ANALYSES OF GROWTH, MORPHOLOGICAL AND WOOD PROPERTIES TRAITS IN ORTET POPULATIONS OF *Eucalyptus* IN THE CONGO

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ABSTRACT

Seventy eight ortets were selected from among 2560 trees in the *E. urophylla x grandis* hybrid progeny test and 39 ortets from 1920 trees in the *E. urophylla x pellita* hybrid progeny test to produce future clones for the commercial plantations in the Congo. Growth traits (height and circumference), morphological traits (taper, branc habit, stem straightness) and wood property traits (bark percentage, density, splitting) were measured and their mean, their distribution and the correlation between traits were analyzed in this narrow genetic base population.

The effect of selection can be observed on the growth traits by of the small coefficient of variation. On the contrary, the morphological and wood property traits exhibit a high variability showing that an significant genetic gain could be achieved. Weak correlation between the different traits highlights the need to select a large number of ortets in the progeny test to detect the clones presenting the most traits with favorable effects. The comparison between the two hybrids shows that *E. urophylla x grandis* is more suitable for pulpwood and *E. urophylla x pellita* for poles. The discussion deals with the strategy of clone selection in the case of a diversification of products.

Key words: ortet selection, growth, morphology, wood properties, splitting, Congo

INTRODUCTION

The main valorization of the commercial plantations of *Eucalyptus* clones in Congo is pulp wood. To improve its quality, optimize its production and diversify the products from these plantings (saw timber wood, poles...), a better knowledge of the genetic expression of growth, morphological and wood property traits is needed at different stages of the selection strategy.

In Congo, the creation of an industrial clone starts with the selection of the ortet, the first individual tree of the clone, in the progeny tests of the reciprocal recurrent selection scheme (Vigneron 1991). This process goes on in the clonal tests and, for the best clones, in the commercial plantation where a definitive choice is made.

Because of the high selection intensity and in consequence its narrow genetic base, the ortet population exhibits specific patterns in comparison to the base breeding population or the progeny tests. Their patterns are supposed to be close to those of the clone population tested in the clonal tests. Therefore they can provide a good assessment of the variability in the clone population of the growth, morphological and wood property traits and of the relationships between those traits.

The objectives of this paper are to analyze for the two hybrids involved in the Congolese strategy (i) the mean value and the distribution of the growth, morphological and wood property traits, (ii) the relationships between those traits and (iii) to draw conclusions for the clone selection process.

MATERIAL AND METHOD

Traits were measured on ortet trees of 58 months (mean height around 22m and mean circumference around 60 cm) selected from the progeny tests established in Pointe-Noire (Kissoko station) in 1990. The ranking of trees was carried out with the OPEP software using the "Best Linear Prediction" approach (Baradat *et al.* 1990) and the selection intensity was :

- 3% of the total population of the *E.urophylla x grandis* hybrid, *i.e*, 78 ortets selected from 2560 trees,

- 2% of the total population of the *E.urophylla x pellita* hybrid, *i.e*, 39 ortets selected from 2560 trees.

The number of selected trees is small and this sample is representative of the genetic base of the clones involved in the creation of commercial varieties (Bouvet 1995).

The traits measured on each individual tree were :

- growth traits: total height (HT) and circumference at breast height ($C_{1.30}$),

- morphological traits; taper (TP), number of thin branches per meter on the stem (HB), number of thick branches per meter on the stem (KB) and the bark percentage (BP) assessed on a disk of 2 or 3 cm thick at breast height.

- the basic density (BD), measured on the disk of 2 or 3 cm thick sampled at breast height (1.3 m),

- The splitting indice (SI), is the ratio of the sum of the splits length to the circumference of the transversal section thirty minutes after the felling. For each selected tree this measurement was made at six levels and because of the high stability on the splitting indice with height, the average of the six measures was used in this study (Combes 1996). This indice is accurate enough to assess saw timber use because it characterizes the ability of the wood to bow or to split during the sawing operations. The splits which can be observed during felling operations are one of the most limiting factors on the use of *Eucalyptus* as sawn timber wood (Baillères 1994, Gérard 1994).

The means, the coefficients of variation, the coefficients of correlation and the comparisons of means were made with the SAS software (SAS Institute 1988).

RESULTS

The means and the coefficients of variation of the different traits are presented in table 1. The histograms (Figure 1) show the shape of the distribution for the two hybrids.

Growth traits exhibit a low coefficient of variation, around 5% for height and 10% for circumference. These values are clearly smaller than those observed in the total hybrid population which are respectively 20% and 40% (Bouvet 1995). This result is normal because of the strong selection intensity on these two traits.

TABLE 1. Comparison of the means and the coefficients of variation for each trait in the two hybrids: total height (HT), circumference at breast height (C1,3), taper (TP), number of thin branches (HB), number of thick branches (KB), bark percentage (BP), the basic density (BD), the splitting indice (SI)

Hybrids	Traits	Mean	Coefficient of variation
E. urophylla x grandis	HT (m)	23.9	4.9
	C1.3 (cm)	60.6	11.6
	TP (cm/m)	2	17.1
	HB	1.2	96.9
	KB	0.4	97.1
	BP (%)	18.5	15.5
	BD (g/cm3)	0.51	6
	SI	0.66	33.7
E. urophylla x pellita	HT (m)	21.7	5.5
	C1.3 (cm)	60.7	9.2
	TP (cm/m)	2.3	14.3
	HB	2.4	49.1
	KB	0.34	106.9
	BP (%)	26.9	25.6
	BD (g/cm3)	0.54	6.4
	SI	0.53	41.98

TABLE 2 : matrix of phenotypic correlation between the different traits in the two hybrid populations, *E.urophylla x grandis* above the diagonale and *E.urophylla x pellita* under. (a) coefficient of correlation, (b) associated probability.
total height (HT), circumference at breast height (C130), taper (TP), number of thin branches (HB), number of thick branches (KB), bark percentage (BP), the basic density (BD), the splitting indice (SI)

	HT	C1.3	TP	HB	KB	BD	BP	SI
HT		0.28 0.01	-0.06 0.61	-0.03 0.80	-0.07 0.56	0.27 0.01	-0.13 0.26	0.08 0.48
C1.3	0.59 (a) 0 (b)		0.89 0	0.12 0.28	0.45 0	0.05 0.65	0.02 0.86	0.14 0.20
TP	-0.01 0.96	0.73 0		0.06 0.62	0.47 0	0.02 0.87	0.1 0.63	-0.01 0.94
HB	-0.22 0.18	-0.15 0.34	0 0.98		0.44 0	0.21 0.06	0.01 0.9	0.12 0.31
KB	0.02 0.9	0.24 0.14	0.27 0.09	0.07 0.69		0.18 0.11	0.18 0.1	-0.07 0.52
BD	-0.09 0.58	-0.17 0.29	-0.01 0.97	-0.34 0.03	0.21 0.19		0.21 0.06	-0.04 0.69
BP	-0.35 0.03	-0.14 0.39	0.18 0.28	-0.03 0.86	0.24 0.14	0.46 0		-0.1 0.36
SI	0.33 0.04	0.23 0.16	-0.06 0.7	-0.25 0.13	0.01 0.94	0.09 0.59	-0.04 0.83	

For the branch traits, the coefficient of variation is very high, which can be explained by the unbalanced distribution showing a higher proportion of trees with a small number of branches. Furthermore the selection intensity was less strong than for the growth traits. The mean of the taper is close to those assessed in the total hybrid population, but the coefficient of variation is smaller because of the selection.

The mean and the coefficient of variation of the basic density are close to those observed in other clonal populations (Bouvet and Baillères 1995) and close to the values assessed in the total hybrid population. This result is to be expected as selection is not made on wood property traits in the progeny tests.

For the splitting indice, a high coefficient of variation can be observed for the two hybrids showing that this trait is strongly variable. The distribution is more or less unbalanced which also explains the value of the coefficient of variation.

The comparison of the two hybrids shows that *E.urophylla x grandis* has the better potentiality with a higher height growth, a branch trait more suitable for commercial plantations, a smaller taper and a lower bark percentage.

For the wood property traits, the two populations are also significantly different with *E.urophylla x pellita* exhibiting a higher basic density and a lower splitting indice.

The matrix of correlation, table 2, highlights the weak correlation between the growth and the morphological traits except for the taper which can be explained by its type of calculation. In the same way, there is no strong correlation between the growth and the wood property traits.

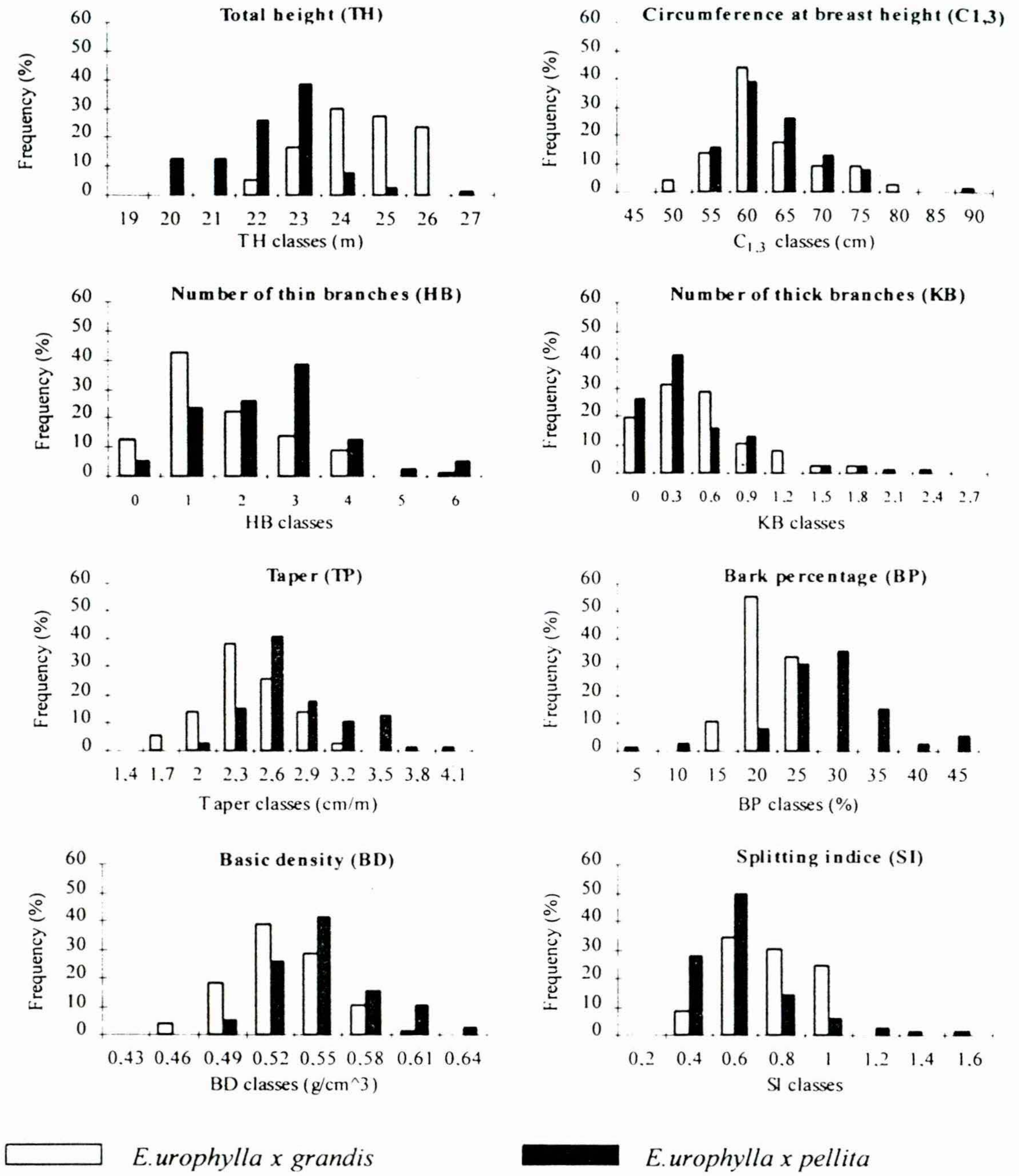

FIGURE 1. histograms of distribution for the differents traits: *E.urophylla x grandis* in grey and *E.urophylla x pellita* in black

DISCUSSION

The two most important parameters in the selection of *Eucalyptus* clones are basal density and growth. (Wright 1993). Good growth is the result of strong adaptive traits and will ensure the production of a high volume of wood, while density is a clear indicator of numerous paper properties (Arbuthnot 1991, Malan 1993) and mechanical properties (Zobel and Van Buijtenen 1989). In the case of these two hybrids, the large range in the variation of basic density indicates that is possible to select a large range of products for the industry from wood chips to pulpwood.

A new parameter, the splitting indice (SI), not previously taken into account in the selection process in the Congo, also presents a strong variability and an accurate selection on this trait could lead to a high genetic gain.

However, the absence of a strong correlation between the morphological and technological traits and between growth and technological traits shows that it will be difficult to find the clones which have the optimal quality of all the combined traits. Therefore, it is necessary to select a large number of ortets in the progeny tests in order to obtain a clone which displays the maximum number of favorable traits at the end of the selection cycle. In addition, it is necessary to anticipate the selection of clones destined for wood pulp use and those destined for timber use. It should be stressed that this study does not cover the rooting ability or resistance to parasite attacks which are two of the most important criteria in the actual selection process. These traits also seem to have little correlation with growth traits (Faradj 1995).

As far as the performance of the two hybrids is concerned, the *E.urophylla x grandis* presents certain advantages over the *E.uraphylla x pellita,* with better height, smaller number of branches, weaker taper, a lower percentage of bark and a density scale better suited to pulp wood. However, the strong splitting indice (often with emerging splits) makes it much less attractive for pole use than *E.urophylla x pellita.* This splitting indice seems to be a good guide for pole use, equally for the production of sawn timber (Gerard 1994)

CONCLUSION

The study presented here had the objective of analyzing , during the varietal output, the expression of classic traits used in the Congo for the production of pulp wood, but also for the production of poles. Technological traits which were taken into account in this study, particularly the splitting indice, provide new informations on the potential of Congolese clones.

This study examines the diversification of products produced by the commercial *Eucalyptus* plantations. With the strong demand for a good quality wood (Malan 1995), *Eucalyptus* plantations need no longer be limited to wood chip production. Their use as round wood for structure will allow the wood industry to be free, at least partially, from the strong constraints imposed by the paper products industry and to be less sensitive to the fluctuations of the dollar which controls the wood chip market.

The objectives in the Congo should therefore be to diversify the wood property of clones to answer the need of pulp mill and the need of local wood construction market.

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