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多変量分析方法에 의한 萌芽生長 資料 分析 *1

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Application of Some Multivariate Analysis Techniques to Coppice Growth Measures *1

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雜種포플라의 萌芽更新後 자란 上部와 下部 生長 特性間의 關係를 알아보며 萌芽生長 能力에 따른 포플라 클론을 分別하고저 多変量 分析法을 適用하였는데 上部와 下部 生長特性間에 밀접하고 直線的인 關係를 보였으며 클론번호 5328이 다른 클론과 比較할때 현저히 다르게 나타나고 萌芽生長能力에 있어서 가장 優秀했다.

Multivariate analysis methods were used to examine the relationships between top and bottom growth variables of hybrid poplars after coppicing and to discriminate between clones in coppice growth potential. Strong and linear relationship was exhibited between top and bottom growth variables. Clone 5328 was different from the other clones and the best among the clones in coppice growth potential.

INTRODUCTION

Forests that have been reproduced vegetatively by sprouts or suckers are called coppices (Baker, 1950). Today, coppicing is often used in intensive culture systems because of its economy in establishing energy plantations with fast-growing woody species.

The data from the coppice growth experiment can be divided into two sets of measurements; one refers to top growth variables such as sprout number, length and dry weight and the other to bottom growth variables (characteristics of the stump and roots). To understand their relationships or for quantitative prediction of growth performance, these sets of data can be analyzed using multivariate methods. These enable the simultaneous interpretation of many physiological measures (Pearce, 1969).

The objectives of this study were 1) to examine the relationships between top and bottom growth variables of hybrid poplars after coppicing and 2) to discriminate between hybrid poplar clones in coppice growth potential.

MATERIALS AND METHODS

The experiment was performed in a greenhouse. The sources of material were six hybrid poplar clones (Table 1). They were propagated by tip cuttings and planted individually in 7400cm³ black plastic pots. The potting medium consisted of a 2:1 mixture of Jiffy Mix and Perlite.

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Plants were growth in a greenhose bay for 24 weeks at 24℃ during the day and 18℃ during the night. An 18-hour photoperiod was maintained during the January 8 to June 25 growth period. At the end of the fourteenth week, all trees were cut back to 10cm in height and sprouts were grown for ten weeks.

Tab. 1. Selected hybrid poplar clones

North Central Forest Experiment Station number	Name and parentage
5377	***Populus*** x ***euramericana*** Guinier
5321	***Populus*** x ***euramericana*** Guinier
5323	***Populus*** x ***euramericana*** Guinier
5326	***Populus*** x ***euramericana*** Guinier
5328	***Populus*** x ***euramericana*** Guinier
5260	***Populus tristis*** Fish. x ***Populus balsamifera*** L.

A randomized block design was adopted for the analysis of coppice growth performance.

Three trees per clone were harvested for growth measurement. Sprout number, top dry weight (stem dry weight + leaf dry weight), basal diameter of stump, stump dry weight and root dry weight were measured at harvest time.

Uni- and multi- variate analysis of variance was used to test whether or not there were any clonal differences in coppice growth performance. In addition, canonical correlation analysis was used to analyze the relationships between top (sprout number and top dry weight) and bottom (stump diameter, stump dry weight and root dry weight) growth variables.

All data were analyzed using the SAS (Statistical Analysis System) developed by the North Carolina State University.

RESULTS AND DISCUSSION

The results obtained from univarate analysis for coppice growth performance show that most variables of clone 5328 had the largest values except for sprout number, and differences were generally significant(Table 2). The significant effect of clone on these variables was primarily due to the responses of clone 5328.

The mean responses of coppice growth variables indicated clonal ranks were as follows: clone 5328〉 clone 5326〉 clone 5323〉 clone 5377〉 clone 5321〉 clone 5260.

In general, partial correlation coefficients holding block and clone constant indicated strong, positive relationships between variables except for sprout number(Table 3): that is, all bottom growth variables correlated with top dry weight, and stump diameter with stump dry weight. However, relationships within top growth variables and within bottom growth variables were generally not significant. This strong association between top and bottom growth variables was also evident when canonical correlation analysis was performed(Table 4). This growth relationship has been found to be generally ture for plants (Loomis, 1953).

Hotelling-Lawley's Trace used as a test criterion showed significance at the 0.3 percent level(Table 5), which illustrates that there were some clonal effects on those variables.

In addition, strong and linear relationship was exhibited between canonical variable # 1(consists of sprout number, top dry weight, stump dry weight, stump basal diameter and root dry weight) in group 1(top growth variable) and canonical variable #1 in group 2(bottom growth variable) (Figure 1). Fig. 1 shows that the points for colne 5328 are located in the upper portion of the graph and quite far from those for other clones. This indicates that clone 5328 is better in terms of those growth variables than the other clones, and is also different from the other clones. This clonal discrimination is similar to that reported by Gordon and Promnitz(1976) who observed the photosynthetic superiority of *Populus* clone 5326 to another ***Populus*** clone 5321

The first two canonical variables explained 86.7 percent of the variation due to clone(Table 6). In canonical varible #1, root dry weight, stump dry weight and stump basal diameter contributed the most to variations between clones (Table 7). The second canonical variable (consists of sprout number, top dry weight, stump dry weight, stump basal diameter and root dry weight) explained 13.6 percent of the variation due to clone. In this case, the dry weight of the stump, top dry weight, and root dry weight contributed the most to the variation between clones (Tables 7).

In summary, such growth variables as root dry weight, stump dry weight, and top dry weight contributed the most to the clonal difference.

Tab. 2. Means of clones for coppice growth variables

Clones	Sprout number	Top dry weight (g)	Stump dia. (cm)	Stump dry wt. (g)	Root dry weight (g)
5377	6.00	29.83	1.53	6.93	26.97
5321	4.67	26.70	1.60	5.87	25.17
5323	6.33	31.80	1.57	6.03	26.17
5326	7.67	37.07	1.70	7.87	27.73
5328	7.00	55.20	1.93	9.73	44.50
5260	6.67	21.13	1.60	6.27	25.90
	0.101 *	0.010	0.010	0.001	0.001

* Indicates significance level between clones.

Tab. 3. Partial correlation coefficients between coppice growth variables holding block and clone constant

	Sprout no.	Top dry wt.	Stump dia.	Stump dry wt.
Top dry wt.	$0.42^{.20*}$			
Stump dia.	$0.28^{.59}$	$0.81^{.00}$		
Stump dry wt.	$0.07^{.83}$	$0.65^{.03}$	$0.68^{.02}$	
Root dry wt.	$0.29^{.61}$	$0.84^{.00}$	$0.49^{.12}$	$0.47^{.14}$

* Indicates significance level.

Tab. 4. Canonical correlation coefficients relating coppice top and bottom growth variables

Canonical variable number	Canonical correlation coefficient	χ^2-value
Var. # 1	0.9616	$21.152^{.00}$ *
Var. # 2	0.2351	$0.455^{.80}$

* Indicates significance level.

Tab. 5. F-values from multi-variate analysis of variance for coppice growth variables

Test hypothesis	F-value
Ho; No clone effect	$3.39^{.003*}$

* Indicates significance level.

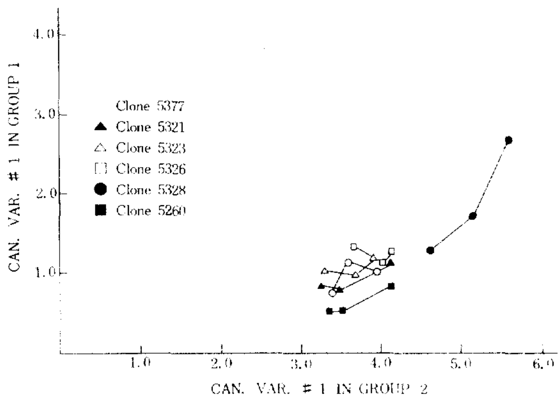

Fig. 1. Canonical analysis of proportion of top and bottom growth variables for six clones

Tab. 6. Characteristic roots and vectors of canonical multi-variate analysis of the variation due to clone

Canonical variable number	Characteristic root	Percent of variation	Normalized characteristic vectors associated with characteristic roots				
			Sprout no.	Top dry weight	Stump diameter	Stump dry weight	Root dry weight
Var. # 1	14.079	73.14	0.107	-0.124	4.446	0.130	0.168
Var. # 2	2.617	13.59	0.039	0.064	-3.531	0.263	-0.047
Var. # 3	1.916	9.95	-0.280	0.041	0.041	-0.233	0.014
Var. # 4	0.455	2.37	0.042	0.016	3.187	-0.188	-0.049
Var. # 5	0.182	0.94	0.141	0.009	-0.750	-0.256	0.042

Tab. 7. Correlation coefficients between each canonical variable and dependent variables (variation due to clone)

Canonical variable number	Correlation coefficients between canonical variable and dependent variables				
	Sprout no.	Top dry weight	Stump diameter	Stump dry weight	Root dry weight
Var. # 1	0.1143	0.2655	0.3704	0.3870	0.5038
Var. # 2	0.3724	0.7270	0.3981	0.7553	0.5968
Var. # 3	-0.5353	0.3704	0.2214	0.0298	0.4811
Var. # 4	0.4079	0.4758	0.7881	0.1800	0.0453
Var. # 5	0.6287	0.1931	-0.1848	-0.4964	0.3955

LITERATURE CITED

Baker, F. S. 1950. Principles of silviculture. McGraw-Hill Co. New York.

Gordon, J. C. and L. C. Promnitz. 1976. Photosynthetic and enzymatic criteria for the early selection of fast-growing ***Populus*** clones. Pages 79—97 ***in*** M. G. R. Cannell and F. T. Last, eds. Tree physiology and yield improvement. Academic Press, New York.

Loomis, W. E. 1953. Growth and differentiation in plants. Iowa State University Press, Ames, Iowa.

Pearce, S. L. 1969. Multivariate techniques of use in biological research. Expl. Agric. 5 : 67-77.