Not for publication

CHARACTERISTICS OF SOIL TEMPERATURE AND MOISTURE, GERMINATION OF JACK PINE SEED, AND SEEDLING ESTABLISHMENT ON SEEDBEDS CREATED BY A MIDDLEBUSTER PLOW IN SOUTHEASTERN MANITOBA

Project MS-222

by
N. Bruce

FOREST RESEARCH LABORATORY
WINNIPEG, MANITOBA
INTERNAL REPORT MS-67

FORESTRY BRANCH
MARCH, 1968

CHARACTERISTICS OF SOIL TEMPERATURE AND MOISTURE, GERMINATION OF JACK PINE SEED, AND SEEDLING ESTABLISHMENT ON SEEDBEDS CREATED BY A MIDDLEBUSTER PLOW IN SOUTHEASTERN MANITOBA

Project MS-222

by

N. Bruce

FOREST RESEARCH LABORATORY
WINNIPEG, MANITOBA
INTERNAL REPORT MS-67

DEPARTMENT OF FORESTRY AND RURAL DEVELOPMENT
MARCH 1968

CONTENTS

INTRODUCTION

The successful regeneration of jack pine in southeastern Manitoba is greatly dependent upon seedbed preparation. One method used creates a furrow two to three inches deep and three to four feet wide with an overturned-sod ridge on each side. In 1962 a study was begun to assess the capacities of the seedbeds created for germination, survival and growth. Preliminary studies on three sites - oligotrophic dry, mesotrophic fresh-minus, and oligotrophic fresh (Mueller-Dombois 1964) indicated that the dry site was the most critical, and in 1964 the study was intensified on such a site. Studies on the original three sites (Study A) were terminated in 1966. This report, therefore, deals with the more intensive study on the dry site (Study B).

WORK COMPLETED IN 1967

Methods

Seedspot tally and measurement - Seedspots established in 1965 and 1966 were checked for mortality during early May and late September of 1967. Total height and 1967 growth measurements were taken on all surviving seedlings during August. Root-collar diameters of the 1965 stock were measured, the seedlings harvested and oven-dry weights obtained.

Planting tally and measurement - Survival counts were carried out during early May and late September on planting stock established during 1965 and 1966. Total height and 1967 growth measurements were taken during August. Root-collar diameters of the 1965 planting stock were measured, the seedlings harvested and oven-dry weights obtained.

Precipitation measurements - Rainfall was collected at weekly intervals beginning May 16 and ending October 10 on the 1967 area of Study B. Three Beal-type rain gauges were used.

Results

Mortality on 1965 seedspots - Per cent mortality occurring on the 1965 seedspots for the period September 1966 to September 1967 is shown in Table 1. Mortality did not reach 10 per cent on any seedbed or exposure. Summer mortality was greater than winter mortality on all seedbeds except BSF[1] where the reverse occurred.

---

[1] The Ridge, Trough, Base of south-facing slope, Base of north-facing slope and Undisturbed seedbeds are defined as R, T, BSF, BNF, and U respectively. The North, Middle and South exposures are defined as N, M and S respectively.

TABLE I

MORTALITY ON 1965 SEEDSPOTS

Exposure	No. seedlings Sept. 1966	No. seedlings died Sept. 1966 - May 1967	Percent mortality[1] Sept. 1966 - May 1967	No. seedlings May 1967	No. seedlings died May 1967 - Sept. 1967	Percent mortality May 1967 - Sept. 1967	No. seedlings Sept. 1967	No. seedlings died Sept. 1966 - Sept. 1967	Per cent mortality Sept. 1966 - Sept. 1967
	R								
N	42	0	0.0	42	2	4.8	40	2	4.8
M	5	0	0.0	5	0	0.0	5	0	0.0
S	24	0	0.0	24	2	8.3	22	2	8.3
Total	71	0	0.0	71	4	5.6	67	4	5.6
	T								
N	125	0	0.0	125	2	1.6	123	2	1.6
M	31	0	0.0	31	0	0.0	31	0	0.0
S	40	0	0.0	40	0	0.0	40	0	0.0
Total	196	0	0.0	196	2	1.0	194	2	1.0
	U								
N	73	1	1.4	72	4	5.6	68	5	6.8
M	21	0	0.0	21	0	0.0	21	0	0.0
S	2	0	0.0	2	0	0.0	2	0	0.0
Total	96	1	1.0	95	4	4.2	91	5	5.2
	BNF								
N	46	0	0.0	46	3	6.5	43	3	6.5
M	50	0	0.0	50	0	0.0	50	0	0.0
S	49	0	0.0	49	0	0.0	49	0	0.0
Total	145	0	0.0	145	3	2.1	142	3	2.1
	BSF								
N	67	0	0.0	67	2	3.0	65	2	3.0
M	37	0	0.0	37	0	0.0	37	0	0.0
S	30	1	6.7	29	1	3.4	28	2	6.7
Total	134	1	0.7	133	3	2.2	130	4	3.0
	All seedbeds								
N	353	1	0.3	352	13	3.7	339	14	4.0
M	144	0	0.0	144	0	0.0	144	0	0.0
S	145	1	0.7	144	3	2.1	141	4	2.8
Total	642	2	0.3	640	16	2.5	624	18	2.8

[1] Per cent based upon number of seedlings at the beginning of each period.

Mortality on 1966 seedspots - Per cent mortality occurring on the 1966 seedspots for the period September 1966 to September 1967 is shown in Table 2. Highest mortality for the year occurred on the U and BNF seedbeds, the lowest on the R seedbeds when all exposures are grouped. Grouping all seedbeds, highest mortality occurred on the N exposure and was lowest on the S exposure. Considering exposures and seedbeds individually the highest mortality occurred on the BNF seedbed of the N exposure and the U seedbeds of the M and S exposures. Summer mortality was greater than winter mortality on all seedbeds and exposures except the T seedbed of the M exposure.

Survival of planted stock - Per cent survival of planted stock on the 1965 and 1966 areas is shown in Table 3. Survival was excellent in all cases.

Growth on seedspots - Average seedling height for seedlings on the 1965 and 1966 seedspots are shown in Table 4. Greatest seedling heights occurred on seedbeds in the M exposure and least on the N exposure. Considering the area as a whole, shortest seedlings were found on U seedbeds of seedspots established in 1965 and on T seedbeds of seedspots established in 1966. The tallest seedlings were found on R seedbeds for both years.

Height growth of planted stock - Height of 1965 and 1966 planted stock is shown in Table 5. Considering all seedbeds grouped, seedlings planted in 1965 showed best growth on the M exposure, and poorest on the N exposure. Best growth for the area as a whole, occurred on the BSF seedbeds. Considering exposures and seedbeds combined the best growth was found on the BSF seedbeds of the N exposure, the BNF seedbeds of the M exposure and the U seedbeds of the S exposure. Seedlings planted in 1966 showed best growth on the M exposure (all seedbeds grouped) and on BSF seedbeds (all exposures grouped). Considering exposures and seedbeds combined the best growth was found on the BNF seedbed of the N exposure, the BSF seedbeds of the M exposure and the U seedbed of the S exposure.

Root-collar diameters and oven-dry weights of 1965 seedlings - Average root-collar diameters and oven-dry weights for the 1965 seeded and planted stock are shown in Tables 6 to 9 inclusive. Both planted and seeded stock exhibited the largest root-collar diameters on the M exposure and smallest on the N exposure. Considering seedbeds in each exposure, largest root-collar diameters for the planted stock were found on the R and BSF seedbeds of the N exposure and in the T and BSF seedbeds of the M exposure and the U seedbeds of the S exposure. Considering the area as a whole, seedlings planted in the BSF seedbeds had the largest root-collar diameters while seedlings planted in the U seedbeds had the smallest. The seeded stock exhibited the largest root-collar diameters on the BSF seedbeds of the N exposure and on the R seedbeds of the M and S exposures. Disregarding exposure, the R seedbeds produced seeded stock with the largest root-collar diameters and the U seedbeds produced seedlings with the smallest.

TABLE 2

MORTALITY ON 1966 SEEDSPOTS SEPTEMBER 1966 TO SEPTEMBER 1967

Percent mortality [1]												
Exposure	N			M			S			Avg. N, M, S.		
Period of mortality	Sept. 1966 to May 1967	May 1967 to Sept. 1967	Sept. 1966 to Sept 1967	Sept. 1966 to May 1967	May 1967 to Sept 1967	Sept. 1966 to Sept 1967	Sept. 1966 to May 1967	May 1967 to Sept. 1967	Sept. 1966 to Sept. 1967	Sept. 1966 to May 1967	May 1967 to Sept 1967	Sept. 1966 to Sept 1967
R	1.1	12.2	13.2	—	—	—	0.0	12.5	12.5	1.0	12.2	13.1
T	3.8	27.0	29.7	16.7	6.7	22.2	0.0	37.9	37.9	4.4	27.0	30.2
U	2.8	23.5	25.7	0.0	75.0	75.0	0.0	100.0	100.0	2.3	37.2	38.6
BNF	2.5	52.9	54.1	0.0	17.1	17.1	0.0	5.0	5.0	1.7	39.0	40.1
BSF	1.8	29.3	30.5	5.6	35.3	38.9	0.0	33.3	33.3	2.1	29.9	31.4
All seedbeds.	2.5	31.9	33.6	5.3	22.5	26.7	0.0	23.9	23.9	2.5	30.0	31.8

1 Based upon the number of seedlings remaining at the beginning of each period.

TABLE 3

SECOND AND THIRD YEAR SURVIVAL OF PLANTED STOCK –

			N							M							S							Average N, M, S.						
Seedbed	Year of planting	Number planted	Seedlings remaining end of first year.	First year survival per cent.	Seedlings remaining end of second year.	Second year survival per cent.	Seedlings remaining end of third year.	Third year survival per cent	Percent survival Time of planting to Sept. 1967	Seedlings remaining end of first year.	First year survival per cent.	Seedlings remaining end of second year.	Second year survival per cent.	Seedlings remaining end of third year.	Third year survival per cent	Per cent survival Time of planting to Sept. 1967	Seedlings remaining end of first year.	First year survival per cent	Seedlings remaining end of second year.	Second year survival per cent.	Seedlings remaining end of third year.	Third year survival per cent	Per cent survival Time of planting to Sept. 1967	Number planted.	Seedlings remaining end of first year.	First year survival per cent.	Seedlings remaining end of second year.	Second year survival per cent.	Seedlings remaining end of third year	Third year survival per cent.	Per cent survival Time of planting to Sept. 1967
R	1965	15	13	86.7	13	100.0	13	100.0	86.7	12	80.0	12	100.0	12	100.0	80.0	15	100.0	14	93.3	13	92.8	86.7	45	40	88.9	39	97.5	38	97.4	84.4
	1966	15	15	100.0	15	100.0				14	93.3	13	92.8				13	86.7	13	100.0				45	42	93.3	41	97.6			
T	1965	15	15	100.0	15	100.0	14	93.3	93.3	14	93.3	14	100.0	13	86.7	86.7	15	100.0	15	100.0	15	100.0	100.0	45	44	97.8	44	100.0	42	93.3	93.3
	1966	15	15	100.0	15	100.0				14	93.3	14	100.0				15	100.0	15	100.0				45	44	97.8	44	100.0			
U	1965	15	14	93.3	12	85.7	11	91.7	73.3	12	80.0	12	100.0	10	83.3	66.7	15	100.0	15	100.0	15	100.0	100.0	45	41	91.1	39	95.1	36	92.3	80.0
	1966	15	15	100.0	15	100.0				14	93.3	13	92.8				14	93.3	14	100.0				45	43	95.6	42	97.6			
BNF	1965	15	15	100.0	14	93.3	14	100.0	93.3	15	100.0	14	93.3	14	100.0	93.3	15	100.0	15	100.0	15	100.0	100.0	45	45	100.0	43	95.6	43	100.0	95.6
	1966	15	15	100.0	15	100.0				15	100.0	15	100.0				15	100.0	15	100.0				45	45	100.0	45	100.0			
BSF	1965	15	15	100.0	15	100.0	13	86.7	86.7	15	100.0	15	100.0	15	100.0	100.0	15	100.0	15	100.0	15	100.0	100.0	45	45	100.0	45	100.0	43	95.6	95.6
	1966	15	15	100.0	15	100.0				15	100.0	15	100.0				15	100.0	15	100.0				45	45	100.0	45	100.0			
All seedbeds	1965	75	72	96.0	69	95.8	65	94.2	86.7	68	90.7	67	98.5	64	94.1	85.3	75	100.0	74	98.7	73	98.6	97.3	225	215	95.6	210	97.7	202	96.2	89.8
	1966	75	75	100.0	75	100.0				72	96.0	70	97.2				72	96.0	72	100.0				225	219	97.3	217	99.1			

TABLE 4

AVERAGE SEEDLING HEIGHTS 1965 AND 1966 SEEDSPOTS

Exposure	Date of establishment	Growth period (years)	R		T		U		BNF		BSF		All seedbeds	
			No. seedling	Avg. ht. inches	No. seedling	Avg ht. inches	No. seedling	Avg. ht inches	No. seedling	Avg ht. inches	No. seedling	Avg. ht. inches	No. seedling	Avg. ht. inches
N	1965	3	18	9.0	123	3.6	70	2.2	43	3.8	65	5.6	319	4.0
	1966	2	88	3.6	126	1.3	31	3.0	108	1.1	131	1.9	484	1.9
M	1965	3	5	14.4	31	7.5	25	5.4	50	10.7	37	10.4	148	9.2
	1966	2	0	—	14	2.8	2	4.4	35	4.6	14	3.5	65	4.0
S	1965	3	23	9.0	40	7.8	2	2.4	49	9.3	28	5.6	142	8.0
	1966	2	8	5.7	29	2.8	5	2.9	39	4.0	4	3.6	85	3.7
Average N, M, S.	1965	3	46	9.6	194	5.1	97	3.0	142	8.1	130	7.0	609	6.2
	1966	2	96	3.8	169	1.7	38	3.0	182	2.4	149	2.1	634	2.4

TABLE 5

SEEDLING HEIGHTS 1965 AND 1966 PLANTING

Seedbed	R		T		U		BNF		BSF		All seedbeds	
Exposure	No. seedlings	Avg. ht. (inches)	No. seedlings	Avg. ht. (inches)	No. seedlings	Avg. ht. (inches)	No. seedlings	Avg. ht. (inches)	No. seedlings	Avg. ht. (inches)	No. seedlings	Avg. ht. (inches)
	1965 planting – height after one growing season											
N	14	4.7	15	5.3	15	5.3	15	4.8	15	5.5	74	5.1
M	12	5.5	14	5.6	12	5.5	15	6.4	15	6.4	68	5.8
S	15	5.9	15	7.6	13	7.7	15	7.4	15	6.4	75	7.0
Avg. N,M.S.	41	5.4	44	6.2	40	6.2	45	6.3	45	6.1	217	6.0
	1965 planting – height after two growing seasons											
N	13	11.2	15	7.6	12	8.6	14	7.2	15	10.6	69	9.0
M	12	12.6	14	12.6	12	13.1	14	15.9	15	14.2	67	13.6
S	14	11.7	16	11.6	15	16.7	15	13.2	15	11.2	74	12.9
Avg. N,M,S.	39	11.8	44	10.6	39	13.1	43	12.0	45	12.0	210	11.9
	1965 planting – height after three growing seasons											
N	13	17.5	14	12.8	11	11.2	14	11.6	13	18.8	65	14.4
M	12	17.6	14	21.7	12	18.6	14	23.4	15	22.9	67	21.0
S	14	15.4	15	18.6	15	23.2	15	21.9	15	17.8	74	19.4
Avg. N.M.S.	39	16.7	43	17.7	38	18.3	43	19.0	43	19.9	206	18.4
	1966 planting – height after one growing season											
N	15	9.1	15	9.6	15	10.4	15	10.7	15	10.5	75	10.1
M	13	9.5	14	10.3	14	9.7	15	10.9	15	9.6	71	10.0
S	13	9.2	15	10.2	14	9.2	15	9.3	15	10.3	72	9.7
Avg. N,M.S	41	9.3	44	10.0	43	9.8	45	10.3	45	10.2	218	9.9
	1966 planting – height after two growing seasons											
N	15	18.0	15	17.1	15	18.3	15	20.1	15	19.8	75	18.6
M	13	21.5	14	21.6	14	22.5	15	22.4	15	22.7	71	22.2
S	13	21.2	15	21.7	14	22.1	15	20.1	15	21.4	72	21.3
Avg. N.M.S.	41	20.1	44	20.1	43	20.9	45	20.9	45	21.3	218	20.7

TABLE 6

AVERAGE ROOT-COLLAR DIAMETER 1965 PLANTING

Exposure	Root-collar diameters (cm.) seedbed.					
	R	T	U	BNF	BSF	All seedbeds
N	0.80	0.60	0.46	0.52	0.80	0.64
M	0.88	0.96	0.74	1.01	0.96	0.92
S	0.77	0.87	1.03	0.99	0.86	0.91
All exposures	0.82	0.81	0.78	0.84	0.87	0.82

TABLE 7

AVERAGE ROOT-COLLAR DIAMETERS 1965 SEEDSPOTS

Exposure	Root-collar diameters (cm.) seedbed.					
	R	T	U	BNF	BSF	All seedbeds.
N	0.21	0.17	0.09	0.19	0.23	0.17
M	0.55	0.29	0.20	0.41	0.39	0.35
S	0.38	0.32	0.06	0.37	0.24	0.32
All exposures	0.29	0.22	0.11	0.33	0.28	0.25

TABLE 8

AVERAGE OVEN-DRY SEEDLING WEIGHTS 1965 SEEDSPOTS

Exposure	Oven dry seedling weights (grams) seedbed					
	R	T	U	BNF	BSF	All seedbeds
N	0.9	0.5	0.1	0.7	1.4	0.7
M	10.5	2.9	2.1	5.0	4.7	4.2
S	4.0	2.9	0.6	3.6	1.5	3.0
All exposures	2.6	1.4	0.5	3.2	2.4	2.0

TABLE 9

AVERAGE OVEN-DRY SEEDLING WEIGHTS 1965 PLANTING

Exposure	Oven dry seedling weights (grams) Seedbed					
	R	T	U	BNF	BSF	All seedbeds
N	19.8	11.1	4.4	7.8	20.1	12.8
M	28.6	39.0	17.5	44.4	39.9	35.1
S	21.4	28.6	30.8	35.3	26.5	28.7
All exposures	23.2	26.0	19.0	29.3	29.2	25.6

The 1965 seed stock exhibited the greatest oven-dry weight on the M exposure followed by the S and N exposures respectively. Considering seedbeds and exposures, seedlings having the greatest oven-dry weight were found on the BSF seedbed of the N exposure, the R seedbeds of the M and S exposures. Averaged over-all exposures, the heaviest seedlings were found on the BNF seedbeds, the lightest on the U seedbeds.

The planted stock exhibited the greatest oven-dry weight on the M exposure followed by the S and N exposures respectively. The BSF seedbed produced the heaviest seedlings in the N exposure and the BNF seedbed the heaviest seedlings in the M and S exposures. Averaged over-all exposures, seedlings of greatest and least oven dry weights were found on the BNF seedbeds and U seedbeds respectively.

Precipitation - Precipitation for the period May 16 to October 10, 1967 is shown in Table 10. Compared to the thirty year average for Sprague, Manitoba the precipitation is 55.6 per cent of the normal.

WORK PROPOSED, 1968 - STUDY B

Measurements

a) Seeding and planting - Mortality of the 1966 stock will be recorded in May and September of 1968.

At the end of the 1968 growing season, height growth and total height of all 1966 stock will be measured. The 1966 stock will be harvested in September of 1968, root-collar diameters will be measured and oven dry weights obtained.

b) Precipitation - Precipitation on one of the three areas will be collected by means of three Beal-type rain gauges.

ANALYSIS OF RESULTS

Analysis of results will be carried out as described in the 1964 progress report at the end of the 3-year duration of Study B.

TABLE 10

PRECIPITATION DURING THE PERIOD MAY 16 TO OCTOBER 10, 1967.

Precipitation (inches)			
Collection period.	Total	Beal gauge	30 year avg. Sprague
May 16 - 23		0.17	
24 - 30		0.20	
31		Trace	
	May 16 - 31	0.37	1.01
June 1 - 6		0.02	
7 - 13		0.82	
14 - 20		0.78	
21 - 27		0.53	
28 - 30		0.53	
	June 1 - 30	2.68	3.06
July 1 - 4		0.70	
5 11		1.42	
12 18		NIL	
19 25		0.31	
26 31		0.52	
	July 1 - 31	2.95	2.92
Aug 1		0.08	
2 - 8		0.92	
9 - 15		Trace	
16 - 22		0.09	
23 - 29		NIL	
30 - 31		NIL	
	Aug. 1 - 31	1.09	3.51
Sept. 1 - 5		NIL	
6 - 12		NIL	
13 - 19		0.12	
20 - 26		NIL	
27 - 30		Trace	
	Sept. 1 - 30	0.12	2.28
Oct. 1 - 3		Trace	
4 - 10		0.49	
	Oct. 1 - 10	0.49	0.43
Total	May 16 - Oct. 10	7.70	13.21

REFERENCES

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

Bruce, N. 1966. Characteristics of soil temperature and moisture, germination of jack pine seed, and seedling establishment on seedbeds created by a Middlebuster plow in southeastern Manitoba. Dept. of Forestry, Canada, For. Res. Br. Unpublished Mimeo 67-MS-42: 45 p.