Correlation Coefficient in Wood Properties for Selection of Plus trees

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ABSTRACT: *Characterization of wood is indispensible for proper selection of plus trees for clonal propagation. The classical system adopted through phenotypical criteria should be supplemented with extensive wood characterization aiming at attaining higher correlation coefficient. Correlation of various properties of wood exists if the trees are of similar character. It has been found that the correlation coefficient of the wood properties determined for Eucalyptus tereticornis from same plantation area is very low.*

INTRODUCTION

The guidelines evolved for eucalyptus plus trees selection in Brazil are:

a. The plus tree should have more than 1 M^3 of volume.

b. It should have an outstanding form i.e. straight bole, good crown shape and area.

c. Bark content should be less than 10% and it should be smooth.

d. Basic density of wood should be in the range of 500-600 kg/M^3.

e. The wood should have good fibre quality.

f. Bleached pulp yield should be more than 50%.

g. Tree should have good coppicing ability and the coppice cuttings, good rooting ability.

It can be seen that for selection, many criteria are based on wood quality rather than on phenotypic superiority [1-4].

Moreover a large number of trees are to be taken for analysis. The Aracurz Florestal has selected 5000 plus trees from a wide spread population i.e. from 36,000 hac. In this investigation about 3500-4000 trees were tested for specific gravity (basic density) and 1500-2000 for bleached pulp yield. About 625 trees were selected based on bleached pulp yield i.e. which gave more than 50%. These were further screened and finally 25 number of trees were selected which gave a bleached pulp yield of 51.0%, Large scale propagation was carried out from these selected 25 trees.

RESULTS AND DISCUSSION

Basic density

Basic density of wood is under genetic control and hence strongly heritable. Basic density as a measure was successfully utilized in tree improvement programmes. Variation in basic density arises due to:

a. Variation in cell wall thickness of fibres.

b. Extent and kind of distribution of vessels and parenchyma.

These two factors in turn are influenced by rate of growth and age of tree.

Selection of trees with high basic density is useful as more weight of wood per unit volume could be obtained. High basic density improves the productivity of handling and operations involved in pulp and paper making. But high basic density adversely effects pulp yield and quality.

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Among the 25 samples studied, basic density varied from 534 kg/M^3 to 653 kg/M^3 with a mean value of 595.8 and a variability of 5.9% (Table-1).

Table-1. Mean and coefficient variability values

Particulars		Mean	Total no. of eucalyptus trees: 25 Standard deviation	Coefficient variability
1. Physical characteristics				
Basic density,	kg/M^3	595.8	35.31	5.9
Bark content,	%	10.1	1.62	16.0
Fibre length,	mm(Avg)	0.829	0.047	5.6
2. Proximate chemical analysis				
Alcohol-benzene solubility,	%	3.38	1.21	35.79
Lignin,	%	22.96	2.19	9.53
Holocellulose,	%	80.28	2.18	2.71
3. Bleaching characteristics				
Kappa no.		19.8	2.46	12.4
Unbleached yield,	%	43.14	2.39	5.54
Bleached yield,	%	39.52	3.44	8.7
Total chlorine consumption,	%	6.7	0.69	10.2
4. Strength properties of Bleached pulp at 40°SR				
Bulk,	cc/g	1.454	0.019	1.30
Burst factor		29.46	3.26	11.06
Breaking length,	m	5014.6	239.77	4.78
Tear factor		35.52	4.27	12.02
Double fold,	no.	11.14	1.98	17.7

Graphs have been plotted to find out correlation of basic density with other properties. The statistical equations used are given in the Annexure.

ANNEXURE

Statistical equations

The following equations (5) have been used for determination of correlation coefficient, standard deviation and coefficient of variation.

$$\rho = \frac{1-6\,\Sigma\,(d^2)}{n\,(n^2-1)} \qquad (1)$$

Where, ρ = Spearman's Correlation Coefficient

$$\sigma = \sqrt{\frac{\Sigma\,Fx^2}{N}} \qquad (2)$$

Where, σ = Standard deviation

$$\upsilon = 100 \times \frac{\sigma}{M} \qquad (3)$$

Where, υ = Coeficient of variation

σ = Standard deviation

M = Mean*

Correlation between basic density and bleached pulp yield (Fig. 1) of these samples is also poor; the points are scattered. Coefficient of 0.07 (Table-2) indicates that increase in density may not adversely effect the unbleached pulp yield.

Table-2. Correlation coefficients

Particulars	Results
Basic density Vs Bleached yield	0.07
Basic density Vs Kappa no.	0.29
Basic density Vs Initial burst factor (Bleached pulp)	0.22

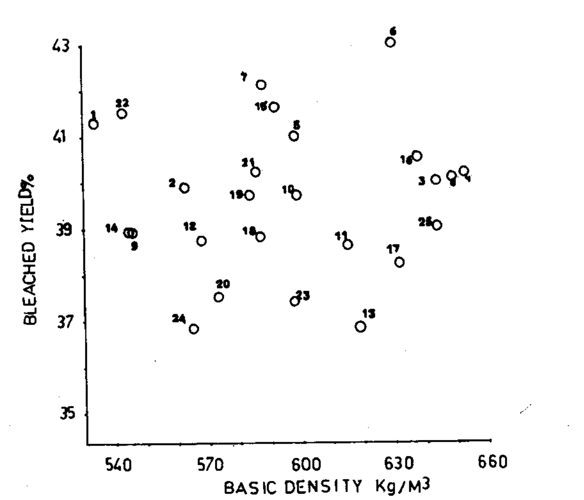


FIG. 1

Increase in basic density shows little effect on bulk of hand sheet made from bleached pulp at initial °SR (Fig. 2) which indicates that increase in basic density of wood may not be due to increase in cell wall thickness of fibres.

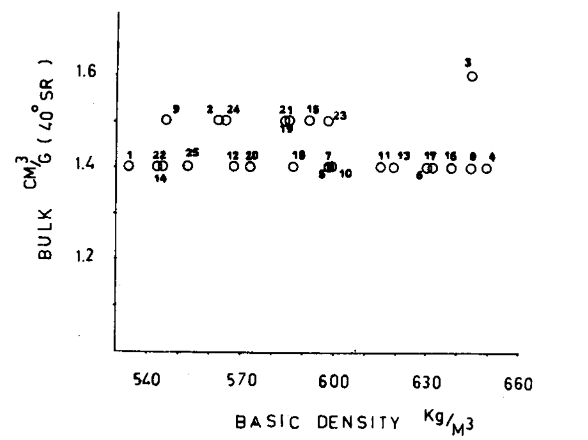
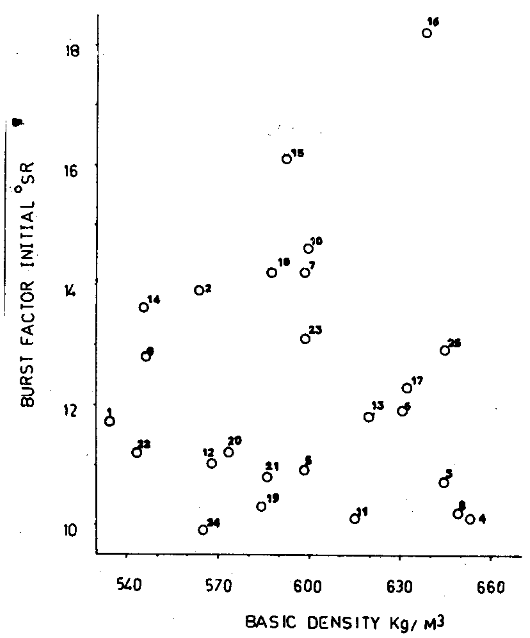


FIG. 2.

Basic density is correlated to burst factor of bleached pulp at initial °SR (Fig. 3) with a correlation factor of 0.22 (Table-2) which is again insignificant.



Basic density shows positive correlation of 0.29 (Table-2) with unbleached kappa no. The relation can be seen from (Fig. 4). As the density of wood increases, the resultant pulp kappa no. tends to increase. This implies that higher the density, more will be the difficulty to extract lignin from wood during pulping.

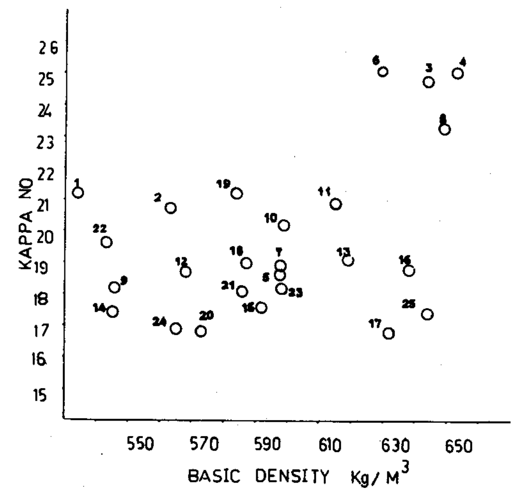


FIG. 4.

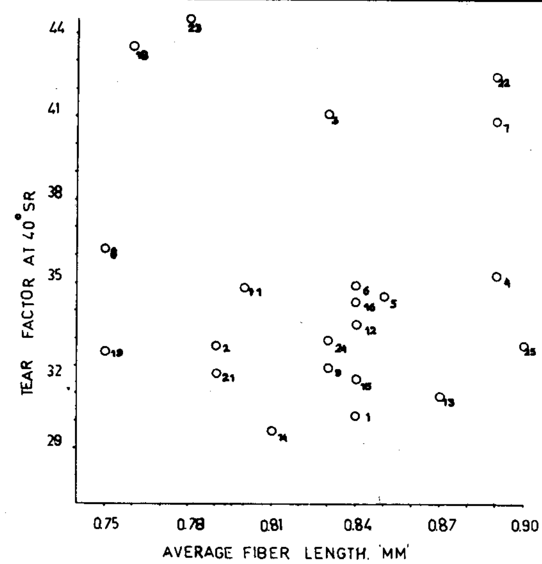


FIG. 5.

Fibre dimensions

Like basic density, fibre length is also governed by genetic control and strongly heritable. Variation in fibre length is due to growth rate and age differences of trees. Fibre length influences the physical strength properties of pulp, notably the tear factor. Higher the fibre length, more will be tearing resistance of resultant sheet.

Average fibre length varied from 0.75 to 0.9 mm and width from 11.75 to 14.1 mm. The mean value of fibre length is 0.83 mm with a variability of 5.6%.

As the fibre length increases, the tear factor also increases; however, the correlation factor is low. The relation between fibre length and breaking length of sheet is also poor (Fig. 6). These poor relations indicate that more variation is needed for proper selection which is possible by testing more number of trees.

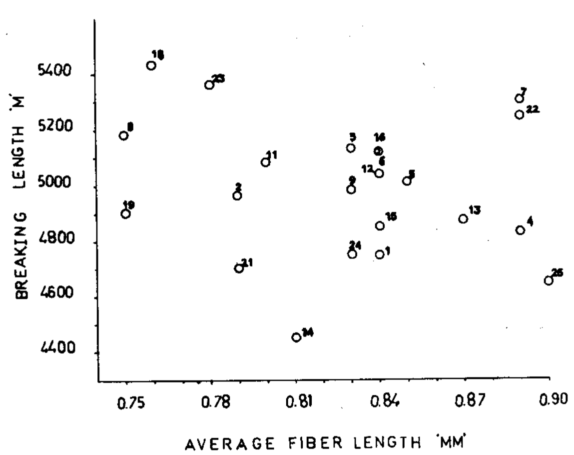


FIG. 6.

Bark content

For plus trees bark should be low and smooth.

The bark content varied from a low value of 6.9% to 13.1%. The samples have shown greater degree of heterogeneity in terms of bark content with a variability of 16.0% (Table-1). This indicates that trees show wide variability in bark content.

Chemical composition

Lignin has varied from 20.4% to 26.3% with a variability factor of 9.5% (Table-1) which is significant. Lignin has a poor relationship with unbleached pulp yield values (Fig. 7) This is due to wood density and holocellulose content which also influence pulp yield.

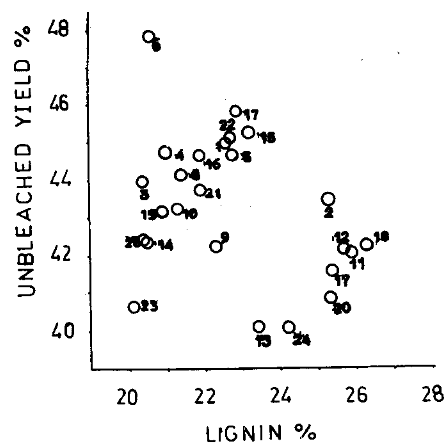


FIG. 7.

The holocellulose content has a mean value of 80.3% which is high with a variability of 2.7% with respect to unbleached pulp yield (Fig. 8). The alcohol-benzene content shows a mean value of 3.38 with a variability of 35.79%.

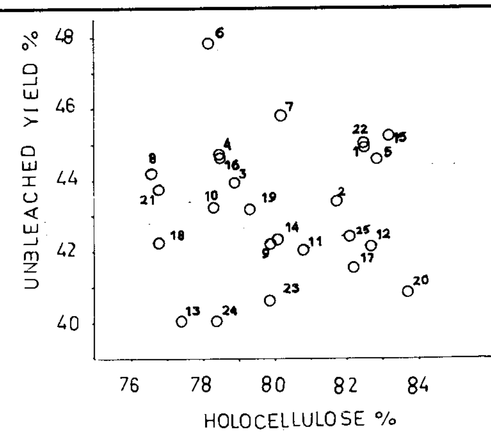


FIG. 8.

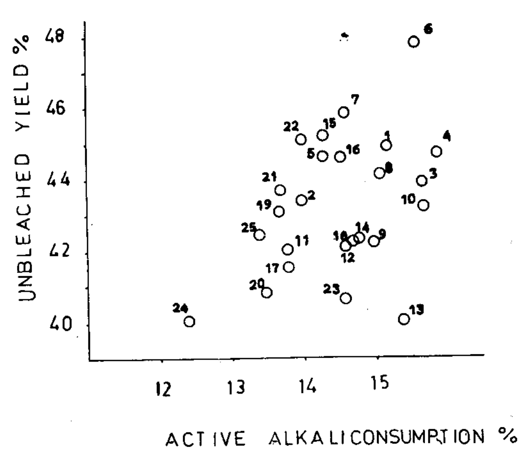


FIG. 9.

Pulping and Bleaching

The screened unbleached yield varied from 40% to 47% with a mean value of 43.1 and a variability of 5.54%. The active alkali consumption has poor relationship with the unbleached pulp yield (Fig. 9). The mean value of bleached pulp yield is 39.5 with a variability of 8.7%.

CONCLUSION

a. Selection of plus trees based only on phenotypic superiority is not adequate for clonal propagation. Selection should be based on both phenotypic superiority as well as wood properties.

b. The correlations among various wood properties are poor and therefore, more number of trees should be tested (1000).

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