

THIS FILE COPY MUST BE RETURNED

Not for publication

TO: INFORMATION SECTION,  
NORTHERN FOREST RESEARCH CENTRE,  
5320 - 122 STREET,  
EDMONTON, ALBERTA.  
T6H 3S5

# **THE USE OF PRESCRIBED BURNING IN JACK PINE MANAGEMENT IN SOUTHEASTERN MANITOBA**

**Project MS-245**

**by**

**N. R. Walker**

**FOREST RESEARCH LABORATORY  
WINNIPEG, MANITOBA  
INTERNAL REPORT MS-20**

**DEPARTMENT OF FORESTRY  
FEBRUARY, 1966**

# CONTENTS

	Page
INTRODUCTION .....	1
REGENERATION STUDIES ON 1964 BURN .....	2
Source of Planting Stock and Seed - Studies 1 to 4 .....	2
Methods for Planting, Seeding and Assessment - Studies 1 to 3..	2
Planting .....	2
Natural and broadcast seeding .....	5
Spot seeding .....	5
Methods for Seeding and Assessment - Study 4 .....	6
RESULTS OF REGENERATION .....	6
Study 1 - 1964. Natural Seeding, Planting, and Artificial Seeding .....	6
Study 2 - 1964. Spring and Fall Seeding and Planting .....	10
Study 3 - 1964. Planting and Seeding on Seedbeds Prepared Mechanically and by Burning .....	12
Study 4 - 1964. Germination and Seedling Development on Various Seedbeds .....	16
SEEDBEDS RESULTING FROM 1964 BURN.....	20
1965 BURN .....	21
Locations .....	21
Seed Collections From 1965 Seed Tree Burn .....	22
WORK PROPOSED FOR 1966 .....	22
1964 Burn .....	22
1965 Burn .....	23
1966 Burn .....	23
REFERENCES .....	23

THE USE OF PRESCRIBED BURNING IN JACK PINE MANAGEMENT  
IN SOUTHEASTERN MANITOBA

Internal Report

Project MS-245

by

M. R. Walker

INTRODUCTION

In 1964 a research project was begun in southeastern Manitoba to investigate the use of prescribed burning in cut-over jack pine (Pinus banksiana Lamb.) stands. The objectives of the project are: (1) to determine whether fire can be used for seedbed preparation for seeding or site preparation for planting, (2) to study factors of fire behaviour, and (3) to study the ecological effects of fire. The study of fire behaviour is being carried out by J. L. Adams (Project MS-603) and the study of the ecological effects by H. P. Sims (Project MS-243).

Five one-acre plots were burned in July of 1964. The plots were located in the Marchand Conservation Officer District in the Sandilands Forest Reserve in southeastern Manitoba. In the fall of 1964 and the spring of 1965 several studies of artificial seeding, planting, and natural regeneration were started on the plots. Details of burning methods and the experimental design for the regeneration studies were given in the establishment and progress report prepared by Cayford in 1965. This report presents details on the establishment of the regeneration studies, results of measurements and observations made during 1965, and the

plans for further work on this project in 1966.

#### REGENERATION STUDIES ON 1964 BURN

##### Source of Planting Stock and Seed - Studies 1 - 4

Planting stock, age 2 - 0, was obtained from the Manitoba Department of Mines and Natural Resources nursery at Hadashville.

Seed was collected in southeastern Manitoba in 1962 by the Department of Mines and Natural Resources and treated by the Department of Forestry in Winnipeg with Arasan, Endrin, and aluminum flakes. Seed used for study 1 was treated in April of 1965 and germination in May was 92.0 per cent. Seed used in studies 2 and 3 was treated in the spring of 1964 and germination after 30 days during September to October was 90.4 per cent. Seed used in study 4 was untreated and germination after 42 days during May to June of 1964 was 92.4 per cent.

##### Methods for Planting, Seeding and Assessment - Studies 1 to 3

(1) Planting. Spring planting took place on April 28 and 29, 1965 (Table 1). Seedlings planted on April 28 were kept in plastic bags; those planted the following day were heeled-in overnight. Weather during planting was clear and sunny with winds to 25 miles per hour. Maximum temperatures at Sprague for the two days were 67° and 74°F. Fall planting took place on September 21, 1964. Maximum temperature on this day was 73°F. Planting was done at a spacing of six feet. The height of all planted seedlings was recorded at the time of planting. Survival counts and height measurements were taken at the end of the first growing season. Planting stock measurements, for the spring and fall planting, are summarized in Table 2.

TABLE 1

DATES OF PLANTING, SEEDING AND ASSESSMENT - STUDIES 1 - 3

Study	Date of treatment						Plot size (acres)
	Planting		Natural and Broadcast seeding		Spot seeding		
	Spring 1965	Fall 1964	Spring 1965	Fall 1964	Spring 1965	Fall 1964	
1	April 28-29	Sept. 21	April 23	Oct. 20	April 21-22	Oct. 19-20	1/5
2	April 29		April 23		April 27-28		1/40
3	April 29		April 23		April 23		1/40
Date of examination - 1965							
1	Aug. 31 - Sept. 2	May 21 and Aug. 31	Sept. 7-21	Sept. 7	Sept. 21-23	June 22 and Sept. 22	
2	Aug. 31		Sept. 7		June 22 and Sept. 22		
3	Aug. 31 - Sept. 2		Sept. 13		June 22 and Sept. 21		

TABLE 2

SUMMARY OF SPRING AND FALL PLANTING STOCK MEASUREMENTS

Planting time	Number of seedlings	Average root length (inches)	Average top length (inches)	Average oven dry wts. (grams) <sup>1</sup>		Top/root ratio (by weight)
				Top	Root	
Spring	25	11.9	5.0	2.21	0.74	2.99
Fall	10	9.2	5.0	1.91	0.65	2.94

<sup>1</sup>dried at 105°C for 48 hours

### Natural and broadcast seeding

Broadcast seeding was done at a rate of 12 ounces of viable seed per acre. On study 1 four permanent transects, each 50 by 10 links and containing five quadrats, were randomly located on each natural regeneration and on each broadcast seeded plot providing for a 10 per cent sample. The northeast corner of each transect was marked with a numbered wooden post, 2 by 2 inches by 2.5 feet in length. The other three corners were marked with wooden posts, 1 by 1 inch by 2 feet in length. Quadrat 1 in each transect was located adjacent to the larger corner post. Each quadrat was recorded as stocked or not stocked to jack pine regeneration and on the second quadrat of each transect a total seedling count was made. The height of the tallest seedling on each quadrat was recorded.

The same procedure was followed on studies 2 and 3 as in study 1 for the regeneration examination on the natural and broadcast seeded areas, except that each five milacre transect on a 1/40 acre plot provided for a 20% sample.

### Spot seeding

Seedspots were located at six foot spacing. Seeding was done at a rate of 15 to 20 seeds per seedspot. The seedspot was scuffed with a foot, the seed scattered, and a fine covering of soil placed over the seed. Each seedspot was marked with a numbered 1-inch square wooden stake placed at the north edge of the spot. Seedspots on study 1 were placed on either mineral soil or on an ash-humus complex. Seedspots on study 2 were located at six foot spacing and moved up to one foot to take advantage of any shade. Seedspots on study 3 were located on five furrows with five seedspots per furrow spaced at six feet. Spacing between rows was dependent upon the furrowing.

During the seedspot examination all seedlings were recorded as healthy, sick or dead. The height of the tallest living seedling was measured to the nearest tenth inch.

#### Methods for Seeding and Assessment - Study 4

Germination and seedling development was studied on three types of seedbed each subjected to two shading and watering regimes. Ninety-six 1-foot-square plots were established, 32 on each of the three seedbed types; mineral soil, ash-humus complex, and burned litter. Four treatments (watering-shading, watering-no shading, no watering-shading, and no watering-no shading) were each randomly applied to 8 plots on each seedbed type. Shade was supplied by shingles stuck vertically into the ground on the south and west side of each plot. The watering treatment consisted of applying the equivalent of one inch of water per week in two waterings at 3 to 4 day intervals. Watering was done from May to September.

Seeding was done on April 27 and 28. Fifty seeds were sown on each plot for a total of 1,600 seeds on each seedbed type. After sowing the seeds were covered with a thin layer of soil.

Each seedspot was examined weekly from May 28 - August 5, and every two weeks thereafter to October 1, 1965. Counts were made of all living and dead seedlings and each living seedling was marked with a coloured skewer; a different color was used for each week of germination. Cause of mortality was recorded when evident.

#### RESULTS OF REGENERATION

##### Study 1 - 1964. Natural Seeding, Planting, and Artificial Seeding

Table 3 gives the stocking and density of jack pine regeneration for the spring broadcast seeding and for natural seeding following the burning



of cone bearing slash. The stocking for all plots on the spring broadcast seeding was 32 per cent with a density of 417 seedlings per acre. The stocking for all plots on the natural seeding was 8 per cent with a density of 167 seedlings per acre. All the stocking for the natural seeding occurred on plot 4 on which 9 seed trees per acre had been left as a seedsource. Stocking on plot 4 was 25 per cent with a density of 500 seedlings per acre.

Table 4 shows the regeneration on the spring spot seeding. On a total of 600 seedspots on three plots, 949 seedlings were found to be either healthy or sick; at the same time a total of 1,043 were recorded as dead. The number of living seedlings per seedspot was 1.6.

Table 5 shows the per cent survival and the average plantation height for the planting on plots 1, 4 and 5. The per cent survival for all seedlings was 86.2. The average plantation height at the time of planting was 4.9 inches; at the end of the first growing season the average plantation height was 8.9 inches, an increase of 4.0 inches.

TABLE 3

SUMMARY OF JACK PINE REGENERATION SURVEY -  
SPRING BROADCAST AND NATURAL SEEDING - STUDY 1

Seeding method	Plot number	Number quadrats	Per cent stocking	Seedlings per acre - Sept., 1965
Spring Broadcast seeding	1	20	25	500
	4	20	35	250
	5	20	35	500
	Total	60	32	417
Natural seeding	1	20	0	0
	4	20	25	500
	5	20	0	0
	Total	60	8	167

TABLE 4

SUMMARY OF JACK PINE REGENERATION SURVEY -

SPRING SPOT SEEDING - STUDY 1

Plot number	Number seedspots	Number of Seedlings - Sept., 1965			
		Healthy	Sick	Dead	Healthy and Sick
1	200	146	7	372	153
4	200	402	2	304	404
5	200	385	7	367	392
Total	600	933	16	1043	949
No. per seedspot		1.6	0.03	1.7	1.6

TABLE 5

SURVIVAL AND GROWTH OF SPRING PLANTING - STUDY 1

Plot number	Number planted	Condition - Sept., 1965				Average heights (inches)		
		Healthy	Sick	Dead	Healthy and sick	Spring	Fall	Increase
1	200	149	21	30	170	5.3	9.1	3.8
4	200	164	6	30	170	4.5	8.7	4.2
5	200	176	1	23	177	4.9	9.0	4.1
Total	600	489	28	83	517	4.9	8.9	4.0
Per Cent		81.5	4.7	13.8	86.2			

Study 2 - 1964. Spring and Fall Seeding and Planting

Regeneration for spring and fall broadcast seeding is given in Table 6. Stocking for spring seeding was 17 per cent and for the fall 30 per cent. No seedlings were found on the total tally quadrats for the spring seeding and the number per acre is zero. Stocking for the fall seeding was 1,333 seedlings per acre.

A comparison of the spring and fall spot seeding is given in Table 7. A total of 248 seedlings were found to be either healthy or sick for an average of 1.6 per seedspot on the spring spot seeding. At the same time a total of 646 seedlings were recorded as dead for an average of 4.3 per seedspot. For the fall spot seeding a total of 319 were either healthy or sick for an average of 2.1 per seedspot. A total of 550 were recorded as dead for an average of 3.7 per seedspot.

Survival for spring planting was 80 per cent and for fall planting, 58 per cent. Height increases averaged 3.1 and 2.6 inches for spring and fall planting respectively (Table 8). The survival count of the fall planting, made on May 21, 1965, showed that 92 per cent of the seedlings were either healthy or sick.

TABLE 6  
SUMMARY OF JACK PINE REGENERATION SURVEY  
SPRING AND FALL BROADCAST SEEDING - STUDY 2

Seeding time	Number quadrats	Per cent stocking	Seedling per acre- Sept., 1965
Spring	30	17	0 <sup>h</sup>
Fall	30	30	1,333

<sup>h</sup>No seedlings were found on the six total tally quadrats.

- 11 -  
TABLE 7

A COMPARISON OF JACK PINE REGENERATION SURVEYS  
OF SPRING AND FALL SPOT SEEDING - STUDY 2

Seeding time	Number of seedspots	Number of seedlings - Sept., 1965			
		Healthy	Sick	Dead	Healthy and sick
Spring	150	242	6	646	248
No. per Seedspot		1.6	0.04	4.3	1.6
Fall	150	311	8	550	319
No. per Seedspot		2.1	0.05	3.7	2.1

TABLE 8

COMPARISON OF SURVIVAL AND GROWTH OF  
SPRING AND FALL PLANTING - STUDY 2

		Condition - August 31, 1965						
Planting time	number planted	Healthy	Sick	Dead	Healthy and sick	Average heights(inches)		
						spring	fall	Increase
Spring	150	113	7	30	120	4.3	7.4	3.1
Per cent		75.3	4.7	20.0	80.0			
Fall	150	77	10	63	87	52	7.8	2.6
Per cent		51.3	6.7	42.0	58.0			

Study 3 - 1964. Planting and Seeding on Seedbeds Prepared Mechanically  
and by Burning<sup>1</sup>

Survival for planting on seedbeds prepared by burning was 80.0 per cent; on mechanically prepared seedbeds survival was 98.7 per cent. The average height increases were 3.1 and 4.0 inches respectively (Table 9).

Spot seeding on seedbeds prepared by burning produced 248 seedlings either healthy or sick for an average of 1.6 per seedspot, (Table 10). A total of 646 seedlings were recorded as dead for an average of 4.3 per seedspot. Spot seeding on mechanically prepared seedbeds produced 1,278 seedlings for an average of 8.5 per seedspot and a total of 225 dead seedlings for an average of 1.5 per seedspot.

Stocking for broadcast seeding on seedbeds prepared by burning was 17 per cent; for mechanically prepared seedbeds stocking was 90 per cent, (Table 11). The density per acre was zero and 6,167 respectively.

The higher survival of seeded and planted stock on the mechanically prepared seedbeds is attributed to the greater wind erosion occurring on seedbeds prepared by burning and the higher temperatures on this seedbed due to the reduced vegetation cover and the blackened seedbed.

---

<sup>1</sup>Seedbeds prepared mechanically are compared with those prepared by burning on the spring treatment of study 2.

TABLE 9

SURVIVAL AND GROWTH OF SEEDLINGS

PLANTED ON BURNED AND ON MECHANICALLY PREPARED SEEDBEDS - STUDY 3

Site preparation method	number planted	Condition-Sept., 1965				Average height (inches)		
		Healthy	Sick	Dead	Healthy and sick	spring	fall	Increase
Burning	150	113	7	30	120	4.3	7.4	3.1
Per cent		75.3	4.7	20.0	80.0			
Furrows	150	148		2	148	4.6	8.6	4.0
Per cent		98.7		1.3	98.7			

TABLE 10

COMPARISON OF JACK PINE REGENERATION SURVEYS OF

SPOT SEEDING ON BURNED AND ON MECHANICALLY PREPARED SEEDBEDS - STUDY 3

Site preparation method	number seedspots	Number of seedlings - Sept., 1965			
		Healthy	Sick	Dead	Healthy and sick
Burning	150	242	6	646	248
No. per seedspot		1.6	0.04	4.3	1.6
Furrows	150	1272	6	225	1278
No. per seedspot		8.5	0.04	1.5	8.5

TABLE 11  
COMPARISON OF REGENERATION SURVEYS OF

BROADCAST SEEDING ON BURNED AND ON MECHANICALLY PREPARED SEEDBEDS - STUDY 3

Site Preparation method	Number quadrats	Per cent stocking	Seedlings per acre
Burning	30	17	0 <sup>1</sup>
Furrows	30	90	6,167

<sup>1</sup> no seedlings were found on the six total tally quadrats

One hundred seedspots on the spring and fall spot seeding (Study 2) and on the spring spot seeding in furrows (Study 3) were examined on June 22 and again on September 22. The number of living and dead seedlings for the two dates is shown in Table 12. On seedbeds prepared by burning more than 50 per cent of seedlings tallied June 22 had died by September 22. On mechanically prepared seedbeds less than 15 per cent mortality occurred during the same period. It is believed that the high mortality on Study 2 occurred during the period from July 27 - August 23. Table 13 shows that the mean maximum air temperatures at this time for two 14 day periods as being 81 and 83 degrees F. respectively. A weekly germination and survival count as carried out on Study 4 showed similar high mortality during this period (Table 15).



TABLE 12

A COMPARISON OF SEEDLING SURVIVAL OF  
SPOT SEEDING ON BURNED AND ON MECHANICALLY PREPARED SEEDBEDS -  
STUDIES 2 AND 3

Study No.	Site preparation method	Seeding time	Number of seedspots	June 22		September 22	
				Living	Dead	Living	Dead
2	Burning	Fall	100	611	43	233	372
No. per seed-spot				6.4	0.4	2.3	3.7
2	Burning	Spring	100	646	135	187	425
No. per seed-spot				6.5	1.4	1.8	4.2
3	Furrows	Spring	100	1019	15	879	143
No. per seed-spot				10.2	0.2	8.8	1.4

TABLE 13

PERIODIC MEAN MAXIMUM AIR TEMPERATURES AND RAINFALL - 1965

Air Temperature		Rainfall	
Period	Mean maximum (Fahrenheit)	Period	Rainfall (inches)
May 19-27, 29-31	64	May 13-May 28	1.80
June 1-June 11	73		
June 15-June 28	78	May 28-June 25	2.00
June 29-July 10	75		
July 13 -July 26	79	June 26-July 29	4.65
July 27-Aug. 9	81		
Aug. 10-Aug. 23	83	July 30-Aug. 27	1.32
Aug. 24-Sept. 6	66		
Sept. 7-Sept. 20	58		
Sept. 21-Sept. 28	51	Aug. 28-Sept. 29	3.94
Total			13.71

Study 4 - 1964. Germination and Seedling Development on Various Seedbeds

The per cent survival by seedbed and treatment is shown in Table 14. From the table it would appear that the litter seedbed was most favourable for both germination and survival, however, high winds blew away most seeds from the ash and mineral soil seedbeds. Litter offered better protection against the wind thus reducing erosion and leaving more seeds to germinate.

The per cent mortality by period is shown in Table 15. Total mortality was 73.7 per cent of 255 germinants. Chief causes of mortality

were from chewing by ants and a combination of drought and high temperature. Chewing was heaviest during June when most germination took place. Between August 5 and September 2 a total of 88 seedlings died; prior to this period mean maximum air temperatures were 81° and 83°F. and rainfall was only 1.3 inches (Table 13).

TABLE 14

PER CENT SURVIVAL BY SEEDBED AND TREATMENT - STUDY 4

Treatment	Mineral Soil			Ash			Litter		
	Total germ.	No. living <sup>1</sup>	Per cent survival	Total germ.	No. living <sup>1</sup>	Per cent survival	Total germ.	No. living <sup>1</sup>	Per cent survival
Watering shading	2	1	50.0	3	3	100.0	83	42	50.6
Watering no shading	11	0	0.0	9	3	33.3	47	17	36.2
No watering shading	4	0	0.0	4	0	0.0	48	0	0.0
No watering no shading	5	0	0.0	0	0	0.0	39	1	2.6
Total	22	1	4.5	16	6	37.5	217	60	27.6

<sup>1</sup>No. living on October 1, 1965

TABLE 15

PER CENT MORTALITY BY PERIOD - STUDY 4

Date	Number of new germinants	Number of new germinants and residual	Mortality cause			Per cent mortality <sup>1</sup>
			Chewing	Other	Total	
May 28	10	10	0	0	0	0
June 4	66	76	12	4	16	21.0
11	29	89	22	6	28	31.5
18	43	104	4	19	23	22.1
25	10	91	4	6	10	11.0
July 2	21	102	1	2	3	2.9
9	28	127	2	1	3	2.4
15	16	140	1	3	4	2.8
23	11	147	1	0	1	0.7
29	9	155	0	3	3	2.0
Aug. 5	8	160	1	4	5	3.1
19	4	159	0	53	53	33.3
Sept. 2	0	106	0	35	35	33.0
16	0	71	0	2	2	2.8
Oct. 1	0	69	0	2	2	2.9
Total	255		48	140	188	73.7

<sup>1</sup>Per cent of number of new germinants and residual

SEEDBEDS RESULTING FROM 1964 BURN

Seedbed occurrence during 1964 and again during May of 1965 is shown in Table 16. Seedbeds have been greatly altered through wind erosion. Mineral soil exposure has increased on plots 1 and 5 while burned litter has decreased on both plots. The ash-humus seedbed has been increased on plot 1 and reduced on plot 5. There is a difference in the per cent of the stumps and logs since two different locations were used in the seedbed survey.

TABLE 16

SEEDBEDS RESULTING FROM 1964 BURN

Seedbed	Per cent distribution of seedbeds			
	Plot 1		Plot 5	
	August 28, 1964	May 26, 1965	September 1, 1964	May 26, 1965
Unburned	0.0	0.0	0.0	0.0
Burned litter	48.0	2.5	25.0	0.0
Ash-humus	22.5	48.5	36.0	17.0
Mineral soil	26.5	44.0	35.5	80.5
Stumps or logs	3.0	5.0	3.5	2.5

1965 BURN<sup>1</sup>

Locations

Six areas ranging from 18 to 102 acres in size were chosen for burning in 1965. During the summer these areas were surveyed and their boundaries established. The areas were located in the following Conservation Officer Districts in the Sandilands Forest Reserve in south-eastern Manitoba: Hadashville, Timber sale No. 4334; Richer, Timber sale No. 4553; Marchand, Timber sales No. 4528 and No. 4330; Woodridge, Timber sale No. 4554; and Piney, Timber sale No. 4003. Time and weather conditions permitted burning of only the first four areas.

On the Richer burn, Timber Sale number 4553, 10 seed trees per acre on a 10-acre block were marked prior to cutting to be left as a seed source following the burn. This block, however, was used as the sawmill site and slabs, sawdust and logs were left on the area. Approximately 1.5 acres had to be fireguarded and left unburned.

Immediately following the burn 50 seed traps were evenly distributed throughout the remainder of the seed tree block. The area was burned on August 17, 1965 and the first collection from the seed traps was made on August 19. Subsequent collections were made on September 2 and 27 and on October 27, 1965. A cutting test was made on all seeds.

---

<sup>1</sup>For further details of the areas and pre burn and post burn measurements the reader is referred to a report prepared for project MS-603 by J. L. Adams.

Seed Collections From 1965 Seed Tree Burn

Total seed fall per acre was 87,600 and soundness of seed was 64 per cent (Table 17). A total of 0.4 pounds of sound seed fell per acre. Seedfall was highest from the period of August 19 to September 2 (16 days after burning).

TABLE 17

SEED FALL PER ACRE - 1965 SEED TREE BURN

Date of collection	Seed fall per acre	Per cent of seeds sound	Sound seed per acre	Pounds sound seed per acre
Aug. 19/65	2,000	100	2,000	0.015
Sept. 2/65	52,800	76	40,128	0.302
Sept. 27/65	26,800	42	11,256	0.085
Oct. 27/65	6,000	47	2,820	0.021
Total	87,600	64	56,204	0.423

WORK PROPOSED FOR 1966

1964 Burn

All the planting and seeding regeneration counts made in 1965 will be repeated during the fall of 1966. The row seeding carried out on study 1 will be assessed at this time.



### 1965 Burn

Seeding and planting will be carried out in the spring of 1966 on the areas burned-over in 1965. All areas except Marchand, No. 4528 will be marked off into approximate quarters and the following treatments will be applied: broadcast seeding at a rate of 12 ounces per acre, spot seeding, planting, and on undisturbed area for natural regeneration. Burning on the Marchand, No. 4528 area was not as intense as on the previous areas and only one-half of the area will be planted and the rest will be set aside for further experimental study. Assessment plots will be established on the treated areas and periodic re-measurements will be made to determine the success of regeneration.

Collections from the seed traps set out on the Richer burn will be made at periodic intervals.

### 1966 Burn

The areas established near Piney and Woodridge in 1965 will be burned during 1966. A 1965-66 timber sale on which a 10-acre block of 10 seed trees per acre were marked, will be burned in 1966. Seed traps will be set out on this area, immediately following burning.

### REFERENCES

- Adams, J. L. 1966. Prescribed burning for site preparation in jack pine management in southeastern Manitoba (Manuscript proposed for publication).
- Cayford, J. H. 1965. The use of prescribed burning in jack pine management in southeastern Manitoba. Canada, Dept. Forestry, Forest Research Branch, Unpubl. MS. 65-MS-1. 27pp.

Sims, H. P. 1965. The ecological effects of prescribed burning in  
jack pine - southeastern Manitoba. Canada, Dept. Forestry.  
For. Res. Br. Unpubl. MS. 65-MS-17 20 pp.