So we have heritability for mass selection in wild stands

$$h^2 \text{ mass selection} = \frac{VG}{VG + VE} - \frac{4\,VF}{VF + VE} = \frac{25.12}{6.28 + 74.48} = .31$$

and heritability for family selection in the test plantation as

$$h^2 \text{ family selection} = \frac{VF}{VF + VE/mb} = \frac{6.28}{6.28 + 74.48124} - .67$$

Genetic Gain

Genetic gain is the product of selection differential and heritability. Selection differential does not need adjustment but the heritability does. By using the corrected heritability one can make a better prediction on genetic gain. For example, if the selected families exceed the population mean by 3 feet and the corrected family heritability is .67, the predicted genetic gain from the selection would be 2 feet.

Summary

In order to study the consequences of measuring only the tallest tree of a m-tree plot a computer simulation with 950 generated data points was used. Data points were drawn from a normal distribution with mean equal to zero and variance equal to 100. The average of mean and variance of the tallest trees of plot size from 2 to 10 were obtained through 20 computer runs. The mean of the tallest trees agreed with the predicted selection differential for chosen one best tree out of a m-tree plot. The empirical ratios between the variance of all original individual trees and the variance of the tallest trees were presented in this paper. The ratio is useful in adjustment of heritability estimates, expected mean of the selected group and predicted genetic gain when only the best tree in a plot is measured.

Key words: Progeny test, sampling, computer simulation, adjustment of genetic Parameter.

Zusammenfassung

An Hand der Meßergebnisse aus einem randomisierten Blockversuch wird untersucht, welche Auswirkungen es hat, wenn zur Beurteilung der Wüchsigkeit jeweils nur der wüchsigste Baum jeder Parzelle gemessen wird. Hierzu wird das empirische Verhältnis der Varianz aller Bäume zur Varianz der höchsten Bäume dargestellt, welches zur Korrektur der Schätzung von Heritabilitäten von Bedeutung ist.

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Short Note: Growth Correlations of Cottonwood Clones Developed from Mature Wood Cuttings

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(Received November 1976 / January 1977)

Introduction

To develop improved cottonwood (Populus deltoides BARTR.) clones geneticists test either seedlings, clones derived from seedlings, or clones propagated from cuttings of mature trees. The growth, development, and characteristics of trees from these three classes of material may not be the same. Most reports deal with trees developed from seedlings or from cloned seedlings. This paper gives results of a study in which clones were developed from cuttings taken from the crowns of mature trees.

Methods

Twenty-four phenotypically superior cottonwoods that were about 25 years old were selected in natural stands in west central Mississippi along a 200 km section adjacent to the Mississippi River. Cuttings from branch tips of the midcrowns were collected in late February 1963. The cuttings were rooted in a greenhouse in peat pots filled with a sand-peat medium, then transplanted to a nursery. The plants grew in the nursery for one year, were cut back to rootstocks, and then allowed a second year's growth in the nursery.

A field test was planted in February 1965 with cuttings from the rejuvenated nursery plants (24 clones) and cuttings from one cloned seedling. The test design was a randomized complete block with four replications, 25 clones, and two-ramet plots. Unrooted cuttings, 46 cm long by 12 to 18 mm in diameter, from each clone were treated with ThimetR[2]) and planted three per spot at 3- by 6-m spacing. In May of the first growing season, each spot was thinned to a single plant. The planting was clean cultivated the first year and mowcd annually thereafter. After the fifth growing season, every other row was removed leaving one ramet per plot at 6- by 6-m spacing. Cloned seedlings in an adjacent study were used to compare with the mature wood cuttings.

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[2]) Mention of trade names is solely to identify material used and does not imply endorsement by the U. S. Department of Agriculture.

Diameters were measured annually from age 1 through age 8 years. Heights were measured at 1, 2, 3, 5, and 7 years. At the time of thinning (5 years), bark thicknness and total stem volume were determined (MOHN and KRINARD 1971).

Measurements were analyzed as a randomized complete block design with clones considered as a random factor. Significance was determined at the 0.05 level. Genotypic and phenotypic correlations were determined from cross-products analysis. Broad-sense heritabilities were determined on a plot-mean basis by the formula:

$$h^2 = \frac{\sigma^2_g}{\sigma^2_g + \sigma^2_e}$$

where h^2 is the heritability, σ^2_g is the genetic variance, and σ^2_e is the environmental variance.

Clone means were used as the basis of selection, and genotypic gain was determined:

$$\Delta M = i h^2 \sigma g$$

where i is the intensity of selection (best 2 clones), h^2 is the heritability (determined on a clone-mean basis), and σg ist the phenotypic standard deviation.

Results and Discussion

After 1 year in the field, survival among clones ranged from 37 to 100 percent and averaged 83 percent. Since three cuttings were planted per spot, the plots were fully stocked. No correlation was observed between rooting percent of ortet material and survival of the clone developed from it. No survival difference between male and female clones was observed, which agrees with FARMER's (1966) results.

During the first year, cuttings from rejuvenated clones grew in height and diameter as rapidly as the cloned seedlings in the adjacent study. By age 2 the mature-wood clones were taller than the cloned seedlings. After 7 years, the mature-wood clones averaged 21.9 m tall (2 m taller than the cloned seedlings), and mean heights ranged from 19.2 to 25.0 m, a significant variation. At 8 years, mean diameter at breast height of mature-wood clones was 24.9 cm; clone means varied significantly from 19.3 to 30.5 cm. Because spacing has a greater influence on diameter than on height and the initial spacing of the mature-wood clones was 3 by 6 m and the spacing of the cloned seedlings was 3 by 3 m, the diameters of the two classes of material were not compared. The cloned seedling included in the study was one of the largest clones in height and diameter. No difference was observed between male and female clones for either height or diameter.

At 5 years, bark thickness of the mature-wood clones averaged 5.3 mm and ranged from 3.6 to 7.1 mm, a significant variation. The clone propagated from a seedling had significantly thicker bark (12.4 mm) than any clone derived from mature-wood cuttings. The cloned seedlings in the adjacent study had a mean bark thickness of 9.4 mm which by t-test was significantly thicker than that of the mature-wood clones. MAY (1963) reported that cuttings used to propagate *Populus* from older trees retain the smooth, thin bark characteristic of physiological age. Even cuttings taken from young (4 to 11 inch diameter) cottonwoods developed this same bark pattern (JOKELA and GRAY 1967).

Heritability for diameter at age 8 was 0.69 and for height at age 7 was 0.56, both of which are higher than values found by MOHN and RANDALL (1971) and RANDALL and COOPER (1973). Heritability for height usually is higher than heritability for diameter, the opposite of what was observed here.

Genotype and phenotypic correlations were of similar size and correlations between age 8 diameter and 1- and 7-year diameters increased from 0.53 to 0.99. Five-year stem volume was correlated more strongly with diameter than with height. Genotypic correlations between volume and diameter increased from 0.61 at age 1 to 0.99 at age 5.

The two clones with the largest diameters at 8 years gave a 17-percent genotypic gain over the mean. Selecting the top two clones for height at age 7 and volume at age 5 gave gains of 8 and 40 percent.

To evaluate the effectiveness of early selection clones were ranked for diameter at all ages. Since only a few clones were used in this study, a simple ranking was used instead of calculating gain through correlated response. In most cases, clones that were ranked at the top for either height or diameter at age 1 were also the largest at the final measurement. The largest clones at age 2 were the largest clones at subsequent measurements in all cases. Thus, the fastest growing clones can be chosen after only one year; waiting to age 2 or 3, however, makes selection more certain. When selecting for volume, early diameter is a slightly better measure than early height. The results substantiate the findings of MOHN and RANDALL (1971) that early selection is effective.

Summary

Cuttings from 24 clones developed from mature ortets had higher heritabilities for diameter than for height. Genotypic and phenotypic correlations of 8-year diameter and 5-year volume with diameters and heights at various ages increased as the trees aged. When two clones were selected for height at age 7, diameter at age 8, or volume at age 5 they gave genotypic gains of 8, 17, and 40 percent over the means. Bark of trees developed from mature ortets was thinner than the bark of trees produced from cloned seedlings.

Key words: Cuttings, Growth, *Populus deltoides*.

Zusammenfassung

In einer Versuchsanlage mit 14jährigen Stecklingsklonen von 24 im Jahre 1963 abgesteckten *Populus deltoides* Mutterbäumen in autochthonen Beständen, 200 km entlang des Mississippi, die bei der Entnahme der Steckreiser etwa 25 Jahre alt waren sowie zum Vergleich mit einem 14jährigen Stecklingsklon, dessen Mutterbaum im Jahre 1963 als Sämling abgesteckt worden war, wurden Höhe, Durchmesser und Volumen in verschiedenen Jahren untersucht. Hierbei ergaben sich bei den physiologisch älteren Stecklingsklonen für den Durchmesser höhere Heritabilitäten als für die Höhe, woraus gegenüber dem physiologisch sehr jungen Stecklingsklon genotypische Zuwachsgewinne bis zu 40% errechnet wurden.

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