ISSN 0535-8418

SERİ SERIES SERIE SÉRIE	A	CİLT VOLUME BAND TOME	57	SAYI NUMBER HEFT FASCICULE	2	2007

İSTANBUL ÜNİVERSİTESİ

ORMAN FAKÜLTESİ

D E R G İ S İ

REVIEW OF THE FACULTY OF FORESTRY,
UNIVERSITY OF ISTANBUL

ZEITSCHRIFT DER FORSTLICHEN FAKULTÄT
DER UNIVERSITÄT ISTANBUL

REVUE DE LA FACULTÉ FORESTIÈRE
DEL 'UNIVERSITÉ D'ISTANBUL

Changes in Physical Properties of Fine – Textured Soils Occurred Within a Rotation Period of 21 Years in *Pinus pinaster* (Aiton) Plantations Established by Mechanized Soil Preparation Methods

Ahmet Hızal[1*] Taneri Zoralioğlu[2] Mustafa Zengin[2]

[1] Istanbul University, Faculty of Forestry, 34473 Bahçeköy, Istanbul.
[2] Poplar and Fast Growing Forest Trees Research Institute, 41050 Izmit.

[*] Tel: 0 212 226 11 03 (25337) Fax: 0 212 226 11 13 E-mail: ahizal@istanbul.edu.tr

Abstract

This study was conducted to examine the changes in physical properties of soils prepared with different methods in Kerpe (Turkey), in 1978. The site preparation methods were: 1) strip soil preparation (0-60 cm) with rippers mounted to D 85-A 12 Komatsu bulldozer (T1), 2) strip soil preparation (0–45 cm) (as gradoni terraces - bench terraces with 12-15 % reverse slope and 60-80 cm wide) with double pass of a tined plough (T2), 3) complete area topsoil preparation (0-30 cm) with double pass of a heavy disk harrow (T3), 4) complete area deep soil preparation (30-60 cm) with rippers mounted to a Komatsu bulldozer followed by a complete topsoil preparation (0-30 cm) with a heavy disk harrow (T4), 5) control plantation plots cleared with a rake mounted to a Komatsu bulldozer where no soil preparation operation was carried out following clearing of the coppice cover (0-30 cm) (C). Twenty one years after soil preparation in November 1999, soil core samples taken from different depth layers and were analyzed for soil texture, bulk density, total porosity, air-filled pore space, maximum water-holding capacity, permeability and moisture equivalent. The results were compared with those of two previous investigations performed at the same study site in 1978 and 1986. The results revealed that fine-textured soils changed to moderately fine-textured soils in 0-60 cm depth layers of all treatment plots (except T2) in 21 years. The conditions of soil bulk density, maximum water-holding capacity, air-filled pore space and total porosity significantly deteriorated for the depth layers of 0-60 cm of all treatment plots (except bulk density and total porosity of C and T3 plots) in the period of the first 8 years (from 1978 to 1986). When 0-15 cm, 15-30 cm, 30-45

Received: 14. 06. 2007; accepted: 27.09.2007

cm and 45-60 cm soil depth layers are considered separately, the conditions of only the first three properties significantly deteriorated in the same period. However, significant improvements occurred in the conditions of total porosity and air-filled pore space for the soils in 0 to 60 cm depth layers of T2, T3 and T4; C, T2, T3 and T4 treatment plots from 1986 to 1999, respectively. The conditions of bulk density also recovered only for the depth layers of 0-15 cm and 45-60 cm, and the conditions of air-filled pore space recovered only for the depth layers of 0-15 cm, 30-45 cm and 45-60 cm in the last 13 years (from 1986 to 1999). Significant deteriorations were observed in the maximum water-holding capacity during the rotation period of 21 years. No significant differences were observed in the conditions of moisture equivalent and permeability in 21 years. It is to underline that the significant differences in conditions of physical soil properties observed following the soil preparation with different methods became non-significant after the period of first 8 years.

Keywords: Pinus pinaster (Aiton), physical soil properties, rotation period, soil texture, soil preparation methods.

1. Introduction

In Turkey, plantation activities with fast growing tree species started in1960 and total planted area reached to a size of 17127 ha in 1972 (AEKGM[1], 1973). In 1972, Turkish Government assisted by FAO started a project entitled "Industrial Forestry Plantations in Turkey" to determine the most suitable equipment and methods for ground clearing and soil preparation (Cooling, 1977). To achieve this goal, demonstrative industrial forestry plantations were established in the Black sea and Marmara regions of Turkey on several sites. The plantation sites generally had undulating topography, deep soil with fine texture, and low gravel content. Dominant vegetation cover was coppice which consisted of trees such as *Quercus* spp., *Castanea sativa* Miller, *Fagus orientalis* L., *Carpinus betulus* L., *Tilia argentea* Desf. exDC. and shrubs such as *Laurus nobilis* L., *Arbutus unedo* L., *Phillyrea latifolia* L., *Erica arborea* L., *Cistus salviifolius* L. and *Rhododendron* sp. The soils in the demonstrative plantation sites were prepared using a unique method which was soil preparation on complete area with deep soil tillage (30-60 cm) by rippers and then a complete area topsoil preparation (0-30 cm) by a heavy disc harrow (Devéria, 1977). This method was rather expensive and had not been compared to other cheaper methods in terms of plant growth in different site conditions. Therefore, in 1978 a comparative study was carried out in Kerpe, Kocaeli, Turkey to determine the most suitable soil preparation method for establishing industrial forestry plantations in the region of Marmara. In this experimental study, soil was prepared with five different mechanized methods and one-year old *Pinus pinaster* (Aiton) seedlings were planted (Tolay et al., 1982). Another

1 Abbreviation for General Directorate of Reforestation and Erosion Control of Turkish Ministry of Forestry

study was also undertaken on the same study area in order to estimate the effects of soil preparation methods on plant growth and to determine the changes in conditions of physical soil properties (Hızal et al., 1991). The overall results of these studies revealed that soil preparation methods had no significant effect on plant growth within the first 8 years after plantation establishment (Tolay et al., 1982; Hızal et al., 1991). Soil examinations conducted after 8 years following the site preparations showed that significant deteriorations occurred in the physical soil properties stated above for the 0-60 cm depth layers of all treatment plots (except C and T3 treatment plots for bulk density and total porosity), and the conditions of the soil properties also deteriorated for all depth layers of 0-15, 15-30, 30-45 and 45-60 cm except for total porosity. As a third stage of the study, soil properties were re-examined combined with an investigation on growth performances in the plots 21 years after the soil preparations, and following results were obtained: mean annual wood increment in the experimental plots varied from 12.9 to 14.9 m^3 ha^{-1} yr^{-1} and the soil preparation methods did not make a significant difference in level of wood increment (Hızal et al., 2002). Therefore, it is to recommend that the cheapest method of soil preparation is to be taken as the best, which alone is vegetation clearing using a rake mounted Komatsu bulldozer.

Compared to studies carried out in agricultural areas, there is limited information about effect of mechanized soil preparation methods on physical soil properties in forest areas and majority of literature concerning the effects of soil preparation methods on plant growth and on some physical soil properties have mostly focused on topsoils, and they generally neglected to examine the changes observed in deeper soil layers in a relatively longer term. For example, Archibold et al. (2000) studied effect of five site preparation techniques on soil properties at the depth of 10 centimetre. Similarly, Piatek and Allen (2000) compared the effect of two different soil preparation methods, shear-pile-disk and chop-burn, on some soil properties at the topsoil disked to a depth of 7-12 centimetre. There is also limited information about deeper soil depths. In this type of study, Merino et al. (2004) examined intensive site preparation methods on soil properties at the soil depth of 40-50 cm. But as it is well known, forest trees and agricultural crops require different soil conditions for growth. For instance, growth of trees is affected very much by the properties of subsoils and not only topsoils. Since annual agricultural crops generally grow in topsoil as indicated in most of the related publications (Ratliff and Denton, 1991; Barber et al., 1996; Salih et al., 1998; Buschiazzo et al., 1998; Baumhardt and Jones, 2002). These studies conducted on agricultural sites dealt with mostly topsoils.

As seen from the literature, most of the studies focused on topsoil and changes in its chemical content rather than deeper soil depth and its physical properties which have very important effect on water budget of the soils (McLaughlin et al., 2000; Merino et al., 2004). Therefore, there is still a lack of information about the relation between mechanized subsoil preparation and physical properties of deeper soil layers, which is important as regards soil moisture conditions in forest sites. That is why, studies concerning the properties and preparation of deep soil layers are very much needed for the purposes of establishment and management of industrial forestry plantations. The objective of this study was to provide the comparative data concerning the relations between soil preparation from top to deeper layers and the changes of physical properties of soils observed during a 21 year rotation period of industrial forestry plantations with *Pinus pinaster* (Aiton).

2. Material And Methods

2. 1. Study area

This study was conducted in the Kerpe district (41° 09" N, 30° 12" E) on the coast of the Izmit province in the Marmara region of Turkey (Fig.1). Size of the study area was 2.2 hectare. According to the meteorological records from 1977 to 1984, mean annual temperature and precipitation were 14.5 °C and 781.7 mm, respectively (Ayberk, 1985). Moderately fine-textured (loamy clay), deep and very rapid or moderately permeable, organic matter content ranging from 0.50 % to 4.89 % and gravel free inceptisols with a pH of 6.7 generated limestone, andesite, and trachyte were located on the V-shaped topography with an average slope of 20 percent. During the study year of 1999, the area was covered with a 21 year old *Pinus pinaster* (Aiton) plantation.

2. 2. Experimental background

In 1978, Tolay et. al. (1982) carried out a study to determine the most suitable mechanized soil preparation method for purpose of establishing industrial forestry plantations in the Marmara region of Turkey. For the purpose, the existing unproductive coppice vegetation consisted of the trees and the shrubs such as *Quercus* spp., *Castanea sativa* Miller, *Carpinus betulus* L., *Tilia argentea* Desf. exDC., *Laurus nobilis* L., *Arbutus unedo* L., and *Rhododendron* sp. in the study area in Kerpe was cleared by D85-A 12 Komatsu bulldozer (with a weight of 21740 kg and mean pressure on the soil surface was 0.76 $kgcm^{-2}$, however, peak pressures can be 2 or 3 times the mean pressure) equipped with a front rake, and then in November 1978, the soils were prepared for planting in accordance with five different mechanized soil preparation methods which were: 1) strip soil preparation (0-60 cm) with rippers mounted to D 85-A 12 Komatsu bulldozer (T1), 2) strip soil preparation (0-45 cm) (as gradoni terraces) with double pass of a tined plough (T2), 3) complete area topsoil preparation (0-30 cm) with double pass of a heavy disk harrow (T3), 4) complete area deep soil preparation (30-60 cm) with rippers mounted to a Komatsu bulldozer followed by a complete topsoil preparation (0-30 cm) with a heavy disk harrow (T4), 5) control plantation plots cleared with a rake mounted to a Komatsu bulldozer where no soil preparation operation was carried out following clearing of the coppice cover (0-30 cm) (C). The experimental design is the same as explained in the section below. Soil sampling procedures were

Figure 1. Location of the study area
Şekil 1. Çalışma alanının yeri

conducted three times in three different stages within November 1978 which were soil sampling before clearing the vegetation, soil sampling just after clearing the vegetation and soil sampling just after soil preparation. In each stage of soil samplings, a separate soil pit was dug in each plot and the pits were divided into five different depth layers as 0-15, 15-30, 30-45, 45-60 and 60-90 centimetre. Then, two soil core samples (with a height of 6.2 cm and diameter of 7.9 cm) were taken from each layer. Thus, altogether six hundred soil samples were collected (20 plots x 3 pits x 5 layers x 2 soil core samples) and analyzed for soil texture, bulk density, total porosity, air-filled pore space, maximum water-holding capacity, permeability and moisture equivalent. One-year old *Pinus pinaster* (Aiton) seedlings were planted in each plot with 2 x 3 m spacings (total 200 seedlings) during a period from December 1978 to March 1979. In November 1986, a similar procedure for soil sampling and analyses (excluding the depth layer of 60-90 cm) were repeated in the study area, and the results of this research were published (Hızal et al., 1991).

2. 3. Experimental design and statistical analyses

The experiment was laid out in a randomized complete block design with 4 replications. Each block included five treatment plots (20 plots in total, each 912 m^2 – 38 x 24 m, excluding buffers-in size). In November 1999, the soil pits were dug in each treatment plot and two sets of soil core samples were collected from each of four depth layers (0-15, 15-30, 30-45, 45-60 cm), one hundered sixty soil samples (20 plots x 4 depth layers x 2 soil core samples), were collected and analyzed for the soil texture, bulk density, total porosity, air-filled pore space, maximum water-holding capacity, permeability, and moisture equivalent. The data analyses were done using the ANOVA and the Duncan's Multiple Range Test ($P<0.05$). Prior to ANOVA, Arcsine transformation was performed on data consisted of percentage values.

2. 4. Laboratory analyses

Soil texture analyses were made on the basis of organic matter-free and oven-dry soil samples less than 2 mm in diameter using the Bouyoucus hydrometer method (Piper, 1950) and the international classification system was used to determine basic soil textural classes (Russel, 1961; Means and Parcher, 1965). These soil textural classes were then grouped into fine-textured soils with a clay content 40 % or more, moderately fine-textured soils with a clay content between 27 % and 40 % and medium-textured soils with a clay content between 7 % and 27 % (Soil Survey Staff, 1951). Moisture equivalent (field capacity) was determined by means of IEC centrifuge at 1/3 atmospheric pressure (Kramer, 1949; Wilde, 1958; Thomson and Troeh, 1973; Özhan, 2004). Bulk density was determined through the oven dry weight of sample divided by its volume. Total porosity was calculated with the equation of St = 100 (Dd – Db / Dd), where St = total porosity, Dd = particle density, and Db = bulk density (Özhan, 2004; Brady, 1990). Maximum water- holding (maximum retention) capacity was calculated from the weight of saturated core samples with the equation of MWHC = (W_1 – Wo / Wo) x 100, where MWHC = maximum water - holding capacity, W_1 = weight of saturated soil core sample, and Wo = oven-dry weight of the soil sample (Kramer, 1949; Millar and Turk, 1951; Thomsoh and Troeh, 1973; Brady, 1990). Air - filled pore space was determined with the equation of S = St – (Pw x Db), where S = air-filled pore space, St = total porosity, Pw= the water content at moisture equvailent (field capacity), and Db = bulk density (Black et al., 1965). Permeability was measured from the saturated core samples under a constant hydraulic head (Özyuvacı, 1976), and particle density (specific gravity) was determined by Pycnometer method (Gustafson, 1941).

3. Results

Only the results of physical soil properties which were found to be statistically significant such as texture, bulk density, total porosity, air-filled pore space and maximum water-holding capacity were given in the sections below.

3. 1. Texture

Until the year 1986, as regards 0-60 cm depth layers, the mean values for clay content decreased significantly for all treatments, except for T2 (Table 1). Significant decreases were also observed for C and T4 treatments during the second period which ended in 1999. The percentage values for sand content significantly increased in depth layer of 0-60 cm for all treatments by 1999. The significant differences observed for the sand values between the treatments in 1978 disappeared in the year 1986 (Table 1). Significant increases in the mean values for sand content were observed in all depth layers, throughout the study period from 1978 to 1986 and also to 1999, only an insignificant increase was observed for the soil layer of 30-45 cm depth during the period from 1986 to 1999 (Table 2). Moreover, in 1978, only the percentage value for sand in the soil layer of 45–60 cm was significantly less compared to other layers. Percentage values for sand content were statistically indifferent for the layers of 0-15, 15-30, and 30-45 cm in 1986, and for the layers of 15-30, 30-45, and 45-60 cm in 1999 (Table 2).

Table 1. Mean values (mean ± standard deviation) for clay and sand percentages by treatments and years for a soil layer in depth of 0-60 cm.
Tablo 1. Yıl ve uygulamalara gore 0-60 cm derinliğindeki topraktaki kil ve kum yüzdeleri (ortalama ± standart sapma).

Years	Treatments				
	C	T_1	T_2	T_3	T_4
			Clay (%)		
1978	$48.32 \pm 11.92^{a1)}$	50.04 ± 9.85^{a}	36.92 ± 8.66^{bc}	40.27 ± 9.47^{b}	46.51 ± 12.48^{a}
1986	40.11 ± 13.94^{b}	37.24 ± 7.20^{bc}	33.23 ± 7.54^{cd}	30.08 ± 8.54^{d}	36.49 ± 7.45^{bc}
1999	30.22 ± 8.14^{d}	34.05 ± 7.25^{bcd}	29.29 ± 10.49^{d}	32.08 ± 8.59^{cd}	28.81 ± 8.49^{d}
			Sand (%)		
1978	$20,68 \pm 7.83^{e}$	$19,44 \pm 5.84^{e}$	$29,32 \pm 11.11^{c}$	$25,59 \pm 7.83^{cd}$	$21,98 \pm 8.21^{de}$
1986	$34,70 \pm 7.91^{b}$	$37,30 \pm 4.89^{b}$	$36,81 \pm 5.50^{b}$	$37,96 \pm 6.21^{b}$	$37,19 \pm 4.76^{b}$
1999	$48,09 \pm 9.15^{a}$	44.28 ± 5.38^{a}	45.50 ± 9.64^{a}	$46,06 \pm 8.74^{a}$	$47,84 \pm 8.08^{a}$

1 Means with different superscript letters within the same columns and rows are statistically significant for each soil property according to Duncan's Multiple Range Test ($P<0.05$).

3. 2. Bulk density

The mean bulk density value significantly increased from 1978 to 1986 in 0-60 cm depth layer for various treatments such as 0.23 g cm^{-3} for T1, 0.20 g cm^{-3} for T2 and 0.26 g cm^{-3} for T4 (Table 3). Although statistically not significant, slight decreases were observed in the means of bulk density for the same treatments as mentioned above from 1986 to 1999. It means that the bulk density means estimated in 1999 for T1, T2 and T4 treatments were still higher than those estimated in 1978. On the other hand, increases occurred from 1978 to 1999 in the mean bulk density values were not statistically significant in 0-60 cm depth layers of the treatments C and T3 (Table 3). Significant increases were observed between 1978 and 1986 means of bulk density values for all soil depth layers. On the contrary, the bulk density means decreased from 1986 to 1999 for all depth layers except the layer for 15-30 cm, although the decreases were not statistically significant except for the layers of 0-15 cm and 45-60 cm (Table 2). As seen from Table 2, the mean values for soil bulk density increased downward in the soil layers in all sampling years, however, increases were not always statistically significant.

3. 3. Total porosity

The mean values of soil total porosity decreased from 1978 to 1986 for 0-60 cm depth layers of all treatments, but they increased from 1986 to 1999. However, decreases for C and T3 treatments in 1986, and increases for C and T1 treatments in 1999 were not significant (Table 3).

able 2. Mean values (mean ± standard deviation) for sand percentage, bulk density, air-filled pore space and maximum water-olding capacity by years to represent varying soil depth layers.

ablo 2. Değişik toprak derinliklerindeki ortalama kum yüzdesi, hacim ağırlığı, boşluk hacmi ve maksimum su tutma kapasitesi ortalama ± standart sapma).

Years	Depths (cm)			
	0-15	15-30	30-45	45-60
	Sand (%)			
1978	$25.47 \pm 8.34^{f\,1)}$	25.68 ± 10.19^{f}	23.45 ± 8.34^{f}	19.02 ± 7.48^{g}
1986	38.91 ± 5.26^{cd}	36.63 ± 6.24^{de}	38.09 ± 6.21^{cde}	33.53 ± 4.76^{e}
1999	54.15 ± 7.58^{a}	46.46 ± 5.66^{b}	42.57 ± 6.25^{bc}	42.24 ± 7.59^{bc}
	Bulk density (g cm^{-3})			
1978	0.97 ± 0.11^{h}	1.11 ± 0.13^{fg}	1.21 ± 0.19^{de}	1.26 ± 0.19^{cd}
1986	1.17 ± 0.17^{ef}	1.28 ± 0.17^{bcd}	1.35 ± 0.13^{b}	1.44 ± 0.10^{a}
1999	1.05 ± 0.09^{gh}	1.32 ± 0.11^{bc}	1.30 ± 0.12^{bc}	1.31 ± 0.12^{bc}
	Air-filled pore space (%)			
1978	35.95 ± 6.24^{a}	29.87 ± 7.39^{b}	22.58 ± 10.60^{cd}	20.03 ± 10.69^{cde}
1986	23.02 ± 10.32^{c}	16.55 ± 8.67^{ef}	12.72 ± 7.48^{fg}	6.76 ± 4.76^{g}
1999	29.74 ± 7.19^{b}	16.64 ± 6.99^{def}	21.46 ± 8.38^{cde}	16.93 ± 7.63^{def}
	Maximum water-holding capacity (%)			
1978	47.74 ± 6.05^{a}	40.04 ± 5.97^{b}	34.76 ± 7.31^{c}	33.85 ± 5.56^{c}
1986	35.49 ± 6.74^{c}	31.89 ± 6.88^{cd}	29.70 ± 4.96^{de}	27.01 ± 4.12^{ef}
1999	30.57 ± 7.46^{d}	25.65 ± 5.51^{f}	24.36 ± 3.59^{f}	24.99 ± 3.47^{f}

Means with different superscript letters within the same columns and rows are statistically significant for each soil property according to Duncan's Multiple Range Test ($P<0.05$).

le 3. Mean values (mean ± standard deviation) for bulk density, total porosity, air-filled pore space and maximum water-holding acity by treatments and years to represent a soil layer in depth of 0 - 60 cm.
lo 3. 0-60 cm toprak derinliğine ait ortalama hacim ağırlığı, toplam boşluk hacmi, hava dolu gözenek hacmi ve maksimum su tutma asitesi (ortalama ± standart sapma).

Years	Treatments				
	C	T_1	T_2	T_3	T_4
			Bulk density (g cm^{-3})		
1978	$1.23 \pm 0.15^{bcd\ 1)}$	1.04 ± 0.13^{e}	1.16 ± 0.23^{d}	1.22 ± 0.18^{bcd}	1.04 ± 0.19^{e}
1986	1.29 ± 0.16^{abc}	1.27 ± 0.16^{abc}	1.36 ± 0.19^{a}	1.32 ± 0.20^{ab}	1.30 ± 0.13^{abc}
1999	1.24 ± 0.10^{bcd}	1.24 ± 0.17^{bcd}	1.30 ± 0.17^{abc}	1.21 ± 0.16^{cd}	1.21 ± 0.18^{cd}
			Total porosity (%)		
1978	54.24 ± 4.61^{cde}	59.75 ± 4.62^{a}	55.62 ± 8.52^{bcd}	52.69 ± 6.44^{cdef}	58.54 ± 7.97^{ab}
1986	49.67 ± 6.25^{ef}	50.38 ± 6.10^{def}	47.44 ± 7.71^{f}	49.57 ± 7.40^{ef}	50.21 ± 4.37^{def}
1999	54.62 ± 3.42^{bcde}	54.27 ± 5.93^{bcde}	52.88 ± 5.51^{cde}	56.73 ± 4.93^{abc}	55.80 ± 6.51^{abc}
			Air-filled pore space (%)		
1978	23.71 ± 8.68^{bcd}	32.10 ± 7.99^{a}	29.06 ± 12.12^{abc}	21.52 ± 9.45^{de}	29.15 ± 12.58^{ab}
1986	12.72 ± 9.71^{g}	17.07 ± 9.65^{efg}	13.68 ± 12.50^{g}	14.59 ± 9.76^{fg}	15.77 ± 8.00^{fg}
1999	21.48 ± 5.32^{def}	18.96 ± 10.83^{def}	19.02 ± 9.89^{def}	22.70 ± 8.72^{cde}	23.80 ± 9.99^{bcd}
			Maximum water-holding capacity (%)		
1978	36.48 ± 5.78^{b}	43.01 ± 5.52^{a}	36.73 ± 9.88^{b}	36.28 ± 9.21^{b}	42.98 ± 7.80^{a}
1986	32.10 ± 6.22^{c}	32.11 ± 5.98^{c}	29.01 ± 7.37^{cde}	31.11 ± 8.15^{cd}	30.77 ± 4.41^{cd}
1999	27.17 ± 5.05^{def}	28.89 ± 6.30^{cde}	24.83 ± 7.43^{f}	25.81 ± 4.62^{ef}	25.24 ± 7.55^{f}

Means with different superscript letters within the same columns and rows are statistically significant for each soil property according to Duncan's Multiple Range Test ($P<0.05$).

3. 4. Air-filled pore space

The mean values for air-filled pore space estimated separately for the treatments to represent 0-60 cm depth layers significantly decreased from 1978 to 1986 (Table 3). On the contrary, significant increases were observed for all treatments except for T1 by the year 1999. The increases observed in 1999 resulted to close the differences between the air-filled pore space values of treatments C, T3 and T4 so as to be statistically similar with the values estimated in 1978 which was also the case for total porosity (Table 3). Air-filled pore space of the soils significantly decreased for all depth layers from 1978 to 1986, but increased from 1986 to 1999 except for the depth layer 15-30 cm (Table 2). Recoveries observed in the air-filled pore space values were not sufficient in the two of upper soil depth layers so as to reach the 1978 levels. It was observed that the air-filled pore space of the soils decreased downward in the soil depth layers according to estimations made in 1978 and in 1986. On the contrary, an irregular trend of changes was observed in the air-filled pore space values among soil depth layers in 1999 due to the low levels in 15-30 cm depth (Table 2).

3. 5. Maximum water-holding capacity

Mean percentage values for soil maximum water-holding capacity to represent soil depth layers of 0-60 cm significantly decreased from 1978 to 1999 for all treatments except for T1 (Table 3). Maximum water-holding capacity values significantly decreased for all depth layers from 1978 to 1999, except for the soil layer of 45-60 cm for the period from 1986 to 1999. In all periods, the values of maximum water-holding capacity for topsoils were greater than those for subsoils (Table 2).

4. Discussion

4. 1. Texture

Similar to other soil properties, soil texture was examined and analysed in two statistical phases: 1) To determine mean values for treatments x years to represent a soil depth layer of 0-60 cm. Soil textural groups for the treatments T1, T3 and T4 changed from fine to moderately fine from 1978 to 1986. Clay (fine) and loamy clay (moderately fine) soil texture remained the same for the treatments C (control) and T2 from 1978 to 1986, respectively. However, the changes of the mean values of clay and sand for the treatment C were significant from 1978 to 1986. But the soil textural group for this treatment varied from the fine to the moderately fine in 21 years. The changes in soil texture estimated for the treatment T2 did not result in a change in the soil textural group, i.e.: soil texture remained as the moderately fine in 21 years. 2) To determine mean values for the years (1978, 1986 and 1999) x soil depth layers (0-15, 15-30, 30-45 and 45-60 cm). Proportion of sand significantly increased in soil depth layer of 0-15 cm in 21 years period, the soil textural group for this layer changed from the moderately fine to medium (clay loam). Soil textural groups in the depth layers of 15-30 cm and 30-45 cm changed from the fine to the moderately fine from 1978 to 1986, whereas the textural group in the soil depth of 45-60 cm changed from the fine to the moderately fine in 21 years period from 1978 to 1999. The changes in the soil textural groups may be related to leaching of the clay, since the climatic type of the study area is temperate with an average annual rainfall of 781.7 mm and the soils are non-calcareous with an average pH of 6.7. Kantarcı (1987) stated that such site conditions are suitable for leaching. In fact, average soil clay content ranged from 37 to 50 % in 1978 and it was decreased to a level of 29 to 34 % by 1999. Also, factors such as alternate wetting and drying of soil, a system of macro voids within the soil, absence of cements such as sesquioxides and carbonates, pH values between 4.5-6.5 support the clay translocation (Northcliff, 1988). Besides, macropores created by roots may also support leaching. Huang (2000) also stated that pore size distribution and continuity is related to transport of colloids. The mean values of clay content in the depths of 60-90 cm in the 17 out of 20 treatment plots were found greater than 45 %, which shows that clay is leached from the top to subsoil layers in 21 years. This process could be related to the formation of small micropores below the depth of rooting zone. As Brady and Weil (1999) mentioned that the decrease in organic matter and increase in clay content to be observed downward in soils are associated with a shift from macropores to micropores. Pyatt (1970) also stated that clay particles might be carried in colloidal solution (suspension) by percolating water from an upper layer and be deposited in a lower layer, thereby producing a more or less pronounced textural change within the profile.

4. 2. Bulk density, total porosity, air-filled pore space and maximum water-holding capacity

The differences in mean values of soil's physical properties were not statistically significant for the interaction of years x depths x treatments but were significant for years x depths interaction when the soil preparations applied 21 years ago. Although, the soil preparations in November 1978 significantly affected the soil properties only in the depth layer of 15-30 cm, the changes in the soil properties in other depth layers were not statistically significant. Thus, total porosity, air-filled pore space, and maximum-water holding capacity of soils in the depth layer increased from 51.19 to 57.09 %, from 20.78 to 29.87 %, and from 33.14 to 40.04 %, respectively, and bulk density decreased from 1.24 to 1.11 gram per cubic centimetre. On the other hand, data which were determined before vegetation clearing and immediately after site preparations in the study area indicated that the conditions of soil bulk density, total porosity, maximum water-holding capacity, and air-filled pore space were improved for soils in 0-60 cm depth layer by only the strip soil preparation (0-60 cm) with rippers mounted to D 85-A 12 Komatsu bulldozer (T1) and complete area deep soil preparation (30-60 cm) with rippers mounted to D 85-A 12 Komatsu bulldozer followed by a complete topsoil preparation (0-30 cm) with a heavy disk harrow (T4). T1 and T4 treatments decreased the bulk density from 1.17 to 1.04 (T1) and from 1.22 to 1.04 g cm^{-3} (T4). Also both treatments increased the total porosity, air-filled pore space, maximum water- holding capacity and permeability from 54.83 to 59.75 % (T1), from 51.71 to 58.54 % (T4);

from 24.09 to 32.10 % (T1), from 19.61 to 29.15 % (T4); from 34.95 to 43.01 % (T1), from 34.72 to 42.98 % (T4) and from 21.6 cmh^{-1} to 28.32 cm h^{-1} (T1), and from 5.51 cm h^{-1} to 64.16 cm h^{-1} (T4), respectively. However, the mean values for bulk density and for total porosity deteriorated for treatments T1, T2 and T4, whereas the mean values for air-filled pore space became worse for all treatments during the first 8 years period from 1978 to 1986 (Table 3). Lutz (1952) stated that excessive disking followed by heavy rains frequently caused a very compact soil. The results also indicated that the bulk density and total porosity did not deteriorate in time for the treatments which represent vegetation clearing (C) and clearing plus topsoil preparation (T3), respectively. Piatek et al. (2003), Ratliff and Denton (1991) stated that ground (vegetation) clearing treatments did not significantly affect the bulk density. Changes in soil properties due to topsoil preparation depend not only to treatments applied but also to land preparation equipment used. For instance, it was found that the bulk density values were greater in the areas treated with Bracke mounder (BR) and with v- Blade compared to untreated control plot (Archibold et al., 2000). Kantarcı (1982) pointed out that an important increase was observed in the bulk density of the soils 5 years after a deep soil preparation (30-50 cm) with rippers followed by a complete area topsoil preparation with a heavy disk harrow. Merino et al. (2004) found that the bulk density values increased significantly in the plots where scalping and down-slope ploughing were employed and the effect was still apparent after 9 years. Furthermore, Barber et al. (1996) stated that the soil compaction caused a 30 % decrease in aeration capacity. Brady and Weil (1999) also mentioned that the effects of subsoiling were quite temporary in many soils. Moreover, the effects of deep tillage on heavy clay soils can be usually temporary, often disappearing within the first year (Unger, 1984). The bulk density for T3, total porosity for T2, T3 and T4, and air-filled pore space for C, T2, T3 and T4 treatments recovered from 1986 to 1999, and these properties reached the initial values estimated in 1978 except for air-filled pore space for T2 and T3 treatments (Table 3). The results indicate that the recovery in the bulk density, total porosity and air-filled pore space observed by years were generally better for treatments C (the control), T3 (complete area topsoil preparation), and T4 (complete top + deep soil preparations) than those for treatments T2 (strip topsoil preparation), and T1 (strip deep soil preparation). The reason for better recovery observed in the treatment plots might be the less compaction of soils due to topsoil preparation, thus, more compaction was observed when topsoils and subsoils were prepared on strips. Bulk density and air-filled pore space also significantly deteriorated in the soils for the depth layers of 0-15, 15-30, 30-45, and 45-60 cm from 1978 to 1986. Compared to the conditions of 1986, the bulk density in the soil layers of 0-15 cm and 45-60 cm, and air-filled pore space in 0-15, 30-45 and 45-60 cm soil depths also significantly recovered by 1999 (Table 2). The soil properties mentioned above reached the initial values of 1978 in the same soil depth layers, except for air-filled pore space in the depth of 0-15 cm. The recovery observed in soil properties in time could be a consequence of root growth and, litter accumulation during the study period from 1986 to 1999. Mean thickness of the forest floor deposited in 21 years was 5.8 cm (leaf: 2.6 cm, fermentation: 1.1 cm, and humus: 2.1 cm). Crocker (1967) found out that there has been a rapid change from initial values of bulk density of about 1.5-1.6 g cm^{-3} to final values as low as 0.5 g cm^{-3} in the surface horizon because of the presence of plant roots and residues and their associated microfloras. Russell (1961) also reported that some roots were such strong growers that they could penetrate even quite compact subsoil, and hence a succession of such crops could improve the drainage or aeration of subsoil. On the other hand, the maximum water-holding capacities deteriorated in 0-60 cm depth layer for all the treatments plots, and in all sampling depths (the soil depth layers of 0-15 cm, 15-30 cm, 30-45 cm and 45-60 cm) from 1978 to 1986 (Tables 2, 3). The deteriorations in the maximum water-holding capacity continued in soils by 1999, except for T1 treatment plot and for soil depth of 45-60 cm. The greatest clay percentages were determined in T1 plot and in the soil depth layer of 45-60 cm. This situation may explain why the deteriorations in the water-holding capacity did not continue for the soils in this treatment and depth. The deteriorations in the maximum water-holding capacities of soils for all depth layers and all treatments except 45-60 cm depth layer and T1 treatment may be related to leaching of clay particles.

5. Conclusion

Changes in soil the texture, bulk density, total porosity, air-filled pore space, maximum water-holding capacity, permeability and moisture equivalent were investigated in this study. Apart from the permeability and moisture equivalent, other soil properties changed in time. For example, fine-textured soils both in 0-60 cm depth layers of all treatments plots (except T2), and in 15-30, 30-45 and 45-60 cm of the soils changed to moderately fine- textured soils within a period of 21 years (from 1978 to 1999). The bulk density, air-filled pore space, maximum water-holding capacity and total porosity in 0-60 cm depth layers of the treatment plots, and of these, the first three properties in 0-15, 15-30, 30-45 and 45-60 cm depth layers of the soils also deteriorated during the first 8 years period (from 1978 to 1986) following the application of the treatments. Except maximum water-holding capacity, other properties mentioned above improved during the study period from 1986 to 1999 by the growth of *Pinus pinaster* (Aiton) trees. The changes in the moisture equivalent and permeability of soils were not found to be significant. On the other hand, as regards soil properties, significant differences observed between the treatments disappeared after a period of 8 years, however, there were no significant differences among the treatments in terms of tree growth in 21 years (Hızal et al. 2002).

Soil preparation constitutes a significant portion of afforestation expenses. Deep soil preparation has been the basic method in the establishment of intensive plantations in Turkey, in order to stimulate plant growth by improving the physical soil properties. This study shows that mechanized topsoil preparation methods should be preferred to mechanized deep soil preparation prior to establishing industrial forestry plantations in similar site conditions with the Kerpe study area, in the absence of an impermeable soil layer. To do this, physical soil properties of an afforestation site should be investigated thoroughly before deciding the site preparation method.

Acknowledgement

The authors would like to thank TUBITAK (The Scientific and Technological Research Council of Turkey) for providing the support for this research project with number of TARP-2164.

Makineli Toprak İşleme Yöntemleri ile Kurulmuş *Pinus pinaster* (Aiton) Ağaçlandırma Sahalarında 21 Yıllık Bir Sürede İnce Tekstürlü Toprakların Fiziksel Özelliklerinde Meydana Gelen Değişimler

Ahmet Hızal[1*] Taneri Zoralioğlu[2] Mustafa Zengin[2]

[1] Istanbul University, Faculty of Forestry, 34473 Bahçeköy, Istanbul.
[2] Poplar and Fast Growing Forest Trees Research Institute, 41050 Izmit.

[*] Tel: 0 212 226 11 03 (25337) Fax: 0 212 226 11 13
E-mail: ahizal@istanbul.edu.tr

Kısa Özet

Bu çalışmada Kerpe araştırma ormanında 1978 yılında *Pinus pinaster* (Aiton) ağaçlandırma sahalarında uygulanan farklı makineli toprak hazırlama metotlarının toprakların fiziksel özellikleri üzerine olan etkileri araştırılmıştır. Çalışmada 5 farklı makineli toprak işleme metodu kullanılmıştır. Bunlar; 1) D 85 –A 12 Komatsu buldozerin arkasına eklenmiş dip kazanlar (riper) ile şeritler halinde toprak işlemesi (0-60 cm) 2) Dip kazan pulluk ile şeritler şeklinde çift sürüşlü gradoni tesisi 3) ağır diskaro ile tam alanda iki geçişli üst toprak (0-30 cm derinlikte) işlemesi 4) komatsu buldozerin arkasına takılmış dip kazanlar ile tam alanda derin toprak işlemesi (30-60 cm) ve bunu takiben ağır diskaro ile tam alanda iki geçişli üst toprak işlemesi 5) komatsu buldozerine takılmış tarak ile bitki örtüsünün temizlenmesi (kontrol parselleri). Toprak işleme çalışmalarından 21 yıl sonra (1999 yılı) sahadan alınan toprak örnekleri üzerinde tekstür, hacim ağırlığı, toplam boşluk hacmi, hava kapasitesi, maksimum su tutma kapasitesi, geçirgenlik ve nem ekivalanı ölçümleri yapılmıştır. Sonuçlar, bu çalışmadan önce aynı araştırma alanında 1978 ve 1986 yıllarında yapılan çalışmaların aynı toprak özellikleri ile ilgili sonuçlarıyla karşılaştırılmıştır.

Sonuçlar; 0-60 cm derinlik kademesindeki toprakların tekstürlerinin 2. işlem parseli hariç, diğer işlem parsellerinin tamamında 21 yıl içerisinde inceden orta inceye değiştiğini göstermiştir. 0-60 cm derinlik kademesindeki toprakların makineli toprak işlemeleri ile hacim ağırlığı, maksimum su tutma kapasitesi, hava kapasitesi ve toplam boşluk hacmi değerlerinde meydana gelen iyileşmeler, kontrol

Yayın Komisyonuna sunulduğu tarih: 14.06.2007
Yayına kabul edildiği tarih: 27.09.2007

ve 3. işlem parsellerinin hacim ağırlıkları ve toplam boşluk hacimleri hariç diğer işlem parsellerinde ilk sekiz yılda (1978-1986) bozulmuştur. Aynı sürede 0-15 cm, 15-30 cm, 30-45 cm ve 45-60 cm derinlik kademeleri dikkate alındığında yukarıda belirtilen ilk üç özellikte istatistiki anlamda önemli bozulmalar meydana gelmiştir. Bununla birlikte toprakların toplam boşluk hacimleri 2., 3. ve 4., hava kapasitesi kontrol, 2., 3. ve 4., işlem parsellerinin 0-60 cm lik derinlik kademelerinde 1986 dan 1999 yılına kadar geçen sürede iyileşmiştir. Son 13 yılda (1986-1999) 0-15 cm ile 45-60 cm derinlik kademelerinin hacim ağırlığı; 0-15cm, 30-45 ve 45-60 cm derinlik kademelerinin hava kapasitesi değerlerinde olumlu yönde iyileşmeler ortaya çıkmıştır. Ağaçlandırmanın 21 yıllık rotasyon süresinde toprakların maksimum su tutma kapasitelerinde önemli bozulmaların meydana gelmesine karşılık nem ekivalanı ve geçirgenlik değerlerinde önemli bir farklılık saptanamamıştır. Bu araştırmanın diğer bir sonucu da, toprakların fiziksel özelliklerinde farklı makineli toprak işleme metotları ile meydana getirilen ve istatistiki anlamda önemli olan farklılıkların toprak işlemelerinden itibaren geçen 8 yıllık bir zaman süresinde ortadan kalktığının belirlenmiş olmasıdır.

Anahtar Kelimeler: Pinus pinaster (Aiton), fiziksel toprak özellikleri, rotasyon süresi, toprak tekstürü, toprak işleme metotları

References

AEKGM, 1973. Ağaçlandırma ve Erozyon Kontrolu Çalışmaları. Türkiye Cumhuriyeti 1923-50 Yıl - 1973, Ankara, TÜRKİYE (in Turkish).

Archibold, O. W., Acton, C. and Ripley, E. A., 2000. Effect of site preparation on soil properties and vegetation cover, and the growth and survival of white spruce (*Picea glauca*) seedlings, in Saskatchewan. *Forest Ecology and Management,* 131: 127-141.

Ayberk, S. 1985. Kerpe ve Işık tepe ağaçlandırma sahaları meteoroloji istasyonu değerleri üzerine bir inceleme (A study on meteorological data of Kerpe and Işıktepe afforestation areas). Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü Dergisi, İzmit, TÜRKİYE, 9 - 21, (in Turkish).

Barber, R. G., M. Orellana, F. Navarro, O. Diaz, and M. A. Soruco, 1996. Effects of conservation and conventional tillage systems after land clearing on soil properties and crop yield in Santa Cruz, Bolivia. *Soil Tillage Research,* 38: 133-152.

Baumhardt, R. L. and O. R. Jones, 2002. Residue management and paratillage effects on some soil properties and rain infiltration. *Soil Tillage Research,* 65: 19-27.

Black, C. A., D. D. Evans, J. L. White, L. E. Ensminger and F. E. Clark, 1965. Methods of Soil Analysis. Part I. Agronomy Number 9, American Society of Agronomy Inc., Publisher Madison, Wisconsin, U.S.A.

Brady, N. C., 1990. The Nature and Properties of Soils. 10th ed. Macmillan Publishing Company, New York. Collier Macmillan Publisher, London.

Brady, N. C. and R. R. Weil, 1999. The Nature and Properties of Soils. 12th edition, Prentice Hall, New Jersey.

Buschiazzo, D. E., J. L. Panigatti and P. W. Unger, 1998. Tillage effects on soil properties and crop production in the subhumid and semiarid Argentinean Pampas. *Soil Tillage Research*, 49: 105-116.

Cooling, E. N. G., 1977. Industrial forestry plantations, Turkey. Final report: Plantation silviculture. Working Doc. No.: 28, UNDP/FAO, Rome.

Crocker, R. L., 1967. The plant factor in soil formation. In: Drew, J.V. (Ed.), Selected Papers in Soil Formation and Classification. SSSA Special Publication No.: 1, Madison, Wisconsin, U.S.A., pp.179-190.

Devéria, N. E., 1977. Industrial forestry plantations, Turkey. Final (Technical) report: Plantation mechanization. Working Doc. No.: 27, UNDP/FAO, Rome. Gustafson A F 1941 Soils and Soil Management. 1st ed. McGraw-Hill Book Company. Inc., New York and London.

Hızal, A., K. Şengönül and T. Zoralioğlu, 1991. Variations occurred in the physical properties of the fine-textured soils which were prepared by means of different tillage methods in the course of time and their effect on the growth of *Pinus pinaster* (Aiton) trees. *Turkish Journal of Agriculture and Forestry,* 15: 89-94.

Hızal, A., Zoralioğlu, T. and Zengin, M., 2002. Effects of different mechanized soil preparation methods on the survival and growth of *Pinus pinaster* (Aiton) industrial plantation at Kerpe-İzmit, Turkey. In: Diner, A., Ercan, M., Goulding, C., Zoralioğlu, T., (Eds.), Management of Fast Growing Plantations. Proceedings, International IUFRO Meeting, 11-13 September, İzmit-Turkey, 126-133.

Huang, P. M., 2000. Soil chemistry. In: Sumner, M.E. (Ed.), Handbook of Soil Science, CRC Press, Washington, D.C. pp. B_1-B_{352}.

Kantarcı, M. D., 1982. Ağaçlandırma alanlarında arazi hazırlığı ve toprak işlemesinin yetişme ortamı üzerindeki etkileri (Effects of land preparation and soil tillage on site conditions in afforestation areas). İstanbul Üniversitesi Orman Fakültesi Dergisi, Serie B, 32 (2), 52-93 (in Turkish).

Kantarcı, M. D., 1987. Toprak İlmi (Soil Science). İstanbul Üniversitesi Orman Fakültesi Yayınları. İ.Ü. Yay. No.: 3444, Orman Fak. Yay. No.: 387, İstanbul, (in Turkish).

Kramer, P. J., 1949. Plant and Soil Water Relationships. 1st ed. McGraw-Hill Book Company, Inc., New York, Toronto, London.

Lutz, J. F., 1952. Mechanical impedance and plant growth. In: Shaw. T. (Ed.), Soil Physical Conditions and Plant Growth,Vol. 2. Academic Press Inc., Publishers, New York N.Y., Vol. II. pp. 43-71.

McLaughlin, J. W., M. R. Gela, M. F. Jurgensen and C. C. Trettin, 2000. Soil organic matter and nitrogen cycling in response to harvesting, mechanical site preparation, and fertilization in a wetland with a mineral substrate. *Forest Ecology and. Management*. 129, 7-23.

Means, R. E. and J. V. Parcher, 1965. Physical Properties of Soils. Prentice-Hall of India (Private) LTD, New Delhi.

Merino, A., A. F. López, F. S. Gullón and J. M. Edeso, 2004. Soil changes and tree growth in intensively managed *Pinus radiata* in northern Spain. *Forest Ecology and Management,* 196: 393-404.

Millar, C. E. and L. M. Turk, 1952. Fundamentals of Soil Science. 2nd ed. John Wiley Sons, Inc., New York Chapman Hall Limited, London.

Nortcliff, S., 1988. Soil formation and characteristics of soil profiles. In : Wild, A. (Ed.), Russell's Soil Conditions and Plant Growth. 11 th ed. ELBS, Longman, Essex, pp. 168-212.

Özhan, S., 2004. Havza Amenajmanı (Watershed Management). İstanbul Üniversitesi Rektörlük Yayın No.: 4510, Orman Fakültesi Yayın No.: 481, İstanbul, (in Turkish).

Özyuvacı, N., 1976. Arnavutköy Deresi Yağış Havzasında Hidrolojik Durumu Etkileyen Bazı Bitki-Toprak-Su İlişkileri (Hydrologic Characteristics of the Arnavutkoy Creek Watershed as Influenced by Some Plant Soil Water Relations). İstanbul Üniversitesi Orman Fak. İ.Ü. Yay. No.: 2082, Orman Fak. Yay. No.: 221, İstanbul, (in Turkish, with English summary).

Piatek, K. B. and H. L. Allen, 2000. Site preparation effects on foliar N and P use, retrans location, and transfer to litter in 15 years old *Pinus taeda. Forest Ecology and Management,* 129: 143-152.

Piatek, K. B., C. A. Harrington and D. S. DeBell, 2003. Site preparation effects on 20 year survival and growth of Douglas-Fir (*Pseudotsuga menziesii*) and on selected soil properties. Reprinted from Western *Journal of Applied Forestry*, 18 (1): 44-51.

Piper, C. S., 1950. Soil and Plant Analysis. Interscience Publishers, Inc., New York, N.Y. Pyatt DG 1970 Soil Groups of Upland Forests. Forestry Commission: Forest Record No.: 71, London.

Ratliff, R. D. and R. G. Denton, 1991. Site preparation + 1 Year: Effect on plant cover and soil properties. USDA For. Ser. Res. Note PSW. RN. 412, August, 1-5.

Russell, E.W., 1961. Soil Conditions and Plant Growth. 9th ed. Longmans, Green and Co. Ltd., 48 Grosvenor Street, London, W.1.

Salih, A. A., H. M. Babikir and S. A. M. Ali, 1998. Preliminary observations on effects of tillage systems on soil physical properties, cotton root growth and yield in Gezira Scheme, Sudan. *Soil Tillage Research,* 46: 187-191.

Soil Survey Staff, 1951. Soil Survey Manual, USDA Handbook No.:18. Thomson L M and Troeh F R 1973 Soils and Soil Fertility. McGraw-Hill Book Company. New York.

Tolay, U., A. Hızal and E. Dönmez, 1982. Çeşitli Toprak İşleme Yöntemlerinin Kerpe Yöresindeki Bozuk Baltalıklarda İnce Tekstürlü Toprakların Fiziksel Özellikleri ve Ağaçlandırma Başarısı Üzerine Etkileri (The effects of different soil preparation methods on the physical conditions of fine-textured soils and on the success of reforestation in the degraded coppice site at Kerpe). Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, İzmit, TÜRKİYE, (in Turkish, with English summary).

Unger, P. W., 1984. Tillage systems for soil and water conservation. FAO Soils Bulletin, 54, Rome.

Wilde, S. A., 1958. Forest Soils, Their Properties and Relation to Silviculture. The Ronald Press Company, New York.