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CONTENTS

EFFECTS OF LAND PREPERATION METHODS ON THE GROWTH OF P. radiata D. Don and P. pinaster Ait. PLANTATIONS ON DEGRADED HARDWOOD SITES

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ABSTRACT

This experiment was designed to determine the effects of different methods and intensities of land colearing and soil preperation on the survival, growth rate and health of two exctic species. (P. radiata and P. pinaster). Cat. D8H crawler tractor, Fleco rake, KG Rome clearing blade, County 1164, 4x4 tractor and heavy disk were used in vegetation clearing and soil cultivation. Seedling were planted in early 1975. The main treatments were combined with fertilisation and maintenance subtreatments. According to analyses of the data obtained; debris and roots left should be uprooted with clearing rake and placed in brushpiles laying paralled to contours. Areas should be disced with a heavy offset disc after clearing. In the first three years after planting weeding should be applied on the rows and inter-rows by hand and tractor. Fertilisation hasn't showed any significant results in Kerpe area.

Introduction :

Demand on forest products has greatly increased parallel to rapid population growth for about 30 years in Turkey. Public autho-

rities have been trying to solve the future forest products deficit problem. To supply the increasing rawmaterial demand of industrial establishments and fuel wood demand for rural population new and urgent policies have been introduced for last two decades. To accepted policies afforestation investments have been enlarged and new technical precautions have been brought in to increase the productivity of per unit area. Under today's social, political, economic realities and land use practices it is impossible to produce new forest land from agricultural land so increasing the productivity of per unit area seems more reasonable.

Turkey has about 11.3 million hectares degraded forest area which is 56 % of total forest area. So rehabilitation of these large degraded areas is one of the most urgent problems of forest authorities. Rehabilitation programmes have needed new and intensive site preperation techniques.

Intensive site preperation techniques is used as a tool to create right environment for trees and to obtain the highest benefit from soil. Intensive preperation techniques makes the trees grow faster in early stages of plantation.

For the application of intensive land preperation techniques the use of machinery is necessary. With the use of machinery, the knowledge of machinery, mechanisation methods, relations of plant - soil machinery are necessary.

Turkey has a huge plantation programmes of industrial plantations. About 1.5 million hectares of degraded forest land has planted since the early 60's. The portion of industrial plantations in forestry investment plans have an important place. Especially with the commencement of large scale plantations with fast - growing exotic species, the introduction of new technologies have been inevitable. So new research projects have been launched since early 70's to produce information and original data for Turkey's problems covering several ecological conditions.

In the forestry literature lots of papers have been produced on plantation mechanisation techniques. Some of the papers reviewed were outlined below.

The Government of Turkey, assisted by the Food and Agriculture Organisation of the United Nations through the United Nations Development Programme (UNDP), initiated in April 1972 a project was to assist the government in obtaining technical and economic

information needed to permit acceleration of the government's programme for the establishment of industrial forestry plantations. One of the aims of the project was to determine methods suitable for the future establishment of large areas of industrial plantations including mechanisation practices with exotic coniferous species (Cooling, 1971).

Guild (1971) introduced a paper titled windrowing and ripping covering a comperative study with other site preperation techniques. Frequent droughts and poor, stony soils are severe establishment hazards in Balmoral Forest. Site amelioration by windrowing and ripping prior to planting was introduced in 1966. Preliminary investigations have shown that the new crops are already benefiting from greatly improved survivals, better height growth and more uniformity than before. The cost of establishment has been reduced and the effect of ripping on tree growth, crop uniformity and stand access is expected to increase the initial cost advantage. It will not be known for some time whether or not the stands are more wind firm on ripped soils.

Neustein (1976), has reviewed the history of plough development in British Forestry and examined the subject under three different titles; 1. Introduction and early developments, 2. Historical review of ploughing on wet soils, 3. Historical review of ploughing on drier soils. In Britain ploughing of hill gorund began in 1920's; but in the 19 th century muchthought was given to site improvement by mechanical means. In 1803 ploughing with horse-drawn equipments were practised as the cheapest and most effective method of preperation on tillageable sites. Benefits of ploughing have been outlined in Neusten (1976)'s review as; 1. Regulation of water movement, 2. Improvement of soil aeration, 3. Mobilisation of nutrients, 4. Suppression of weeds, 5. Provision of a favourable planting position, 6. Limitation of lateral root extension. First machine drawn plough equipment appeared in 1950's in Britain and have been developed in the following years.

Althen (1977), expressed that mechanical site preperation eliminated the opening of the planting slits in his paper on site preperation prevents re-opening of planting slits in heavy-textured soils.

Norman (1978), studied ripper scarification as an silvicultural technique developed in Northwestern Alberta. There are currently several different scarification techniques being applied silviculturally in Alberta. All techniques are designed around a crawler trac-

tor equipped with a front mounted dozer or ripper blade. Although these techniques are effective on better drained sites, their efficiency is limited on wet or frozen ground. Summer is the most suitable time for general reforestation operations but is often a very poor time for good forest access and site operability in low wet areas. To an investigation it has been determined that the most economical time to carry out the scarification would be in winter when access is best and winter logging is in full scale operation. A parallelogram ripper mounted on the rear of a suitably sized crawler tractor has proven to be best suited for this heavy work. Equipment was designed, modified and built for use on the parallelogram ripper. 1200 hectares have been treated to date at a very reasonable cost, the bulk of the area being untreatable during the summer or winter by conventional means.

Chapman and Allan (1978) have noted some information about site preperation in their forestry paper published by FAO. Site preperation is confined to firm, well-drained or generally dry land sites, already occupied by a usually indigenous ground cover. This vegetative cover can sometimes prevent the succesful establishment of a new plantation crop by occupying and utilizing the required land, by creating excessive competition for available moisture or nutrients, by depriving seedlings of light or by hindering the introduction of techniques necessary for succesful establishment. Under such conditions a pirmary requirement is to determine efficient and economic methods of eliminating harmful competition. Site preperation is an early investment and often constitutes a major proportion of total establishment costs. Labour can do almost all of the work in establishing a forest plantation, and even on a large scale can be efficient and economic. Mechanisation is an important alternative. It is frequently suggested that mechanisation reduces employment opportunities. In comparing the relative merits of labour employment and mechanisation, it is necessary to balance social benefits against the cost benefits of using more efficient alternatives. In general, where mechanisation of larger scale plantation projects reduce costs.

Appeltroth (1981), summarised the latest development in site preperations in Finland. Forest soils in Finland consist mainly of rocky morain with a layer of raw humus on top. The topography is uneven. Slash and stumps are an obstacle for mechanized site preperation. Site preperation equipments and methods have been used for about 15 years and covered about 100.000 hectares in Finland. After long and intensive research and development efforts the TTS

35 and 35 lt disc plows have been the most popular and universally used units in the country.

Tolay et al (1982) investigated the effects of different site preperation methods on the physical conditions of fine textured soils and on the success of reforestation in the degraded coppice site at Kerpe Plantation area. According to results obtained the effective deep soil preperation without turnover the soils and the topsoil preperation to obtain fine soil before planting is a suitable method for plantation. This soil preperation operation can be done with Komatsu rippers in strips or on complete area. Disc-harrowing plus ripping can increase the survival rate of plants. NPK aplication is effective on height increment in first two years.

Ayberk (1983), studied the effects of several site preperation methods on the growth of P. pinaster Ait. on maquis sites at Marmara region, northwestern part of Turkey. Results showed that single furrow gradoni formed by one run of single mouldboard tine plough at 3 metres centres after complete ploughing by plough and weeding are the best treatments for P. pinaster's growth.

Intensive silvicultural methods covering site preperation create appropriate conditions which make the plants exploit the soil better and grow faster. According to the observations in Antalya and Balikesir site preperation with front mounted rakes create better conditions for plant growth (Zoralioğlu, 1987).

The potential plantation area, which can be prepared with mechanisation methods, is about 1.5 million hectares in different regions of the country. According to regions vegetation cover, slopes, soil and climate characteristics, different site preperation methods are needed.

The experiment of which results are explained below is one of the regional land preperation projects.

This experiment has been designed to determine the effect of different methods and intensities of land clearing and preperation on the survival, growth rate and health of two main and important fast growing exotic coniferous species (P. radiata D. Don and P. pinaster Ait.) on a site by the Black Sea Coasts in Marmara Region.

Essentially the objective is to contrast the growth, survival and vigour of the two pine species on land prepared to different intensities of clearing and superficial soil working, with and without sub-

soiling. In effect the treatments will range from the removal of vegetative cover without soil preperation apart from pitting, to the complete removal of vegetation including roots and stumps followed by intensive soil cultivation plus subsoiling. Experiment has also been designed to investigate the possible interactions between intensity of site preperation, species and the application of fertilizer at shortly after planting. Objectives of the experiment :

The objectives of the experiment have been outlined in two main paragraphs as below.

— To compare, in heavy degraded coppice, the relative merits on the bases of plant survival, growth rates, health and cost of a range of methods and intensities of land clearing and preperation, ranging from the removal of the vegetative cover with minimum soil preperation for planting, to the complete removal of the vegetation including roots and stumps together with intensive soil cultivation and subsoiling.

— To investigate the possible influence exerted by the application of compound fertiliser (NPK) at or soon after planting, on the results achieved in respect of different species and intensities of land preparation.

Materials and methods :

Location :

The experiment was established in the coastal strip of the Black Sea in the eastern section of the Marmara Region, in the north of Kocaeli Province, at the fast growing exotic coniferous pilot plantation area (Kefken/Kandira) (Map: 1).

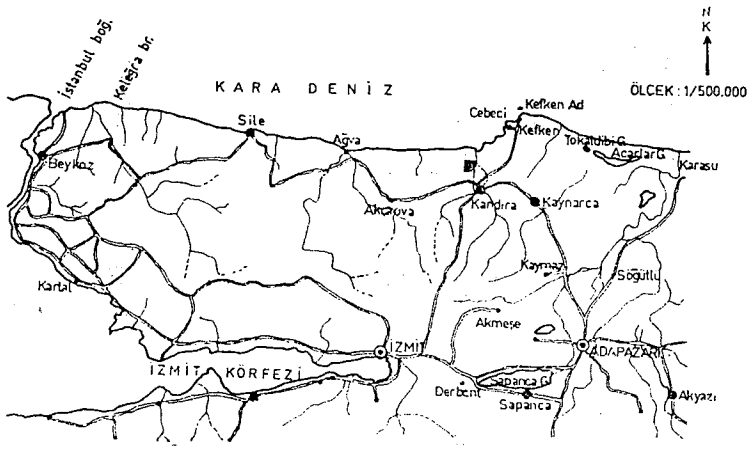
Treatments :

The experiment has covered five main treatments as explained below, (Table: 1, 2).

— Operation as in the KG/H technique above except that the KG blade set low to shear closely at ground level. This operation then followed by heavy discing of the prepared surface by means of counry 1164 4 x 4 tractor and heavy trailed disc harrow (KG/L plus D).

— Vegetation clearing by D8H and KG blade set low (as above) but followed by the uprooting of stumps and large roots by means of D8H equipped with 3 tine rippers and lifting sweeps, followed by

Plan : 1 — DENEME ALANININ HARİTADAKİ KONUMU
Plan : 1 — Location map



the piling of the roots and woody debris by front-end rake on D8H and finally by heavy discing by means of County 1164 4 x 4 and heavy disc harrow (KG/L/U plus R/D).

— One light clearing pass by Caterpillar D8H crawler tractor with a modified Fleco clearing rake set high and used to clear the vegetation in to parallel brushpiles 36 metres apart as in the KG operation above. Following the clearing, the remaining stumps and roots to be uprooted by Caterpillar D8H with ripper tires and sweeps; then roots and debris to be raked up and piled by clearing rake, followed by heavy discing by means of County 1164 4 x and heavy disc harrow (F/H/U plus R/D).

— Complete clearing by means of uprooting and raking of the vegetation in one pass with the Fleco rake (modified) on Caterpillar D8H crawler tracter set low to ensure good soil penetration. Vegetation including stumps and roots placed in brushpiles as previously and clearing pass followed by heavy discing by means of county 1164 4 x 4 and heavy disc harrow (F/L plus D).

Each main treatment plot is split into thre sub-plots of aqual size to which the following subsoiling treatments have randomly been allocated.

Tablo : 1-2 Varyans analizi ve Duncan testi sonuçları-Boy ve Çap gelişimi-1987.
Table : 1-2 The results of analysis of variance and Duncan test Height and diameter growth-1987.

P. radiata

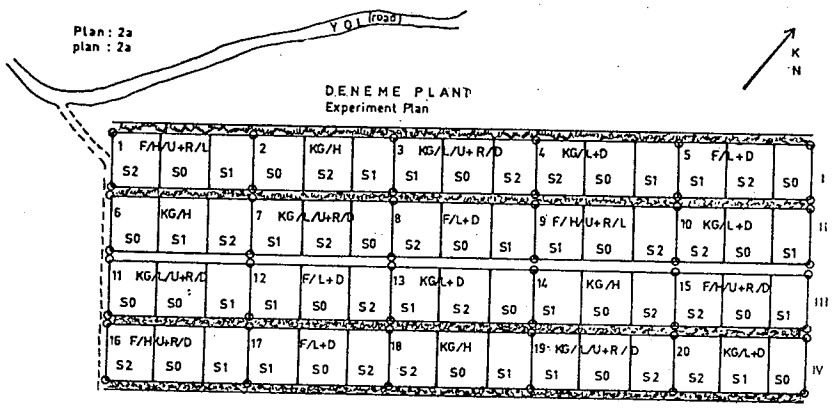
Mean height
Ort. boy

Arazi hazırlığı Site preperation				Alt toprak işleme Subsoiling		Gübreleme Fertilisation	
İşlemler Treats	Ort. Mean	Bloklar Blocks	Ort. Mean	İşlemler Treats	Ort. Mean	İşlemler Treats	Ort. Mean
(F=3.25x)	(cm)	(F=1.40)	(cm)	(F=1.67)	(cm)	(F=2.67)	(cm)
5	8.35)	III	8.27	S_0	8.17	F_1	8.18
2	8.33	IV	8.18	S_2	8.13	F_0	7.98
4	8.14	I	8.04	S_1	7.95		
3	8.00	II	7.84				
1	7.58						

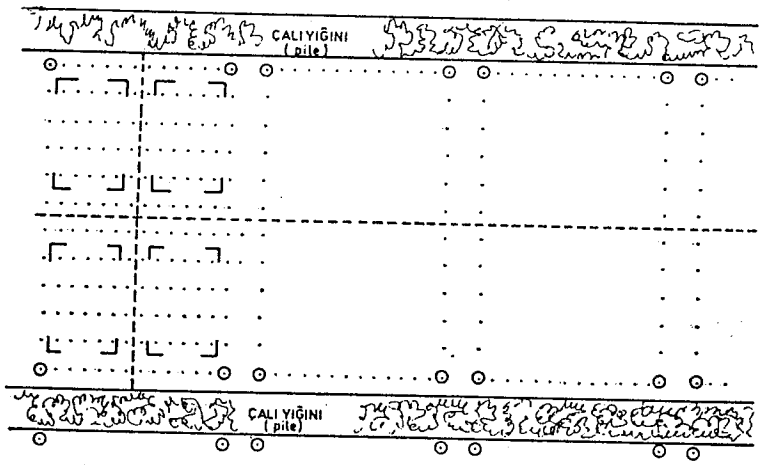
Mean diameter
Ort. çap

	Ort. Mean		Ort. Mean		Ort. Mean		Ort. Mean
(F=0.83)	(cm)	(F=3.26)	(cm)	(F=0.69)	(cm)	(F=18.72xxx)	(cm)
5	15.5	IV	15.5	S_0	15.1	F_1	15.3
2	15.0	III	15.2	S_2	15.0	F_0	14.8
4	14.9	II	15.0	S_1	15.0		
1	14.9	I					

Plan : 2a
Plan : 2a



Plan : 2b
Plan : 2b
DİKİM ve ÖLÇÜ PARSELİ PLANI
Plan for planting and measurement parcels



İşaretler (marks)

O = Köşe kazıklar : Ana işlem parseli (Corner posts: Main treatment parcel)

O = Köşe kazıkları : Alt işlem parselleri (Corner posts: Sub treatmet parcels)

□ = İç ölçü parselleri (Internal measurement parcels)

S0 — No subsoiling

S1 — Subsoiling to approximately 50 cm at about one metre centres by means of 3-tine rippers rear-mounted on a cat. D8H tractor and drawn parallel to the contours.

S2 — As for S1 above but with additional subsoiling pass at right angles to the first cross tining.

Species, spacings fertilisation and maintenance :

P. radiata D. Don (N2 144) and P. pinaster (maritima) Aiton were planted in main treatment plots in March 1975. Each of the foregoing three subsoiling plots per main treatment plot is in turn sub-divided for the random allocation of two species. Seedling were planted in 3 x 2 m. spacing Each of the species sub-plots have finally been sub-divided into two halves — one of which received compound fertiliser, the other remained unfertilised F0-Unfertilised, F1-Fertilised with NPK (15:15:15) granular fertiliser, applied at the rate of 120 g within one month of planting, fallowed by a second booster dose in the spring of the second season. Each of the fertiliser applications were carried out by splitting the amount into two equal portions for insertion into two slits 15 cm. deep on either side of the plants and 20-30 cm. away from the base.

All planting losses were determined and dead plants were replaced in the beginning of the following years vegetation season. And also the place of replaced plants were marked on assesment forms.

All plots were line weeded twice annually for first three years. Interrow weeding was carried out by tracter and disc harrow in all plots.

Statistical design :

A completely randomised block design with 5 main treatment plots in each of four blocks (replications) was used in experiment. Each mean treatment plot was split for three levels of subsoiling allocated at random, with secondary splits for two species and tertiary splits for fertiliser all randomly allocated.

Field observations records and assesments :

The height measurements of all young plants were taken within one month of planting. Periodic re-measurements were made at the end of every years vegetation seasons. Heights were measured

to the nearest an until the mean height of 100 cm was reached, there after all trees were measured precisely. The breast height diameters were measured after the mean height reached 1.5 m. and greater. All records were kept in specially designed annual assesment forms.

The data were analysed with advisory assistance of the Institute's Computer Section using necessry statistical analysis methods such a anovar.

Ecological conditions :

Climate :

The type of climate is Mediterranean maritime mesothermic with hot summer and cool winters. During the project activities climatological data were observed and recorded through a small station In the area for about 8 years. To these records mean annual temperature is 14.5°C, mean max. temperature is 18.1°C, mean min. temperature is 11.1°C, absolute max. temperature is 37.2°C, absolute min. temperature is —6.2°C, annual rainfall is 781.7 mm. Dry period is between July — September, about three months. Snow accumulation also is negligible in the plantation area. Winter frosts are rare

Parent material and soils :

In the profect pilots parent material is developed on limestones and shales, deeply weathered. The limestones, sometimes interbedded with thin layers of chert, appear on in limited areas. Soils are mainly gray brown podsolic, deep and well drained and slightly hidromorphic (gleyic luvisols). Brown, slightly moist pH 6.5 in upper layers and dark reddish brown pH 5. in deeper layers ,30-60 cm.).

Natural vegetation cover :

The natural vegetation cover, before clearing consisted of Castanea Sativa, Quercus cerris, Q. conferta, Q. petraea, Fagus orientalis, Tilia argentea with Laurus nobilis, Arbutus unedo, Rhododendron ponticum, Erica arborea and Cistus salviifolius in understorrey.

Machinery and equipments used :

Cat. D8H Crawler tractor: Turbocharged Indirect Injection Diesel Engine Developing 270 FWHP at 1280 rpm, 6 cyl., Sealed lubricated track chain running on 60 track rollers with 2 track carrier rollers

each side. Lenght of track on ground 2900 mm, Track shoe width 27 mm, Heavy duty tractor.

County 1164 Tractor: 4 wheel drive, Ford 4015 direct injection diesel, 6 cyl. developing 110 FWHP at 2200 rpm. A heavy duty agricultural tractor is tended for use on light clearing and for the preperation of soil with various types of implements to the standard requiined for planting.

Shearing Blade: KGA 81 Rome International Co. Cedartown, Geofgia, USA. A heavy duty blade of special alloy stell, designed to apply the horse power and weigh of a heavy crawler tracter to a fine sharp cutting edge. It is mounted on the 'C' frame of the tractor at an angle of approximately 30° to the line of travel. The leading edge of the blade is fitted with a point, a vertical extension which extends forward approx. 60 cm beyond the cutting edge. The cutting edge extends across the full width of the tractor and forms the sheering tool which cuts the vegetation. A guide bar, above and parallel to the cutting edge, projects the tractor and guides the cut material forward and to the sight of the line of travel.

Front mounted rake: Model 8S Heavy Duty Clearing Rake 4 m wide, 2,5 m high, a heavy duty clearing rake for maximum service land clearing, suitable for use on the clearing of trees, stumps and rocks. The rake is mounted to the C frame of the tractor. In the clearing of degraded coppice, the rake is lowered into the ground until the rake teeth penetrate the ground to approximately half their lenght. The teeth of the rake penetrate beneath the roots complete with stems in one pass. The vegetation removed is deposited in windrows or piles a long the contour.

Ripper for crawler tractor : Rome Int. Co., Cedartown, Georgia, USA. Draft member and clamp assembly 7400 DB, Heavy Duty Tool Bar — TB. 144. Subsoilers 4 TAC. with soil lifters 3 TA — 1890. A heavy duty ripper tine assembly designed to rupture the sub-soil to a debth of approx. 50 cm. and to lift roots to the surface. The ripper tines are sunk into the cleared area to a depth of 50-60 cm. and pulled through ground by the crawler tractor. The soil-lifters extending to each side of the ripper tine ensure almost complete coverage of the area to the full width of th tractor. These Sweeps slide under the roots of the vegetation and these are directed upwards by the tilt of the wings on the sweeps and the curved shank of the ripper tine to the surface.

Disc Harrow : Napier Bros Ltd., Buny Street, Dalby, Australia

24 Disc Heavy Duty Wheeled Offset Discer with 65 cm diameter scalloped discs carried on 4-gangs mounted in heavy steel fabricated frame and turning a pre-packed «Sealed for life» self-aligning bearings. Carrying wheels with 7.50 x 16 tyres and machine complete with scrapers, hydraulic lift cylinders and hoses. The equipment is suitable for surface tillage of compacted soil to a depth of 25 cm. The equipment is pulled by County 1164 tractor.

Conclusions :

At the end of 12 years,all records were analyed and commented by the technical staff of the project. The results obtained were outlined below.

Statistical analyses have showed significant differences among main treatments. Main treatments have effected the diameter and height growth of P. pinaster and P. radiata. The treatments nr. 4 and 5 have showed better growth comparing the others. Fleco rake is the main equipment in both treatments, 4 and 5. In case of proper use of Fleco rake soil losses are reduced to a minimum level during operations. Soil should be dry during raking operations.

No significant findings have been found among subsoiling combinations. According to mean values measurement figures of S2 treatments (complete and cross ripping to a depth of 50 cm) are higher than others. Kerpe plantation area is quite rich from the organic matter point of view. Kerpe has organic matter accumulation of many years. So in areas like Kerpe, subsoiling is not necessary. For that reason the comparisons of subsoiling treatments gave no significant results.

There was no significant differences between the sub-plots, fertilised and unfertilised.

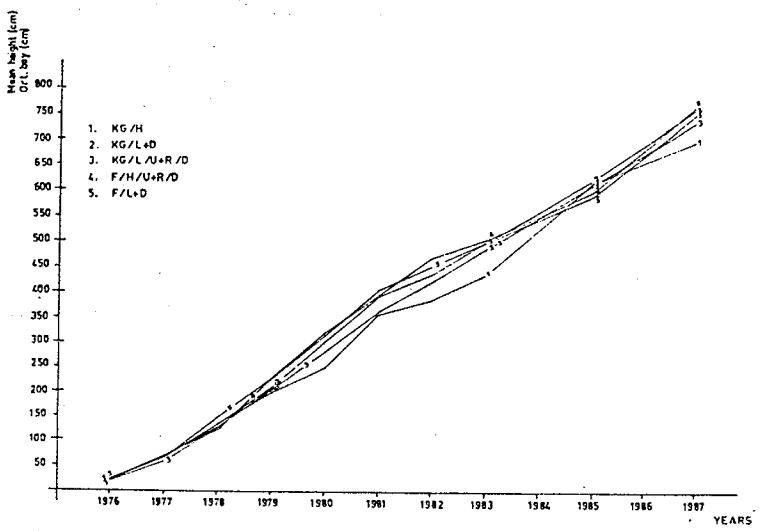
Existing vegetation, if it has economic value, should be cut with axe or chain saw and material has to be marketed.

Remnants of roots and debris have to be cleared and piled on contours by Fleco rake on complete area.

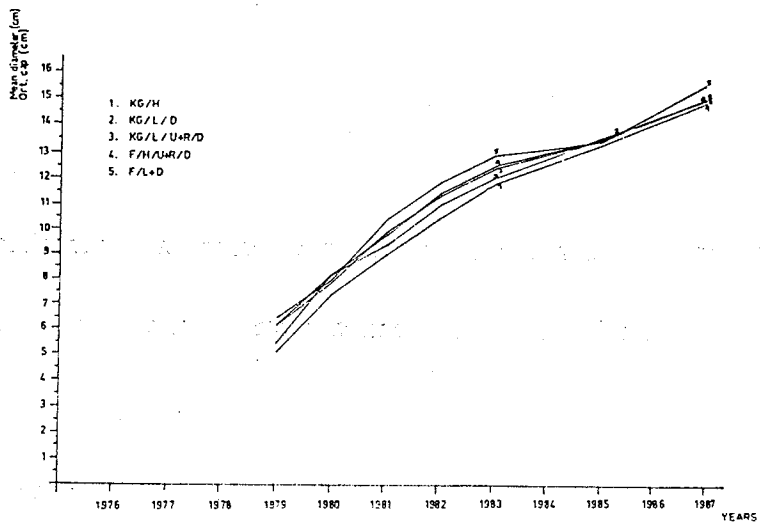
After clearing the land the area is disced with a heavy disc-harrow.

In the following first three years after planting weeding is necessary on rows by hand and inter-rows by tractor.

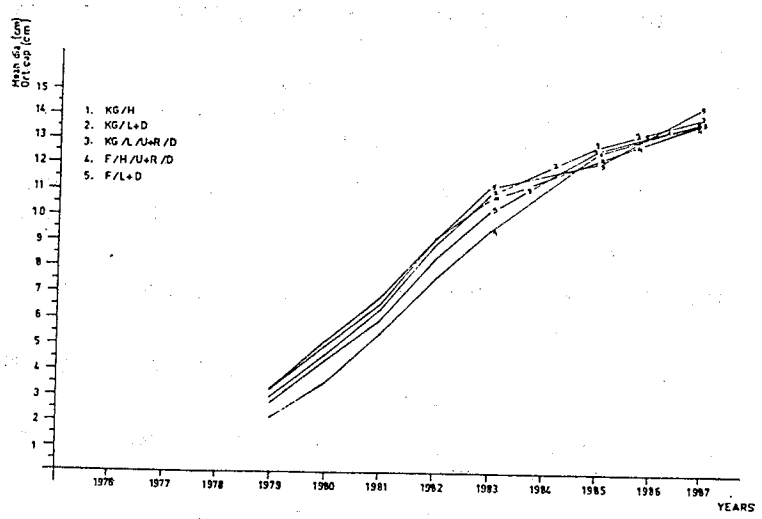
The tables, showing the height and diameter growths of P. radiata and P. pinaster, were given in Table: 1, 2, 3, 4.



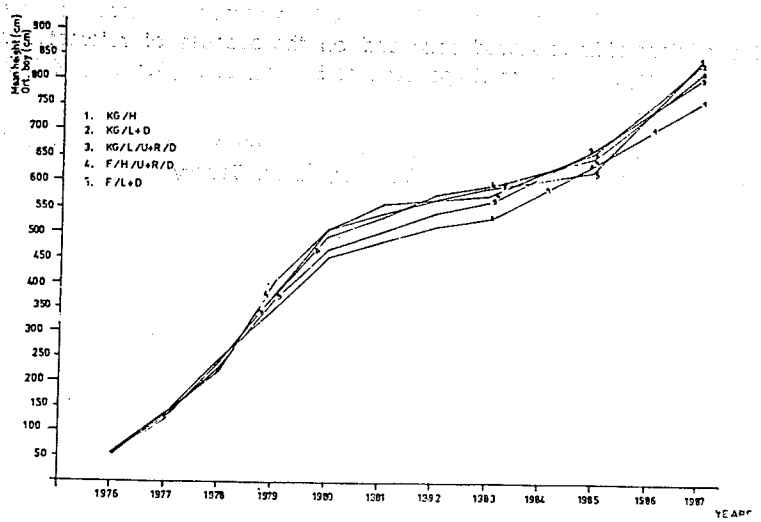
Şekil : 1 — P. Pinaster Aiton Boy Büyüme Grafiği
Figure : 1 — Height growth of P. Pinaster Aiton



Şekil : 2 — P. Pinaster Aiton Çap Büyüme Grafiği
Figure : 2 — Diameter growth of P. Pinaster Aiton



Şekil : 3 — P. Radiata D. Don Boy Büyüme Grafiği
Figure : 3 — Height growth of P. Radiata D. Don



Şekil : 4 — P. Radiata D. Don Çap Büyüme Grafiği
Figure : 4 — Diameter growth of P. Radiata D. Don

LİTERATURE

Althen, F.W., 1977 : Site preperation prevents re-opening of planting slits in heavy - textured soils, The Forestry Chronicle, Canada.

Appelroth, S.E., 1981 : Latest developments in site preperation in Finland, Precee-dings of the American Society of Agricultural Engineers Symposium on Engi-neering Systems for forest Regeneration, Michigan.

Ayberk, et al, 1983 : An investigation on the effects of land preperation methods on the growth of P. pinaster Ait. on maquis sites, Annual Bulletin of the Poplar Inst. of Turkey, Nr. 19, Izmit.

Ayberk, S., 1985 : Climatological data for Kerpe Plantation area, Journal of Poplar Institute, Izmit, Turkey.

Chapman, G.W. - Allan, T.G., 1978 : Establishment techniques for forest planta-tions, FAO. Forestry Paper Nr. 8, FAO, Rome.

Guild, D.W., 1971 : Windrowing and ripping-a comperative study with other site preperation techniques, NZJF, New Zealand.

Norman, C.M., 1978: Ripper scarification: A silvicultural technique developed in Northwestern Alberta, The Forestry Chronicle, Canada.

Neustein, S.A., 1976 : A history of plough development in British Forestry, Scottish Forestry, Vol. 30, No. 1, Edinburgh.

Tolay, U.T' et al, 1982 : The effect of different soil preperation methods on the physical conditions of fine textured soils and on the success of reforestation in the degraded coppice site at Kerpe, Annual Bulletin of Poplar Inst. of Tur-key. Nr. 18, Izmit.

Zoralioğlu, T., 1987 : Investigations on regional site preperation techniques in Antalya and Balıkesir. Journal of Poplar Inst. İzmit, Turkey.

INVESTIGATIONS ON GROWTH PERFORMANCES AND MORPHO - GENETIC CHARACTERISTICS OF MARITIME PINE (PINUS PINASTER AIT.) ORIGINS

Korhan TUNÇTANER
Mümtaz TULUKÇU — Ferit TOPLU

Abstract :

Three Pinus pinaster provenance trials were established at the locations of İstanbul - Fatih Ormanı and İzmit - Kerpe in Marmara region and Zonguldak - Ereğli in western Blacksea region in 1979. These trial were evaluated at the end of 1987. The most satisfactory origins regarding their growth performances and resistancy against biotic and abiotic factors under different ecological conditions were investigated and morpho - genetic characteristics of the origins were determined and compared to each other. The provenances from Morocco and Corsica showed the maximum volume increment and production at all trial sites. These provenances were recommended for the plantations to be established at similar ecological conditions to trial sites since they were also resistant against snow damages.

1. Introduction

Maritime pine is the most important fast growing exotic coniferous species for industrial plantations in Turkey (Ürgenç 1972, Greathouse 1975, Cooling 1977, Şimşek1982, Tunçtaner et al. 1985).

General information on Maritime pine was given in the technical

annual bulletin of Institute in 1985, and the results of growth performances of various Maritime pine provenances at 13 trial sites established in different regions were also given at the same publication. Furthermore it was indicated that Marmara and western Blacksea regions had large potential area for Maritime pine but snow damage was a limiting factor for the sites above 300 m. elevation. Therefore emphasis should be given to the selection of resistant origins against snow damages.

At this study the relations with morphological characteristics of the origins and their growth performances and resistancy level against snow damages were investigated. The evaluations on growth performances and morphological characteristics of the origins were made for the trial sites established at İstanbul-Fatih Ormanı, İzmit-Kerpe and Zonguldak-Ereğli in 1979. Site-origin interactions were also investigated for h ıight, diameter and survival values of the origins.

2. MATERIAL AND METHOD

2.1. **Origins**

Seed of Maritime pine origins used at the trial sites were provided from Italy, Spain, France, Greece and Morocco research institutions through TUR/71/521 FAO project. The list of the origins tested in the trial sites was given in Table 1.

2.2. **Trial sites**

The trial sites representing potential plantation area of Maritime pine are located at İstanbul-Fatih Ormanı, İzmit-Kerpe and Zonguldak-Ereğli. These trials were established in February or March of 1979. Land preperation and maintenance at trial sites were carried out by machines. Locations of the trial sites were shown in figure 1. Ecological conditions of the trial sites and their experimental desings were given in Table 2.

2.3. **Evaluation methods**

Height and diameter measurements of the origins were taken at the end of 1987 at three trial sites. Survival percentages of the origins were also determined at the same time. Variance analysis were applied for the mean values of origins in each trial site Duncan test was used for classification of the origins.

Table 1. Seed sources of P. pinaster Ait. tested in the trial sites

No.	Origin No.	Seed sources of P. pinaster Ait.	FATİH ORMANI	KERPE	EREĞLİ
1	E. 99	Huelva	X	X	X
2	I.100	Pisa	X	X	X
3	I.228	Italy	X	X	X
4	FC. 233	Corsica, var. mesogeensis (Pies et Gaus)	X	X	X
5	F. 234	Landes	X	X	X
6	GR. 236	Patras	X	X	X
7	E. 237	Malaga	X	X	X
8	MA. 238	Sidi Meskour (31° 28 N, 06° 57' W, 1910 m)	X	X	X
9	MA. 239	Ain Tamellilt (31° 26' N, 06° 53' W, 2100 m)	X	X	X
10	MA. 240	Tidiouine (34° 56' N, 04° 32' W, 1550 m)	X	X	X
11	FC. 333	Corsica, var. mesogeensis	X	X	X
12	USA. 378	USA	X	X	X
13	E. 439	Spain	X	X	X
14	I.441	Italy	X	X	X

Table: 2 Informations on site conditions and experimental designs of the trials

	Site conditions	Trial sites								
		Fatih Ormanı			Kerpe			Kdz.Ereğli		
Location	Working division	İstanbul			İzmit			Kdz.Ereğli		
	Range district	İstanbul			Kandıra			Kdz.Ereğli		
	Forest serie	Şeytandere			Kefken			Ereğli		
	Latitude (N)	41° 06'			41° 08'			41° 18'		
	Longitude (E)	28° 56'			30° 11'			31° 31'		
	Altitude (m)	120			30			440		
Climate	Mean annual temperature (°C)	12.8			14.5			12.7		
	April-August mean temp. (°C)	17.5			19.5			17.7		
	Mean annual rainfall (mm)	1074.4			1108.4			1337.1		
	April-August mean rainfall (mm)	389.6			227.6			411.9		
	Absolute max. temperature (°C)	39.7			39.8			41.9		
	Absolute min. temperature (°C)	-15.8			-15.6			-13.2		
	Maximum snow accumulation (cm)	68			90			91		
Soil	Depth of soil	0-30	30-60	60-90	0-30	30-60	60-90	0-30	30-60	60-90
	Soil texture	Clay	Clay	Clay	Clay	Heavy Clay	H.Clay	H.Clay	H.Clay	H.Clay
	Sand (%)	14.90	18.92	18.04	2.43	1.82	3.18	2.90	4.38	12.74
	Silt (%)	37.25	29.01	32.11	39.44	31.02	22.84	33.44	30.64	44.66
	Clay (%)	47.85	52.08	49.85	58.13	67.16	73.98	63.66	64.98	42.60
	Soil reaction (pH)	5.90	6.10	6.10	6.00	5.40	5.20	4.70	4.80	4.90
	$CaCo_3$ (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Organic-matter (%)	1.636	0.783	0.324	1.720	1.424	0.758	4.497	1.873	0.232
	Total N (%)	0.082	0.039	0.016	0.086	0.071	0.038	0.225	0.094	0.012
	$P_2 O_5$ (ppm)	7.28	7.28	7.26	9.08	10.44	9.73	2.68	1.08	0.82
	K^+ (me/100 gr)	0.80	0.53	0.53	11.89	9.56	24.08	4.92	4.96	4.98
	C/N	11.6	11.7	11.8	11.5	11.7	11.6	11.6	11.6	11.3
Experimental design	Establishment date	12.2.1979			6.2.1979			8.3.1979		
	Experimental desing	Randomized blocks			Randomized blocks			Randomized blocks		
	Number of block	3			3			3		
	Number of origin	14			14			14		
	Number of trees in each plot	30			30			30		
	Spacing (m)	2 x 3			2 x 3			2 x 3		

Stem analysis was made for the origins which had showed good growth performances at trial sites. So that height, diameter, volume and increments of selected origins for each age class were determined.

Determination of snow damages for the origins was made using a scale shown in Figure 2.

Morphological characteristics of the origins determined for each trial site (Figure 3) are as follows :

— Length of needle
— Width of needle
— Thickness of needle

— Number of needle
— Angle of branch
— Thickness of branch
— Number of branch
— Length of branch
— Height-diameter ratio

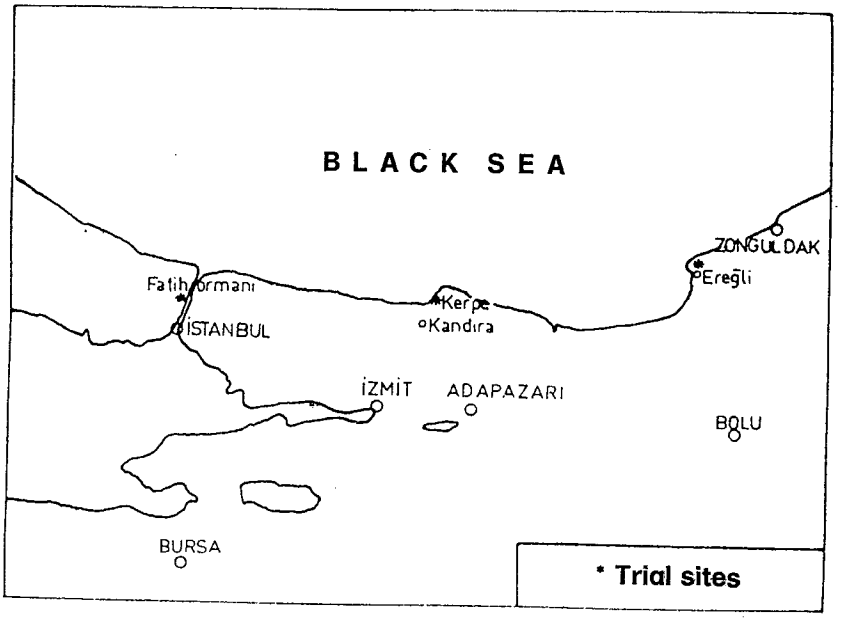


Figure : 1 The map of the location of the trial sites

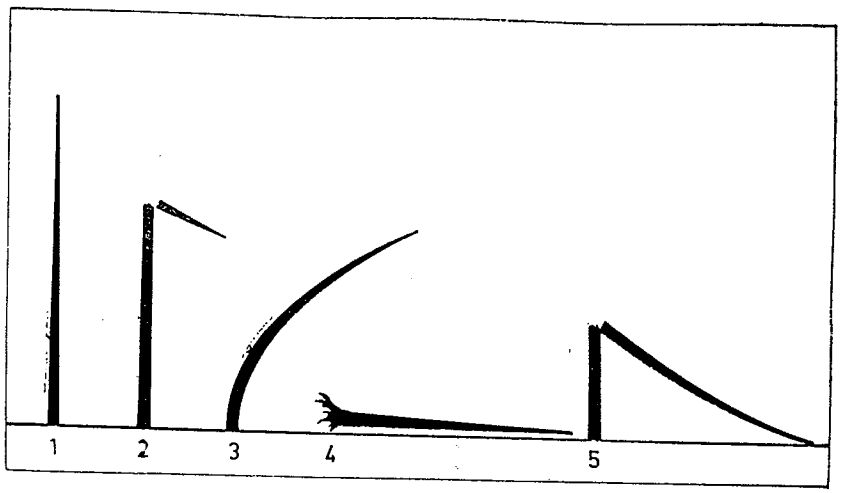


Figure — 2 : Scale of snow damage

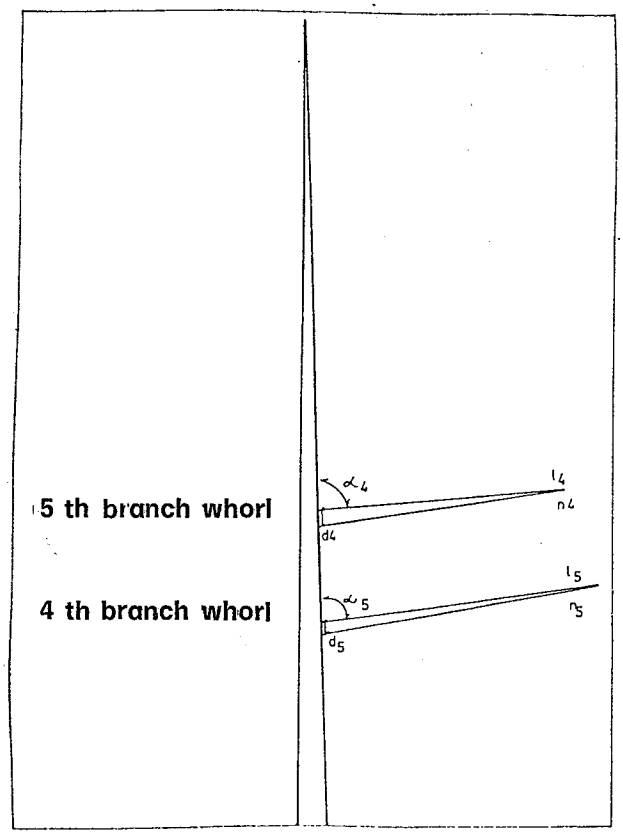


Figure — 3 : Morphological characteristics

3. RESULTS

3.1. Height, diameter and survival of origins and races

The results of analysis of variance for the height, diameter and survival of the origins at the end of 9 th year and comparison of the means at 0.05 probability level were given in Table 3. The origins GR. 236, F. 234, FC. 233 showed the best height performances at Fatih Ormanı, Kerpe and Kdz. Ereğli trial sites respectively.

The origins MA. 240, FC. 333 and MA. 240 were the best origins regarding their diameter growth at these sites.

The origins MA. 240 showed the highest survival percentages at Fatih Ormanı and Ereğli trial sites, while I. 228 was the best at Kerpe.

Table 3. Results of analysis of variance and comparison of the means of height, diameter and survival values of provenances for trial sites

ORİJİNLER (Provenances)	F A T İ H O R M A N I			K E R P E			K D Z. E R E Ğ L I		
	BOY (cm) Height	ÇAP (mm) d. b. h.	YAŞ.FİD.SAYISI Survival	BOY (cm) Height	ÇAP (mm) d. b. h.	YAŞ.FİD.SAYISI Survival	BOY (cm) Height	ÇAP (mm) d. b. h.	YAŞ.FİD.SAYISI Survival
	F = 1.02 NS	F = 0.87 NS	F = 6.22***	F=7.10 ***	F=1.80 NS	F = 2.39*	F=3.84*	F=2.12*	F = 6.66 ***
1- E. 99	(6) 300.9	(10) 53.0	(10) 86.5	(5)571.1	(11) 108.6	(3) 86.5	(4)459.2	(10) 102.5	(10) 76.8
2- I.100	(1) 286.4	(7) 50.9	(12) 78.5	(1)545.2	(4) 102.7	(11) 85.0	(5)454.1	(4) 98.0	(9) 76.6
3- I.226	(10) 278.5	(11) 47.9	(3) 75.3	(11)533.6	(10) 101.9	(6) 83.8	(6)443.4	(1) 97.3	(8) 71.7
4- FC.233	(11) 276.3	(1) 47.3	(6) 74.4	(4)527.6	(5) 100.7	(7) 83.0	(1)437.1	(5) 93.7	(5) 70.7
5- F.234	(3) 268.6	(6) 45.6	(4) 72.3	(6)490.3	(1) 98.9	(9) 81.5	(10)428.7	(11) 93.2	(3) 70.5
6- GA.236	(7) 262.0	(3) 44.3	(2) 72.3	(3)487.6	(14) 92.6	(4) 81.5	(11)426.9	(6) 85.2	(13) 69.7
7- E.237	(12) 261.9	(14) 43.1	(9) 70.0	(12)472.2	(3) 92.1	(10) 79.3	(14)418.7	(14) 84.6	(14) 69.6
8- HA.238	(14) 250.6	(12) 43.0	(14) 68.2	(14)458.5	(7) 91.3	(14) 78.9	(12)404.4	(8) 83.8	(12) 68.1
9- HA.239	(9) 240.6	(8) 41.9	(8) 67.5	(2)454.5	(2) 89.7	(12) 77.7	(3)400.5	(3) 83.3	(6) 67.0
10- HA.240	(4) 240.4	(9) 41.8	(13) 66.2	(10)443.7	(12) 88.7	(5) 77.6	(13)394.9	(13) 79.5	(4) 66.1
11- FC.333	(2) 237.4	(2) 40.9	(7) 63.3	(7)430.9	(6) 84.4	(1) 76.5	(8)368.9	(7) 79.4	(11) 63.2
12- UBA.378	(8) 218.6	(4) 35.9	(1) 61.1	(9)403.6	(9) 83.4	(8) 71.6	(7)355.6	(12) 76.9	(2) 62.0
13- E.439	(13) 203.9	(13) 33.7	(5) 57.4	(13)350.4	(8) 80.5	(2) 70.4	(2)353.8	(2) 74.7	(7) 59.4
14- I.441	(5) 158.8	(5) 25.9	(11) 53.5	(8)379.6	(13) 77.2	(13) 66.9	(9)313.0	(9) 65.8	(1) 41.7

NS : Nonsignificant

* : p = 0.05 Significant

*** : p = 0.001 Significant

Duncan tests were made at p = 0.05 level

The results of analysis of variance made for the mean values of the races regarding their height, diameter and survival were given in Table 4. Comparisons of the means at 0.05 probability level were also given in the same table.

3.2. Combined analysis of the trial sites

The results of combined analysis made for height, diameter, survival and snow damages of the origins at three sites were given in Table 5. Apart from this, the results of Duncan tests applied for trial sites were given in Table 6, and for origins were given in Table 7, at 0.05 probability level. Interactions between trial sites and provenances were given in Table 8.

3.3. Stem analysis

Height, diameter, volume and volume increment of the mean trees were found by stem analysis. Volume production and mean annual volume increment of the origins per hectare at ten years were calculated using the values obtained by stem analysis (Table 9 and Figure 4).

3.4. Snow damages

Results of analysis of variance and comparison of the means of snow damage values of provenances for Fatih Ormanı and Kdz. Ereğli trial sites were given in Table 10.

Relations between snow damages and morphological characteristics

Simple and multiple regression analysis were made using snow damage values and morphological characters (length of needle, width of needle, tickness of needle, number of needle, branch angle, branch thickness, number of branches, branch length of the origins for Fatih Ormanı and Kdz.-Ereğli trial sites. Correlation matrices for Fatih Ormanı were given in Table 11, for Kdz. Ereğli in Table 12. Correlation matrices of relations between morphological characters and snow damage of races at two trial sites were given in Table 13 and 14.

Table 4. **Results of analysis of variance and comparison of the means of height, diameter and survival values of races for trial sites**

IRK Race	FATİH. ORMANI			KERPE			KDZ. EREĞLİ		
	BOY (cm) Height	ÇAP (mm) d. b. h.	YAŞ.FİD.SAYISI Survival	BOY (cm) Height	ÇAP (mm) d. b. h.	YAŞ.FİD.SAYISI Survival	BOY (cm) Height	ÇAP (mm) d. b. h.	YAŞ.FİD.SAYISI Survival
	F=2.41 NS	F=5.40 *	F = 6.69 *	F=13.96***	F=2.96 NS	F = 1.24 NS	F=4.62 *	F=1.80 NS	F = 3.74 NS
1- LAND	(2) 250.2	(5) 45.7	(3) 71.7	(1) 571.1	(2) 105.6	(2) 85.0	(1) 451.1	(2) 95.6	(4) 70.7
2- KORSİKA	(3) 254.9	(4) 45.6	(4) 71.1	(2) 530.6	(1) 100.7	(4) 83.8	(2) 443.0	(1) 93.7	(1) 70.7
3- İTALYA	(5) 252.2	(3) 42.7	(5) 62.9	(3) 466.9	(3) 91.4	(3) 78.9	(5) 392.5	(5) 85.4	(3) 67.7
4- FAS	(4) 245.9	(2) 41.8	(2) 61.3	(5) 460.9	(5) 89.1	(1) 77.6	(3) 391.0	(4) 84.0	(2) 64.3
5- İSPANYA	(1) 358.8	(1) 25.8	(1) 57.4	(4) 408.9	(4) 86.6	(5) 72.7	(4) 369.9	(3) 80.9	(5) 56.3

NS : Nonsignificant
* : p = 0.05 Significant
*** . p = 0.001 Significant
Duncan tests were made at p = 0.05 level

Table 5. Results of combined analysis of trial sites

VARYASYON KAYNAĞI Source of variation	BOY-Height		ÇAP-Diameter		YAŞAYAN FİDAN SAYISI Survival		KAR ZARARI Snow Damages	
	SD	F	SD	F	SD	F	SD	F
Aynı yerdeki bloklar (Blocks in the same trial)	6	8.10***	6	5.78**	6	9.46***	4	1.80 NS
Deneme alanları (Trial sites)	2	272.23***	2	202.34***	2	45.14***	1	2.51 NS
Orijinler (Provenances)	13	6.04***	13	2.71**	13	6.93***	13	12.50***
Deneme Alanı x Orijinler (Trial site x provenances)	26	1.80*	26	1.00 NS	26	3.95**	13	0.66 NS
Residual	78		78		78		52	
GENEL	125		125		125		83	

NS : Nonsignificant
* : p = 0.05 Significant
** : p = 0.01 Significant
*** : p = 0.001 Significant
Duncan tests were made at p = 0.05 level

Table 6. Comparison of the mean values of trial sites with regard to the results of combined analysis

DENEME ALANLARI Trial Sites	BOY-Height	ÇAP-Diameter	YAŞAYAN FİDAN SAYISI Survival	KAR ZARARI Snow Damages
	F = 272.23***	F = 202.34***	F = 45.14***	F = 2.51 NS
1- Fatih Ormanı	(2) 471.8	(2) 92.3	(2) 78.6	(2) 0.877
2- Kerpe	(3) 403.5	(3) 85.7	(1) 69.0	(1) 0.824
3- Kdz.Ereğli	(1) 252.3	(1) 42.5	(3) 66.7	

*** : p = 0.001 Significant
NS : Nonsignificant
Duncan tests were made at p = 0.05 level

Table 7. Comparison of the mean values of provenances at the trial sites with regard to the results of combined analysis

ORİJİNLER Provenances	BOY-Height	ÇAP-Diameter	YAŞAYAN FİDAN SAYISI Survival	KAR ZARARI Snow Damages
	F = 6.04***	F = 2.71**	F = 6.93***	F = 12.50***
1- E. 99	(1) 422.8	(10) 85.8	(10) 80.9	(10) 1.133
2- I.100	(6) 414.2	(11) 83.2	(3) 77.5	(9) 1.127
3- I.228	(11) 412.2	(1) 81.2	(9) 76.1	(8) 1.103
4- FC.233	(4) 408.9	(4) 78.9	(6) 75.1	(4) 1.083
5- F.234	(5) 408.0	(7) 73.8	(12) 74.0	(11) 1.075
6- GR.236	(3) 385.5	(14) 73.4	(4) 73.3	(14) 0.897
7- E.237	(10) 383.6	(5) 73.4	(14) 72.2	(12) 0.845
8- MA.238	(12) 379.5	(3) 73.2	(8) 70.3	(3) 0.747
9- MA.239	(14) 378.6	(6) 71.7	(5) 68.6	(1) 0.728
10- MA.240	(7) 352.1	(12) 70.2	(7) 68.5	(2) 0.725
11- FC.333	(2) 348.6	(8) 68.7	(2) 68.2	(6) 0.688
12- USA.378	(13) 329.1	(2) 68.4	(13) 67.6	(13) 0.640
13- E.439	(8) 322.4	(9) 63.6	(11) 67.3	(5) 0.638
14- I.441	(9) 319.1	(13) 63.5	(1) 59.8	(7) 0.480

** : p = 0.01 Significant
*** : p = 0.001 Significant
Duncan tests were made at p = 0.05 level

Table 8. Interactions between trial sites and provenances with regard to the results of combined analysis

ORIJİNLER (Provenances)	BOY-Height (cm)	ÇAP-d. b. h.(mm)	YAŞAMA ORANI Survival	KAR ZARARI Snow damages
	F = 1.30*	F = 1.60 NS	F = 3.55 **	F = 0.66 NS
1- E. 99	(19) 571.1	(25) 100.6	(17) 86.5	(32) 1.1600
2- I.100	(15) 545.1	(18) 102.7	(10) 86.5	(10) 1.1467
3- I.228	(25) 533.6	(30) 102.5	(25) 85.0	(37) 1.1467
4- FC.233	(18) 527.6	(24) 101.9	(20) 83.8	(36) 1.1200
5- F.234	(20) 490.3	(19) 100.7	(21) 82.9	(38) 1.1200
6- GR.236	(17) 487.6	(15) 98.9	(23) 81.5	(9) 1.1067
7- E.237	(26) 472.2	(32) 98.0	(18) 81.5	(39) 1.0867
8- MA.238	(32) 459.2	(29) 97.3	(24) 79.3	(8) 1.0867
9- MA.239	(28) 458.5	(33) 93.7	(28) 78.9	(11) 1.0633
10- MA.240	(16) 454.5	(39) 93.2	(12) 78.4	(42) 1.0133
11- FC.333	(33) 454.1	(28) 92.6	(34) 77.7	(4) 1.0067
12- USA.378	(24) 443.7	(17) 92.1	(15) 77.6	(40) 0.8800
13- E.439	(34) 443.4	(21) 91.3	(38) 76.8	(29) 0.8500
14- I.441	(21) 438.9	(16) 89.7	(37) 76.8	(12) 0.8100
15- E. 99	(29) 437.1	(26) 88.7	(13) 76.5	(2) 0.7967
16- I.100	(38) 428.6	(34) 85.2	(3) 75.4	(14) 0.7800
17- I.228	(39) 426.9	(42) 84.6	(6) 74.4	(2) 0.7400
18- FC.233	(42) 418.8	(22) 84.5	(4) 72.3	(6) 0.7100
19- F.234	(40) 404.4	(20) 84.4	(2) 72.3	(30) 0.7100
20- GR.236	(23) 403.6	(36) 83.7	(36) 71.7	(31) 0.6967
21- E.237	(31) 400.5	(31) 83.3	(22) 71.6	(41) 0.6900
22- MA.238	(27) 398.6	(23) 83.3	(33) 70.7	(34) 0.6667
23- MA.239	(41) 384.9	(41) 79.5	(31) 70.6	(33) 0.6500
24- MA.240	(22) 379.7	(35) 79.4	(16) 70.4	(5) 0.6267
25- FC.333	(36) 368.9	(40) 78.9	(9) 69.9	(1) 0.6067
26- USA.378	(35) 355.6	(27) 77.3	(41) 69.7	(13) 0.5900
27- E.439	(30) 353.8	(30) 74.7	(42) 69.6	(35) 0.4867
28- I.441	(37) 313.0	(37) 65.8	(14) 68.2	(7) 0.4733
29- E. 99	(6) 308.9	(10) 53.0	(40) 68.1	
30- I.100	(1) 286.4	(7) 50.9	(8) 67.5	
31- I.228	(10) 276.5	(11) 47.9	(34) 66.9	
32- FC.233	(11) 276.3	(1) 47.3	(27) 66.9	
33- F.234	(3) 268.3	(6) 45.6	(13) 66.2	
34- GR.236	(7) 262.0	(3) 44.3	(32) 66.1	
35- E.237	(12) 261.9	(14) 43.1	(7) 63.3	
36- MA.238	(14) 258.6	(12) 43.0	(39) 63.2	
37- MA.239	(4) 240.1	(8) 41.9	(30) 62.0	
38- MA.240	(9) 240.0	(9) 41.8	(1) 61.1	
39- FC.333	(2) 237.4	(2) 40.9	(35) 59.4	
40- USA.378	(8) 238.6	(4) 38.9	(5) 57.4	
41- E.439	(13) 203.9	(13) 33.7	(11) 53.6	
42- I.441	(5) 198.8	(5) 25.9	(33) 47.7	

NS : Nonsignificant

* : p = 0.05 Significant

** : p = 0.01 Significant

Duncan tests were made at p = 0.05 level

Table 9. Growth values of the origins obtained by stem analysis of sample trees in the trial sites

DENEME ALANLARI Trial sites	ORİJİNLER Origins	GÖĞÜS ÇAPI (Kabuklu) d.b.h.with bark (cm)	AĞAÇ TAM BOYU Tree height (m)	AĞAÇ HACMI (Kabuklu) Tree volume(with bark) (m^3)	ORTALAMA ARTIM (Kabuklu) Mean annual increment (With bark) (m^3/ha./yıl)	HEKTARDAKİ m^3/ha. HACIM (Kabuklu) Volume(with bark) m^3/ha.	HEKTARDAKİ m^3/ha. ORTALAMA ARTIM Mean annual increment (With bark) m^3/ha./yıl
KDZ. EREĞLİ FATİH ORMANI	MA.240	5.3	2.95	0.0057	0.0006	9.405	0.940
	GR.236	4.5	2.95	0.0055	0.0005	8.437	0.844
	E. 237	5.1	2.55	0.0052	0.0005	6.671	0.667
	I. 441	4.6	2.65	0.0043	0.0004	6.162	0.616
	FC.333	4.7	2.60	0.0048	0.0005	5.117	0.512
KERPE	FC.333	10.7	5.50	0.0286	0.0029	46.732	4.673
	E. 99	9.9	5.30	0.0179	0.0018	28.049	2.805
	F. 234	10.0	5.30	0.0171	0.0017	26.214	2.621
	MA.240	10.1	4.30	0.0167	0.0017	26.169	2.617
	MA.240	10.2	4.50	0.0257	0.0026	40.272	4.027
	FC.233	9.8	5.25	0.0252	0.0025	34.851	3.485
	F. 234	9.4	4.75	0.0227	0.0023	33.301	3.330
	GR.236	8.6	4.75	0.0181	0.0018	25.340	2.534
	FC.333	9.3	4.05	0.0191	0.0019	25.155	2.515
	I. 441	8.4	4.15	0.0168	0.0017	24.645	2.464
	F. 99	9.8	4.95	0.0212	0.0021	15.549	1.555

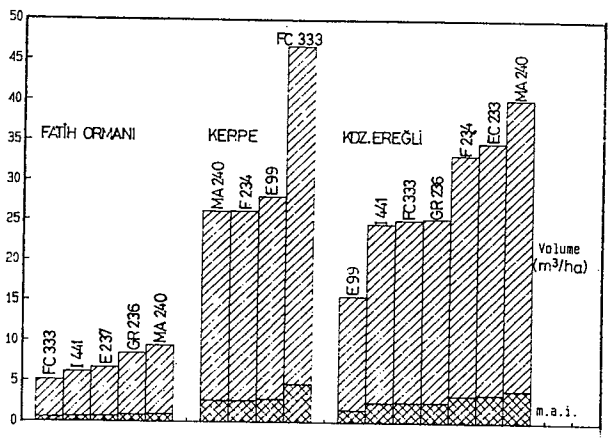


Figure 4 — The volume and increment values of the origins obtained by stem analysis

Table 10. **Results of analysis of variance and comparison of the means of snow damages values of provenances for trial sites**

ORİJİNLER (Provenences)	FATİH ORMANI F = 6.88***	Kdz.EREĞLİ F = 6.33***
1- E. 99	(10) 1.147	(4) 1.160
2- I.100	(9) 1.107	(9) 1.147
3- I.228	(8) 1.087	(10) 1.120
4- FC.233	(11) 1.063	(8) 1.120
5- F.234	(4) 1.007	(11) 1.087
6- GR.236	(12) 0.810	(14) 1.013
7- E. 237	(3) 0.797	(12) 0.880
8- MA.238	(14) 0.780	(1) 0.850
9- MA.239	(2) 0.740	(2) 0.710
10- MA.240	(6) 0.710	(3) 0.697
11- FC.333	(5) 0.627	(13) 0.690
12- USA.378	(1) 0.607	(6) 0.667
13- E. 439	(13) 0.590	(5) 0.650
14- I. 441	(7) 0.473	(7) 0.487

*** : p = 0.001 Significant
Duncan tests were made at p = 0.05 level

3.5. Morphological characteristics

3.5.1. Morphological characteristics of the origins

The results of analysis of variance and comparison of the mean values of morphological properties of provenances at Fatih Ormanı, Kerpe and Kdz. Ereğli trial sites were shown in Tables 15-17.

3.5.2. Morphological characteristics of the races

The results of the analysis of variance and comparison of the mean values of morphological properties of the races (France-Land, France-Corsica, Italy, Morocco and Spain) for trial sites were given in Tables 18-20.

3.5.3. Description the races regarding their morphological properties

Morphological characteristics were evaluated separately for origins and races at each trial sites. According to these evaluations,

Races	Length of needle (cm)	Width of needle (mm)	Thickness of needle (mm)	Number of needle
1. Land-France	Long (14.5-16.5	Medium (1.6-1.8	Medium (0.9-1.1	Few (140-165)
2. Corsica-France	Medium (12.5-14.5	Wide (1.8-2.0	Medium (0.9-1.1	Medium (165-190)
3. Italy	Medium (12.5-14.5	Medium (1.6-1.8	Medium (0.9-1.1	Few (140-165)
4. Morocco	Short (10.5-12.5	Narrow (1.4-1.6	Thin (0.8-0.9	Many (190-215)
5. Spain	Medium (12.5-14.5	Wide (1.8-2.0	Thick (1.1-1.2	Few (140-165)

it was not possible to make a description for the races concerning morphological characteristics of branches. However, the races were described concerning their needle characteristics. These definitions were given below.

Table 11. Correlation matrix of relations between morphological characters and snow damage of origins at Fatih Orman trial site

		1	2	3	4	5	6	7	8	9
1	Snow damage	1.000								
2	Length of needle	0.493	1.000							
3	Width of needle	0.544	0.695	1.000						
4	Thickness of needle	0.131	0.390	0.695	1.000					
5	Number of needle	—0.556	—0.331	—0.292	—0.007	1.000				
6	Angle of branch	0.087	—0.133	—0.181	—0.138	—0.071	1.000			
7	Thickness of branch	—0.057	0.153	0.235	0.337	0.524	—0.267	1.000		
8	Number of branch	—0.187	—0.166	—0.164	—0.027	0.150	0.017	0.067	1.000	
9	Length of branch	—0.142	0.175	0.141	0.195	0.455	—0.411	0.837	0.119	1.000

degree of freedom of r = 40

Table 12. **Correlation matrix of relations between morphological characters and snow damage of origins at Kdz. Ereğli trial site**

		1	2	3	4	5	6	7	8	9
1	Snow damage	1.000								
2	Length of needle	1.188	1.000							
3	Width of needle	0.351	0.679	1.000						
4	Thickness of needle	0.149	0.361	0.428	1.000					
5	Number of needle	0.026	—0.149	—0.100	—0.314	1.000				
6	Angle of branch	—0.023	0.122	0.110	0.019	—0.447	1.000			
7	Thickness of branch	0.298	0.313	0.326	0.234	0.342	—0.092	1.000		
8	Number of branch	—0.176	—0.011	—0.123	—0.186	0.296	—0.078	—0.021	1.000	
9	Length of branch	0.192	0.168	0.106	0.014	0.319	—0.044	0.839	—0.031	1.000

degree of freedom of $r = 40$

Table 13. Correlation matrix of relations between morphological characters and snow damage of races at Fatih Ormanı trial site

		1	2	3	4	5	6	7	8	9
1	Snow damage	1.000								
2	Length of needle	0.677	1.000							
3	Width of needle	0.622	0.654	1.000						
4	Thickness of needle	0.201	0.050	0.594	1.000					
5	Number of needle	—0.740	—0.638	—0.348	0.221	1.000				
6	Angle of branch	—0.137	—0.371	—0.081	0.077	0.350	1.000			
7	Thickness of branch	—0.224	—0.025	0.283	0.750	0.621	0.155	1.000		
8	Number of branch	—0.152	—0.459	—0.233	0.195	0.405	0.645	0.177	1.000	
9	Length of branch	—0.214	0.030	0.170	0.590	0.569	0.043	0.900	0.204	1.000

degree of freedom of $r = 13$

Table 14. Correlation matrix of relations between morphological characters and snow damage of races at Kdz. Ereğli trial site

		1	2	3	4	5	6	7	8	9
1	Snow damage	1.000								
2	Length of needle	0.397	1.000							
3	Width of needle	0.490	0.734	1.000						
4	Thickness of needle	0.399	0.242	0.305	1.000					
5	Number of needle	0.127	—0.236	—0.364	—0.364	1.000				
6	Angle of branch	—0.182	0.149	0.303	0.264	—0.811	1.000			
7	Thickness of branch	0.435	0.401	0.309	0.728	—0.009	0.166	1.000		
8	Number of branch	—0.140	0.029	—0.142	0.280	0.580	—0.587	—0.007	1.000	
9	Length of branch	0.288	0.322	0.135	0.441	—0.002	0.278	0.861	—0.050	1.000

degree of freedom of $r = 13$

Table 15. The results of analysis of variance and comparison of the mean values of morphological properties of provenances at Fatih Ormanı trial site

ORİJİNLER (Provenances)	İBRE BOYU(cm) Length of needle	İBRE ENİ(mm) Width of needle	İBRE KALINLIĞI(mm) Thickness of needle	İBRE SAYISI Number of needle	DAL AÇISI Angle of branch	DAL KALINLIĞI Thickness of branch	DAL SAYISI Number of branch	DAL UZUNLUĞU Length of branch	BOY/ÇAP ORANI Height/diameter ratio
	F = 1.94 NS	F = 4.79 ***	F = 1.23 NS	F = 2.16 *	F = 0.62 NS	F = 0.64 NS	F = 2.64 *	F = 0.54 NS	F = 1.80 NS
1- S. 99	(6) 17.1	(1) 1.957	(8) 1.33	(9) 157.7	(13) 94.1	(7) 22.0	(3) 2.26	(6) 109.6	(5) 76.6
2- T.100	(5) 16.3	(13) 1.663	(1) 1.12	(14) 161.3	(9) 93.8	(9) 20.3	(1) 2.17	(7) 108.1	(6) 71.1
3- I.228	(1) 16.1	(12) 1.607	(2) 1.03	(10) 157.3	(2) 93.6	(11) 19.3	(10) 2.17	(9) 104.5	(4) 68.9
4- F.233	(2) 15.6	(6) 1.777	(13) 1.01	(8) 154.0	(7) 93.4	(14) 19.2	(9) 2.16	(11) 101.1	(13) 64.0
5- F.234	(11) 14.9	(2) 1.777	(14) 0.99	(4) 145.7	(14) 93.3	(12) 18.9	(2) 2.14	(12) 100.5	(3) 61.9
6- G.236	(13) 14.5	(14) 1.767	(11) 0.98	(11) 131.0	(10) 93.1	(3) 18.8	(8) 2.10	(14) 98.9	(1) 61.4
7- S.237	(12) 14.2	(5) 1.760	(7) 0.98	(7) 123.7	(6) 91.4	(8) 18.1	(7) 2.10	(8) 97.7	(14) 60.5
8- M.238	(7) 13.8	(3) 1.747	(3) 0.98	(1) 122.0	(11) 91.2	(6) 18.0	(14) 2.07	(10) 97.6	(11) 60.3
9- M.239	(3) 13.7	(7) 1.727	(4) 0.96	(2) 117.7	(1) 90.9	(1) 17.7	(4) 2.06	(1) 96.5	(2) 60.2
10- M.240	(14) 13.1	(11) 1.713	(12) 0.94	(6) 117.0	(4) 90.8	(4) 17.4	(12) 2.05	(3) 91.8	(12) 59.9
11- F.333	(4) 12.9	(4) 1.713	(5) 0.92	(12) 116.7	(8) 89.9	(2) 17.0	(13) 2.03	(13) 89.2	(5) 57.5
12- DEA.376	(8) 12.2	(8) 1.510	(6) 0.90	(3) 113.3	(3) 88.8	(10) 15.9	(6) 1.95	(5) 66.6	(8) 54.1
13- S.439	(9) 11.5	(9) 1.450	(10) 0.84	(5) 74.7	(12) 68.6	(13) 15.7	(11) 1.93	(2) 62.1	(7) 53.9
14- I.441	(10) 11.2	(10) 1.430	(9) 0.82	(13) 71.0	(5) 87.5	(5) 14.8	(5) 1.84	(4) 81.9	(10) 53.6

*** : p = 0.001 Significant

NS : Nonsignificant

* : p = 0.05 Significant

Duncan tests were made at p = 0.05 level

Table 16. The results of the analysis of variance and comparison of the mean values of morphological properties of provenances at Kerpe trial site

ORİJİNLER (Provenances)	İBRE BOYU(mm) Length of needle F = 2.53 NS	İBRE ENİ (mm) Width of needle F = 4.74 ***	İBRE KALINLIĞI (mm) Thickness of needle F = 6.75 ***	İBRE SAYISI Number of needle F = 1.60 NS	DAL AÇISI Angle of needle F = 1.13 NS	DAL KALINLIĞI Thickness of branch F = 0.57 NS	DAL SAYISI Number of branch F = 0.94 NS	DAL UZUNLUĞU Length of branch F = 0.61 NS	BOY/ÇAP ORANI Height/diameter ratio F = 2.44 NS
1- [illegible]	(1) 15.1	(1) 2.03	(1) 1.15	(11) 094.7	(14) 91.1	(7) 21.1	(10) 2.25	(5) 147.9	(6) 58.0
2- I.100	(6) 14.2	(13) 1.91	(13) 1.08	(3) 156.7	(2) 90.6	(11) 22.9	(11) 2.23	(6) 145.2	(5) 57.0
3- I.228	(4) 13.6	(4) 1.91	(6) 1.07	(10) 145.7	(13) 90.1	(14) 22.7	(4) 2.37	(4) 135.0	(1) 55.3
4- FC.233	(8) 13.3	(6) 1.85	(4) 1.06	(4) 143.7	(6) 89.4	(9) 21.1	(8) 2.17	(12) 131.8	(12) 53.0
5- F.234	(7) 12.9	(11) 1.76	(7) 1.03	(6) 136.7	(11) 88.3	(6) 21.1	(3) 2.14	(11) 131.7	(3) 53.0
6- GE.236	(5) 12.8	(5) 1.74	(9) 0.99	(8) 136.3	(7) 88.2	(4) 21.0	(5) 2.13	(7) 131.0	(13) 52.3
7- E.237	(3) 12.7	(7) 1.73	(2) 0.98	(9) 131.7	(9) 88.1	(3) 20.9	(13) 2.11	(9) 129.8	(2) 52.0
8- MA.238	(9) 12.6	(12) 1.71	(5) 0.97	(14) 127.3	(8) 88.8	(5) 20.6	(6) 2.11	(10) 128.5	(4) 51.7
9- MA.239	(12) 12.5	(3) 1.71	(12) 0.95	(13) 119.0	(1) 88.1	(8) 20.2	(7) 2.09	(2) 127.5	(14) 50.0
10- MA.240	(11) 12.2	(2) 1.67	(14) 0.94	(5) 113.7	(3) 88.0	(2) 20.1	(1) 2.09	(3) 127.1	(11) 49.3
11- FC.333	(2) 12.0	(14) 1.64	(10) 0.91	(2) 110.3	(12) 87.7	(12) 19.2	(2) 2.07	(14) 126.6	(9) 48.3
12- USA.378	(13) 12.0	(8) 1.64	(11) 0.86	(12) 93.7	(10) 87.0	(1) 19.1	(14) 2.05	(8) 125.5	(7) 48.0
13- E.439	(10) 11.2	(9) 1.64	(8) 0.86	(7) 87.0	(4) 85.4	(10) 19.1	(12) 2.05	(1) 121.6	(8) 47.0
14- I.441	(14) 10.5	(10) 1.53	(3) 0.85	(1) 86.3	(5) 84.6	(13) 18.7	(9) 1.96	(13) 119.9	(10) 44.7

NS : Nonsignificant

*** : p = 0.001 Significant

Duncan tests were made at p = 0.05 level

Table 17. The results of the analysis of variance and comparison of the mean values of morphological properties of provenances at Kdz. Ereğli trial site

ORİJİNLER (Provenances)	İBRE BOYU(mm) Length of needle	İBRE ENİ(mm) Width of needle	İBRE KALINLIĞI(mm) Thickness of needle	İBRE SAYISI Number of needle	DAL AÇISI Angle of branch	DAL KALINLIĞI Thickness of branch	DAL SAYISI Number of branch	DAL UZUNLUĞU Length of branch	BOY/ÇAP ORANI Height/diameter ratio
	F = 5.06 NS	F = 4.08 NS	F = 1.72 NS	F = 1.17 NS	F = 0.53 NS	F = 1.79 NS	F = 1.36 NS	F = 2.38 *	F = 0.71 NS
1- E. 99	(5) 17.1	(1) 2.08	(1) 1.59	(8) 376.7	(3) 92.9	(3) 31.7	(4) 2.29	(3) 160.9	(6) 52.3
2- I.160	(11) 16.6	(12) 2.04	(5) 1.38	(9) 335.0	(14) 92.7	(5) 31.4	(10) 2.28	(5) 153.6	(12) 51.3
3- I.228	(4) 15.3	(14) 1.98	(14) 1.14	(10) 297.0	(13) 93.6	(13) 29.0	(8) 2.25	(10) 145.3	(14) 49.9
4- FC.233	(1) 15.3	(3) 1.97	(12) 1.14	(14) 279.7	(7) 91.4	(11) 27.7	(7) 2.17	(8) 141.0	(13) 49.3
5- F.234	(3) 15.2	(11) 1.91	(3) 1.13	(13) 271.0	(10) 90.5	(8) 26.9	(2) 2.17	(13) 137.6	(5) 49.1
6- G.236	(14) 15.2	(2) 1.91	(13) 1.12	(7) 265.7	(12) 90.5	(10) 26.5	(11) 2.16	(11) 132.6	(2) 48.0
7- E.237	(6) 15.0	(13) 1.91	(11) 1.11	(5) 265.3	(5) 90.4	(12) 25.7	(1) 2.12	(6) 131.5	(3) 47.9
8- MA.235	(13) 14.3	(4) 1.88	(6) 1.09	(3) 239.3	(1) 90.3	(14) 25.4	(5) 2.11	(14) 128.6	(9) 47.6
9- MA.239	(2) 13.9	(5) 1.87	(4) 1.08	(11) 219.3	(9) 90.3	(7) 25.2	(12) 2.09	(12) 122.9	(4) 47.2
10- MA.240	(12) 13.8	(6) 1.83	(2) 1.07	(4) 218.7	(4) 90.0	(2) 24.4	(9) 2.08	(2) 119.0	(7) 46.9
11- FC.333	(7) 12.6	(7) 1.80	(7) 1.05	(12) 212.0	(2) 89.9	(1) 23.3	(6) 2.07	(7) 118.6	(10) 46.8
12- MA.376	(10) 12.0	(10) 1.63	(8) 0.97	(6) 210.0	(6) 89.3	(6) 23.0	(13) 2.04	(9) 111.8	(11) 45.9
13- E.439	(9) 11.8	(8) 1.63	(10) 0.96	(1) 191.3	(13) 88.9	(9) 23.0	(14) 2.01	(4) 105.3	(1) 44.9
14- I.441	(8) 11.5	(9) 1.59	(9) 0.94	(2) 169.0	(8) 85.8	(4) 22.0	(3) 1.96	(1) 101.4	(8) 44.2

NS : Nonsignificant

* : p = 0.05 Significant

Duncan tests were made at p = 0.05 level

Table 18. The results of the analysis of variance and comparison of the mean values of the morphological properties of races at Fatih Ormanı trial site

IRKLAR / Races	İBRE BOYU(mm) Length of needle	İBRE ENİ(mm) Width of needle	İBRE KALINLIĞI(mm) Thickness of needle	İBRE SAYISI Number of needle	DAL AÇISI Angle of branch	DAL KALINLIĞI Thickness of branch	DAL SAYISI Number of branch	DAL UZUNLUĞU Length of branch	BOY/ÇAP ORANI Height/diameter ratio
	F = 3.53 NS	F = 10.60 **	F = 4.33 *	F = 5.33 *	F = 1.05 NS	F = 1.63 NS	F = 9.47 **	F = 1.09 NS	F = 7.50 **
1- IAND	(1) 16.3	(5) 1.84	(5) 1.03	(4) 169.3	(5) 92.7	(5) 18.5	(3) 4.6	(4) 99.9	(1) 76.3
2- KONSİKA	(5) 14.7	(3) 1.76	(3) 1.00	(2) 138.0	(4) 92.2	(2) 18.4	(4) 4.6	(5) 96.6	(2) 63.0
3- İTALYA	(3) 14.1	(1) 1.76	(2) 0.97	(3) 130.3	(3) 91.8	(3) 18.3	(5) 4.4	(2) 91.5	(3) 60.7
4- PAS	(2) 13.2	(2) 1.71	(1) 0.92	(5) 105.3	(2) 91.0	(4) 18.0	(2) 3.9	(3) 90.9	(5) 57.3
5- İSPANYA	(4) 11.6	(4) 1.46	(4) 0.92	(1) 74.7	(1) 87.5	(1) 14.8	(1) 3.4	(1) 86.6	(4) 55.0

NS : Nonsignificant

* : p = 0.05 Significant

** : p = 0.01 Significant

Duncan tests were made at p = 0.05 level

Table 19. The results of the analysis of variance and comparison of the mean values of the morphological properties of races at Kerpe trial site

IRKIAR Races	İĞNE BOYU(mm) Length of needle	İĞNE ENİ(mm) Width of needle	İĞNE KALINLIĞI(mm) Thickness of needle	İĞNE SAYISI Number of needle	DAL AÇISI Angle of branch	DAL KALINLIĞI Thickness of branch	DAL SAYISI Number of branch	DAL BOYU Length of branch	BOY/ÇAP ORANI Height/diameter ratio
	F = 2.07 NS	F = 9.19 **	F = 14.00 **	F = 3.54 NS	F = 2.06 NS	F = 0.57 NS	F = 0.92 NS	F = 0.81 NS	F = 7.20 **
1- KARD	(5) 12.3	(5) 1.09	(5) 1.10	(2) 369.0	(3) 89.9	(2) 21.9	(2) 4.80	(1) 347.9	(1) 57.0
2- YUNBİNA	(2) 12.9	(2) 1.83	(1) 0.98	(4) 338.0	(5) 89.1	(3) 21.2	(1) 4.53	(2) 333.3	(3) 53.7
3- İTALYA	(1) 12.9	(1) 1.74	(2) 0.96	(3) 331.3	(4) 89.0	(1) 20.6	(4) 4.50	(4) 327.9	(5) 48.7
4- FAS	(4) 12.3	(3) 1.67	(3) 0.92	(1) 313.7	(2) 87.2	(5) 20.3	(5) 4.40	(3) 327.0	(2) 47.0
5- İSPANYA	(3) 11.7	(4) 1.60	(4) 0.92	(5) 97.3	(1) 84.6	(4) 20.1	(3) 4.37	(5) 326.1	(4) 46.7

NS : Nonsignificant

** : p = 0.01 Significant

Duncan tests were made at p = 0.05 level

Table 20. The results of the analysis of variance and comparison of the mean values of the morphological properties of races at Kdz. Ereğli trial site

IRKLAR Races	İBRE BOYU(mm) Length of needle	İBRE ENİ(mm) Width of needle	İBRE KALINLIĞI(mm) Thickness of needle	İBRE SAYISI Number of needle	DAL AÇISI Angle of branch	DAL KALINLIĞI Thickness of branch	DAL SAYISI Number of branch	DAL UZUNLUĞU Length of branch	BOY/ÇAP ORANI Height/diameter ratio
	F = 8.53 NS	F = 4.91 NS	F = 1.18 NS	F = 1.03 NS	F = 0.23 NS	F = 2.48 NS	F=1.74 NS	F=3.65 NS	F = 1.77 NS
1- LAND	(1) 17.1	(3) 1.95	(1) 1.38	(4) 329.3	(3) 91.8	(1) 31.4	(2) 4.97	(1) 153.6	(1) 49.0
2- KORSİKA	(2) 15.9	(5) 1.91	(5) 1.23	(1) 265.3	(2) 90.7	(3) 27.2	(4) 4.87	(3) 136.1	(3) 48.0
3- İTALYA	(3) 14.8	(2) 1.89	(3) 1.11	(5) 242.3	(1) 90.4	(5) 25.8	(5) 4.47	(4) 132.7	(2) 46.7
4- FAS	(5) 14.0	(1) 1.87	(2) 1.09	(3) 229.0	(5) 90.1	(4) 25.4	(1) 4.47	(2) 119.9	(5) 46.6
5- İSPANYA	(4) 13.7	(4) 1.61	(4) 0.96	(2) 216.7	(4) 88.8	(2) 24.8	(3) 4.20	(5) 119.2	(4) 44.0

NS : Nonsignificant

Duncan tests were made at p = 0.05 level

3.6. Relations between growth values and morphological characteristics

3.6.1. Relations between dbh values and morphological characteristics of the origins and races

Correlations and regressions between diameters at breast height (d.b.h.) and morphological characteristics of origins were investigated for trial sites. Correlation matrices of relations were given in Tables 21-23. A multiple correlation was found between d.b.h. and number of branch and length of branch at Fatih Ormanı trial site.

For the races, multiple correlation was determined between d.b.h. and length of needle, width of needle, thickness of needle, angle of branch, thickness of branch and number of branch and length of branch (Table 24). A linear regression was only found between d.b.h. and length of needle at Kerpe trial site (Table 25). There were not any linear or multiple corelations and regression between d.b.h. and morphological characteristics at Kdz. Ereğli (Table 26).

3.6.2. Relations between height and morphological characteristics of origins and races

The correlations and regressions between height and morphological characteristics of origins and races were investigated. A multiple correlation was found between height and thickness of branch, number of branch and length of branch at Fatih Ormanı trial site. In addition, linear regressions were determined between height and thickness of branch, number of branch and length of branch (Table 27).

A linear regression was found between height and length of branch at Kerpe trial site (Table 28). A multiple correlation was found between height and length of needle, thickness of branch and length of branch at Ereğli trial site (Table 29).

For the races, a multiple correlation was determined between height and width of needle, number of needle, angle of branch and number of branch at Fatih Ormanı trial site (Table 30).

Table 21. Correlation matrix of relations between morphological characters and d.b.h. of origins at Fatih Ormanı trial site

		1	2	3	4	5	6	7	8	9
1	d.b.h.	1.000								
2	Length of needle	0.053	1.000							
3	Width of needle	0.084	0.695	1.000						
4	Thickness of needle	0.172	0.390	0.546	1.000					
5	Number of needle	0.291	—0.331	—0.292	—0.007	1.000				
6	Angle of branch	—0.199	—0.133	—0.181	—0.138	0.071	1.000			
7	Thickness of branch	0.533	0.153	0.235	0.337	0.524	—0.267	1.000		
8	Number of branch	0.043	—0.166	—0.164	—0.027	0.150	0.017	0.067	1.000	
9	Length of branch	0.728	0.175	0.141	0.195	0.455	—0.411	0.837	0.119	1.000

degree of freedom of $r = 40$

Table 22. Correlation matrix of relations between morphological characters and d.b.h. of origins at Kerpe trial site

		1	2	3	4	5	6	7	8	9
1	d.b.h.	1.000								
2	Length of needle	0.101	1.000							
3	Width of needle	—0.035	0.591	1.000						
4	Thickness of needle	—0.136	0.357	0.772	1.000					
5	Number of needle	0.173	—0.136	—0.223	—0.394	1.000				
6	Angle of branch	—0.283	—0.294	—0.169	—0.144	—0.156	1.000			
7	Thickness of branch	0.123	0.125	0.060	0.091	0.135	—0.278	1.000		
8	Number of branch	0.075	0.062	—0.077	—0.162	0.273	—0.059	0.006	1.000	
9	Length of branch	0.384	0.206	0.051	0.151	0.118	—0.459	0.589	—0.175	1.000

degree of freedom of $r = 40$

Tele 23. Correlation matrix of relations between morphological characters and d.b.h. of origins at Kdz. Ereğli trial site

		1	2	3	4	5	6	7	8	9
1	d.b.h.	1.000								
2	Length of needle	0.229	1.000							
3	Width of needle	0.180	0.679	1.000						
4	Thickness of needle	0.066	0.361	0.428	1.000					
5	Number of needle	0.029	—0.149	—0.100	—0.314	1.000				
6	Angle of branch	0.042	0.122	0.110	0.019	—0.447	1.000			
7	Thickness of branch	0.039	0.313	0.326	0.234	0.342	—0.092	1.000		
8	Number of branch	0.358	—0.011	—0.123	—0.186	0.296	—0.078	—0.021	1.000	
9	Length of branch	0.084	0.168	0.106	0.014	0.319	—0.044	0.839	0.031	1.000

degree of freedom of $r = 40$

Table 24. Correlation matrix of relations between morphological characters and d.b.h. of races at Fatih Orman trial site

		1	2	3	4	5	6	7	8	9
1	d.b.h.	1.000								
2	Length of needle	—0.296	1.000							
3	Width of needle	0.003	0.654	1.000						
4	Thickness of needle	0.400	0.050	0.594	1.000					
5	Number of needle	0.626	—0.638	—0.348	0.221	1.000				
6	Angle of branch	0.115	—0.371	—0.081	0.077	0.350	1.000			
7	Thickness of branch	0.580	—0.025	0.283	0.750	0.621	0.155	1.000		
8	Number of branch	0.581	—0.459	—0.233	0.195	0.405	0.645	0.177	1.000	
9	Length of branch	0.664	0.030	0.170	0.590	0.569	0.043	0.900	0.204	1.000

degree of freedom of $r = 13$

Table 25. Correlation matrix of relations between morphological characters and d.b.h. of races at Kerpe trial site

		1	2	3	4	5	6	7	8	9
1	d.b.h.	1.000								
2	Length of needle	0.235	1.000							
3	Width of needle	0.095	0.640	1.000						
4	Thickness of needle	—0.109	0.681	0.822	1.000					
5	Number of needle	0.385	—0.051	0.202	—0.090	1.000				
6	Angle of branch	—0.418	—0.311	—0.090	—5.111	—0.217	1.000			
7	Thickness of branch	0.510	0.296	0.128	—0.001	—0.262	—0.355	1.000		
8	Number of branch	0.091	—0.037	0.041	—0.043	0.347	—0.319	—0.094	1.000	
9	Length of branch	0.669	0.345	—0.096	—0.024	0.198	—0.589	0.662	—0.223	1 000

degree of freedom of $r = 13$

Table 26. Correlatin matrix of relations between morphological characters d.b.h. of races at Kdz. Ereğli trial site

		1	2	3	4	5	6	7	8	9
1	d.b.h.	1.000								
2	Length of needle	—0.021	1.000							
3	Width of needle	—0.127	0.734	1.000						
4	Thickness of needle	—0.399	0.242	0.305	1.000					
5	Number of needle	0.311	—0.236	—0.364	—0.364	1.000				
6	Angle of branch	—0.251	0.149	0.303	0.264	—0.811	1.000			
7	Thickness of branch	—0.307	0.401	0.309	0.728	—0.009	0.166	1.000		
8	Number ot branch	0.508	0.029	—0.142	—0.280	0.580	—0.587	—0.007	1.000	
9	Length of branch	—0.130	0.322	0.135	0.441	—0.002	0.278	0.861	—0.050	1.000

degree of freedom of r = 13

A multiple regression was determined between height and width of needle, tickness of needle, thickness of branch and length of branch at Kerpe trial site (Table 31).

But there were not any linear or multiple correlations and regressions between height and morphological characteristics at Kdz. Ereğli trial site (Table 32).

3.6.3. Relations between volume and morphological characteristics of origins and races

The correlations and regressions between volume and morphological characteristics of origins and races were investigated. A linear regression was found between volume and thickness of branch at Fatih Ormanı trial site (Table 33). A multiple correlation was determined between volume and width of needle, thickness of needle, thickness of branch and number of branch at Kerpe trial site (Table 34). A multiple correlation was found between volume and width of needle, number of branch, length of branch at Ereğli trial site (Table 35).

For the races, a multiple correlation was found between volume and width of needle and length of branch at Ereğli trial site (Table 36). For Fatih Ormanı and Kerpe trial sites, the regressions made for the origins are valid for the races.

4. DISCUSSION AND CONCLUSION

In this study, evaluations were made concerning the selection of origins at trial sites and morphological characteristics of the origins. According to the results of stem analysis, at Fatih Ormanı trial site Moroccon provenance MA. 240 showed the best volume production and increment at the end of 10 th years (9.4 m^3/ha., 0.94 m^3/ha./year).

Growth performances of the origins were poor at this trial site because of intensive land preparation and maintenance techniques were not used at this site efficiently. It was reported that considerable growth increments are obtained by using intensive cultivation methods (Tolay et al. 1976, Ayberk et al 1983, Tunçtaner 1986, Tunçtaner et al. 1985).

Table 27. Correlation matrix of relations between morphological characters and tree height of origins at Fatih Ormanı trial site

		1	2	3	4	5	6	7	8	9
1	Height	1.000								
2	Length of needle	0.150	1.000							
3	Width of needle	0.173	0.695	1.000						
4	Thickness of needle	0.068	0.390	0.546	1.000					
5	Number of needle	0.247	—0.331	—0.292	—0.007	1.000				
6	Angle of branch	—0.269	—0.133	—0.181	—0.138	—0.071	1.000			
7	Thickness of branch	0.412	0.153	0.235	0.337	0.524	—0.267	1.000		
8	Number of branch	0.328	—0.166	—0.164	—0.027	0.150	0.017	0.067	1.000	
9	Length of branch	0.658	0.175	0.141	0.195	0.455	—0.411	0.837	0.119	1.000

degree of freedom of $r = 40$

Table 28. Correlation matrix of relations between morphological characters and tree height of origins at Kerpe trial site

		1	2	3	4	5	6	7	8	9
1	Height	1.000								
2	Length of needle	0.279	1.000							
3	Width of needle	0.264	0.591	1.000						
4	Thickness of needle	0.125	0.357	0.772	1.000					
5	Number of needle	0.071	—0.136	—0.223	—0.394	1.000				
6	Angle of branch	—0.262	—0.294	—0.169	—0.144	—0.156	1.000			
7	Thickness of branch	0.095	0.125	0.060	0.091	0.135	—0.278	1.000		
8	Number of branch	—0.003	0.062	—0.077	—0.162	0.273	—0.059	0.006	1.000	
9	Length of branch	0.458	0.206	0.051	0.151	0.118	—0.459	0.589	—0.175	1.000

degree of freedom of $r = 40$

Table 29. Correlation matrix of relations between morphological characters and tree height of origins at Kdz. Ereğli trial site

		1	2	3	4	5	6	7	8	9
1	Height	1.000								
2	Length of needle	0.460	1.000							
3	Width of needle	0.353	0.679	1.000						
4	Thickness of needle	0.215	0.361	0.428	1.000					
5	Number of needle	—0.149	—0.149	—0.100	—0.314	1.000				
6	Angle of branch	0.194	0.122	0.110	0.019	—0.447	1.000			
7	Thickness of branch	0.066	0.313	0.326	0.234	0.342	—0.092	1.000		
8	Number of branch	0.186	—0.011	—0.123	—0.186	0.296	—0.078	—0.021	1.000	
9	Length of branch	0.186	0.168	0.106	0.014	0.319	—0.044	0.839	—0.031	1.000

degree of freedom of r = 40

Table 30. Correlation matrix of relations between morphological characters and tree height of races at Fatih Ormanı trial site

		1	2	3	4	5	6	7	8	9
1	Height	1.000								
2	Length of needle	—0.160	1.000							
3	Width of needle	0.123	0.654	1.000						
4	Thickness of needle	0.347	0.050	0.594	1.000					
5	Number of needle	0.500	—0.638	—0.348	0.221	1.000				
6	Angle of branch	0.068	—0.371	—0.081	0.077	0.350	1.000			
7	Thickness of branch	0.411	—0.025	0.283	0.750	0.621	0.155	1.000		
8	Number of branch	0.431	—0.459	—0.233	0.195	0.405	0.645	0.177	1.000	
9	Length of branch	0.548	0.030	0.170	0.590	0.569	0.043	0.900	0.204	1.000

degree of freedom of $r = 13$

Table 31. Correlation matrix of relations between morphological characters and tree height of races at Kerpe trial site

		1	2	3	4	5	6	7	8	9
1	Height	1.000								
2	Length of needle	0.241	1.000							
3	Width of needle	0.163	0.640	1.000						
4	Thickness of needle	—0.062	0.681	0.822	1.000					
5	Number of needle	0.300	—0.051	0.202	—0.090	1.000				
6	Angle of branch	—0.515	—0.311	—0.090	—0.111	—0.217	1.000			
7	Thickness of branch	0.396	0.296	0.128	—0.001	—0.262	—0.353	1.000		
8	Number of branch	0.052	—0.037	0.041	—0.043	0.347	0.319	—0.094	1.000	
9	Length of branch	0.655	0.345	—0.096	—0.024	0.198	—0.589	0.662	—0.223	1.000

degree of freedom of $r = 13$

Table 32. Correlation matrix of relations between morphological characters and tree height of races at Kdz. Ereğli trial site

		1	2	3	4	5	6	7	8	9
1	Height	1.000								
2	Length of needle	0.313	1.000							
3	Width of needle	0.217	0.733	1.000						
4	Thickness of needle	—0.136	0.242	0.245	1.000					
5	Number of needle	—0.057	—0.236	—0.299	—0.364	1.000				
6	Angle of branch	0.143	0.149	0.223	0.264	—0.811	1.000			
7	Thickness of branch	—0.077	0.401	0.292	0.728	—0.009	0.166	1.000		
8	Number of branch	0.202	0.029	—0.053	—0.280	0.580	—0.587	—0.007	1.000	
9	Length of branch	0.135	0.322	0.123	0.441	—0.002	0.278	0.861	—0.050	1.000

degree of freedom of $r = 13$

Table 33. **Correlation matrix of relations between morphological characters and volume of origins at Fatih Ormanı trial site**

		1	2	3	4	5	6	7	8	9
1	Volume	1.000								
2	Length of needle	—0.068	1.000							
3	Width of needle	—0.467	0.730	1.000						
4	Thickness of needle	—0.572	0.522	0.818	1.000					
5	Number of needle	—0.009	—0.453	—0.219	—0.141	1.000				
6	Angle of branch	—0.023	—0.092	—0.133	0.009	—0.451	1.000			
7	Thickness of branch	—0.281	0.324	0.504	0.632	0.311	—0.498	1.000		
8	Number of branch	0.096	—0.313	—0.478	—0.275	0.161	—0.166	—0.045	1.000	
9	Length of branch	0.010	0.359	0.336	0.396	0.341	—0.699	0.872	0.052	1.000

degree of freedom of $r = 13$

Table 34. Correlation matrix of relations between morphological characters and volume of origins at Kerpe trial site

		1	2	3	4	5	6	7	8	9
1	Volume	1.000								
2	Length of needle	—0.038	1.000							
3	Width of needle	0.185	0.881	1.000						
4	Thickness of needle	—0.380	0.848	0.792	1.000					
5	Number of needle	0.547	—0.515	—0.330	—0.567	1.000				
6	Angle of branch	0.323	—0.075	—0.023	—0.219	—0.045	1.000			
7	Thickness of branch	0.477	—0.237	—0.057	—0.298	0.355	—0.199	1.000		
8	Number of branch	0.132	—0.554	—0.648	—0.535	0.315	0.189	—0.217	1.000	
9	Length of branch	—0.047	—0.093	—0.173	—0.125	0.241	—0.458	0.673	—0.341	1.000

degree of freedom of r = 10

Table 35. Correlation matrix of relations between morphological characters and volume of origins at Kdz. Ereğli trial site

					4	5	6	7	8	9
1	Volume	1.000								
2	Length of needle	—0.246	1.000							
3	Width of needle	—0.644	0.651	1.000						
4	Thickness of needle	—0.388	0.194	0.341	1.000					
5	Number of needle	0.264	0.089	0.170	—0.337	1.000				
6	Angle of branch	—0.055	—0.019	0.064	—0.084	—0.335	1.000			
7	Thickness of branch	0.230	0.356	0.245	0.253	0.432	—0.067	1.000		
8	Number of branch	0.356	0.155	0.023	—0.269	0.542	—0.228	0.128	1.000	
9	Length of branch	0.422	0.150	0.059	—0.016	0.493	—0.104	0.861	0.061	1.000

degree of freedom of $r = 19$

Table 36. **Correlation matrix of relations between morphological characters and volume of races at Kdz. Ereğli trial site**

		1	2	3	4	5	6	7	8	9
1	Volume	1.000								
2	Length of needle	—0.258	1.000							
3	Width of needle	—0.695	0.637	1.000						
4	Thickness of needle	—0.395	0.203	0.344	1.000					
5	Number of needle	0.303	0.011	0.157	—0.397	1.000				
6	Angle of branch	—0.027	—0.095	0.012	—0.088	—0.347	1.000			
7	Thickness of branch	0.369	0.285	0.195	0.245	0.429	—0.134	1.000		
8	Number of branch	0.371	—0.120	—0.126	—0.354	0.567	—0.286	0.131	1.000	
9	Length of branch	0.554	0.108	0.021	—0.049	0.525	—0.148	0.859	0.128	1.000

degree of freedom of $r = 16$

At Kerpe trial site, the Corsican origin FC. 333 had the maximum volume production and increment (46.7 m^3/ha., 4.67 m^3/ha./year). The same origin in another trial site at Kerpe gave 8.4 m^3 volume increment at the end of 11 th year (Tunçtaner et al. 1985). It was estimated by Grut (1976) that 13.5 m^3/ha. volume increment could be provided from intensively cultivated Maritime Pine plantations for 26 year rotation period in Marmara region. Birler and Yüksel (1983) reported that annual volume increment of Maritime Pine plantation at Alemdağ site in İstanbul was 13.8 m^3/ha. for 30 years rotation period.

At Kdz. Ereğli trial site, Moroccon provenance MA. 240 took the first priority with 4.0 m^3/ha./year volume increment and it was followed by FC. 233 (Table 9, Figure 4). This trial site is located at 440 m altitude and snow fall is very intensive. Therefore, the great emphasis was given to this site for comparison the provenances regarding their resistancy level against snow damages. Moroccon and Corsican origins showed better resistancy than the others (Table 10). As it was indicated before that Moroccon and Corsican provenances should be used in the plantations to be established at high altitudes (300-500 m) in Marmara and Blacksea regions (Tunçtaner et al. 1985, Toplu and Bozkuş 1988). There is a close relation between snow resistancy and stem form of the origins. Corsican and Moroccon provenances have also good stem form. Discussions on stem form of Maritime pine were made by many scientists and it was reported that Corsican origins had better stem form than the others (Auberlinder 1982, Matziris 1982, Shelbourne 1969, Papadakis 1961, Marsh 1969).

Investigations were made for determining the relations between snow damage and morphological characteristics (needle length, needle width, thickness of needle, branch angle, branch thickness, number of branches, branch length) of origins and races (Tables 11-14). Morphological characteristics of the origins and races were evaluated for the trial sites (Tables 15-20).

Faulkner (1969) reports that branch diameters affect pruning costs and influence the volume of knot wood which in turn affects the volume of reaction wood and wood density in proximity to the knots. Although, Forde (1964) found no significant variation between several natural populations of P. radiata in either number of branch whorls or the number of branches per whorl, she did detect significant differences in both traits within the populations. Faulkner (1969)

reports that genotypic variation in branch numbers per whorl in P. sylvestris has been demonstrated by Arnborg et al., and Ehrenberg. High variability for the trait in P. taeda is predicted by von Wedell et al. The number of branches per whorl is correlated with stem diameter in P. taeda. In accordance with our study it was not possible to make a distinc definition for the branch characteristics of the races. But the races were described concerning their needle characteristics. Branch habit of Maritime pine races was explained by Scott (1962) and Marsh (1969) in detail. They indicated that Corsican and Moroccon origins had extremely horizontal branches. Branch angle values obtained from our trial sites showed the similar results (Tables 18-20).

Height and diameter ratio of trees (H/D) is an important index for snow damages (Cremer et al. 1983, Johann 1980). Height/dbt ratios (H/D) of undamaged and damaged spruce were determined on 0.3 ha. test plots at 4 sites and for Douglas Fir at 5 th site in Upper Austria; Critical H/D (less than 5 % damage) for spruce was; 74 (at alt. 400-530 m); 79 (up to 580 m); 89 (up to 690 m); above or below these altitudinal limits rate of snowbreakage decreased rapidly. Critical H/D for Douglas Fir was 82 (Bentz and Schön, 1981). At this study, there were no significant differences between the origins on the basis of height/diameter ratio. But according to the evaluations of races significant differences were found for two trial sites. Land race had maximum height/diameter ratio while Corsican race had the minimum (Tables 18-20).

Relations between d.b.h., height, volume and morphological characteristics of origins and races were investigated. Linear and multiple regression were made for Fatih Ormanı, Ereğli and Kerpe trial sites (Tables 21-36). A multiple correlation was found between d.b.h and number of branch and length of branch for the origins at Fatih Ormanı trial site ($r = 0.812$, $F = 37.79^{***}$). A multiple correlation was also found for races between d.b.h. and needle length, needle width, thickness of needle, branch angle, branch thickness and number of branch at Fatih Ormanı trial site ($r = 0.932$, $F = 8.90^{*}$).

A multiple correlation was found between height and branch thickness, number of branch and branch length of the origins at Fatih Ormanı ($r = 17.45$, $F = 15.77^{**}$) A significant correlation was also found between height and needle width, number of needle, branch angle, number of branch for the races at Fatih Ormanı ($r = 0.859$, $F = 7.09^{*}$).

A multiple correlation was found between volume and needle length, needle thickness, branch thickness and number of branch of the origins at Kerpe ($r = 0.969$, $F = 26.77^{***}$). At Ereğli trial site, a multiple correlation was also found for the origins between volume and needle width, number of branch and branch length ($r = 0.863$, $F = 16.56^{***}$). A significant correlation was determined between volume and needle width and branch length for the races at Ereğli trial site ($r = 0.898$, $F = 31.26^{***}$).

As a conclusion, it can be said that Corsican and Moroccon provenances showed better growth performances than the others at three trial site. Their morplogical characteristics are more suitable for resistancy against snow damages. Therefore, these origins should be used at the plantations to be established in Marmara and Blacksea regions.

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BIBLIOGRAPHY

AUBERLINDER, V., 1982 : Effects of Site and Silvicultural Techniques On The Instability of Maritime pine, Annales de Recherches Sylvicoles, AFOCEL, Paris, France.

AYBERK, S., TOLAY, U., BUL, M., ZORALİOĞLU, T., 1983 : Maki sahalarında arazi hazırlığı metodlarının P. pinaster Aiton'un gelişimi üzerine etkilerinin araştırılması. Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü Yıllık Bülten No. 19, İzmit.

BENTZ, F., SCHÖN, B., 1981 : Critical ht/diam. value in relation to snowbreakage. Allgemeine Forstzeitung, 92 (12).

BİRLER, A.S., YÜKSEL, Y., 1983 : Sahil çamı (Pinus pinaster Ait.) Ağaçlandırma Meşcerelerinde Hasılat Araştırması. Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Yıllık Bülten No. 19.

COOLING, E.N.G. 1977 : Industrial Forestry Plantations Turkey. Final Report, Plantation Silviculture. FO: DP/TUR/71 521 Working Document No. 28.

CREMER, K.W., CARTER, P.R., MINKO, G., 1983 : Snow damage in Australian pine plantations, Australian Forestry, 46 (1), 53-66, Canberra.

FAULKNER, R., 1969 : Some Characters of Secondary Importance to Stem Straightness in the Breeding of Conifers. Second World Consultation on Forest Tree Breeding, Invited Paper, Washington.

FORDE, M.B., 1964 : Variation in natural populations of Pinus radiata in California Pt 1. Sampling methods and branch characters, N.Z. JL. Bot. 2 (3), 213-236.

GREATHOUSE, T.E., 1975 : Industrial Plantations, Turkey. Final Report (Genetics). FO: DP/TUR/71/521 Working Document No. 18, İzmit.

GRUT, M., 1976 : Cost-Benefit Analysis of Industrial Reforestation in the Marmara Region, FO: DP/TUR/71/521 Working Document No. 18, İzmit.

JOHANN, K., 1980 : Stand treatment and risk of snow damage, Niedersasische Forstliche Versuchsanstalt 67, 269-286.

MARSH, E.K., 1969 : Selecting Adapted Races of Introduced Species. Invited Paper, Second World Consultation on Forest Tree Breeding, Washington.

MATZIRIS, D.I., 1982 : Variation in Growth and Quality Characters in Pinus pinaster Provenances Grown at Seven Sites in Greece, Silvae Genetica, 31 (5/6).

PAPADAKIS, J., 1961 : Climatic Tables for the World. Buenos Aires.

SCOTT, C.W., 1962 : A Summary of Information on Pinus pinaster. Forestry Abstract, Vol 23, Number: 1, 2.

SHELBOURNE, C.J.A., 1969 : Breeding for stem straightness in conifers. Second World Conscultation on Forest Tree Breeding. Invited Paper, Washington.

ŞİMŞEK, Y., 1982 : Hızlı Gelişen Ekzotik Tür Denemelerinin Ortaya Koyduğu Teknik ve Ekonomik Bulgular, Pilot Ağaçlandırma ve Geniş Uygulamalara Geçilebilme Olanakları, Türkiye'de Hızlı Gelişen Türlerce Endüstriyel Ağaçlandırmalar Simpozyumu. 21-26 Eylül 1981, Ankara, 465, S.

TOLAY, U., HIZAL, A., DÖNMEZ, E., 1982 : Çeşitli Toprak İşleme Yöntemlerinin Kerpe Yöresindeki Bozuk Baltalıklarda İnce Tekstürlü Toprakların Fiziksel Özellikleri ve Ağaçlandırma Başarısı üzerine etkileri, Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Yıllık Bülten No. 18, İzmit.

TOPLU, F., BOZKUŞ, S., 1988 : Marmara ve Batı Karadeniz Bölgelerinde Hızlı Gelişen Türlerle Tesis Edilen Deneme ve Ağaçlandırmalarda Kâr Zararları. Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü Dergisi, 1988/1, İzmit.

TUNÇTANER, K., TULUKÇU, M., TOPLU, F., 1985 : Türkiye'de Endüstriyel Ağaçlandırmalarda Kullanılabilecek Sahil Çamı (Pinus pinaster Aiton). Orijinlerinin Seçimi Üzerine Araştırmalar. Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Yıllık Bülten No. 21, İzmit.

TUNÇTANER, K., 1986 : Hızlı Gelişen Egzotik İbreli Türlerin İthalinde Mekanizasyonun Önemi. Ormancılıkta Mekanizasyon ve Verimliliği 1. Ulusal Sempozyumu, MPM Merkezi Yayınları : 339, Ankara.

ÜRGENÇ, S., 1972 : Hızlı Gelişen Bazı Ekzotik (Yabancı) İğne Yapraklı Ağaç Türlerinin İthali ve Yetiştirilmesi İmkânları Üzerine Araştırmalar. İ.Ü. Orman Fakültesi, Yayın No. 175/188, İstanbul.

EUCALYPTUS GRANDIS W. Hill ex Maiden ORIGIN TRIAL

by
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ABSTRACT

In this study it was tried to be found that which origin of Eucalyptus grandis W. Hill ex Maiden is the most suitable for Turkey's ecological conditions.

For this purpose eleven origins were brought from abroad and one origin from Turkey was added them. So the trial site having twelve origins was established in Tarsus-Karabucak that represents Eastern Mediterranean Region.

The measurements which were made the end of the five years of age showed that the origin of Tarsus-Karabucak is the best according to comparison of volumes per hectare.

Karabucak origin of E. grandis should be used in eucalyptus plantation with E. camaldulensis to be established in Eastern Mediterranean region.

1 — INTRODUCTION

Turkey's forest area is a little more than 20 million hectare

(OAE 1987). If this amount is compared with Turkey's area which is 774815 km^2 it is seen that forest area is 26 percent of Turkey's area and this is rather enough number. But 43 percent of 20 million hectare forest area is productive forest which is formed only 11 percent of Turkey's area and this is not an enough number.

On the other hand, the population is on the increase with a big rate such 24,88 % per year. (DİE 1986, S. 2). Therefore the needs of wood raw material are increacing year by year. According to Forestry Main Plan which includes year between 1973-1995 this increase will continue in the next years too. (T.C. ORMAN BAKANLIĞI 1976).

Here is at this point the importance of fast growing forest trees has shown itself.

The most important species of fast growing forest trees are Poplar and Eucalyptus. Today in Turkey the wood production of Poplar are more than 2 million cubic meter. (GÜMÜŞDERE 1987). On the other hand Turkey has fourteen thousand hectare areas planted with Eucalypus (GÜRSES 1987). Eucalyptus camaldulensis species was used in these areas.

The publication named Results of the Investigations on Comparison Eucalypteta Established in Turkey suggested that Eucalyptus grandis can be used some areas which have high water level and fertile soils. Because it can grow more than other Eucalyptus species in this kind of soils (AVCIOĞLU — GÜRSES 1986).

So Eucalyptus Grandis Origin trial formed the first ring of adaptation trial chain was established and finished in Tarsus-Karabucak to find out which origin is the most suitable for Turkey's ecological conditions.

2 — MATERIAL AND METHODS

2.1. Supply of the Seed Material

The seeds required for the research were brought from abroad by means of The Institute of Forest Tree Seeds and Improvement at a total of 22 different origins, 20 from Australia, one from Italia and one from Republic of Southern Africa. Also the seeds of E. grandis planted in 1950's in Karabucak were gathered and included

in the trial as Tarsus-Karabucak origin. Deep information about the origins of seeds are given in Table : 1.

2.2. Supply of the Seedlings

The seeds of 23 origins were planted in Karabucak Nursery to get seedlings, on the 14 th of April, 1982. Seedlings of some origins were either eliminated in the stage of nursery or they didn't develop much. The best developing of 12 origins were moved to the trial site. The origins are shown in Table : 1.

2.3. The General Geographic Locality Properties of the Trial Site

A part of the 25 numbered plot in Tarsus - Karabucak Eucalyptus Forest was chosen as the trial site. Information about the trial site are stated below.

Conservancy	:	Mersin
Forest district	:	Tarsus
Forest subdistrict	:	Karabucak
Locality	:	25 numbered plot
Altitude (m)	:	7
Latitude (N)	:	36° 51'
Longitude (E)	:	34° 52'

2.4. The Climatic Properties of the Trial Site

The climatical values of Tarsus Rural Affairs Research Institude Meteorological Station were taken as the climatic values of the trial site. This station has the same altitude of the trial site and 10 km. for away from it as the crow flies. The climatical values are shown in Table : 2.

Table: 1 — E. grandis origins tested in the experiment

	Seedlot Number	Provenance Location		Latitude °S	Longitude °E	Altitude M
X	12380	East of Maroeba	Northern Queensland	17° 03'	145° 36'	740
	12423	Tinarco Falls dam area	" "	17° 11'	145° 36'	800
X	12426	S.F.R. 700.Cillies Highway	" "	17° 13'	145° 42'	730
X	12422	S.F.R. 310.Cadgarra	" "	17° 16'	145° 42'	690
	12383	Herberton area	" "	17° 20'	145° 24'	1000
X	12381	Wondecla area	" "	17° 25'	145° 27'	1010
	12409	Pavenshoe area	" "	17° 42'	145° 28'	940
	12382	Tully Falls area	" "	17° 49'	145° 31'	800
	12461	West of paluma	" "	19° 00'	146° 00'	900
	12143	Crediton	" "	21° 09'	148° 30'	730
X	10693	Northeast of Gympie	Southern Queensland	26° 07'	152° 42'	76
X	10694	Southeast of Gympie	" "	26° 18'	152° 46'	75
	10695	Kenilworth	" "	26° 40'	152° 33'	530
X	10696	Bellthorpe	" "	26° 52'	152° 42'	460
	11243	South of Tyalgum	Northern New South wales	28° 27'	153° 12'	100
	11244	South of Murwillumbah	" " " "	28° 33'	153° 23'	300
X	11681	North of Woolgoolga	" " " "	29° 32'	153° 12'	30
X	7823	North of Coffs Harbour	" " " "	30° 10'	153° 08'	18
	7810	North of Bulahdelah	" " " "	32° 20'	152° 13'	120
	11587	Port Stephens	" " " "	32° 55	151° 48	6
X	1263	Sabaudia	Italy			
X	29223	Sabie	South Africa			
X	18-C	Karabucak-Tarsus	Turkey	36° 51' °N	34° 52'	6

Not: 1—S.F.R. is state forest reserve

Not: 2—The origins having (x) became successful in the nursery then they were planted on the experiment area.

Table : 2 — Climatical valures of Tarsus Rural Affairs Research. Institute Meteorological Station (1950-1980).

Months	Mean Temperature	Mean Max. Temperature	Mean Min. Temperature	Absolute Max. Temperature	Absolute Min. Temperature	Mean Precipitation	Humidity
	°C	°C	°C	°C	oC	mm.	%
October	20.0	28.6	13.4	39.3	2.0	30.8	62.8
November	15.0	22.8	9.0	33.5	—6.1	75.6	63.4
December	10.5	16.6	5.5	27.5	—6.2	140.6	70.8
January	9.0	14.7	4.3	28.4	—8.5	117.8	70.4
February	10.1	15.7	5.0	25.5	—8.2	84.2	71.0
March	12.8	19.3	7.3	30.3	—9.6	62.8	71.0
April	16.6	23.5	10.7	36.7	0.7	46.5	70.6
May	20.8	27.4	14.3	38.5	6.5	25.3	69.6
June	24.6	30.6	18.3	40.1	12.0	12.4	69.3
July	26.8	31.2	21.2	39.5	14.0	2.6	73.3
August	26.8	32.8	21.3	43.0	14.0	3.0	73.1
September	24.1	31.8	17.9	40.7	8.7	10.8	67.1
TOTAL	217.1	295.0	148.2	—	—	612.4	831.8
MEAN	18.1	24.6	12.4	—	—	—	69.3
EXTREME	—	—	—	43.0	—9.6	—	—

2.5 The properties of Soil of the Trial Site

The soil examples taken from the trial site were analysed in Tarsus Rural Affairs Research Institute Soil Laboratory and the results are shown in Table : 3.

2.6. Experiment Design

The experiment design was organised according to randomised block design with 3 repetitions. Each repetition contains 12 plots. Each plot's dimension is 18.0 x 18.0 m. and each repetition's dimension is 36.0 x 108.0 m. 36 seedlings were planted in each plot. The experiment design is shown in Figure : 1.

2.7. The Preparation, Foundation and Maintenance of the Trial Site.

The trial site was at first plowed by a heavy plaw connected to a Ford - 5000 tractor and then harrowed by a Disc Harrow as a whole The sensitivity of E. grandis to colt was considered and the plantation of the seedlings was done in March when the strong winter cold lost its effect. In observations done later, the trace of cold damage wasn't seen. The poted E. grandis seedlings were planted in the holes dug 40 cm. deep and 3.0 x 3.0 m. spacings. Following the plantation 3 years, the maintenance was done. As the maintenance in the summer months at intervals of one month the spaces between seedlings were plowed by tractors and following this the soil at the bottom was hoed. Irrigation was done twice a year in the first two years and once in the third year.

2.8. Measurements and Observations in the Trial Site.

Following the plantation each year after the vegetation season in the trial site in each plot he height of 16 measurement-trees were measured at the sensitivity of 5 cm. and the diameters at the sensitivity of 1 mm. Also the surviving trees of the whole plot was counted and the survival rate was found.

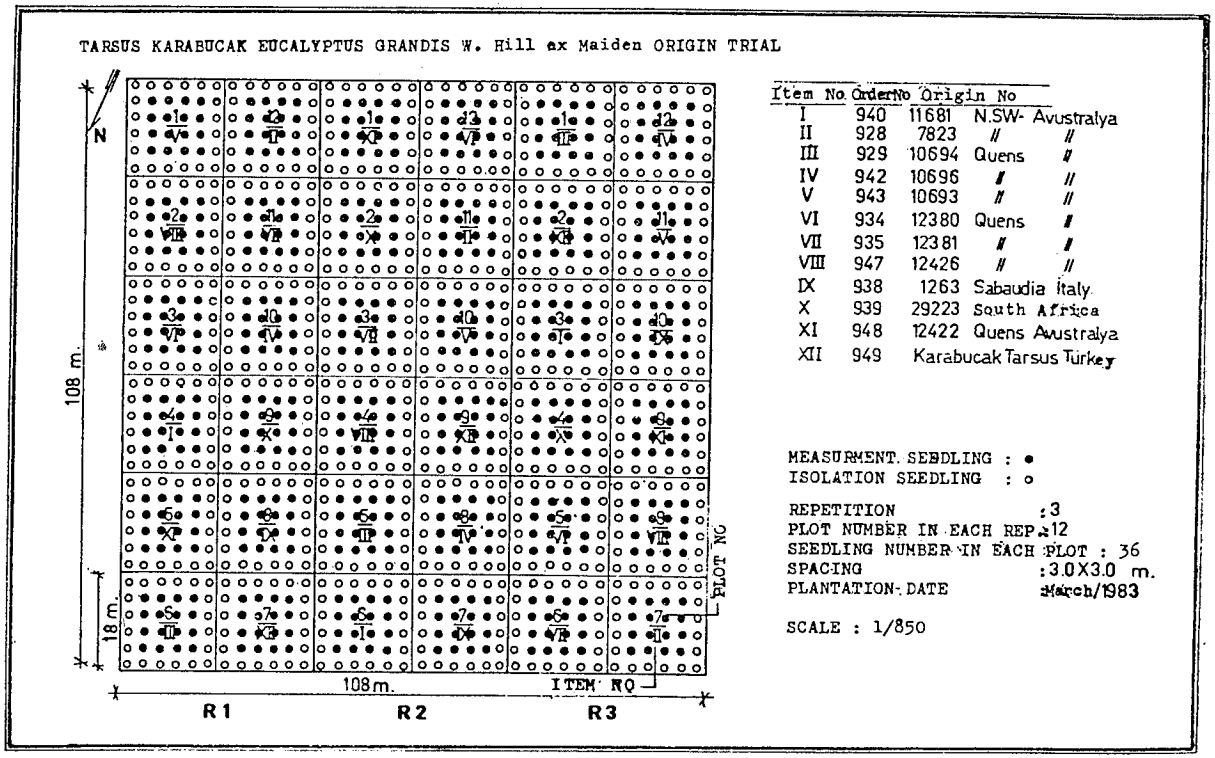
2.9. The Method of Evaluation

Relying on the last measurements of height and diameter variance analysis was made according to the average valuse of origins in each block.

Table : 3 — Informations on soil properties of the trial site

Repetition	Depth (cm)	% Saturation	Ph		$Ec_{25}10^3$	% $CaCo_3$	Permeability cm/hour		Kg/da K_2O	Kg/da P_2O_5	Organic Material
			In mud	1 : 10			First 2 hours	Last 2 hours			
R I	0—20	92	7.8	7.9	1.08	36.48	2.78	2.31	42.40	4.52	8.60
	20—40	92	8.1	8.4	0.61	35.26	0.68	0.68	36.04	4.31	8.60
	40—60	85	8.1	8.4	0.61	35.26	0.41	0.51			
	60—90	67	8.1	8.4	0.38	38.00	0.38	0.49			
	90—120	65	8.2	8.5	0.27	41.95	0.37	0.48			
R II	0—20	79	7.9	8.0	1.14	43.16	21.40	14.51	65.72	4.31	6.82
	20—40	99	8.1	8.2	0.53	35.87	0.54	0.69	33.92	3.29	4.88
	40—60	88	8.2	8.4	0.43	34.05	0.24	0.31			
	60—9 0	64	8.1	8.6	0.28	39.52	0.33	0.37			
	90—120	79	8.2	8.6	0.32	43.16	0.39	0.39			
R III	0—20	51	8.0	8.3	0.80	40.70	3.04	3.10	44.52	4.31	2.69
	20—40	52	8.1	8.2	0.71	38.00	2.40	1.90	21.40	3.29	1.55
	40—60	73	7.9	8.0	0.71	34.66	3.00	2.50			
	60—90	70	8.3	8.7	0.44	41.04	0.68	0.74			
	90—120	51	8.5	8.8	0.52	42.56	1.06	1.24			

Figure : 1 — Experiment design



According to the results of analysis if significant differences existed with the statistics then using «Duncan test» the classes the trees formed were found in the level of 0.05 probability.

The number of surviving seedlings were transformed according to Freeman - Turkey Arc. Sin. formation table (Mosteller-Youtz, 1961). The variance analysis was applied to the transformed values.

The evaluations done only by height, diameter or survival rate data for the adaptation for an exotic species can give deceiving results. For example, the origin of the best developing in hight, may not be the best developing in diameter. Because of this, the best evaluation must contain all of these elements and must be done according to the volume data per unit area.

On the other hand, E. grandis is an exotic species, so we don't have a volume table. For this reason, in each plot the values of average tree was calculated and then the tree about the size of this average was cut down. Thus, as one from each plot they were added up to 36 trees. At 0.00, 1.00, 1.30, 2.00 and after this at each one meter until the stem has a diameter of 5 cm. of these cut trees at sensitivity of mm. the ring and the thickness of the bark were measured by a vernier scaled compass at sensitivity of a tenth of mm. Then, data about these measurements being evaluated by the Section Volume Program of a Computer, belonging to the average trees the volume of the stem was calculated as over bark and under bark. Also the bark volume was calculated. Later using these data and the survival rate of each seedling in each plot, the volume of the stems as over bark and under bark in each hectare of each plot was calculated (Table : 4).

Relying on the volume values of stems as over bark variance analysis was applied to the average of the origins. Because of the statistical differences in the results, «Duncan test» was done and the classes that the origins formed at the level of 0.05 probability was determined.

3 — RESULT AND DISCUSSION

The results of variance analysis which was made for the height and diameter values of the last year and also the survival rate and the volume per hectare in the trial site are shown in Table : 5.

Tablo : 4 — Euc. Grandis orijin Denemesi hacim verileri
Table : 4 — Volume data in the E. grandis origin trial

ORİJİNLER ORIGINS	REPETİSYONLAR REPETITIONS	ORTA AĞACA AİT BELONG TO MEAN TREE				YAŞAMA YÜZDESİ SURVIVAL	HEKTARDAKİ PER HEKTAR	
		BOY HEIGHT m.	ÇEVRE SURROUNDINGS mm	K.luG.Hac VOLUME with bark m³	KsuzG.Hac VOLUME without bark m³	PERCENTAGE	K.luG.Hac VOLUME with bark m³	KsuzG.Hac VOLUME without bark m³
11681	R I	20.38	471	0.1687	0.1466	50.0	93.629	81.363
	II	23.23	536	0.2432	0.2169	75.0	202.464	180.569
N. S. W.	III	20.27	526	0.1911	0.1640	52.8	112.000	96.117
	TOPLAM TOTAL	63.88	1533	0.6030	0.5275	177.8	408.093	358.049
AUSTRALIA	ORTALAMA MEAN	21.29	511	0.2010	0.1758	59.3	136.031	119.350
7823	R I	18.70	470	0.1541	0.1362	80.6	137.867	121.853
	II	20.80	468	0.1725	0.1515	91.7	175.583	154.207
N. S. W.	III	21.50	492	0.1995	0.1768	86.1	190.664	168.970
	TOPLAM TOTAL	61.00	1430	0.5261	0.4645	258.4	504.114	445.030
AUSTRALIA	ORTALAMA MEAN	20.33	477	0.1754	0.1548	86.1	168.038	148.343
10 694	R I	23.20	544	0.2453	0.2166	69.4	188.964	166.856
	II	20.67	472	0.1520	0.1319	52.8	89.084	77.304
QUEENSLAND	III	20.57	449	0.1394	0.1265	63.9	98.875	89.725
	TOPLAM TOTAL	64.44	1465	0.5367	0.4750	186.1	376.923	333.885
AUSTRALIA	ORTALAMA MEAN	21.48	488	0.1789	0.1583	62.0	125.641	111.295
10 696	R I	22.00	472	0.1721	0.1528	91.7	175.175	155.531
	II	24.00	557	0.2829	0.2500	61.1	191.866	169.553
QUEENSLAND	III	21.93	503	0.2062	0.1765	86.1	197.067	168.683
	TOPLAM TOTAL	67.93	1532	0.6612	0.5793	238.9	564.108	493.767
AUSTRALIA	ORTALAMA MEAN	22.64	511	0.2204	0.1931	79.6	188.036	164.589
10 693	R I	19.60	465	0.1583	0.1350	91.7	161.129	137.412
	II	20.00	546	0.2025	0.1768	66.7	149.925	132.378
QUEENSLAND	III	18.50	466	0.1490	0.1309	83.3	137.770	121.034
	TOPLAM TOTAL	58.10	1477	0.5098	0.4447	241.7	448.824	390.824
AUSTRALIA	ORTALAMA MEAN	19.37	492	0.1699	0.1482	80.6	149.608	130.295
12 380	R I	19.85	583	0.2488	0.2132	33.3	91.964	78.805
	II	22.44	489	0.1950	0.1780	77.8	168.398	153.717
QUEENSLAND	III	19.60	462	0.1429	0.1248	58.3	92.475	80.762
	TOPLAM TOTAL	61.89	1534	0.5867	0.5160	169.4	352.837	313.284
AUSTRALIA	ORTALAMA MEAN	20.63	511	0.1956	0.1720	56.5	117.612	104.428
12 381	R I	19.50	479	0.1630	0.1421	61.1	110.548	96.374
	II	19.95	474	0.1706	0.1463	80.6	152.629	130.889
QUEENSLAND	III	20.90	600	0.2556	0.2269	58.3	165.406	146.834
	TOPLAM TOTAL	60.35	1553	0.5892	0.5153	200.0	428.583	374.097
AUSTRALIA	ORTALAMA MEAN	20.12	518	0.1964	0.1718	66.7	142.861	124.699
12 426	R I	19.53	512	0.1934	0.1685	77.8	167.016	145.513
	II	23.10	503	0.2213	0.1955	80.6	197.988	174.906
QUEENSLAND	III	20.80	489	0.1795	0.1605	72.2	143.855	128.628
	TOPLAM TOTAL	63.43	1504	0.5942	0.5245	230.6	508.859	449.047
AUSTRALIA	ORTALAMA MEAN	21.14	501	0.1981	0.1748	76.9	169.620	149.682
1263	R I	20.82	548	0.2125	0.1824	72.2	170.302	146.179
	II	20.00	507	0.1839	0.1570	77.8	158.812	135.582
SABAUDIA	III	21.07	532	0.2211	0.1942	94.4	231.677	203.491
	TOPLAM TOTAL	61.89	1587	0.6175	0.5336	244.4	560.791	485.252
ITALY	ORTALAMA MEAN	20.63	529	0.2058	0.1779	81.5	186.930	161.751
29 223	R I	17.80	480	0.1516	0.1293	91.7	154.309	131.611
	II	21.00	504	0.1991	0.1767	94.4	208.625	185.153
	III	21.50	532	0.2204	0.1988	72.2	176.633	159.322
	TOPLAM TOTAL	60.30	1516	0.5711	0.5048	258.3	539.567	476.086
SOUTH AFRICA	ORTALAMA MEAN	20.10	505	0.1904	0.1683	86.1	179.856	158.695
12 422	R I	20.25	569	0.2341	0.2047	27.8	72.239	63.166
	II	20.15	447	0.1547	0.1335	88.9	152.656	131.736
QUEENSLAND	III	22.06	497	0.1860	0.1634	88.9	183.543	161.241
	TOPLAM TOTAL	62.46	1513	0.5748	0.5016	205.6	408.438	356.143
AUSTRALIA	ORTALAMA MEAN	20.82	504	0.1916	0.1672	68.5	136.146	118.714
KARABUCAK	R I	24.00	582	0.2992	0.2722	88.9	295.248	268.604
	II	21.87	532	0.2349	0.2120	83.3	217.196	196.022
TARSUS	III	23.90	623	0.3188	0.2812	69.4	245.584	216.620
	TOPLAM TOTAL	69.77	1737	0.8529	0.7654	241.6	758.028	681.246
TURKEY	ORTALAMA MEAN	23.26	579	0.2843	0.2551	80.5	252.676	227.082

As seen in the table there are significant differences between origins in development of height in the level 0.05 (F = 2.43x). According to this Karabucak origin is the first origin with a height value of 17.84 m. It is followed by the origins of 1263, 10696, 29223, 7823, 10693, 12426, and 11681 in the same group.

In the variance analysis which was made for diameter values there are no significant differances (F = 0,94 NS). Karabucak origin is the first origin with diameter of 17.74 cm. and it is followed by the origin of 12380 with a diameter of 16.79 cm.

In the variance analysis which was made for survival rate there are no differences statistically (F = 1.32 NS). The origin of 29223 has the highest rate of survival and it is followed by the origin of 7823. Karabucak origin which is the first in development of height and diameter is the fifth in the survival rates.

In the variance analysis made for volumes per hectare there are significant differences in the level of 0,05 (F = 2.70x). According to this Karabucak origin is the first with the value of 252.676 m^3/Ha. It is followed by the origins of 10696 and 1263 with the values of 188.036 m^3/Ha. and 186.930 m^3/Ha. respectively. These form the first group.

In the variance analysis made for the bark rates at the end of the 5 th. year in the trial site there are no significant differences statistically. The order of the mean from the smallest to the biggest are shown in Table : 6. As seen in the table, the bark rate of the Karabucak origin is the smallest between 12 different origins of E. grandis. It is followed by the origins of 10694 and 12426.

As a summary, Karabucak origin is the first in the development of height, diameter and the volume per hectare among the 12 different origins of E. grandis compared. The same origin also is the first in the order of bark rates with the least bark rate.

At the end of the 5 th. year Karabucak origin produced 252.676 m^3/Ha. volume with bark. This shows that it can produce an annual volume increment of 50.535 m^3/ha.

However, in a study made early it was indicated that Karabucak origin of Eucalyptus camaldulensis in Tarsus - Karabucak produced a volume of 334.823 m^3/ha. at the end of the tenth year, that is anannual average volume increment of 33.482 m^3/ha. (AVCIOĞLU - ACAR, 1984).

Table : 5 Results of analysis of variance and comparison of the means of origins in trial site

ORIGIN NO	ANALYSIS OF VARIANCE			
	HEIGHT (m)	dbh. (cm)	SURVIVAL (Arc. Sin)	VOLUME (m^3/ha.)
	F = 2.43 *	F = 0.94 NS	F = 1.32 NS	F = 2.70 *
1 11681	(12) 17.84	(12) 17.74	(10) 69.25	(12) 252.676
2 7823	(9) 17.43	(6) 16.79	(2) 68.41	(4) 188.036
3 10694	(4) 17.43	(9) 16.38	(9) 65.46	(9) 186.930
4 10696	(10) 17.30	(1) 15.97	(5) 64.63	(10) 179.856
5 10693	(2) 17.19	(4) 15.88	(12) 64.28	(8) 169.620
6 12380	(5) 16.98	(10) 15.79	(4) 64.26	(2) 168.038
7 12381	(8) 16.93	(11) 15.78	(8) 61.31	(5) 149.608
8 12426	(1) 16.86	(5) 15.73	(11) 57.63	(7) 142.861
9 1263	(11) 16.57	(8) 15.72	(7) 55.02	(11) 136.146
10 29223	(6) 16.46	(7) 15.71	(3) 52.03	(1) 136.031
11 12422	(7) 16.44	(3) 15.22	(1) 50.53	(3) 125.641
12 Karabucak	(3) 15.87	(2) 15.15	(6) 48.97	(6) 117.612

Table : 6 Bark values of the origins at age 5. (From the smallest to the biggest)

Order No	Origins	Bark (The values are transformed to arc-sinus)
1	Karabucak	18,587
2	10694	19,679
3	12426	19,993
4	7823	20,020
5	12380	20,083
6	29223	20,131
7	10696	20,603
8	11681	20,847
9	12381	20,911
10	12422	20,961
11	10693	20,988
12	1263	21,670

As seen, the difference between the annual average volume increments per hectare of these two species is more than 17 m^3 and this is not a small number.

On the other hand, an annual average volume increment of 50.535 m^3/ha. found in this study seems satisfying when compared to the similar studies in other countries. For example in the

project of Aracruz in Brazil E. grandis and E. urophylla were planted for the production of cellulose wood and an annual average volume increment was obtained as 36 m^3/ha. at the age of 7. In the plantations in optimum sites with the selected seeds this number rises to 45 m^3/ha. after fertilization and maintanence and also with the selected offsprings an annual average volume of 73 m^3/ha. was obtained (Hillis - Brown, 1978).

Also, it was stated that E. grandis had 40 m^3/ha/year with irrigation in Zimbabve, in good sites between 17 and 45 M^3/ha/year in Uganda and 35 m^3/ha/year in South Africa (NAS, 1980).

In the origin trial of E. grandis made in two different sites in Hawaii an increment between 15 and 42 m^3/ha/year was found at the age of 3. The best origin in the better site made in increment of 56 m^3/ha/year (Skolmen, 1983).

In good sites of Uruguay between 35 and 45 m^3/ha/year of E. grandis product was obtained and in Argentina an increment of 50 m^3/ha/year at the age of 14 was obtained (FAO, 1970).

In a study in Zimbabwe made to find the variation among neighbouring and distant provenances of E. grandis and E. tereticornis (Matheson - Mullin, 1987), 19 origins of E. grandis used in this study were also used. According to the data in the research in Zimbabwe after 3.5 years (42 months) the origin of 7810 was the first in development of height, diameter and it was followed by the origin of 7823.

However in this study (Karabucak), the origin of 7810 was eliminated because it was unsuccesful at the stage of nursery. The origin of 7823 as seen in Table : 5 was 5 th in height order, 12 th and last in diameter order, 2 nd is survival rate order and 6 th in the order of volume per hectare. The best foreigner origin in Karabucak in the volume per hectare order was the origin of 10696 and in Zimbabwe it was 6 th in height with the value of 10.00 m., 9 th in diameter with the value of 8.87 cm.

By the side of the ability of fast growth its wood also can be used in many great things. Referring to FAO (1979), AVCIOĞLU (1987) counts 25 use of the wood of E. grandis. Relying on Smith (1979). Geary and his friends (1983) indicate that good guality of activated carbon can be obtained from E. grandis.

E. grandis maybe is the leading Eucalyptus species as a plantation tree in last years in the world thanks to its fast growth and

broad use. According to FAO (1979) out of Australia, its motherland, it has been planted in more than half a million hectares in the word. In a recent publication it was stated that this number was about a million hectare (Schönau, 1983).

As a conclusion we can say that Karabucak origin of E. grandis should be used in the plantations to be established at Karabucak and the other sites which have similar ecological conditions.

On the other hand, growing of E. grandis seedlings should be started at Karabucak and Osmaniye nurseries and distributes to farmers. Emphasis should be given to research works on vegetative propagation of this species.

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LİTERATURE CITED

AVCIOĞLU, 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, S: 71-112.

AVCIOĞLU, E., 1985 : Dünyada Yapılan Okaliptus Ağaçlandırma Çalışmaları ve Okaliptus Odununun Kullanma Yerleri, Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları, Araştırma Enstitüsü Dergisi, İzmit, S: 72-98.

AVCIOĞLU, E. — GÜRSES, M.K., 1986 : Türkiye Mukayese Okaliptetumları Araştırma Sonuçları, Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Yıllık Bülten No: 22, İzmit, S: 67-112.

BAŞBAKANLIK DEVLET İSTATİSTİK ENSTİTÜSÜ, 1986 : Genel Nüfus Sayımı, İdari Bölünüş 1985, Devlet İstatistik Enstitüsü Yayın No: 1211, Ankara.

FAO, 1989 : Eucalyptus for Planting, FAO Forestry Series No: 11, Rome, 677 S.

GEARY, T.F. — MESKİMEN, G.F. — FRANKLIN, E.C., 1983 : Growing Eucalyptus in Florida for Industrial wood production. U.S. Department of Agriculture, Forest service, Southeastern Forest Experiment Station, General Technical Report SE : 23, Asheville, 43 S.

GÜMÜŞDERE, İ., 1987 : Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Orman Mühendisleri Odası «Ormancılıkta Araştırmanın Yeri ve Önemi Paneli» Tebliğ Metinleri, Ankara, S: 51-64.

GÜRSES, M.K., 1987 : Yurdumuzda Mevcut Okaliptus Ağaçlandırmalarının Kapladıkları Alanlar ile Bu Alanlardaki Servet Tahminleri ve Okaliptus Odunu Tüketen Sanayi Kollarının Tespiti, Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü Dergisi, İzmit, S. 90-100.

HILLIS, W.E. — BROWN, A.G., 1978 : Eucalyptus for wood production, Commonwealth Scientific and Industrial Research Organization, Australia, 433. S.

MATHESON, A.C. — MULLIN, L.J., 1987 : Variation Among Neighbouring and Distant Provenances of Eucalyptus grandis and E. tereticornis in Zimbabwean Field trials, Australian Forest Research, Volume 17, Number 3, Melbourne, Australia, S: 233-250.

MOSTELLER, F. — YOUTZ, C., 1961 : Tables of the Freeman - Tukey Transformations for the Binomial and Poisson Distributions, Biometrica 48.

NATIONAL ACADEMY OF SCIENCES, 1980 : Firewood Crops Shrub and Tree Species for Energy Production, National Academy Press, Washington, D.C., 237 S.

ORMANCILIK ARAŞTIRMA ENSTİTÜSÜ, 1987 : Türkiye Orman Varlığı, OAE Muhtelif Yayınlar Serisi No : 48, Ankara.

ORMAN BAKANLIĞI, 1976 : Ormancılık Ana Planı 1973-1995, Ankara, 146. S.

SCHÖNAU, A.P.G., 1983 : Basic Silviculture for the Establisment of Eucalypt Plantations with Special Reference to Eucalyptus grandis, Colloque International Surles Eucalyptus Resistants au Froid, 26-30 septembre 1983 Bordeaux-France, S: 469-479.

SKOLMEN, R.G., 1983 : Growth and Yield of Some Eucalyptus of Interest to Califonia, Eucalyptus in California, Pasific Southwest Forest and Range Experiment Station, P.O. BOX 245, Berkeley, California 94701 S. 49-57.

A STUDY OF THE ECONOMICS OF BLACK POPLAR PLANTATIONS WITH AGRICULTURAL INTERCROPPING

Aydan ALANAY

ABSTRACT

In this study, financial and economic analyses were made for black poplar plantations. The plantation effect on agricultural crops were determined as regarded to the regional economy.

Poplar plantations at five various spacings combined with different agricultural crops were sampled. The study was carried out on the conditions of 37 different types of land use. Financial analyses were made for 7 different criteria of profitability.

1. INTRODUCTION

More than half of the present forest in our country is unproductive and degraded; the deficit for the demand towards the forest products has already commenced and increasingly moving through a bottleneck. The supply - demand balance for wood rawmaterial should be kept stable by the local production, therefore it turns to be a must produce wood oven in the afforestated land. Regarding the increase of wood production in afforestated areas, the private sector poplar plantations have an utmost importance, and should be consequently oriented in a right manner.

In Turkey blackpoplars are traditionally cultivated for the sake of wood production and this mainly covers the source of wood rawmaterial in Central, East and Sutheast Anatolia which are the forest regions in terms of forest cover, almost most of the wood is consumed for construction purposes. The blackpoplar wood market is formed in accordance with the rural construction characteristics and there is accordingly a high demant for round wood, 7-20 cm. medium diameter, and narrow plantings (1x1, 2x1, 2x1.5, 2x2 meters) with short rotations are applied to meet this high demand.

Poplar cultivation in Turkey is especially carried out by the land owners having small or medium land, as a production unit within their agrucultural explaitation business.

Today «the land utilization crisis» has turned to be a problem that receives the interest and the attraction of all the world countries; some measures and precautions are being tried to be found for a solution of this crisis and the most attractive solution is the« Joint production systems.» In this content, it is going to be possible to apply and implement forestry and stock-breeding activities on the agricultural field or agricultural and stock-breeding activities on forest areas. The most common wood rawmaterial production on agricultural fields in Turkey is the pplar cultivation. Production traditionally performed by our farmers, and accordingly appropriate of agricultural crops and fodder crops between the poplar rows is to the producer's choices.

The investment projects have a high importance for the devoloping countries aiming a planned development. It is not sufficient to evaluate these investments according to the criteria of profitability from the standpoint of investors. Some other development targets should also be taken into consideration as the increase of the national income, reaching the targests of a certain production and employment, improvement of the income distribution.

The «whole - area» poplar cultivation activity in Central Anatolia mainly suits the development targets of Turkey, since it takes into consideration the social and economic features of the region through a macro - level approach, identifying the efficiency among other agricultural crops and within the economy of the whole country and contributes accordingly to orient some encouraging policies.

2. MATERIAL AND METHOD

2.1. MATERIAL

2.1.1. GENERAL STRUCTURE OF CENTRAL ANATOLIA

Two - thirds of the whole country poplar wood production is supplied from native blackpoplars; and 40 % of this production is effected in Central Anatolia region.

Central Anatolia covering 29 % of the whole area of the country is a region with heterogenous climate, soil, settlement and population, characteristics it indicaties rural characteristics and regarding the basic economies, this region is based on the agricultural sector. Grain production is realized on 26 % of the total area of the region and this region holds 43 % of the whole country land on which cereals are grown, fallowed agriculture is applied at about 40 %, 14.9 % of the total forests in the country is available in this region, and forests cover 13 % of the area of the region. The production from the forests within the general production of the country has a little share and consequently the income for the villagers within the forests areas is at a lower level.

The share of this region within the general added value is 25 %. The added value for each working person is higher than the average of the country. The change in the economic structure exists in this region like all through the country. In spite of the inter differences within the region, the share of the agricultural supplementary value decreases, however, the shares of the manufacture and servicing sectors are continuing to increase.

34 % of the available land in this region is under exploitation; and 9.16 % of the land under work can be irrigated. Poplar is grown on the 2.09 % of the irrigated land. In order to increase this rate to 5 %, the available land for poplar growing process, which is 15.000 ha. at present, should be also increased to about 40.000 ha.

2.2. METHOD

The followings were identified and determined; the necessary inputs and the obtained outputs regarding the production of the main agricultural crops that have been selected in one da. Of land;

in local blackpoplar plantations with 5 different spacings, and in accordance with the standard treatments, the establishment and operational expenditures and the possible incomes as per the type of crops at the end of the rotation period; the production expenses and incomes regarding the agricultural production under the poplars in the first years.

Following these expence and income tables and for each production choice, the internal rate return, benefit cost ratio, net present value and annual net incomes were all estimated. At the second stage, these production choices were all studied and investigated as per the increase of the national income, its being operated, improvement of the balance of payment and similar development targets.

2.2.1. METHOD FOR THE DETERMİNATION OF THE EXPENSES

Regarding the standard treatments effected in blackpoplar plantations with different spacings and regarding the determination of the unit times for these treatments, we benefited partly from the cost surveys (BİRLER 1984) performed for I-214 hybrid poplar and partly measurements carried out in the field.

Althought it will be possible to effect mechanized tending work through small garden - type tractors in poplar plantations with spacings of 1.5 x 1.5 and 2x1 m; it is finally accepted that instead of the tending ploughing, discharrowing weeding and hoeing for poplar plantations, here with this said spacing soil has been worked through man power. Pruning is effected at 4 and 8 ages with a spacing of 3x3 and 3x2 m. and at the 7 th age with a spacing of 3x1, 1x5x1.5 and 2x1 m.

Regarding the estimation of the production costs, the alternative cost principle has been treated as a base - this means it does not matter whether the goods and services utilized in the production are owned by the institution itself, but still they are treated as purchased or rented upon their marketing value. The renting price of 1 da. of land in Central Anatolia Region is approximately 20.000.— TL. and «various expenses» are added to the expenditures with a rate of 5 %.

The basic agricultural crops of the region are; wheat, beans

for leguminous plants, sugar - beet for industrial crops, sunflower for oily seeds, potatoes and onions tubercle crops, vetch for fodders, melons and apples for fruits. Regarding the estimation of the production costs of these crops, «Production Inputs and Costs Guide - 1988 for the agricultural crops produced in Turkey» is benefited. In the first two or three years, agricultural crops production can be effected beneath the blackpoplar plantations with wide spacings. In order to obtain the highest product from their limited area, the farmers effect the agricultural crop production business even in narrow spacings in the first two years, especially deal with any kind of crops appropriate for hoeing, Regarding this study, the implementations with beans, potatoes, onions and melon beneath the blackpoplar plantations with spacings of 3x3, 3x2 and 3x1 m. under mechanized tending treatments have been investigated as well as-vetch in the first three years.

2.2.2. METHOD FOR THE DETERMINATION OF THE OUTPUTS

Regarding the cutting age of the plantations, the «economic rotation period» is taken as a base since it provides the highest annual average wood increment. The growing stock in unit area (da.) in accordance with the wood classes in blackpoplar plantations, priced with the average figures of the blackpoplar wood in Central Anatolia Region as of the end of the year 1987 and consequently the incomes are extracted.

2.2.3. METHODS FOR EVALUATION

2.2.3.1. FINANCIAL ANAYSIS METHODS

These analysis evaluate the investment from the standpoint of the investor and estimate the financial profitiability of the investment. The profitalibity is estimated through various criteria - Regarding the selection of the criteria, the ones taking into consideration the time value of the money and the economic life of the investment are preferred; this selection of the criteria especially gains importance when it is necessary to select more than one investment project. In this study, the criteria with strong theoric structures are utilized, such as «internal rate of return», «present net value» and «benefit/cost ratio» methods. Regarding the alternative agricultural crops production, annual

crops are obtained (the investment is for one year), therefore concerning with the comparison of such investments with multi-year propagations (poplar - apples) at an equivalent base, the «Annual Standard Equivalent Net Incomes» are estimated through the Capital Recovery Factor in accordance with the existing net value.

2.2.3.2. ECONOMIC ANALYSIS METHODS

At this step the alternative productions are studied from the standpoint of the national economy, considering each of them as a seperate investment project, they are investigated especially on their features like their supplementary value (contribution to the national income), operation and exploitation (creating employment) and their effect on the balance of payment (foreign currency utilization and/or foreign currency saving).

3. DATA

3.1. DATA ON THE FINANCIAL PROFITABILITY OF THE ALTERNATIVE PRODUCTIONS

Regarding the determination of the financial profitability of the alternative productions, necessary data should be available to carry out the selected analysis; the establishment and tending treatments in blackpoplar plantations with different spacings are indicated in Table : 1; the data on the unit times in Table : 2, Table : 3 indicates globally the production expenses in Da. as of years, in accordance with the age of the blackpoplar plantation with 5 different spacing.

The average production inputs and outputs of the selected basic agricultural crops in the region are stated in the table no. 4 Tables 5, 6, and 7, indicate the incomes and revenues, as per the plantation ages, within the agricultural production implementation beneath the blackpoplar plantations with spacings of 3x3, 3x2 and 3x1 m.

Concerning with the blackpoplar plantations with 5 different spacings; the bulk densities as per the plantation ages, the distribution of the growing stock as per the type of product and the revenues to be obtained from the growing stock in unit area as

per the wood classification ar all indicated in the Tables : 8,9, 10,11,12.

The existing net value, interior profitability rate and benefit/ cost rate that have been estimated for 37 seperate land utilization alternatives are all globally stated in Table : 13.

3.2. DATA ON THE EFFICIENCY OF THE ALTERNATIVE PRODUCTIONS ON GENERAL ECONOMY :

Table : 14 indicates the payments for the production factors regarding the alternative productions in unit area (da.), the «net supplementary value» which is the total of these payments and the figures on the «annual average net supplementary value» in multi-year productions.

Table : 13 indicates the rate (%-percantage) of the labour expenditures within the total production cost in unit area (da.) of the alternative productions, as well as the number of worker days for each TL. 100.000.— spent within the project.

Table : 15 states the foreign - currency efficiency in alternative productions.

Tablo : 16 indicates the financial and economic profitability values for 23 seperate implementing alternatives in blackpoplar growing of which the economic indicaters are much higher when compared to other agricultural productions in central Anatolia, the priorities of these alternatives in accordance with each criteria, as well as the percantage rates of the increase in the profitability criteria when agricultural production is implemented beneath the poplar.

4. CONCLUSIONS AND RECOMMENDATIONS

According to the analysis, the production of apple, vetch and sunflower resulted a loss. Wheat, sugar beat and, potato cultivations proved non profitable. Whereas, green bean onion and melon were found most profitable kind of cultivations compared to other agricultural crops. The highest rate of internal return (40.18 %) was estimated for green bean cultivation. The internal rate of return

was estimated 24.57 % for wheat cultivation whereas, the other economic indicators were found negative. Apple cultivation gave a loss, but when it was combined with clover cultivation it proved profitable at a lower level for the first seven years.

When these agricultural production alternatives were investigated in the view of general econocmy, the rates of added value for patato, sugar beet, green bean and onion cultivations were estimated highe, compare to other agricultural crops. Employment capacities of sugar beet, onion, green bean and apple cultivations were estimated higher than the others. The saving of foreing exchange were positive for onion and vetch cultivations.

Poplar cultivation combined with agricultural crops and poplar cultivation alone resulted greater profitability when compared with cultivation of agricultural crops alone. In Central Anatolia, spacings affected the profitability of poplar cultivations.) The narrower spacings in black poplar plantations resulted greater profitability. During the years of black poplar plantations, combination with agricultural crops caused an increase in the profitability. This increment became evidint for black poplar plantations at wider spacings. The greatest profitability was found for black poplar plantations in spacing of 3m x 1m and combined with agricultural crops. Although, vetch cultivation resulted a loss, When, it was combined with black poplar plantation, a maximum profitability was achieved for the first 3 years.

Black poplar cultivation resulted a maximum added value, when compared with agricultural crops only. The rate of added value increased for plantations with narrower spacings. It also increased for plantations combined with agricultural crops. Foreigh exchange saving were estimated negative for agricultural cultivations except for onion and vetch, whereas it was found positive for black poplar plantations. As regards with the employment capacity, black poplar plantations resulted lower values compared with some agricultural crops (sugar beet, onion, green bean) Employment capacity increased for black poplar plantations combined with agricultural crops. It is to indicate as a low rate of profitability in rural Central Anatolia. Black poplar cultivations has become an alternative type of land use, because it secures relatlveiy high rate of profitability. Black poplar cultivation is important not only for the farmers point of view but also for national economy. Farmers should be encauraged by the state to grow black poplars. Black pop-

uld be enccureged by the state to grow black poplars. Black poplar plantations combined with agricultural crops should be studied much in detail and extensive demostrative plantations should be established. Fodder crops should also be taken into consideration to combine with poplar plantatins at older age of years. Not only poplar wood production, but also agricultural production should be increased. Therefore , necessary measurments must be taken to increase the productivity in land use such as, fallow practices must be avoided, irrigation facilities must be developed.

TABLOLAR

Table: 1 Establishment and Tending Activities in Populus nigra Plantations

	No	OPERATIONS	Frequency of operations by years													
			0	1	2	3	4	5	6	7	8	9	10	11	12	13
Plantation establishment operations	1	Cross subsoiling on complete area	1													
	2	Soil levelling	1													
	3	Cross disc-harrowing on complete area	1													
	4	Marking planting spots	1													
	5	Digging planting holes	1													
	6	Planting														
Weeding and Tending Operations	7	Digging holes for beating up			1											
	8	Beating up			1											
	9	Ploughing between planting rows(in one direction)		2	2	2	1									
	10	Discharrowing " " " " " "		3	3	3	2	2	1	1						
	11	Weeding and hoeing around plants		2	2	2										
	12	Irrigation		4	4	4	3	3	2	2	1	1				
	13	4 th year pruning					1									
	14	7 th " "								1						
	15	8 th " "					1				1					
	16	Pest and disease control (chemical)				1	1									
	17	Management of the plantation	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table : 2 The Unit-times of Populus nigra Plantations Established at Various Spacings

	No	OPERATİONS	Unit	Planting espacement (mxm)				
				3x3	3x2	3x1	1.5x1.5	2x1
Plantation establishment operations	1	Cross subsoiling on complete area	MH/Da	0.684	0.684	0.684	0.684	0.684
	2	Soil levelling	MH/Da	0.148	0.148	0.148	0.148	0.148
	3	Cross disc-harrowing on complete area	MH/Da	0.381	0.381	0.381	0.381	0.381
	4	Marking planting spots	WD/Da	0.358	0.519	0.979	1.250	1.351
	5	Digging planting holes	MH/Da	0.79	1.19	2.38	3.17	3.57
	6	Planting	WD/Da	0.42	0.62	1.25	1.66	1.87
Weeding and Tending Operations	7	Digging holes for beating up	MH/Da	0.043	0.057	0.121	1.10	1.25
	8	Beating up	WD/Da	0.022	0.03	0.064	0.082	0.094
	9	Ploughing between planting rows(in one direction)	MH/Da	0.41	0.41	0.41	-	-
	10	Discharrowing " " " " " "	MH/Da	0.41	0.41	0.41	-	-
	11	Weeding and hoeing around plants	WD/Da	0.82	1.23	2.42	-	-
	12	Irrigation	WD/Da	0.3	0.3	0.3	0.3	0.3
	13	4 th year pruning	WD/Da	0.943	1.361	-	-	-
	14	7 th " "	WD/Da	-	-	2.99	3.11	3.75
	15	8 th " "	WD/Da	1.221	1.66	-	-	-
	16	Pest and disease control (chemical)	MH/Da	0.222	0.332	0.666	0.888	1.0
	17	Management of the plantation	WD/Da	-	-	-	2.5	2.5
	18	Management and control	WD/Da	0.1	0.1	0.1	0.1	0.1

MH/Da : Machine hours/Dekar
WD/Da : Workday (8 hours)/Dekar

Table: 3 The Expenditures of Estabilishment and Tending Operations According to Ages for Populus nigra Plantations at Various Spacings.

Year	Spacing and annual expenditures				
	3x3 m	3x2 m	3x1 m	1,5x1,5 m	2x1 m
	TL/Da	TL/Da	TL/Da	TL/Da	TL/Da
0	82200	117400	224031	294714	330246
1	50450	53880	63870	56940	56940
2	53553	58049	72741	71606	73610
3	55875	62035	80191	75387	78251
4	44442	48904	51359	64118	66491
5	31435	31435	31435	45180	45180
6	26562	26562	26560	33420	33420
7	26562	26562	39120	35982	38690
8	26804	27400	21680	21680	21680
9	20420	20420	20420	20420	20420
10	20420	20420	20420	20420	20420
11	20420	20420	20420	20420	20420
12	20420	20420	20420	20420	-
13	20420	20420	20420	-	-
Total	499993	554327	692667	730707	805758

Table: 4 The Average Production Inputs and Outputs of the Selected Basic Agrucultural Crops on Irrigated Soils per 1000 m³

Agricultural crops	Vorker Time Spent (Total)		Total Cost (₺)	Productivity (kg/Da)	Side Product (₺/Da)	Production Cost (₺/Da)	Production Cost (₺/Rg)	Sale Price (₺/kg)	Gross Product Value (₺)	Difference (₺)
	Vorker (H/Da)	Machine (H/Da)								
Wheat	4,69	1,11	40.704	265	25.000	40.704	138	97	50.705	10.000
Green Beans	43,85	1,60	69.194	136	8.600	69.194	468,57	659	97.000	27.806
Sugar Beet	90,15	2,32	93.027	4380	2.858	93.027	21,24	22,0	99.218	6.191
Sunflower	13,12	0,65	37.001	165	-	37.001	197	215	35.475	-1.526
Potatoes	66,83	4,23	175.246	1900	-	175.246	34,23	100	190.000	14.754
Onion	77,11	1,41	98.260	1160	-	98.260	87,71	100	116.000	17.740
Melon	23,29	2,12	62.692	1690	-	62.692	37,10	45	76.050	13.358
Vetch	6,77	1,21	41.863	97	8.350	41.863	431	350	42.300	-437
Apple (Establishment)	229,40	0,91	453,300	300	80.000 (clover)	-	-	100	30.000	-423.300
Apple (Culture Annual)	86,53	0,38	146.291	1573	-	14.629	9.300	100	157.300	11.009
Clover 1.year	40,12	0,79	28.921							
2.year	39,68	0,57	16.463	800	-	180.63	2.258	100	80.000	61.937

Table : 5 The Production Inputs and Outputs of Different Aged Populus nigra Plantations (at 3x3 m spacings) in Combined with Agricultural

Years	Types of crop											
	Poplar		Beans		Potatoes		Onion		Melon		Vetch	
	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue
0	[illegible]											
1	40100		32404	35250	111235	170000	50500	103100	23372	57500	14323	41350
2	43213		31320	52000	107835	102000	59135	61900	25872	40500	14064	26200
3	55875 45525										13594	18750
4	44442											
5	31435											
6	26562											
7	26562											
8	26804											
9	20420											
10	20420											
11	20420											
12	20420											
13	20420	2383516										
Total	479393 468943	2383516	64224	134750	219070	272000	111635	165000	54744	108000	42080	86300

Table: 6 The Production Inputs and Outputs of Different Aged Populus nigra Plantations (at 3x2 m spacings) in Combined with Agricultural Crops.

Years	Type of crop											
	Poplar		Beans		Potatoes		Onion		Melon		Vetch	
	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue
0	224071											
1	53 520		29 677	59 150	95 115	126 700	54703	77400	28471	[illegible]	13418	28700
2	62 391		29 826	35 100	92 580	76 000	54701	46400	28210	30420	12092	20000
3	80191 69841										11854	14000
4	51359											
5	31435											
6	26560											
7	39120											
8	21680											
9	20420											
10	20420											
11	20420											
12	20420	4362151										
Total	671967 661617	4362151	58903	94250	187695	202700	109004	123800	46682	81120	28270	62700

Table: 7 The Production inputs and Outputs of Different Aged Populus nigra Plantations (at 3x1 m spacings) in Combined with Agricultural Crops.

Years	Type of crop											
	Poplar		Beans		Potatoes		Onion		Melon		Vetch	
	Expend.	Revenue	Expend.	Revenue	Expend.	Revenue	Expend.	Revenue	Expend.	Revenue	Expend.	Revenue
0	117900											
1	43529		31672	2000	307030	158500	56928	9000	28261	0	[illegible]	[illegible]
2	47499		[illegible]	4400	303850	95100	58088	18000	25381	3960	[illegible]	[illegible]
3	52033 51635										[illegible]	22850
4	[illegible]											
5	32435											
6	26562											-
7	26562											
8	27400											
9	20420											
10	20420											
11	20420											
12	20420											
13	20420	2699727										
TOTAL	532627 583277	2699727	62857	126900	610880	253600	115016	27000	53642	200800	40484	77350

Table : 8 The Average Volume Values and Money Equivalents According to Crops and Plantation Ages of Populus nigra Plantations (3x3 m spacings) per 1000 m²

A G	d1.30	VOLUME	PRICES AND VOLUMES BY THE WOOD ASSORTMENTS			
			POST	SMALL TOP END	BIG TOP END	[illegible]

Table: 9 The Average Volume Volues and Money Equivalents According to Crops and Plantation Ages of Populus nigra Plantations (3x2 m spacings) per 1000 m²

AGE	d1.30 cm	VOLUME m3/da	PRICES AND VOLUMES BY THE WOOD ASSORTMENTS										TOTAL TL/da
			POST m3/da	TL/m3	SMALL TOP END m3/da	TL/m3	BIG TOP END m3/da	TL/m3	SMALL ROUND W. m3/da	TL/m3	BIG ROUND WOOD m3/da	TL/m3	VAIST WOOD m3/da	TL/m3	
1	1.47	0.1708											0.1708 (%100)	36000	6149
2	3.22	0.7193											0.7193 (%100)	36000	25895
3	5.10	1.6816	1.6143 (% 96)	80000									0.0673 (%4)	36000	131567
4	6.97	3.0710	2.9481	8000									0.1228 (% 3)	36000	240261
5	8.73	4.8773					4.7309 (% 97)	100000					0.1463 (% 3)	36000	478357
6	10.30	7.0675					6.8555 (% 97)	100000					0.2120 (% 3)	36000	693182
7	11.64	9.5850					4.0736	100000	5.2718 (%55)	105000			0.2396 (%2.5)	36000	969525
8	12.74	12.3504					5.2489	100000	6.7927 (%55)	105000			0.3088 (%2.5)	36000	1249241
9	13.60	15.2609					6.4859	100000	8.3935 (%55)	105000			0.3815 (%2.5)	36000	1543642
10	14.26	18.1908			3.4563 (%19)	90000			5.7301 (%31.5)	105000	115000		0.2728 (%1.5)	36000	1926682
11	14.80	20.9909			3.9883 (%19)	90000			6.6121 (%31.5)	105000	115000		0.3149 (%1.5)	36000	2223248
12	15.30	23.4890			4.4629 (%19)	90000			7.3991 (%31.5)	105000	115000		0.3523 (%1.5)	36000	2487841
13	15.89	25.4897			4.8430 (%19)	90000			8.0292 (%31.5)	105000	115000		0.3824 (%1.5)	36000	2699727

Table : 10 The Average Volume Values and Money Equivalents According to Crops and Plantation Ages of Populus nigra Plantations (3x1 m spacings) per 1000 m²

A			PRICES AND VOLUMES BY THE WOOD ASSORTMENTS															
G	d1.30	VOLUME	POST		SMALL TOP END		BIG TOP END		SMALL ROUND W.		BIG ROUND WOOD		VAIST		WOOD		TOTAL
E	cm	m3/da	m3/da	TL/m3	m3/da	TL/m3	m3/da	TL/m3	m3/da	TL/m3	m3/da	TL/m3	m3/da		TL/m3		TL/da
1	1.38	0.1465											0.1465		36000		5274
													(%100)				
2	2.87	0.7659											0.7659		36000		27572
													(%100)				
3	4.40	2.0779											2.0779		36000		74804
													(%100)				
4	5.94	2.2191	4.0503	80000									0.1688		36000		330101
			(% 96)										(% 4)				
5	7.42	7.2461	6.9563	80000									0.2898		36000		566937
			(% 96)										(% 4)				
6	8.83	11.1355					10.801	100000					0.3341		36000		1092168
							(% 97)						(% 3)				
7	10.13	15.7809					15.307	100000					0.4734		36000		1547792
							(% 97)						(% 3)				
8	11.29	21.0056					8.9274	100000	11.553	105000			0.5251		36000		2124720
							(%42.5		(% 55)				(%2.5)				
9	12.29	26.5434					11.281	100000	14.599	105000			0.6636		36000		2684865
							(%42.5)		(% 55)				(%2.5)				
10	13.11	32.0446					13.619		17.624	105000			0.8011		36000		3241313
							(%42.5)		(% 55)				(%2.5)				
11	13.75	37.0929					15.764	100000	20.401	105000			0.9273		36000		3751949
							(%42.5)		(% 55)				(%2.5)				
12	14.21	41.1854			4.4629	90000			12.973	105000	19.769	115000	0.6178		36000		4362151
					(%19)				(% 48)		(%31.5)				(%1.5)		

Table: 11 The Average Volume Values and Money Equivalents According to Crops and Plantation Ages of Populus nigra Plantations (1.5x1.5 m spacings) per 1000 m²

AGE	d1.30 cm	VOLUME m3/da	PRICES AND VOLUMES BY THE WOOD ASSORTMENTS									
			POST m3/da	TL/m3	SMALL TOP END m3/da	TL/m3	BIG TOP END m3/da	TL/m3	SMALL ROUND W. m3/da	TL/m3	BIG ROUND WOOD m3/da	TL/m3	VAIST WOOD m3/da	TL/m3	TOTAL TL/da
1	1.30	0.0479											0.1708	36000	6149
2	2.69	0.1834											(%100) 0.7193	36000	25895
3	4.13	1.1491											(%100) 0.0673	36000	131567
4	5.58	3.1622	3.0357	80000									(% 4) 0.1228	36000	240261
5	6.99	6.3900	(% 96) 6.1344	80000									(% 4) 0.1463	36000	478357
6	8.35	10.8580	(% 96)				10.532	000000					(% 3) 0.2120	36000	693182
7	9.62	16.4462					(% 97) 15.953	100000					(% 3) 0.1340	36000	969525
8	10.76	22.8929					(% 97) 22.206	100000					(%2.5) 0.1666	36000	1249241
9	11.75	29.7915					(% 97) 12.661	100000	16.385	105000			(%2.5 0.1996	36000	1543642
10	12.57	36.5927					(%42.5) 15.552	100000	(% 55) 20.126	105000			(%2.5) 0.2326	36000	1926682
11	13.18	42.6027					(%42.5) 18.106	100000	(% 55) 23.431	105000			(%1.5) 0.2642	36000	2223248
12	13.57	46.9844					(%42.5) 19.713	100000	(% 55) 25.511	10500u			(%1.5) 0.2939	36000	2487841
13							(%42.5)		(% 55)				(%1.5) 0.3202	36000	2699727
													(%1.5)		

Table: 12 The Average Volume Values and Money Equivalents According to Crops and Plantation Ages of Populus nigra Plantations (2x1 m spacings) per 1000 m²

AGE	d1.30 cm	VOLUME m3/da	PRICES AND VOLUMES BY THE WOOD ASSORTMENTS													
			POST		SMALL TOP END		BIG TOP END		SMALL ROUND W.		BIG ROUND WOOD		VAIST	WOOD	TOTAL
			m3/da	TL/m3	m3/da	TL/m3	m3/da	TL/m3	m3/da	TL/m3	m3/da	TL/m3	m3/da	TL/m3	TL/da
1	0.99	0.0490											0.1708	36000	6149
													(%100)		
2	2.22	0.2125											0.7193	36000	25895
													(%100)		
3	3.61	1.2745											0.0673	36000	131567
													(% 4)		
4	5.08	3.4655	3.3269	80000									0.1228	36000	240261
													(% 3)		
													0.1463	36000	478357
													(% 3)		
													0.2120	36000	693182
													(% 3)		
5	6.56	6.9500	6.6720	80000									0.2396	36000	969525
			(% 96)										(%2.5)		
6	8.00	11.7310					11.379	000000					0.3088	36000	1249241
							(% 97)						(%2.5)		
7	9.33	17.5600					17.120	100000					0.3815	36000	1543642
					(% 97)								(%2.5)		
8	10.50	24.3840					23.652	100000					0.2728	36000	1926682
							(% 97)						(%1.5)		
9	11.47	31.4500					13.366	100000	17.297	105000			0.3149	36000	2223248
							(%42.5)		(% 55)				(%1.5)		
10	12.19	38.2000					16.235	100000	21.010	105000			0.3523	36000	2487841
							(%42.5)		(% 55)				(%1.5)		
11	12.62	43.8250					18.626	100000	24.104	105000			0.3824	36000	2699727
							(%42.5)		(% 55)				(%1.5)		

Table : 13 The Economic Values of Alternative Productions per 1000 m²

ALTERNATIVE PRODUCTIONS	ROTATION PERIOD (year)	PNW 1/ TL/Da.	IRR %	B/C RATIO	ANNUAL NET REVENUE TL/Da.	ADDED VALUE TL/Da/year	EMPLOYMENT CREATION EFFECT		FOREIGN EXCHANGE EFFECT TL/Da/year
							Labour expenditure %	worker days for per TL.300000	
Black poplar (3x3 m)	13	224416	18.05	1.70	34936	177519	13.96	3.49	893
" " (3x2 m)	13	247584	17.67	1.67	38543	199218	14.97	3.74	992
" " (3x1 m)	12	608096	21.01	2.19	98169	345657	16.14	4.03	2617
" " (1,5x1,5 m)	12	614569	20.07	2.04	99214	367493	24.38	6.09	2727
" " (2x1 m)	11	647999	20.77	2.03	109133 *	374177	23.40	5.85	2511
Apple	35	-306565	-	0.68	-37498	67168	29.04	7.17	-21318
Wheat	1	7131	24.57	1.17	7131	44040	4.40	1.10	-2469
Beans	1	22315	40.18 *	1.32	22315	82095	30.53	7.63	-1407
Sugar beet	1	575	0.66	1.00	575	88094	47.21 *	11.80 *	-4525
Sunflower	1	-3534	-1.70	0.90	-3534	50097	16.85	4.21	-1077
Potatoes	1	3999	8.42	1.02	3999	115846	17.86	4.47	-7649
Onion	1	11174	18.05	1.11	11174	87218	53.52	9.63	9493 *
Melon	1	9053	21.31	1.14	9053	60451	16.89	4.22	-1893
Vetch	1	-1957	1.04	0.95	-1957	53105	6.44	1.66	8522
poplar+beans (3x3 m)	13	306076	21.92	1.85	47649	186699	20.51	5.13	
" +beans+clover (3x3 m)	13	317031	22.51	1.88	49354	147971	20.92	5.23	
" +potatoes (3x3 m)	13	284726	21.07	1.59	43104	149982	18.68	4.67	
" +onion (3x3 m)	13	282950	20.68	1.70	44049	142191	24.78	6.20	
" +melon (3x3 m)	13	288059	20.91	1.82	44844	184223	16.67	4.17	
" +vetch (3x3 m)	13	286669	20.77	1.87	44628	181936	15.60	3.90	
" +beans (3x2 m)	13	322613	20.45	1.79	50223	207791	20.70	5.17	
" +beans+vetch (3x2 m)	13	333308	20.86	1.82	51888	208716	21.08	5.27	
" +potatoes (3x2 m)	13	304065	19.72	1.57	47336	210306	19.19	4.80	
" +onion (3x2 m)	13	299099	19.50	1.66	46563	208253	24.53	6.13	
" +melon (3x2 m)	13	305886	19.75	1.77	47619	205444	17.31	4.33	
" +vetch (3x2 m)	13	303965	19.62	1.80	47320	203869	16.43	4.11	
" +beans (3x1 m)	12	636585	22.25	2.21	105997	352528	20.44	5.11	
" +beans+vetch (3x1 m)	12	667979 *	22.53	2.25	107837	353106	20.86	5.22	
" +potatoes (3x1 m)	12	640570	21.85	1.98	103412	355688	19.77	4.94	
" +onion (3x1 m)	12	639554	21.81	2.09	103248	353493	23.53	5.88	
" +melon (3x1 m)	12	655559	22.21	2.23	105831	351103	18.00	4.50	
" +vetch (3x1 m)	12	654965	22.16	2.27	105736	349683	17.30	4.32	
apple+clover	35	5741	12.71	1.00	702	82523	30.48	7.62	
sugar beet+wheat+beans	13	85481	19.06	1.13	9656	73693	34.35	8.59	
sugar beet+wheat+beans	12	85196	19.41	1.14	10162	71410	33.36	8.34	
beans+onion+melon	12	128327	26.59	1.19	15306	76581	30.43	7.61	
sugar beet+sunflower+beans	12	53039	14.63	1.09	6398	66762	36.20	9.05	

1/ US Dollars = TL.1300 in March 1988

Table : 14 The Effects of Added Values in Alternative Productions

ALTERNATIVE PRODUCTIONS	ROTATION PERIOD (year)	A D D E D V A L U E (TL/Da)					
		Wages, salaries	Rents		Profit	Added value	ANNUAL AVERAGE ADDED VALUE
			Machines and equipment	Land			
Black poplar (3x3 m)	15	64734	99494	260000	1883523	2307751	177519
" " (3x2 m)	15	78690	106150	260000	2145400	2589840	199218
" " (3x1 m)	12	112012	126391	240000	2669484	3147887	345657
" " (1,5x1,5 m)	12	201608	57283	240000	3911085	4409916*	367493
" " (2x1 m)	11	205636	62159	220000	3627133	4115948	374177*
Apple	35	1363578	391365	700000	-104075	2350368	67168
Wheat	1	1790	12249	20000	10001	44040	44040
Beans	1	21125	15164	20000	27806	82095	82095
Sugar beet	1	43915	17988	20000	6191	88094	88094
Sunflower	1	6255	5388	20000	-1526	30097	30097
Potatoes	1	51300	49792	20000	14754	115846	115846
Onion	1	37850	11628	20000	17740	87218	87218
Melon	1	105685	16488	20000	13358	60431	60431
Vetch	1	2780	9388	20000	427	33105	33105
poplar+beans (3x3 m)	13	98804	90228	260000	1978249	2427081	186699
" +beans+clover (3x3 m)	13	101284	84586	260000	1993753	2439725	187671
" +potatoes (3x3 m)	13	119744	132570	260000	1957151	2469507	189962
" +onion (3x3 m)	13	130204	92759	260000	1950488	2433485	187191
" +melon (3x3 m)	13	80744	90674	260000	1957479	2389897	184223
" +vetch (3x3 m)	13	73074	83552	260000	1948537	2365163	181936
" +beans (3x2 m)	13	112160	96727	260000	2233405	2701288	207791
" +beans+vetch (3x2 m)	13	114940	90951	260000	2247427	2713320	208716
" +potatoes (3x2 m)	13	133340	138306	260000	2209850	2740476	210806
" +onion (3x2 m)	13	143820	99274	260000	2204196	2707290	208253
" +melon (3x2 m)	13	94300	103330	260000	2213138	2670768	205444
" +vetch (3x2 m)	13	86630	89747	260000	2213916	2650293	203869
" +beans (3x1 m)	12	145882	116528	240000	3725531	4227941	352328
" +beans+vetch (3x1 m)	12	148662	110588	240000	3758027	4257277	353106
" +potatoes (3x1 m)	12	167062	150002	240000	3705139	4268253	355688
" +onion (3x1 m)	12	177542	119391	240000	3704980	4241913	353493
" +melon (3x1 m)	12	128022	120586	240000	3724652	4213240	351103
" +vetch (3x1 m)	12	120352	109374	240000	3726469	4196195	349683
apple+clover	35	1450068	410013	700000	328226	2888307	82523
sugar beet+wheat+beans	13	511635	191592	260000	182183	945010	72693
sugar beet+wheat+beans	12	267320	173604	240000	175992	856916	71410
beans+onion+melon	12	278240	165120	240000	235616	918976	76581
sugar beet+sunflower+beans	12	285100	140160	240000	129884	801144	66762

Table: 15 The Effects of Foreign Exchange in Alternative Productions.

ALTERNATIVE PRODUCTIONS	Value of the annual average production	IMPORT		EXPORT		COST OF THE ANNUAL AVERAGE PRODUCTION TL/Da	FOREIGN EXCHANGE INPUT IN THE PRODUCTION		FOREIGN EXCHANGE EFFECT OF THE PROJECT TL/Da/YEAR
		%	TL/Da	%	TL/Da		%	TL/Da	
Poplar (3x3 m)	183347	0.11	202	1.3	2383	38461	3.35	1288	893
" - (3x2 m)	207671	0.11	228	1.3	2700	42641	3.47	1480	992
" (3x1 m)	363513	0.11	400	1.3	4726	57722	3.76	1709	2617
" (1,5x1,5 m)	390981	0.11	430	1.3	5083	65059	2.96	1926	2727
" (2x1 m)	402991	0.11	443	1.3	5239	73252	3.12	2285	2511
Aple	157300	-	-	3.43	5395	146291	18.26	26713	-21318
Wheat	50705	1.96	994	1.57	796	40704	5.58	2271	-2469
Beans	97000	-	-	0.29	281	69194	2.44	1688	-1407
Sugar beet	99218	-	-	0.0005	5	93027	4.87	4530	-4525
Sunflower	35475	-	-	0.002	7	37001	2.93	1084	-1077
Potatoes	190000	0.14	266	1.04	1976	175246	5.34	9358	-7648
Onion	116000	-	-	10.36	12018	98260	2.57	2525	9493
Melon	76050	-	-	0.99	753	62692	4.22	2646	-1893
Vetch	42300	0.002	8	22.5	9518	41363	2.36	988	8522

* Values are at 1987 level

Table : 16 The Financial and Economic Profitability Values in Populus nigra Plantations

ALTERNATIVE PRODUCTIONS	VALUE of FINANCIAL PROFITABILITY IRR %	ORD. NO	B/C %	ORD. NO	ANR TL/DA	ORD. NO	VALUE of ECONOMIC PROFITABILITY ADDED VALUE TL/Da	ORD. NO	WORK CREA. %	ORD. NO	CURR. EFFECT TL/DA	ORD. NO
3x3 m BLACK POPLAR	18.03	21	1.70	16	34936	23	177519	23	13.96	23	893	5
3x2 m. "	17.67	22	1.67	17	38543	22	199218	16	14.97	22	992	4
3x1 m "	21.01	10	2.19	4	98169	9	345657	9	16.14	20	2617	2
1.5x1.5 m "	20.07	16	2.04	6	99214	8	367493	2	24.38	3	2727	1
2x1 m "	20.77	13	2.03	7	109133	1	374177	1	23.40	5	2511	3

ALTERNATIVE PRODUCTIONS	VALUE of FINANCIAL PROFITABILITY IRI %	ORD. NO	INCR. %	B/C %	ORD. NO	INCR. PUANI	ANR TL/DA	ORD. NO	INCR. %	VALUE of ECONOMIC PROFITABILITY ADDED VALUE TL/DA	ORD. NO	INCR. %	WORK CREAT. %	OF N	IN
3x3 m poplar+bean	21.92	6	18	1.85	11	0.15	47649	13	36	186699	20	5	20.51	1	
3x3 m poplar+bean+vetch	22.51	2	25	1.88	9	0.18	49354	12	41	187671	18	6	20.92	1	
3x3 m poplar+potato	21.07	9	17	1.59	19	-0.11	45104	18	29	189962	17	7	18.68	14	34
3x3 m poplar+onion	20.68	14	15	1.70	16	0	44049	21	26	187191	19	5	24.78	1	
3x3 m poplar+melon	20.91	11	16	1.82	12	0.12	44844	19	28	184223	21	4	16.67	18	
3x3 m poplar+vetch	20.77	13	15	1.87	10	0.17	44628	20	28	181936	22	2	15.60	21	12
3x2 m poplar+bean	20.45	15	16	1.79	14	0.12	50223	11	30	207791	13	4	20.70	9	
3x2 m poplar+bean+vetch	20.86	12	18	1.82	12	0.15	51888	10	35	208716	11	5	21.08	6	21
3x2 m poplar+potato	19.72	18	12	1.57	20	-0.10	47336	15	23	210806	10	6	19.19	13	
3x2 m poplar+onion	19.50	20	10	1.66	18	-0.01	46563	17	21	208253	12	5	24.53	2	
3x2 m poplar+melon	19.75	17	12	1.77	15	0.10	47619	14	24	205444	14	3	17.31	16	0
3x2 m poplar+vetch	19.62	19	11	1.80	13	0.13	47320	16	23	203869	15	2	16.43	19	
3x1 m poplar+bean	22.25	3	6	2.21	3	0.02	105997	3	8	352328	6	2	20.44	11	
3x1 m poplar+bean+vetch	22.53	1	7	2.23	2	0.04	107837	2	10	353106	5	2	20.86	8	
3x1 m poplar+potato	21.85	7	4	1.98	8	-0.21	103412	6	5	355688	3	3	19.77	12	
3x1 m poplar+onion	21.81	8	4	2.09	5	-0.10	103248	7	5	353493	4	2	23.53	4	
3x1 m poplar+melon	22.21	4	6	2.23	2	0.14	105831	4	8	351103	7	2	18.00	15	
3x1 m poplar+vetch	22.16	5	5	2.27	1	0.08	105736	5	8	349683	8	1	17.30	17	

IRI=internal rate of return B/C=rate of benefit cost ANR=Annual net revenue