Zusammenfassung

Die ,,Herkunfts-Sämlings-Samenplantage" wird als eine neue Methode der Forstpflanzenzüchtung vorgeschlagen. — Beschreibung und praktische Durchführung werden im einzelnen dargestellt. — Vorteile und Nachteile werden diskutiert. Es zeigt sich, daß Herkunfts-Sämlings-Samenplantagen ganz allgemein leicht und schnell zu erstellen und zu handhaben sind. Man kann innerhalb kurzer Zeit eine Nachkommenschaft erhalten, die durch große Anpassungsfähigkeit und eine breite genetische Basis ausgezeichnet ist und die auch schon ohne den zusätzlich zu erwartenden Heterosis-Effekt einen wertvollen Gewinn darstellt. Jedoch dürften noch weitere Untersuchungen nötig sein, um die Selektionsmethoden für die Auslese der Baum-Komponenten für solche Samenplantagen zu verbessern.

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Statistical Efficiency in Wood Quality Study Based on a Black Pine Plantation

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A randomized complete block design containing four-tree plots has been a popular experimental design for the assessment of geographic variation patterns in tree species. Frequently plot means are used as items in the analysis of variance and other statistical computations.

Since tree breeding is time consuming and costly, tree breeders are in constant search of techniques that will help evaluate genetic constituents of the species under investigation at its early stage of life. Numerous publications established strong nursery-plantation, juvenile-mature age, trunkwood-branchwood and increment core-entire tree relationships.

In the assessment of European black pine *(Pinus nigra* ARNOLD) wood properties, plot means were used as items in the analysis of variance. They were satisfactory to show the geographic variation pattern in specific gravity and tracheid length (LEE and WRIGHT, in press). However, a number of questions remained unanswered. What would be statistical efficiency if study material were collected from less than four trees per plot and from less than 10 replications? If reduced plot size and smaller number of replications could yield equally acceptable inforrnation, they would imply that time and land can be saved. The present paper was intended to analyze the impact of different plot sizes and replicate numbers on the evaluation of branchwood specific gravity and tracheid length in 27 different European black pine seed sources.

Material and Methods

I measured tracheid length and alcohol-benzene extractives free specific gravity on one lateral branch collected from the south aspect of the top-most whorl of each of 4 trees per plot on each of 10 blocks of a 27-origin black pine plantation (MSFG 5-61) in Kellogg Experiment Forest, Kalamazoo County, southwestern Michigan.

Each of 4 trees per plot and all 10 replications were numbered and with the aid of random number table I selected four different plot sizes (1-,2-, 3-, 4-tree plots) and eight different numbers of replications (1-, 2-, 3-, 4-, 5-, 6-, 8-, and 10-replications) in the laboratory following a sampling scheme technically called sampling with replacement. Regardless of what the first number may be, every number has an equal chance of being drawn in the second drawing. Analysis of variance and correlation analysis were conducted by an electronic computer, IBM 1130.

Results and Discussion

Study of Plot *Sizes:* Since the study plantation had 16 (= 5.93 percent) missing plots, substituted values were calculated by computing the average for surviving plots of the same provenance and treatment. After substituting the missing plot values and reducing the degrees of freedom accordingly each set of measurements was subjected to analysis of variance for which the degrees of freedom

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Table 1. — The F values comparing effect of different plot sizes.

Trees per plot	Specific gravity	Tracheid length
1	1.681*	1.677*
2	1.866**	1.880**
3	2.181**	2.205**
4	2.059**	1.917**

* Significant at the 5 percent level.
** Significant at the 1 percent level.

Table 2. — The correlation coefficients comparing the effect of different plot sizes and replicate numbers.

Tree per plot	Specific gravity	Tracheid length	Replicate numbers	Specific gravity	Tracheid length
1 vs 2	0.908	0.907	1 vs 10	0.561	0.422
1 vs 3	0.844	0.898	2 vs 10	0.614	0.586
1 vs 4	0.855	0.898	3 vs 10	0.837	0.774
2 vs 3	0.967	0.971	4 vs 10	0.892	0.821
2 vs 4	0.974	0.955	5 vs 10	0.929	0.853
3 vs 4	0.980	0.968	6 vs 10	0.957	0.893
			8 vs 10	0.971	0.948

The 5 percent point of r with 25 degrees of freedom = 0.381.
The 1 percent point of r with 25 degrees of freedom = 0.487.

were 26, and 227 for provenance and block plus error respectively. Plot means were used as items in the analysis.

The between-seedlot differences were significant at the 5 percent level for 1-tree plots and at the 1 percent level for the other three plot sizes in the two selected wood properties *(Table 1)*. Only a slight improvement in accuracy was obtained when the number of trees was increased from one to four per plot.

The second technique used was the correlation analysis. The correlation coefficients (with 25 degrees of freedom) obtained between any set of the two different plot sizes were strong at the 1 percent level *(Table 2)*. It appeared that there was a moderate improvement in accuracy with an increase in plot size from one to two trees for specific gravity. However, an increase in plot size from two to three or two to four trees gave only slight improvement in statistical knowledge. That was true also for tracheid length. STRAND (1952) used similar technique successfully in his Scotch pine *(Pinus sylvestris* L.) study. He concluded that there was no significant improvement in the statistical accuracy with an increase in the number of trees from four to fifty per plot.

One tree selected at random per plot appeared to be adequate to furnish the necessary information for wood quality evaluation.

Number of Replications and Statistical Adequacy of the Data: I computed seedlot means based upon measurements of 1, 2, 3, 4, 5, 6, 8, and 10 replications, then calculated simple correlations among the seedlot means determined in those ways. The results are presented in *Table 2*.

The correlations were higher for specific gravity. In that trait measurement of 8 instead of 10 replications was accompanied by a very small loss in accuracy of estimate of the seedlot means. Even if the means were based on 4 instead of 10 replications the loss of information was not serious, for the coefficient of determination ($= r^2$) was .80. In other words, a reduction of 60 percent in measurement time was accompanied by a reduction of only 20 percent in amount of information.

The correlations were lower for tracheid length. In that trait, measurement of 6 replications was necessary to yield 80 percent as much information as measurement of all 10 replications.

One may agree that a loss of 20 percent in amount of information is bad. But that is the loss of information for one plantation only. I do not know specific gravity and tracheid length of these 27 seedlots of black pine when planted at other locations, but do have such data on growth rate and other traits (LEE and WRIGHT, in press). In those traits there is significant seedlot × plantation interaction that one is not warranted in measuring the performance of any one seedlot at any one plantation with extreme accuracy. When viewed from this standpoint, a loss of 20 percent in information about any one seedlot in any one plantation is not serious, and one is warranted in considering that future plantations could be established with only half as many replications as were planted at the Kellogg Forest.

Summary

Twenty seven black pine *(Pinus nigra* ARNOLD) seed sources outplanted in the Kellogg Experiment Forest, Augusta, Michigan followed a randomized complete block design with 10 replications, and each replication had 27 four-tree plots. I collected a lateral branch from each tree and analyzed the statistical accuracy of specific gravity and tracheid length as affected by the different plot sizes and replicate numbers. Study material collected from randomly selected tree per plot and five replications appeared adequate to provide the necessary information in the assessment of wood properties.

Key words: Pinus nigra, experimental design, wood density, fiber length, specific gravity.

Zusammenfassung

27 Schwarzkiefern-Herkünfte waren im Kellogg-Versuchsforst in Michigan nach dem Plan eines randomisierten vollständigen Blockversuchs mit 10 Wiederholungen ausgepflanzt worden. Jede Wiederholung bestand aus 27 Vier-Baum-Parzellen. Verf. entnahm von jedem Baum einen Seitenzweig und analysierte die statistische Genauigkeit der Bestimmung des spezifischen Gewichtes und der Tracheidenlänge, die z. B. verschiedene Parzellengrößen und Wiederholungszahlen beeinflußten. Das Untersuchungsmaterial, das von je einem zufallsmäßig ausgewählten Baum einer Parzelle aus 5 Wiederholungen genommen worden war, zeigte sich als ausreichend, um die notwendige Information für die Schätzung von Holzeigenschaften zu erhalten.

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