak Duglas (Pseudotsuga menziessi (Mirb.) Franco.) Ağaçlandırmaları İçin Orijin Seçimi. Ormancılık Araştırma Enstitüsü Yayınları. Teknik Bülten Serisi, No. 190, 49 s., Ankara.

Toplu, F.; Tunçtaner, K.; Tulukçu, M. 1987. Investigation on growth and resistance to eurepean shoot moth (Evetria buoliana Schiff.) of Radiata pine (Pinus radiata D. Don) origins in Kocaeli Peninsula, Poplar and Fast Growing Forest Tree Species research Institute,Technical Bulltein, No:139, İzmit.

Tunçtaner, K.1989. Kavak Islah Çalışmalarında Kuzey Amerika Karakavaklarının (Populus deltoides Bartr.) Sağladığı İmkanlar, Kavak ve Hızlı Gelişen Orman ağaçları Araştırma Enstitüsü Dergisi, 1989/1, s.1-8, İzmit.

Tunçtaner, K. 1990. Çeşitli Söğüt Klonlarının Genetik Varyasyonları ve Türkiye'nin Değişik Yörelerine Adaptasyonları Üzerine Araştırmalar, Kavak Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü, Teknik Bülten No: 150, İzmit.

Tunçtaner, K. 1998. Yabancı Tür İthal Çalışmaları ve Endüstriyel Plantasyonlar için Tür Seçimi Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop) s. 65-71, Ankara.

Tunçtaner, K. 2002. Primary Selection Willow Clones for Multi-Purpose Use In Short Rotation Plantation, Silvae Genetica, 51: 2-3.

Tunçtaner, K.; Tulukçu, M.; Toplu, F.1985. Türkiye'de Endüstriyel Ağaçlandırmalarda Kullanılabilecek Sahilçamı (Pinus pinaster Ait.) Orijinlarinin Seçimi Üzerine Araştırmalar. Kavak Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü, Yıllık Bülten No: 21, İzmit.

Tunçtaner, K.; Tulukçu, M.; Toplu, F. 1988. Sahilçamı (Pinus pinaster Ait) Orijinlerinin Morfogenetik Özellikleri ve Büyüme Performansları Üzerine Araştırmalar. Kavak Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü, Teknik Bülten No: 144, İzmit

Tunçtaner, K.;Tulukçu, M.1991. Karadeniz ve Marmara Bölgelerinde Bulunan Tür Denemelerinde Sedirin Büyüme Performansı, Kavak Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü, Enstitü Dergisi, 1991/2, No:17, s.6-25, İzmit.

Tunçtaner, K.; Tulukçu, M.; Toplu, F. 1992. Kavaklarda Yapay Melezleme Çalışmaları (1987-1990), Kavak ve Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü. Teknik Bülten No. 156, İzmit.

Tunçtaner, K.; Tulukçu, M.; Toplu, F. 1994. Bazı Kavak Klonlarının Büyümeleri ve Teknolojik özellikleri Üzerine Araştırmalar, Kavak ve Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü. Teknik Bülten No. 170, İzmit.

Tunçtaner, K.;Tulukçu, M.; Toplu,F.; Durcan, E. 1998. Marmara ve Orta Anadolu Bölgeleri Oryantasyon Populetumları Araştırma Sonuçları, Kavak Hızlı Gelişen Orman Ağaçları Araştırma Enstitüsü, Teknik Bülten No: 185, İzmit.

Tunçtaner, K.; As, N.; Özden, Ö. 2004. Bazı Kavak Klonlarının Büyüme Performansları, Odunlarının Bazı Teknolojik Özellikleri ve Kağıt Üretimine Uygunlukları Üzerine Araştırmalar, Kavak ve Hızlı Gelişen Orman ağaçları Araştırma Enstitüsü. Teknik Bülten No. 196, İzmit.

Üçler, A. Ö. 1998. Gelecekteki Uygulamalar için Bazı Öneriler, Hızlı Gelişen Türlerle Yapılan Ağaçlandırma Çalışmalarının Değerlendirilmesi ve Yapılacak Çalışmalar (Workshop), s.239-248, Ankara.

Ulu, F.;Çetiner, Ş.; Eren, N.; Ayan, S. 2002. Results of the Field Stage in Third Year of Species and Provenances Trials of Paulownia Sieb.&Zucc. in Eastern Black Sea Region, Management of Fast Growing Plantations (IUFRO Meeting),Proceedings, DIV. 4.04.06, p. 174-182, 11-13 September 2002, İzmit-Turkey.

Usta, H. Z. 1991. A study on the yield of Pinus brutia Ten. plantations, Turkish Forest Research Institute, Technical Bulletin, No:219, Antalya-Turkey.

Yahyaoğlu, Z. 1988. Picea abies L. Karst. Orijin Denemeleri, Doğu Karadeniz Ormancılığı Sempozyumu Tebliğ Metinleri, 12-13 Ekim 1988. p. 59-66, Trabzon.

Yaltırık, F.; Efe, A.; Uzun, A. 1994. İstanbul Park, Bahçe ve Korularındaki Egzotik Ağaç ve Çalı Türlerinin Envanteri. TUBİTAK Yayınları No.294, TOAG Seri No. 805, 343 s., İstanbul.

Yavuz, H.; Mısır, N. 2002. An Emprirical Growth Model for Ash Plantations in Suleymania Forest, Management of Fast Growing Plantations (IUFRO Meeting) Proceedings, DIV. 4.04.06, p. 52-59, 11-13 September 2002, İzmit-Turkey.

Zoralioğlu, T. 1990. Investigations on the Determination of Suitable Land Preparation Methods with Machinery in the Plantation of Arid and Semi-Arid Areas of Eskişehir Region, Poplar and Fast Growing Forest Trees Research Institute, Technical Bulltein No. 149, 168 p., İzmit-Turkey.