GROWTH OF YOUNG JACK PINE AFTER MECHANICAL STRIP THINNING IN MANITOBA

by

I.E. Bella and J.P. DeFranceschi

FOREST RESEARCH LABORATORY

EDMONTON, ALBERTA

INFORMATION REPORT A-X-40

CANADIAN FORESTRY SERVICE

DEPARTMENT OF FISHERIES AND FORESTRY

FEBRUARY, 1971

TABLE OF CONTENTS

ABSTRACT

Significant release in diameter growth was observed on fresh and moist sandy sites within five growing seasons after mechanical strip thinning in dense, 10-year-old stands of jack pine, *Pinus banksiana* Lamb., of fire origin. In some stands, rate of growth of the largest trees doubled after treatment. Earliest response was in less dense stands. The amount of mortality in residual strips was relatively low on these sites and was not affected by treatment. At the present rate of crown growth, complete closure over cut strips is likely to occur within 10 to 15 years after thinning. Results suggest that treatment at younger ages -- between 5 to 10 years -- may be even more effective in similar, or in denser, stands on these site types.

To date, only limited growth response has been observed on the dry sites. However, a severe summer-drought -- not an unusual occurrence in this area -- caused heavy tree mortality on some dry sites, and could have resulted in serious understocking had it coincided with thinning. So, thinning is not recommended on dry sites.

Treatment did not increase the incidence of insects, diseases, or physical damage in the reserve strips.

GROWTH OF YOUNG JACK PINE AFTER MECHANICAL STRIP THINNING IN MANITOBA

by

I. E. Bella and J. P. DeFranceschi[1]

BACKGROUND

Young stands of jack pine, Pinus banksiana Lamb., originating after forest fires frequently contain as many as 50,000 trees per acre. At such high densities, all available growing space is usually occupied by the time the stand is 10 to 15 years old, resulting in a decline in rate of growth of the tree. To maintain rapid growth of individual trees, dense stands should be thinned. Selecting and cutting individual trees is costly, but non-selective multi-stem thinning, such as mechanical strip thinning, may provide an economical solution to density control.

Records of strip thinning date back to the beginning of this century (Tackle reviewed studies up to 1959). In early work, trees were generally felled by hand, but in recent studies in young stands of lodgepole pine, Pinus contorta Dougl., trees were "felled" or cut mechanically, either by an Athens disk (Crossley, 1952), or by a bulldozer blade (Tackle, 1959). Both of these methods had drawbacks. Disking was not adequate in killing the trees and injured the roots of residual trees. Blading often bent, rather than cut, the trees, and encountered difficulties with debris and in keeping parallel lines. The drum chopper chosen for the present operation appeared to be

[1] Research Forester and Technician, respectively, Forest Research Laboratory, Canadian Forestry Service, Department of Fisheries and Forestry, Edmonton, Alberta.

more suitable and economical for strip thinning than either of the former implements.

Having extensive areas of young, dense, jack pine stands in its southeastern region, the Operations Branch of the Manitoba Department of Mines and Natural Resources initiated a large-scale program of strip thinning in 1963, using a drum chopper. At that time no data were available on the effect of such treatment on the growth of residual jack pine trees; the possible detrimental effects from machine damage; or on the possible increased incidence of insects and diseases. It was not known at what age, stand densities, and site types thinning would be most effective and economical. To seek answers to these questions, the Canadian Forestry Service and the Manitoba Operations Branch undertook a co-operative study. The first study plots were established in the spring of 1964 in stands thinned the previous fall. Additional plots were established in the spring of 1965, 1966, and 1967, always following treatment the previous fall and covering various conditions of site and stand.

The first results obtained from a remeasurement of the 1964 plots have been summarized by Bella (1966). Those initial data indicated no observable growth in diameter or height increment for the first two growing seasons after thinning. Damage to residual trees by the chopper was found to be slight and no mortality resulted. The cost of one-directional strip thinning was relatively low, varying between $2.10 and $3.50 per acre, depending mainly on the equipment used and the size of the area treated. No increased damage by insect and disease could be associated with the treatment.

This report presents the analysis of growth data obtained from all study plots up to 1970. To this date, plots established in 1964 and 1965 provide data for up to 5 years after treatment; the other for a 3- or a 2-year period. Although further remeasurements are required to evaluate long-term effects on growth, yield, and stand development, results presently available will provide some guidelines for thinning planned in the near future.

DESCRIPTION

Thinnings were conducted in the Sandilands Forest Reserve in southeastern Manitoba on areas supporting dense, young stands of jack pine of fire origin. At the time of treatment, stand density varied between 6,000 and 55,000 trees per acre, stand age between 8 and 17 years, and the diameter and height of the largest trees were 3.7 inches and 21.0 ft, respectively. The stands were predominantly jack pine, with local admixtures of black spruce, *Picea mariana* (Mill.) BSP. Scattered individuals of trembling aspen, *Populus tremuloides* Michx., and balsam poplar, *P. balsamifera* L., were also present. The forests in this area constitute the most westerly portion of the Great Lakes - St. Lawrence Region, Rainy River, Section L.12 (Rowe, 1959).

The topography is flat to gently rolling. Soils are mostly colloid-poor, fine to medium sands, although some loamy sands are also present. Mueller-Dombois (1964) developed a detailed forest-land classification for this area. He distinguished four important jack pine sites according to their nutrition and moisture status; dry type "d", oligotrophic (nutritionally poor); oligotrophic fresh type "of";

oligotrophic moist type "om"; mesotrophic (nutritionally intermediate) fresh type "mf"; and a drier mesotrophic fresh subtype "mf-"

METHODS

One of the Fleco Drum Choppers used (Model 710) is shown in Figure 1. Filled with water, it weighs 11,250 lb and cuts a swath 7 ft wide. The other chopper used (Model 812) weighs 14,000 lb when filled, and cuts a swath 8 ft wide.

The chopper -- dragged by a crawler type tractor (either a D-4 or an HD-9) -- bends, breaks, and cuts trees in its path. Most trees are cut within 2 ft of ground level. Very small trees missed by the blades and do not snap off sometimes spring back to a semi-erect position after the machine has passed.

Thinning was done in parallel strips -- 7- or 8-ft cleared swath alternating with reserve strips about 10 ft wide. Two-directional thinning was also carried out on a small area with the machine passing over the same area a second time at right angles to the first. This treatment left groups of trees in blocks about 10 by 10 ft. Three classes of narrower reserve strips were also produced -- about 2, 4, and 6 ft wide. These treatments were not analysed, however, because a severe summer-drought resulted in excessive mortality of residual trees.

On each site and treatment, plots were located along two or three selectively chosen lines. Areas understocked or not uniformly stocked were rejected. Plots in the control area were 10 by 10 ft. Those in the thinned areas varied in size depending upon the distances between thinned strips. However, all trees across an uncut strip or

Figure 1. View of Fleco Drum Chopper Model 710.
(Photo by J. H. Cayford)

uncut square block were included. Table 1 lists all plots by site type, treatment, stand age, and measurement dates.

At plot establishment, all trees over 0.5 inches in diameter were tallied by species in 1-inch diameter classes. Trees under 0.5 inch were counted and the number was recorded by species. On treated plots, the mechanical-damage condition of each tree was recorded by classes (four classes). The 10 tallest trees on each plot were tagged and their d.b.h. to the nearest 1/10 inch, height to the nearest 1/10 foot, crown class, damage class, and distance to nearest thinning border were recorded.

At remeasurement, all living and dead trees were tallied by diameter and condition class. Height, diameter, and condition of tagged trees were measured and recorded.

Responses in tree diameter and height growth were analysed by multiple regression and correlation techniques. The analysis was based on the assumption that if the treatment was effective, the growth rate of residual trees would be higher close to the open swath than in the center part of the reserve strip. A separate regression analysis was run for groups of trees representing different sites, treatments, and ages, but data from the one- and two-directional treatments were combined. The effect of original tree-size was removed by introducing initial d.b.h. in the analysis, and the effect of differences in stand density between plots was removed with the use of initial number of trees per acre of the plot to which the trees belonged. The average increments of the 10 largest (tagged) trees on the

Table 1. Plot listing by site type, treatment, stand age, and measurement date.

Site (location)		Treatment	Plot establishment Date	Stand Age	Number of plots	Remeasurements	
d	(Badger)	1-way	May 1965	13	5	May 1967	May 1970
		Check	" "	"	"	" "	" "
mf-	(Badger)	1-way	May 1965	13	5	May 1967	May 1970
		Check	" "	"	"	" "	" "
	(N.of Woodridge)	1-way	" 1966	17	5	Sept 1968	
		Check	" "	"	"	" "	
of	(Tougas and Central Road)	1-way	May 1964	9	5	Oct 1965	Sept 1968
		2-way	" "	"	"	" "	" "
		Check	" "	"	"	" "	" "
	(N.E.of Woodridge)	1-way	" 1967	11	5	May 1969	
om	(Tougas and Central Road)	1-way	May 1964	9	5	Oct 1965	Sept 1968
		2-way	" "	"	"	" "	" "
		Check	" "	"	"	" "	" "
	(N.E.of Woodridge)	1-way	" 1967	11	5	May 1969	

treated and check plots were directly compared. Mortality trends were evaluated with data from both treated and control plots.

Insect and disease conditions were assessed by the Forest Insect and Disease Survey of the Canadian Forestry Service (Lawrence and Melvin, 1967). In addition to general surveys in the area, tagged sample trees were examined on each plot established in 1964. Information was collected twice during the growing season (in mid-June and in mid-August) for the first five growing seasons after thinning.

RESULTS

Diameter Increment

Stand summaries and descriptions, and size and increment statistics for the 10 largest trees for all plots are shown by site and measurement period in Table 2.

Multiple regression analyses revealed no significant increase in rate of diameter growth in relation to tree distance to the nearest open strip for "d", "mf-", or "of" sites. This means that trees grew at much the same rate all across the reserve strip, even for five growing seasons after treatment, which is a surprising result particularly for the "d" site, considering the high stand-densities on these plots (e.g., in May, 1970, the average number of stems per acre was 23,200, with individual values between 10,100 and 37,900).

Thinning on <u>"om"</u> sites resulted in a highly significant relation between tree diameter increment and distance to the nearest thinned strip border for both the measurement periods of 1 to 2 and 3 to 5 years. (Table 3 presents detailed regression statistics).

Table 2. Stand summaries and descriptions, tree size and diameter increment for the 10 largest trees (tagged at plot establishment) from all treated and check plots up to 1970.

Site Type	Year of treatment	Number of plots	Measurement period (seasons)	Diameter at the beginning of increment period			Height at the beginning of increment period			Number of stems per acre at the beginning of increment period			Diameter Increment		
				Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
d	1964	5	1965-67 (2)	0.6	0.1	0.9	6.9	5.1	9.3	23,375	10,120	37,880	0.16	0.0	0.5
	N.A.[1](Check)	5	1965-67 (2)	0.6	0.2	1.2	7.5	5.1	10.6	18,199	11,531	26,572	0.17	0.0	0.4
	1964	5	1967-70 (3)	0.7	0.3	1.2	8.3	5.6	11.0	22,478	9,440	37,880	0.38	0.1	0.8
	N.A.(Check)	5	1967-70 (3)	0.8	0.3	1.5	9.0	6.0	12.3	20,841	12,812	30,928	0.29	0.1	0.6
mf-	1964	5	1965-67 (2)	1.0	0.7	1.5	9.9	8.3	12.2	19,120	12,690	25,370	0.19	0.0	0.4
	N.A.(Check)	5	1965-67 (2)	0.7	0.5	1.0	8.4	7.0	10.0	40,879	29,101	54,787	0.14	0.0	0.5
	1964	5	1967-70 (3)	1.2	0.8	1.6	11.6	9.9	13.8	18,130	13,990	23,680	0.22	0.0	0.4
	N.A.(Check)	5	1967-70 (3)	0.8	0.6	1.2	10.0	8.0	12.2	38,915	26,462	49,459	0.15	0.0	0.4
	1965	5	1966-68 (3)	1.1	0.7	1.9	11.5	8.7	16.0	46,620	18,420	63,290	0.04	0.0	0.3
	N.A.(Check)	5	1966-68 (3)	1.2	0.8	1.8	12.6	9.6	15.8	35,719	22,651	61,420	0.05	0.0	0.5
of	1963	10	1964-65 (2)	0.7	0.1	1.4	7.3	4.5	11.5	12,440	7,860	20,080	0.48	0.1	0.8
	N.A.(Check)	5	1964-65 (2)	0.7	0.4	1.1	7.3	5.7	10.1	10,115	6,976	13,080	0.49	0.1	0.8
	1963	10	1965-68 (3)	1.2	0.6	2.2	9.8	4.5	15.6	13,460	8,300	21,510	0.48	0.0	1.2
	N.A.(Check)	5	1965-68 (3)	1.2	0.7	1.9	10.0	6.8	13.7	13,429	11,772	13,952	0.29	0.0	0.5
	1966	5	1967-69 (2)	1.7	1.1	3.1	13.9	10.5	17.9	22,750	13,260	32,870	0.12	0.0	0.4
om	1963	10	1964-65 (2)	0.4	0.2	0.8	6.7	4.6	8.6	27,571	10,430	43,070	0.31	0.0	0.7
	N.A.(Check)	5	1964-65 (2)	0.6	0.5	1.2	8.0	6.2	9.9	24,678	11,772	39,240	0.46	0.1	0.7
	1963	10	1965-68 (3)	0.8	0.5	1.3	8.3	6.0	11.7	31,080	11,920	56,480	0.29	0.0	0.8
	N.A.(Check)	5	1965-68 (3)	1.1	0.6	1.9	10.6	8.3	13.1	29,212	14,824	49,704	0.20	0.0	0.5
	1966	5	1967-69 (2)	2.1	1.5	3.3	16.5	13.0	20.8	10,070	7,440	11,880	0.21	0.0	0.5

[1]Not applicable - these are check plots.

Table 3. Some statistics for significant (0.05 probability level) regression combinations of periodic diameter increment on thinning border distance (DIS), diameter (D), and number of stems per acre (NT) at the beginning of the increment period.

Site (location)	Year of treatment	Increment period (seasons)	Number of trees	Independent variables and their significance									R^2 or r^2
				X_1=DIS			$X_2=X_1^2$		X_3=D		X_5=NT		
				Regression coefficients and F-ratios									
				a	b_1	Fx_1	b_2	Fx_2	b_3	Fx_3	b_5	Fx_5	
om (Tougas and Central Rd.)	1963	1965-68 (3)	95	.61	-.085	9.94**	.0084	4.81*			-.000005	22**	.41
			95	.55	-.029	12**					-.000006	28**	.37
			95	.49							-.000007	38**	.29
			95	.42	-.041	21**							.18
			95	.41	-.13	22**	.013	11**	.15	5.17*			.30
om (N.E. of Woodridge)	1966	1967-69 (2)	50	-.026			-.0038	6.19*	.13	12**			.32
			50	-.10					.14	14**			.23

Significance level: * .05% probability
** .01% probability

The "om" plots had much lower stand density than the "of" plots (on the average, 10,000 vs. 23,000 stems per acre).

With the above regression, it is possible to estimate diameter increment of the dominant trees in the stand (as these regressions are based on data from the 10 largest trees on each plot) from thinning border distance, and determine the difference in increment of trees of similar size but of various distances from the thinning border. For example, the study trees of average size on the thinning border had nearly double the growth rate of those in the center of the reserve strip on "om" sites in the two growing seasons after treatment. Generally, however, the response is expected to be much less even on moist sites, perhaps by around 25%.

Thinning response may also be evaluated by comparing the growth of the 10 largest trees on treated and check plots, provided they are directly comparable in initial stand density and site. The plots established on "of" sites in stands treated in 1964 and the plots established on "d" sites appear to qualify.

In growth of the 10 largest trees, no difference is evident between treated and check plots for either "of" or "d" sites during the first 2 years after treatment (Table 2). However, in the three subsequent growing seasons, diameter increment on the treated "of" plots was nearly double that on the check plots (0.48 vs. 0.29 inches); and on the "d" plots it was 25% greater (0.38 inches vs. 0.29 inches).

These differences in average increment of the 10 largest trees between treated and control plots on the "of" and "d" sites occurred while no significant relation could be established between increment and

and (3b) shows a stand 3 years after thinning (northeast of Woodridge, 11 years old at treatment) growing on "om" site. It seems that on these better sites, the expanding crowns of trees on residual strip borders will occupy nearly 50% of the crown space available in the 7 to 8-ft cleared strip within 5 years after treatment. Only very limited response in crown development was observed on dry sites, where no significant response in d.b.h. growth could be established by the regression analysis.

Figure 3a illustrates that within 6 years after treatment, all "stumps" and most of the trees bent rather than severed by the chopper in the cut strip, have succumbed. The organic debris in the cut strips is decomposing rapidly, even if the cut stems were relatively large (Fig. 3b). This may, in part, be due to moist conditions favorable to decomposition on these sites.

DISCUSSION AND CONCLUSIONS

Results presented above show that trees growing on the two better quality sites ("of" and "om") generally respond to release in terms of diameter increment within five growing seasons after treatment. The earliest response was observed on the 1967 plots on "om" sites. The data here have come from sample plots with relatively low stand-density, about one-half the number of stems per acre of the adjacent "of" sample plots. Yet, trees from the comparable "of" plots did not show response to release for the same period. This would suggest that residual trees in less dense stands, on similar sites at least, may respond quicker to release than trees growing in more dense stands, probably because of better development of crown and root and generally this reason, and because of the lack of significant growth-response up to five growing seasons after treatment, thinning is not recommended on the two dry sites.

The amount of natural mortality was relatively low on the two better sites -- "of" and "om" -- even at relatively high levels of stand density. This would indicate that, on these sites, crowding and reduction of individual tree growth would likely intensify. Thus, thinning is particularly desirable on these better sites.

Strip thinning is applied on the assumption that residual trees close to the open strip will increase their growth and eventually utilize all available growing space. There is every indication that near-complete crown closure will be achieved on better sites by age 25 years if the stands are thinned at 10 years of age. Because of faster growth and expressed dominance of these border trees, they are also likely to crowd out more quickly the suppressed individuals growing in the center part of the reserve strip.

The gradual reoccupation of crown space in the cut strips resulted in the death of "stumps" and of damaged trees which had escaped the chopper blades. All organic debris that remained after thinning are breaking up and rapidly decomposing, making access in these stands easier. The improved accessibility will make any future stand treatment or fire suppression less costly, and would likely reduce harvest costs.

No conclusions can be drawn as yet regarding the advantages of the heavier strip-thinning, viz., two directional or one directional, with reserve strips under 8 to 10 ft. Until definite conclusions can be drawn from more data, 10-foot reserve strips are recommended.

The results of the insect and disease survey were summarized by Lawrence and Melvin (1967). They found no increase in the activity of insect and disease organisms which could be attributed to strip thinning during the first three growing seasons following treatment. Furthermore, no increase in physical damage to residual trees from other causes, e.g., browsing, hail, snow, etc., resulted after thinning.

While these are only short-term results, they are useful in the planning of future strip thinning operations. Further measurements will provide the necessary data on growth and yield for evaluation of the economics of strip thinning.

REFERENCES

Bella, I.E. 1966. Strip thinning jack pine thickets with a "drum chopper" in Manitoba. Can.Dep.Forest., Inform.Rep.MS-X-3. 9 p.

Crossley, D.I. 1952. Discing in overdense lodgepole pine reproduction. Can. Dep. Resour. and Develop., Silvicult. Leafl. 66. 3 p.

Lawrence, J.J. and J.C.E. Melvin. 1967. The status of forest insects and diseases following strip thinning of jack pine thickets in Manitoba. Can. Dep. Forest. Rural Develop., Forest. Br., Intern. Rep. MS-51. 6 p.

Mueller-Dombois, D. 1964. The forest habitat types of southeastern Manitoba and their application to forest management. Can. J. Bot.42: 1417-1444.

Rowe, J.S. 1959. Forest regions of Canada. Can. Dep. N. Aff. Nat. Resour., Forest. Br. Bull. 123. 71 p.

Tackle, D. and R.C. Shearer. 1959. Strip thinning by bulldozer in a young lodgepole pine stand. Montana Acad. Sci. Proc. 19: 142-148.