English Version

Evaluation of initial diametric increase in different species of Pinus in the region of Santa Maria do Oeste (PR)

Edson Luis Serpe[1], Luciano Farinha Watzlawick[2]

Abstract

The evaluation of initial diametric increment in different species of *Pinus* was performed in the Central region of the Paraná State at a farm called Renato Festugato that is owned by the Ibema Brazilian Paper Company. Several species of Pinus (*Pinus caribaea* var. *hondurensis* Barr. & Golf., *Pinus oocarpa* Schiede, *Pinus elliottii* Engelm. and *Pinus taeda* L.) were studied. Each study subject was 4 years old and the initial intervals were 2.50 per 2.00 m. The research objective was to compare the growth rate of two species implanted in large scale in the region "*P. elliottii* Engelm. and *P. taeda* L." and two tropical species, "*P. caribaea* var. *hondurensis* Barr. & Golf. and *P. oocarpa* Schiede", as well to compare these results with results of similar studies in other regions. In order to achieve the objective, 12 sample units were installed. Each sample unit had an area of 360 m^2 and included 3 samples of each species. Statistical tools were used, including the Bartlett test, variance analysis (ANOVA), and the Tukey test. Study variables included survival rate, diameter, and base area. The results showed that *P. taeda* L. is the most productive variety of *Pinus* for the region, followed by *P. oocarpa* Schiede, *P. caribaea* var. *hondurensis* Barr. & Golf., and *P. elliottii* Engelm.. In hotter regions *P. taeda* L. variety had smaller diameter when compared to *P. caribaea* var. *hondurensis* Barr. & Golf. and *P. oocarpa* Schiede. *P. taeda* L. is the best variety of *Pinus* for plantation in the tree farms of the south region of Brazil. *P. oocarpa* Schiede and *P. caribaea* var. *hondurensis* Barr. & Golf. are the most productive varieties for hotter regions (Southeastern Region of Brazil).

Key-words: Growth; reforestation; Pinus sort

Introduction

The genus *Pinus*, from the family Pinaceae, is composed by woody plants, in general trees, with height that ranges from 3 to 50 m. Plants have straight stem, more or less cylindrical and crown in a cone shape. They have leaves in form of needles, grouped in brunches. Its wood present specific mass that ranges from 400 to 520 m^{-3}. The color of the wood of the heartwood ranges from pale yellow to orange or reddish brown (LIMA et al., 1988 quoted by MORAIS et al., 2005).

The species of *Pinus* introduced in Brazil come from, mainly, the United Stated, although they initially came from Europe. They grow naturally in North America, Central America, in the north of Europe and Asia (MORAIS et al., 2005).

The genus *Pinus* has been used by man since the most ancient times. Theophrastus (370 – 285 b.C.), in his survey about plants, wrote about the morphology of this genus, its reproduction and utility for man (MIROV, 1967 quoted by TONINI, 2000).

P. caribaea var. *hondurensis* Barr. & Golf.: It is found along the lowlands and wetlands from the Atlantic coast, mainly in the coastal plains from Belize, northeast of Honduras and Nicaragua. There is great discontinuity in its distribution, mainly along the north coast of Honduras, where the high mountain ranges get close to the sea, in latitudes from 12° to 18° N and altitudes from 0 to 1000 m. The rainfall is periodic, and, in some places, there can be dry periods that last until 6 months.

The annual average temperature ranges from 21 °C to 27 °C, the average of the hottest month, between 29 °C and 34 °C and the average of the minimums of the coldest month, between 15 °C and 23 °C. The soils are sandy, well drained, acid of neutral, and may occasionally bear periods of flooding, reaching its better growth in the alluvial soils (GREAVES, 1983 quoted by SAMPAIO,

1 Engenheiro Florestal, Coordenador Florestal - Planejamento de Operações Florestais da Ibema Cia Brasileira de Papel, Rua Beira Rio nº 03 - Faxinal da Boa Vista - 85.150-000 Turvo/PR. E-mail: serpe@ibema.com.br - serpe.forest@ig.com.br

2 Prof. Adjunto do Departamento de Agronomia da Unicentro.E-mail: farinha@unicentro.br

1996).

Trees of this species may reach until 45 m of height and diameter at breast height (DBH) of 1.35 m in good quality sites. They have 2 to 3 needles per brunch, cones from 4 to 12 cm of length, winged seeds and brown barks. The sensitivity to cold is a limiting condition to this species. In its natural habitat, rarely the minimum temperature reaches 5 °C. The quality of the site also influences the development of this species (SAMPAIO, 1996).

P. oocarpa Schiede: it is widely distributed in the Central America. It grows in Mexico, Belize, Guatemala, Honduras and Nicaragua. In Guatemala it presents an altitudinal distribution, between 1500 and 2100 m, in Mexico and from 250 to 2400 m, according to what is described by SAMPAIO, (1996). However, more recent studies describe that most of the areas of natural occurrences are located between 700 to 1500 m (DVORAK, 1992 quoted by SAMPAIO, 1996).

The rainfall ranges from 750 to 1500 mm, with dry period of 2 to 6 months per year. The average temperature ranges from 13 °C to 21 °C, the average temperature of the maximums of the hottest month ranges from 20 °C to 30 °C, and the average temperature of the minimums of the coldest month varies between 8 °C and 16 °C. The species is found in acid and neutral soils, swallow and with free drainage (SAMPAIO, 1996).

The wood is moderately heavy, with good technological characteristics, with density between 0.45 and 0.60 g/cm^3, and may be used for the production of celluloses of long fibers, hardboards and particleboards (BARRICHELO, 1984 quoted by SAMPAIO, 1996).

P. elliottii Engelm.: It has, as region of natural occurrence, the state of South Carolina until the west of the state of Louisiana, in a narrow strip close to Atlantic Ocean in the southwest of the United States (TONINI, 2000). As an heliophyle species with fast growth, it has high competitiveness, reaching height of 20 to 30 meters (maximum 40 meters), and a DBH from 60 to 90 cm (LAMPRECHT, 1990 quoted by TONINI, 2000).

It has natural preference by acid and sandy soils located, mainly, in lowlands and close to water courses, as well as areas with groundwater close to the surface (LAMPRECHT, 1990 quoted by TONINI, 2000). The most recommended soils in Brazil are podzols and more clayey latossols, and the author found positive correlations between the quality of the site and the sum of exchangeable bases and the content of phosphorus in the soil (TONINI, 2000).

The average annual temperature in the region of origin ranges between 15 ºC and 24 ºC, and the rainfall index ranges from 650 to 2500 mm, with a dry period of a maximum of 4 months. It is considered very resistant to frost and widely tolerant to winds with high content of salt (LAMPRECHT, 1990 quoted by TONINI, 2000).

P. taeda L.: It is the most abundant, widely adapted and distributed species in the south of the United Stated. Its occurrence extends along the Atlantic coast from Maryland to Florida, in the east, and from Texas and Oklahoma in the west (DUDA, 2003).

The climate of most of the natural formations is humid, with temperatures ranging from hot to mild, long and hot summers and intermediate winters. The average annual rainfall ranges from 1020 to 1520 mm. The period free from frost ranges from five, in the north region, to ten months in the coast region, in southeast. The annual average temperature ranges from 13 °C to 24 °C. The average temperature of the hottest month (July) is 27 °C and frequently exceeds 38 °C. The average temperature of the coldest month (January) is from 4 °C to 16 °C, and may drop to – 23 °C in the north and west of its occurrence area. Occasionally, there are rainy days with more than 13 mm per day and high temperatures in the winter.

The main factor which limits the occurrence of the species in the north is mainly the low temperatures in winter, associated with damages by snow, ice and still damages by cold during the flowering period of the species. The lack of an appropriated rainfall in the growth period is probably the factor which limits the natural occurrence of the species in the west region, in the states of Oklahoma and Texas (BACKER, 1990 quoted by DUDA, 2003).

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Its better development occurs in soils moderately acids with low superficial drainage and superficial layer in the medium texture. These soils are common in the higher regions of the Atlantic Coastal Plain and also in the flooded plains and terraces of rivers and stems. They do not grow well, tough, in very wet or flooded places, as well as in areas with narrow or eroded soils. In the Atlantic Coastal Plain, the productivity generally decreases with the increase of the superficial drainage (BACKER, 1990 quoted by DUDA, 2003).

Materials and methods

The research was installed in a permanent experimental area of 4.41 ha in September 2003 in the area of Ibema - Brazilian Paper Company located in the Farm Festugato, municipality of Santa Maria do Oeste, center region of Paraná.

The experimental area is located in the geographic coordinates 24º 50' 19" South Latitude and 51º 57' 36" West Longitude, at altitude of 981 m, according to Figure 1.

The experiment was installed with *P. caribaea*

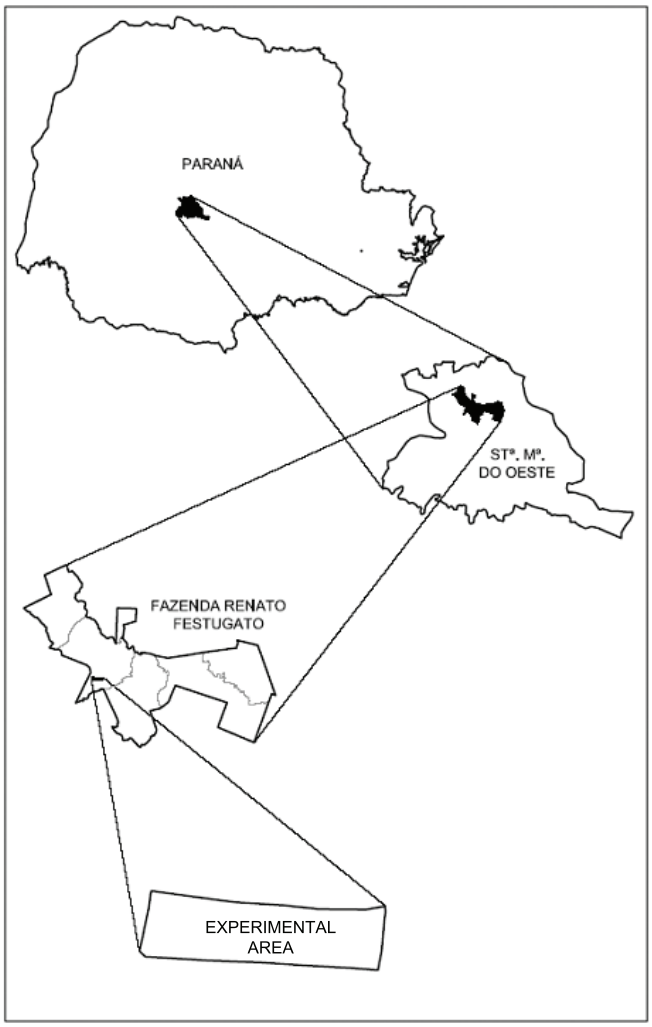

Figure 1. Map of location of the experimental area. Guarapuava-PR, 2009.

var. *hondurensis* Barr. & Golf., *P. oocarpa* Schiede, *P. elliottii* Engelm. and *P. taeda* with initial spacing of 2.50 x 2.0 m, with a total of 2000 trees per ha. In Figure 2 it is presented the croqui of the experimental area.

The seedlings were produced with seeds which come from: *P. caribaea* var. *hondurensis* Barr. & Golf. (PSC - Fazenda Morada Nova - Jaguariaíva - PR), *P. oocarpa* Schiede (PSC - Duratex - SP), *P. elliottii* Engelm. (PSC - Rigesa - SC) and *P. taeda* L. (PSC Rigesa - SC).

According to the classification by Köppen, the climate of the region in which the experiment is installed is characterized as Humid Subtropical mesothermic (Cfb), with cool summers and withers with the occurrence of severe frost, and has no dry seasons (IAPAR, 2008a). The regional average of the maximum and minimum averages is 23.5 °C and 12.7 °C, respectively. The monthly average rainfall is 160.42 mm and monthly average of relative humidity is 77.6% (IAPAR, 2008b).

There is a prevalence of soils named Neossolos Litólicos Distróficos Típicos[1] e Neossolos Litólicos Eutróficos chernossólicos (EMBRAPA, 2003). The natural vegetation of the studied area is the Araucaria Forest (IBGE, 1992), which covered originally approximately 200,000 km^2 in Brazil, being found in the states of Paraná (40% of its surface), Santa Catarina (31%) and Rio Grande do Sul (25%) and in small patches in the south of the state of São Paulo (3%), going to the south of the stated of Minas Gearis and Rio de Janeiro (1%) (CARVALHO, 1994).

By using the mentioned experimental area, it was defined as sampling method the method of the fixed area, with sample units rectangular shaped and size of 360 m^2 (15 m x 24 m). The sampled units were located using process of systematic sample in toposequense, i.e., accompanying the slopes of the area, using for this one sample unit for each species in each replication, according to Figure 3.

The sample units were installed with measuring tape, being the perimeter of the sample unit marked with a circle painted in white in the trees of the extremities. The measure of the CBHs (circumference at breast height) was performed at 1.30 m of height with measure tape in October 2007, aiming at the conclusion of 4 years of increment.

The data coming from the field tab page were transferred, tabulated, converted and analyzed in electronic spreadsheet. It was performed analysis with Barlett test, analysis of variance (ANOVA) and Tukey test, for 1% of significance, applied to the variables survival, diameter and basal area.

Results and discussion

1 According to the Brazilian soil classification

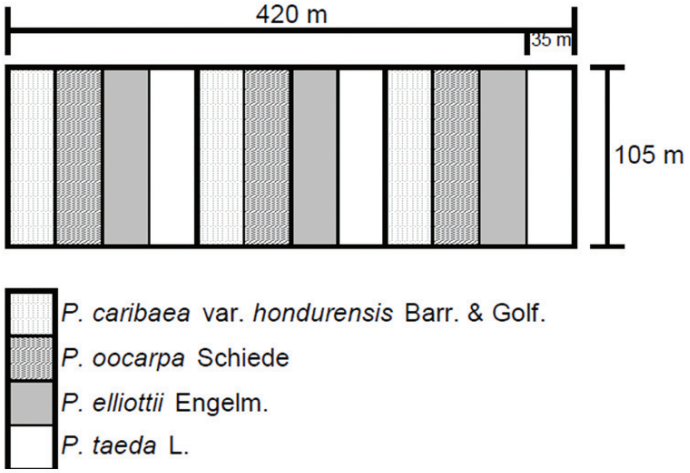

Figure 2. Croqui of the experimental area. Guarapuava – PR, 2009.

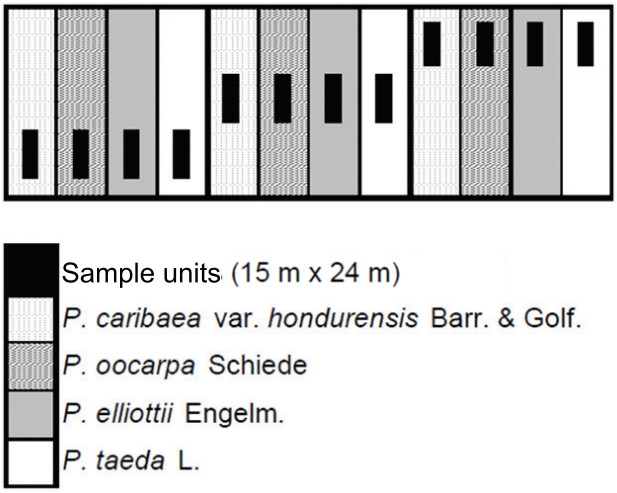

Figure 3. Croqui of positioning of the sample units. Guarapuava-PR, 2009.

The statistic evaluation with the variance for the variable survival is presented in Table 1.

The statistic evaluation with Barlett test for the variable survival, with objective of proving the homogeneity of the variances is presented in Table 2 and Table 3 presentes the average with percentage of survival.

In Table 4 it is presented the analysis of variance – ANOVA for the variable survival, aiming to verify if there is a significant difference between averages.

For the variable survival at the level of 1% of probability of error, the Bartlett test indicated that the variances are homogenous. It was verified also with ANOVA that there is no significant difference between averages for blocks and treatments, i.e., the difference between blocks and treatments is random.

The survival of 79.63% of the plants in *P.*

Table 1. Results of the variance for the variable survival. Guarapuava-PR, 2009.

Treatments	Blocks			Total	Average
	1	2	3		
P. elliottii Engelm.	144.68	248.84	648.15	1041.61	347.22
P. caribaea var. *hondurensis* Barr. & Golf.	23.15	52.08	283.56	358.80	119.60
Pinus oocarpa Schiede	75.23	121.53	17.36	214.12	71.37
Pinus taeda L.	40.51	23.15	75.23	138.89	46.30
Total	283.56	445.60	1024.31	1753.47	

Table 2. Results of the analysis with the Barlett test for the variable survival. Guarapuava-PR, 2009.

Treatments	dl	s^2	log s^2	dl x log s^2	x^2 corr
P. elliottii Engelm.	3	347.22	2.54	7.62	8.11*
P. caribaea var. *hondurensis* Barr. & Golf.	3	119.60	2.08	6.23	
P. oocarpa Schiede	3	71.37	1.85	5.56	
P. taeda L.	3	46.30	1.67	5.00	
Total	12	584.49		24.41	
Average		233.80			

*dl: degrees of liberty; s^2: variance; log s^2: Natural logarithm of variance; x^2 corr: value of x^2 calculated. * Significant at the level of 1% of probability of error.*

Table 3. Values of the averages in percentage for the variable survival. Guarapuava-PR, 2009.

Treatments	Block			Total	Average
	1	2	3		
P. elliottii Engelm.	84.72	81.94	72.22	238.89	79.63
P. caribaea var. *hondurensis* Barr. & Golf.	80.56	87.50	84.72	252.78	84.26
P. oocarpa Schiede	88.89	91.67	91.67	272.22	90.74
P. taeda L.	93.06	94.44	88.89	276.39	92.13
Total	347.22	355.56	337.50	1040.28	

Table 4. Results of the analysis of variance – ANOVA for the variable survival. Guarapuava-PR, 2009.

SV	sl	SS	QM	F
Blocks	2	40,8308	20,4154	1,3368^{ns}
Treatments	3	305,2662	101,7554	6,6632^{ns}
Residue	6	91,6281	15,2713	
Total	11	437,7251		

SV: source of variation; dl: degrees of liberty; SS: sum of squares; MS: mean square; F: Value of f calculated. ns Non significant at the level of 1% of probability of error.

elliottii Engelm. is very different from the data found by Romanelli et al. (2004) in test of production of resin, which were 12 years old in Itapetininga - SP, with 90.30%, in which prevail soils classified as argilossolos. This variation may be due to the difference of the soils, as well as presence of the fungi *Armillaria luteobubalina* Kile and Watling in the soil (GOMES, 2005). The fungus *Armillaria luteobubalina* Kile e Watling is the agent which causes Armillaria rot root, a disease which causes the decay of bark and wood of roots and plant collar, resulting in the death of the host (GOMES, 2005).

P. caribaea var. *hondurensis* Barr. & Golf. presented 84.26% of survival comparing to the one found by Moraes et al. (2007) in test of thinning in progenies, which are 12 years old in the region of Selvíria - MS, with 90.44%, in which the annual average temperature is 24.5 °C.

The survival of 90.74% of plants in *P. oocarpa* Schiede is similar to the one found by KAGEYAMA et al. (1977) in genetic progeny test which is 4 years old in the region of Agudos – SP, with 95.8%, where the temperature in the coldest month is 18 °C. The variation in *P. caribaea* var. *hondurensis* Barr. & Golf. and *P. oocarpa* Schiede may be atributted to the difference of temperature, as well as by the incidence of Amillaria rot root.

P. taeda L. presented 92.13% of survival comparing to the one found by MENDES (1983), in progeny test which is 4 years old, in Telêmaco Borba - PR, with 92.67%. The great similarity of the variable may be attributed to the minimum variation edaphoclimatic.

The statistic evaluation with the variance for the variable diameter is presented in Table 5.

In Table 6 it is presented the Barlett test for the variable diameter, aiming to verify the homogenity of the variances and in Table 7 it is presented the averages for this variable.

In Table 8 and 9 it is presented the results of the analysis of variance – ANOVA for the variable diameter and the Tukey test for the comparison of

Table 5. Results of the variance for the variable diameter. Guarapuava-PR, 2009.

Treatments	Blocks			Total	Averages
	1	2	3		
P. elliottii Engelm.	2.33	0.98	0.81	4.12	1.37
P. caribaea var. *hondurensis* Barr. & Golf.	3.16	2.72	3.21	9.10	3.03
P. oocarpa Schiede	0.07	0.89	1.62	2.59	0.86
P. taeda L.	0.01	0.02	0.33	0.36	0.12
Total	5.58	4.61	5.98	16.17	

Table 6. Results of the analysis with Barlett test for the variable diameter. Guarapuava-PR, 2009.

Treatments	Dl	s^2	log s^2	dl x log s^2	x^2 corr
P. elliottii Engelm.	3	1,37	0,14	0,41	10,9*
P. caribaea var. *hondurensis* Barr. & Golf.	3	3,03	0,48	1,45	
P. oocarpa Schiede	3	0,86	-0,06	-0,19	
P. taeda L.	3	0,12	-0,92	-2,76	
Total	3	5,39		-1,09	
Average		2,16			

*dl: degrees of liberty; s^2: variance; log s^2: Natural logarithm of variance; x^2 corr: value of x^2 calculated. * Significant at the level of 1% of probability of error.*

Table 7. Value of the averages (cm) for the variable survival. Guarapuava-PR, 2009.

Treatments	Blocks			Total	Averages (cm)
	1	2	3		
P. elliottii Engelm.	8.54	8.40	7.85	24.79	8.26
P. caribaea var. *hondurensis* Barr. & Golf.	9.18	8.82	8.07	26.08	8.69
P. oocarpa Schiede	9.49	9.18	9.31	27.98	9.33
P. taeda L.	10.49	9.95	10.08	30.52	10.17
Total	37.70	36.35	35.32	109.38	

Table 8. Result of the analysis of variance – ANOVA for the variable diameter. Guarapuava - PR, 2009.

SV	dl	SS	SM	F
Blocks	2	0.7096	0.3548	5.3761ns
Treatments	3	6.2111	2.0704	31.3726*
Residue	6	0.3960	0.0660	
Total	11	7.3167		

*SV: source of variation; dl: degrees of liberty; SS: sum of squares; MS: mean square; F: Value of f calculated. ns Non significant at the level of 1% of probability of error. *Significant at the level of 1% of probability of error.*

Table 9. Results of the analysis of the Tukey test to compare averages of the variable diameter. Guarapuava-PR, 2009.

Tratamentos	Diâmetro (cm)
P. taeda L.	10.17a
P. oocarpa Schiede	9.33ab
P. caribaea var. *hondurensis* Barr. & Golf.	8.69bc
P. elliottii Engelm.	8.26c

Averages followed by the same letter do not differ statistically by Tukey test at the level of 1% of probability of error.

averages, respectively.

For the variable diameter at the lever of 1% of probability of error, the Barlett test indicated that the variances are homogenous. ANOVA found that there is no significant difference between the averages for the block, in other words, the difference is random, however there is a difference between the averages for the treatments.

Tukey test indicated that *P. taeda* L. is the one which presents higher diametric increase, followed by *P. oocarpa* Schiede, *P. caribaea* var. *hondurensis* Barr. & Golf. and *P. elliottii* Engelm.. The diameter of 8.26 cm in *P. elliottii* Engelm. is very similar to the one found by Romanelli et al. (2004) in test of production of 4 year old resin in the south region of São Paulo, with 8.50 cm, where the minimum and maximum average temperature ranges from 21.9 °C and 14.7 °C. The great similarity of the variable may be attributed to the minimum climatic range.

P. caribaea var. *hondurensis* Barr. & Golf. at

the age of 4 years, presented 8.69 cm of diameter in contrasting with the one found by Nicolielo (1984) in progeny test from the region of Agudos - SP, with 8.64 cm.

The diameter of 9.33 cm in *P. oocarpa* Schiede is very different to the one found by KAGEYAMA et al. (1977) in genetic test of provenience, which is 4 years old, in the region of Agudos – SP, with 11.25 cm, where the temperature of the coldest month is 18 °C and soil classified as latossolo vermelho amarelo.

The variation in *P. caribaea* var. *hondurensis* Barr. & Golf. and *P. oocarpa* Schiede may be attributed to the difference of temperature, as well as the type of the soil. *P. taeda* L. presented 10.17 cm of diameter, which can be compared to the one found by MENDES (1983), in progeny test which is 4 years old in Telêmaco Borba - PR, with 10.73 cm. The great similarity of the variable may be attributed to the minimum edaphoclimatic variations.

In Figure 4 it is presented the distribution of frequency in classes of diameter according to what was verified for the different treatments.

The distribution of frequency, in classes of diameter, is necessary in order to verify in which class it is found the highest number of individuals per species. The species which presented the largest number of individuals in a highest class of diameter in the one with the highest potential is basal area, which is a variable of great importance for the definition of the species to be planted.

It can be observed that *P. taeda* L. is the one which presents the highest frequency in the class of diameter between 9.00 and 11.99, followed by *P. oocarpa* Schiede. *P. elliottii* Engelm., for its turn, is followed by *P. caribaea* var. *hondurensis* Barr. & Golf. in the class of diameter between 6.00 to 8.99 cm.

The statistic evaluation with the variance for the variable basal area is presented in Table 10.

In Table 11 it is presented the Barlett test for the variable basal area, aiming to verify the homogeneity of the variances and in Table 12 it is presented the averages for this variable.

In Table 13 and 14 it is presented the results of the analysis of variance – ANOVA for the variable basal area and the Tukey test for average comparison, respectively.

For the variable basal area, at the level of 1% of probability of error, the Barlett test indicated that the

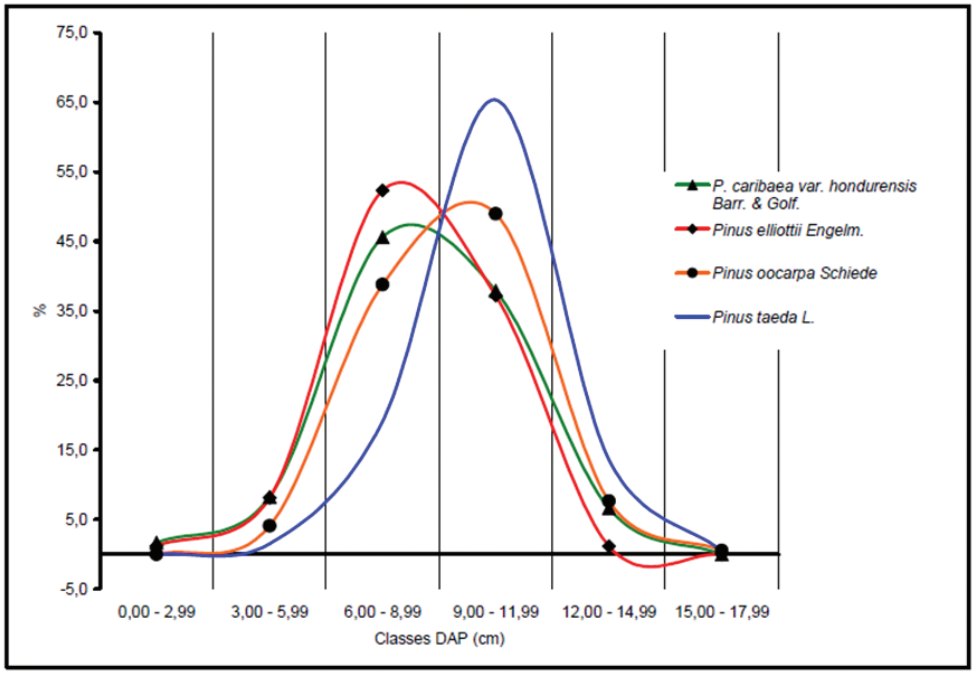

Figure 4. Distribution of frequency in classes of diameter. Guarapuava-PR, 2009.

Table 10. Results of the variance for the variable basal area. Guarapuava-PR, 2009.

Treatments	Blocks			Total	Average
	1	2	3		
P. elliottii Engelm.	20.48	10.47	12.14	43.10	14.37
P. caribaea var. *hondurensis* Barr. & Golf.	21.12	25.86	36.62	83.60	27.87
P. oocarpa Schiede	2.73	13.85	14.62	31.20	10.40
P. taeda L.	1.66	1.69	1.42	4.77	1.59
Total	45.99	51.88	64.80	162.67	

Table 11. Results of the analysis with Barlett test for the variable basal area. Guarapuava-PR, 2009.

Treatments	gl	s^2	log s^2	gl x log s^2	x^2 corr
P. elliottii Engelm.	3	14.37	1.16	3.47	9.24*
P. caribaea var. hondurensis Barr. & Golf.	3	27.87	1.45	4.34	
P. oocarpa Schiede	3	10.40	1.02	3.05	
P. taeda L.	3	1.59	0.20	0.60	
Total	12	54.22		11.46	
Average		21.69			

*dl: degrees of liberty; s^2: variance; log s^2: Natural logarithm of variance; x^2 corr: value of x^2 calculated. * Significant at the level of 1% of probability of error.*

Table 12. Values of the average in percentage for the variable basal area. Guarapuava-PR, 2009.

Treatments	Blocks			Total	Average (m^2 ha^{-1})
	1	2	3		
P. elliottii Engelm.	10.62	9.64	1.49	27.75	9.25
P. caribaea var. hondurensis Barr. & Golf.	11.29	11.40	9.88	32.58	10.86
P. occarpa Schiede	13.04	12.85	13.12	39.01	13.00
P. taeda L.	16.48	15.01	14.55	46.05	15.35
Total	51.43	48.91	45.04	145.38	

Table 13. Results of the analysis of variance - ANOVA for the variable basal area. Guarapuava-PR, 2009.

SV	dl	SS	MS	F
Blocks	2	5.1868	2.5934	4.4951^{ns}
Treatments	3	63.1208	21.0403	36.4693*
Residue	6	3.4616	0.5769	
Total	11	71.7692		

*SV: source of variation; dl: degrees of liberty; SS: sum of squares; MS: mean square; F: Value of f calculated. ns Non significant at the level of 1% of probability of error. *significant at the level of 1% of probability of error.*

Table 14. Result of the analysis with the Tukey test to compare averages of the variable basal area. Guarapuava-PR, 2009.

Treatments	Basal area (m^2/ha)
P. taeda L.	15.35[a]
P. occarpa Schiede	13.00ab
P. caribaea var. *hondurensis* Barr. & Golf.	10.86bc
P. elliottii Engelm.	9.25c

Averages followed by the same letter do not differ statistically by the Tukey test at the level of 1% of probability of error.

variances are homogeneous. Trough ANOVA it was found that there is significant difference between the averages for the blocks, i.e., the difference is random; however, there is difference between the averages for the treatments.

Tukey test indicated that *P. taeda* L. is the one which presents highest basal area, followed by *P. oocarpa* Schiede, *P. caribaea* var. *hondurensis* Barr. & Golf. and *P. elliottii* Engelm. The basal area per ha is directly proportional to the number of trees and to the average diameter, i.e., the higher the number of tress and the higher the average diameter, the higher the basal area per ha. Trough the basal area, it can be defined which is the best species to be planted in the region.

In Table 15 it is presented a summary with the work developed by several researches, in order to determine the quantitative variables of forest planted in other regions.

It can be observed that there is small difference between *P. elliottii* Engelm. and *P. taeda* L. in different regions, however, between *P. caribaea* var. *hondurensis* Barr. & Golf. and *P. oocarpa* Schiede, it can be verified that there is a greater difference between the coldest and hottest regions.

Conclusions

P. taeda L. is the species with highest diametric increase and basal area, besides presenting highest frequency in the highest class of diameter, followed by *P. oocarpa* Schiede., *P. caribaea* var. *hondurensis* Barr. & Golf. and *P. elliottii* Engelm.

The best performance of the *P. taeda* L. is due to its better adaptation to the site, climate and rainfall of the region.

Trough the comparison of this study with researches performed by other authors in other regions, it can be proved that *P. taeda* L. looses diametric increase when compared to *P. caribaea* var.

Table 15. Summary of the results of studies about the quantitative variables of Forest planted in other regions.

Research	Species	Place of study	Area (m^2 $tree^{-1}$)	Age (years)	Number (Trees ha^{-1})	Annual diametric increase (cm)
Nicolielo, 1984	*P. caribea* var. *hondurensis* Bar. & Golf.	Agudos-SP	*	5	*	3.09**
			*	7	*	2.56**
			*	9	*	2.28**
			*	11	*	2.03**
Moraes et al. 2007		Selvíria-MS	9	12	1005	1.85**
Kageyama et al., 1977	*P. oocarpa* Shiede	Agudos-SP	9	4	1064	2.81**
Brasil et al., 1980			4	7	2300	2.10
			4	13	1075	1.35
Romanelli et al., 2004	*P. elliottii* Engelm	Angatuba-SP Itapetininiga-SP Itapeva-SP	9	4	*	2.13
			9	12	1003	1.58
Tonini, 2000		Encruzilhada do Sul-RS	4	18	892	1.40
		Mostardas-RS Palmares-RS Piratini-RS	4	21	780	1.09
Mendes, 1983	*Pinus taeda*	Tlêmaco Borba-PR	6	4	1545	2.69
Leite et al. 2006		Otacílio Costa-SC	6	4	1650	2.18**
			5	4	1990	1.98**
			4	4	2475	1.95**
Barricheloet al. 1977		Tlêmaco Borba-PR	*	9	*	1.50**

** Information was not presented in the research ** Results obtained trough mathematical estimates.*

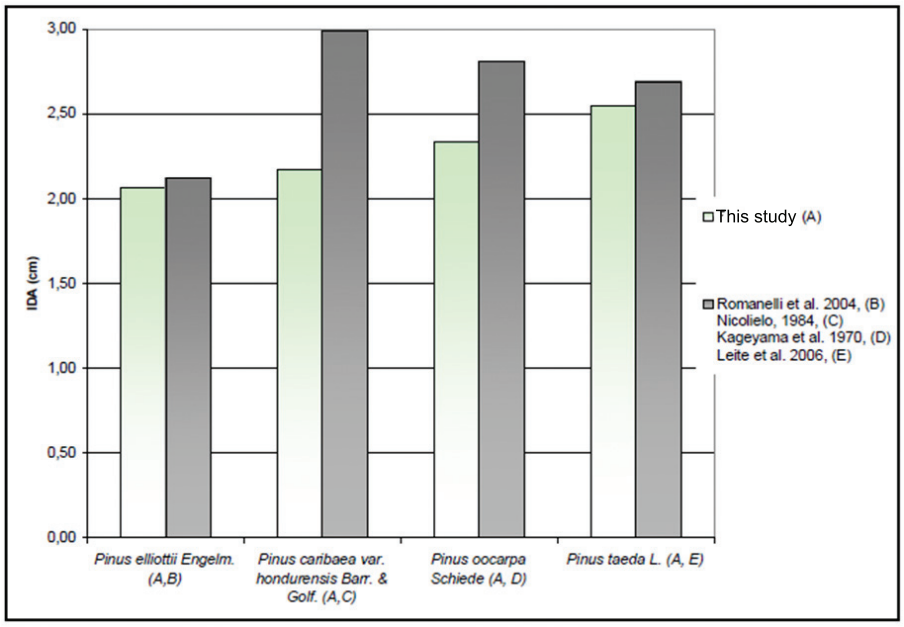

Figure 5. Comparison between this study (A), the researches performed by ROMANELLIET al. 2004, (B), NICOLIELO, 1984, (C), KAGEYAMA et al. 1970, (D), and LEITE et al. 2006, (E) in annual diametric increase (ADI). Guarapuava-PR, 2009.

hondurensis Barr. & Golf. and *P. oocarpa* Schiede in hottest regions, i.e., it is confirmed that *P. taeda* L. can be adapted to the climate and rainfall of the south region of Brazil.

P. taeda L. is the species to be implanted in the south region of Brazil, as well as *P. oocarpa* Schiede and *P. caribaea* var. *hondurensis* Barr. & Golf. should be implanted in hotter regions (Southeast region of Brazil), aiming to maximize the production and consequently the revenue.

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