GROWTH-DENSITY RELATIONS IN YOUNG ASPEN SUCKER STANDS

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ABSTRACT

Using diameter increment data from thinning experiments conducted in 3-, 5-, and 6-year old aspen (Populus tremuloides *Michx.) stands in the Mixedwood forests of Alberta and Saskatchewan, it was inferred that stand density has a significant effect on growth, and crowding may reduce by half the diameter increment of dominant and codominant trees at an age as early as 5 years. It is suggested that thinning, even at this early age, may be effective for improving diameter increment in similar stands.*

RESUME

Utilisant des données d'accroissement de diamètre par suite d'expériences d'éclaircies conduites en peuplements de Tremble, Populus tremuloides *Michx., de 3, 5 et 6 ans en forêt mixte en Alberta et en Saskatchewan, l'auteur conclut que la densité du peuplement influe significativement sur la croissance, et que le resserrement peut réduire de moitié l'accroissement du diamètre d'arbres dominants et codominants âgés d'aussi peu que 5 ans. L'auteur suggère donc d'éclaircir dès lors afin d'améliorer l'accroissement du diamètre en peuplements similaires.*

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INTRODUCTION

The utilization of our aspen resource has accelerated in the last decade and it is now of some economic importance. Its future is especially promising. This means the coming of age of aspen stand management, which requires related silvicultural knowledge. Growth and development trends of young stands that have become established after logging are of particular interest, first because there is a relative lack of such information on these stands, and secondly because here the manager has the opportunity to influence future stand development with very little or no additional cost by the way he conducts his logging operations in the parent stand.

A recent study (Bella and De Franceschi 1972) provided information on how logging practices influence the abundance of sucker regeneration and on the course of early stand development in terms of number of stems per acre. The present study evaluates the effect of density on tree growth in juvenile stands. This information can be of direct use to the forest manager, and it is also needed in research work aimed at improving growth and yield prediction techniques.

DESCRIPTION OF THE STUDY AREAS

The data for this analysis were taken from a thinning experiment in juvenile aspen stands (*Populus tremuloides* Michx.). At two localities, tree and stand data from permanent sample plots were obtained from stands treated at age 3 and 6 years (Hudson Bay, Sask.) and at 5 years (Slave Lake, Alberta).

The stands were growing on what were considered average sites for aspen at these locations. At establishment of the study, care was taken to minimize site variation. At Hudson Bay the soils were clay-loam with fresh to moist moisture regime; topography was flat and elevation about 300 m (1000 ft). At Slave Lake the soils were sandy silt-loam with fresh moisture regime. Topography was hilly and elevation about 600 m (2000 ft).

The stands were nearly pure aspen, with a sprinkling of balsam poplar (*P. balsamifera* L.). In Saskatchewan, the young stands originated after logging; in Alberta, after an extensive wild fire. The forests at both localities belong to the Mixedwood Section, B18a, of the Boreal Forest Region (Rowe 1972).

METHODS

The quickest way to obtain information on the effect of density on tree growth is through sampling untreated stands of different densities in the desired age group and sites using temporary sample plots. Tree size characteristics are then related to stand density using regression analysis. This approach, however, is unsuitable in aspen stands because the species' clonal habit can result in substantial differences in tree growth and size which tend to obscure density effects.

Growth-stand density information, however, can be obtained experimentally from thinning studies. This method has the drawback of providing information only at actual treatment levels (which are limited in number and yield discontinuous data) rather than over a wide range of density conditions. As well, relationships derived from data obtained in treated stands can be extrapolated to untreated stands only with caution.

The present analysis was based on the first 2-year increment data from strip and selection thinning experiments. The strip thinning left 3-m (10-ft) parallel residual strips between cut strips of 1.2, 1.8, 2.4, or 3.0 m (4, 6, 8, or 10 ft) width, which were to represent different thinning intensities. Selection thinning was done to .9 m (3 ft) and 1.2 m(4 ft) spacings. Figure 1 illustrates stand conditions and treatments at re-examination in the autumn of 1974.

Six 3 x 3 m (10 x 10 ft) plots were established for each treatment level and age group, including untreated controls, except at Slave Lake, where selection thinning intensities were replicated only three times (Table 1). There was a total of 120 plots. Data from two plots from the 5- and from the 6-year-old stands were later discarded because of damage, and in the 3-year-old stand the entire selection thinning treatment had to be abandoned because of extensive mortality from undetermined factors.

Measurements on the plots included a dbh tally of all trees to the nearest .25 cm (1/10 in.); those under breast height were counted. In addition, individual tree measurement data in dbh (to .01 cm) and height (to 3 cm or 0.1 ft) were obtained for 5-12 healthy dominant and codominant trees that had been tagged at plot establishment. Two of these were the largest aspen trees on the plot, while the remainder were selected from two 60-cm (2-ft) wide strips adjacent to the open edge after strip thinning. Tagged trees on the control plots were selected also in two similar strips on plot borders. On selectively thinned plots all residual trees were tagged.

Covariance techniques were used in the analysis. This means that trend lines of tree increment over initial tree size (i.e. diameter increment over dbh) were compared, rather than simply means of tree increment between different treatment (stand density) levels. Thus, initial differences in tree growth and dbh that might reflect clonal or micro-site variations were considered, and appropriate adjusted means calculated for treatment comparisons.

RESULTS AND DISCUSSION

Two-year diameter increment trends of the tagged dominant and codominant trees over initial diameter in 1972 are presented in Figure 2. They show first of all that increment was dependent on and increased with initial dbh, and secondly that the treatment resulted in significant differences between dbh increment trends (those shown are different at .05 level probability). In all three age classes increment was lowest in the control stand, higher in the strip thinned, and generally highest in the selectively thinned stands. No conclusive trends could be established for height increment.

In the 3- and 5-year-old stands, although the trends for different treatments were at different levels, there was no significant difference between their slopes (i.e. rate of increase) within an age group. This means that there was no real difference in absolute response in diameter increment between dominant and codominant trees of different sizes (dbh). Therefore, adjusted treatment means were calculated using a common slope.

In the 6-year-old stand there was no significant difference between increment trends after strip and selection thinning, so they were combined in a common regression line. The slope of this common line for treated stands and that of the control stands were not significantly different, so again adjusted means could be calculated using a common slope.

Adjusted diameter increment means of tagged trees by age and treatment are presented in Figure 3. The highest increase, 75%, occurred after selection thinning in the 5-year-old stand, while after strip thinning the increase was half as much, i.e., 37%. In the 6-year-old stand, the two thinning treatments combined resulted in nearly a 50% improvement in diameter increment. The least improvement in increment was 33%, which occurred in the 3-year-old stand after strip thinning.

The best growth and the best response to release occurred in the 5-year-old stand located at Slave Lake. The best growth occurred despite the fact that this stand had the highest density of the three stands studied. This high density however would explain the particularly good response to thinning treatment. The superior growth of aspen here seems to be related to environmental factors that make this region almost optimal for the development of this species.

Generally, these results indicate that there is already a substantial negative density effect on stem growth at around 5 years of age in dense aspen stands. Even at this early age, crowding may reduce diameter increment by as much as half of what it could be under more open stand conditions. This is inferred from accelerated diameter increment of up to 75% within two growing seasons, after a reduction of density by selection thinning to .9 m and 1.2 m (3 ft and 4 ft) spacings in dense young stands. It is very likely that in subsequent years there would be an even greater increase in diameter increment in the thinned stands, as it generally requires more than 2 years for the affected trees to take full advantage of increased growing space.

This conclusion is supported by the results of the study on the effect of logging practices on the development of new aspen stands (Bella and De Franceschi 1972), where juvenile stands with high initial density suffered heavy mortality in the first 5 years of their life. This also suggests overcrowding and density effects in these stands.

The response in tree growth was somewhat less pronounced after strip thinning because initially at least, only trees immediately adjacent to the open strip gained extra growing space, while those farther in the residual strip were hardly affected. In other words, this thinning creates unstocked areas in the cut strips, while leaving stand density unchanged in the residual strips.

Although this analysis is not intended to evaluate the effectiveness and relative merit of the two kinds of thinning treatment for improving tree growth in dense juvenile aspen stands, there is enough information here to say that even as early as 5 years of age, thinning treatments such as the above are effective for the purpose of improving diameter increment. However, additional measurement data are required for detailed evaluation.

ACKNOWLEDGEMENTS

The sample stands at Hudson Bay, Saskatchewan were located within the company limits of the Aspenite Division of MacMillan-Bloedel Ltd. Company personnel cooperated in locating suitable sample stands and also provided technical assistance in plot establishment and measurements. Mr. J. P. DeFranceschi, Forestry Research Technician, CFS, was in charge of field work and ran the statistical analyses required for this report.

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TABLE 1 STAND AND TREE STATISTICS AT STUDY ESTABLISHMENT IN 1972.

Stand Age (years)	Treatment	Number of Plots	Number of Trees[a] Average	Number of Trees[a] Minimum (per ha) (per acre)	Number of Trees[a] Maximum	Diameter at breast height[b] Average	Diameter at breast height[b] Minimum (cm) (inches)	Diameter at breast height[b] Maximum
3	Strip thinning	24	61,175	27,986	86,111	0.51	0.0	2.03
			24,757	11,326	34,848	0.20	0.0	1.2
	Selection thinning	12	59,381	41,979	72,118	0.61	0.0	2.29
			24,031	16,988	29,185	0.24	0.0	0.90
	Control	6	64,583	40,903	83,958	0.52	0.0	2.03
			26,136	16,553	33,977	0.20	0.0	0.8
5	Strip thinning	24	50,142	27,986	87,188	1.07	0.0	3.30
			20,292	11,326	35,284	0.42	0.0	1.3
	Selection thinning	6	46,105	23,680	74,271	1.22	0.0	2.79
			18,658	9,583	30,056	0.48	0.0	1.1
	Control	6	48,079	33,521	63,507	1.16	0.0	3.05
			19,457	14,375	25,700	0.46	0.0	1.2
6	Strip thinning	24	29,915	17,222	50,590	1.61	0.0	4.06
			12,106	6,970	20,473	0.63	0.0	1.6
	Selection thinning	12	34,086	22,604	47,361	1.58	0.0	3.30
			13,794	9,148	19,166	0.62	0.0	1.3
	Control	6	33,189	22,604	46,285	1.68	0.0	3.56
			13,431	9,148	18,731	0.66	0.0	1.4

a Includes all living aspen and poplar trees on plot.

b Trees less than 1.37 meters (4.5 feet) in height were given dbh=0.0.

Figure 1. An 8-year-old aspen stand in Hudson Bay, Sask., treated 2 years earlier:

(a) selectively thinned to 1.2 m (4 ft) spacing,
(b) strip thinned, 3 m (10 ft) cut strips.

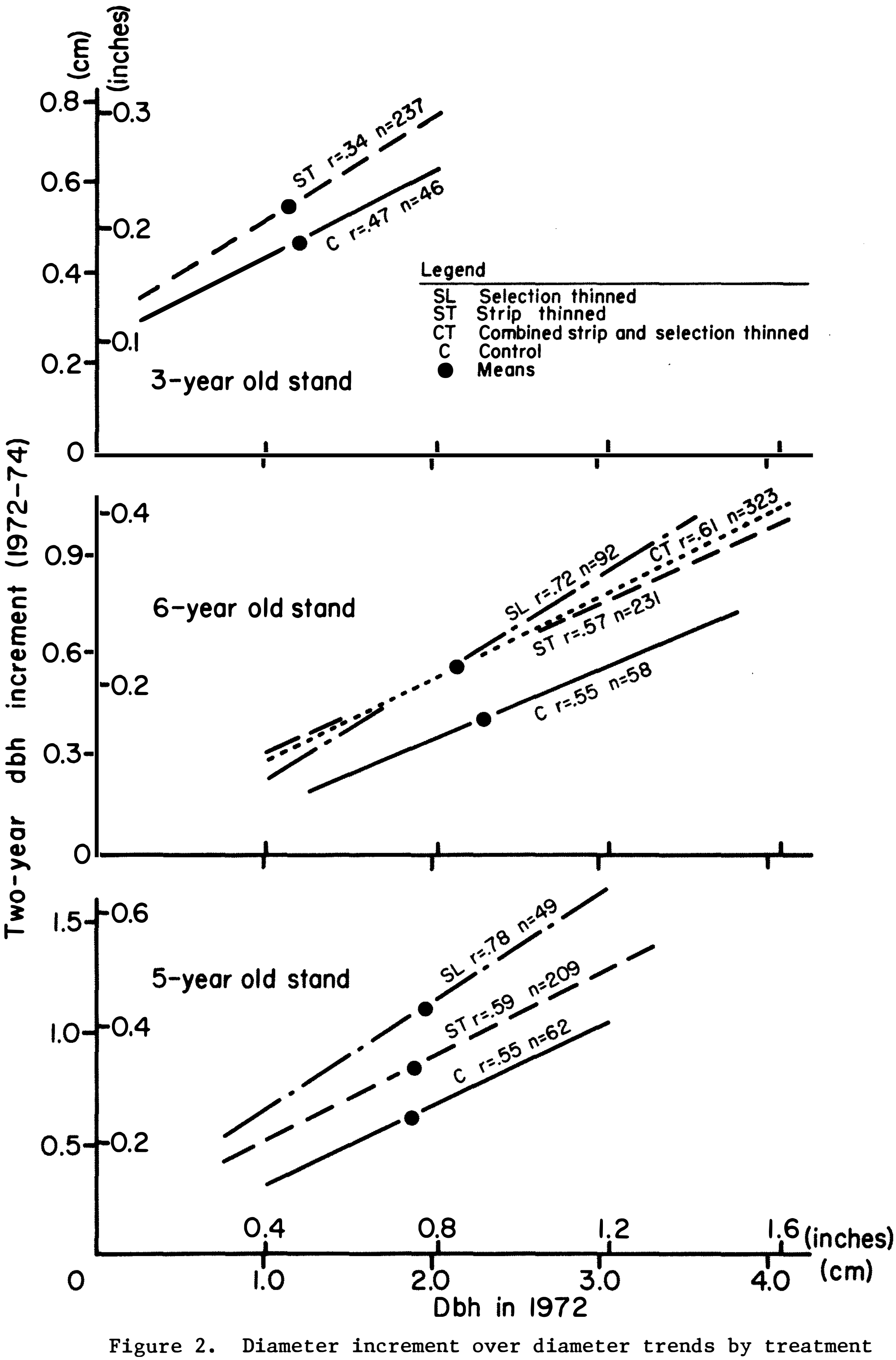

Figure 2. Diameter increment over diameter trends by treatment of dominant and codominant sample trees in 3-, 5-, and 6- year-old aspen stands.

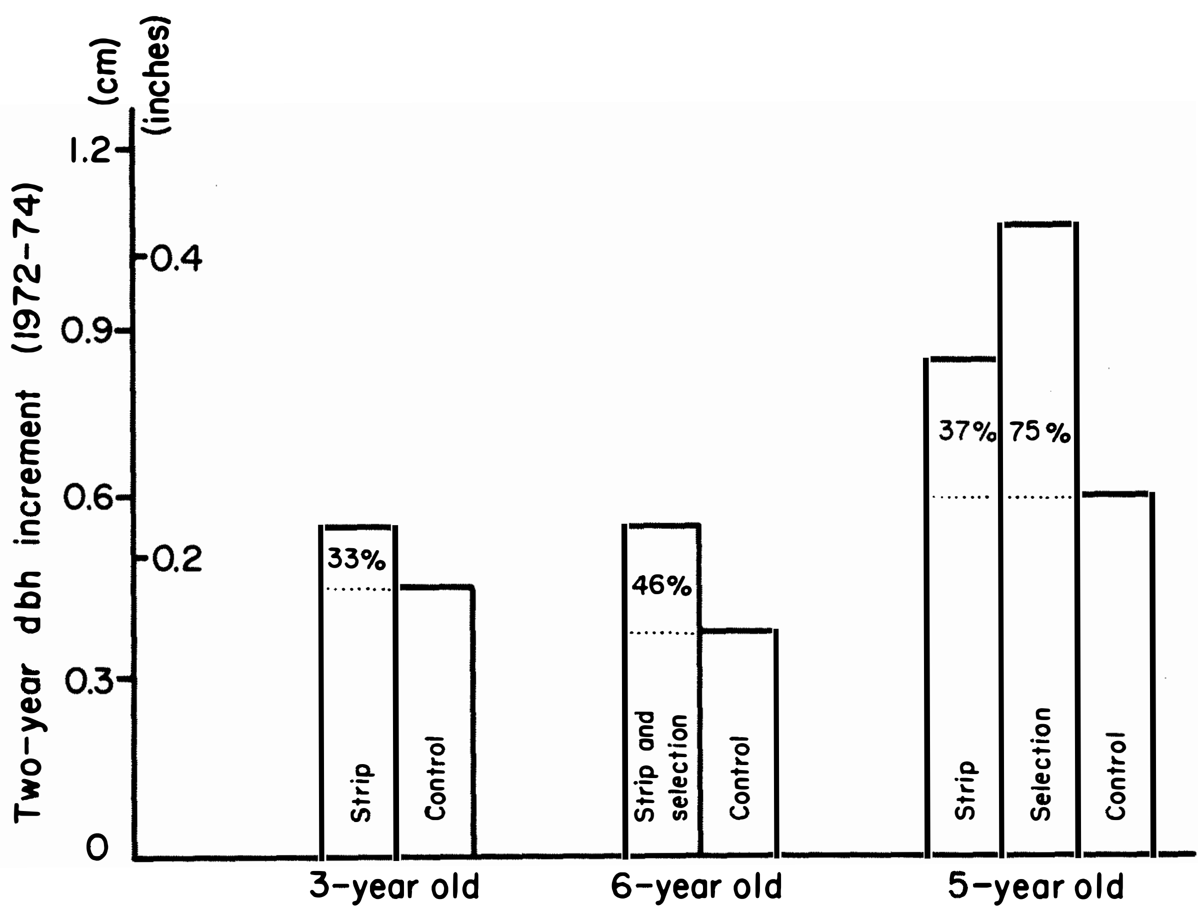

Figure 3. Diameter increment by treatment (adjusted means) of dominant and codominant sample trees in 3-, 5-, and 6-year-old aspen stands.