MECHANIZED ROW SEEDING OF JACK PINE

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ABSTRACT

Degree of scarification, percent stocking, density and growth attained by ground seeding jack pine (*Pinus banksiana* Lamb.) with the Canadian Forestry Service (CFS) Row Seeder are summarized. These results are a by-product of operational field testing of successive prototypes of the seeding unit developed during the period 1972-1975. Six trials were carried out at test sites near Chapleau and Thessalon, Ontario, and in all cases percent stocking exceeded the provincial minimum stocking standard for plantations.

As development of the unit is still in progress (June 1979), it is not feasible tc provide engineering drawings or definitive evaluations of mechanical performance at this time.

RÉSUMÉ

Cette étude résume le degré de scarifiage, le pourcentage de matériel sur pied, la densité et la croissance obtenue par l'ensemencement du Pin gris (*Pinus banksiana* Lamb.) avec la semeuse en rangées du Service canadien des forêts. Ces résultats sont un sous-produit des essais opérationnels sur place effectués avec des prototypes successifs de la semeuse mise au point au cours de la période de 1972 à 1975. Six essais ont eu lieu aux stations d'essais près de Chapleau et de Thessalon, Ontario, et dans tous les cas le pourcentage de matériel sur pied a excédé la norme minimale provinciale exigée pour les plantations.

Étant donné que la mise au point de la semeuse n'est pas encore terminée (juin 1979), il est présentement impossible de fournir des dessins techniques ou des évaluations définitives des performances mécaniques.

The CFS Row Seeder

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Cover Photo: Plantation in Haughton Township, Blind River District, seeded during May, 1973. Manually released and photographed during July, 1978.

ACKNOWLEDGMENTS

Thanks are extended to the staff of the Ontario Ministry of Natural Resources (OMNR) on the Kirkwood Management Unit for their support of the project during its early development. Their use of the unit during the period 1971-1975 enabled operational-scale testing of successive prototypes at minimal cost to the Great Lakes Forest Research Centre.

The authors also wish to thank OMNR staff in Wawa, Cochrane, and Timmins districts for using the unit and reporting its performance to us. It is the interest shown by staff in Timmins District which prompted continued development of the scarifier-seeder by the Ministry's Mechanical Development Unit.

INTRODUCTION

The traditional appeal of direct seeding as a regeneration technique stems largely from its low cost and low labor requirements relative to planting. The present dramatic increase in aerial seeding (following mechanical site preparation) can be attributed mainly to these factors. However, the same desirable features would apply to a one-pass ground scarification-seeding technique if a rugged and reliable scarifier-seeder were available. The more economical use of tree seed and improved spacing in the resulting stands would then become strong considerations favoring row seeding over aerial seeding (Mattice 1975).

Attempts to develop such a ground seeder were initiated at the Great Lakes Forest Research Centre in 1971. Several prototypes were produced and tested during the period 1972-1975, but as the development of an operationally viable unit is still in progress (in cooperation with the Mechanical Development Unit of the Ontario Ministry of Natural Resources at Maple, Ontario) this report will focus on the silvicultural results of the tests conducted with the prototypes.

Description of the CFS Row Seeder

The CFS Row Seeder (see Frontispiece) is, in effect, a continuation of earlier row seeder developments reported by Horton and Flowers (1965) and by Graber and Thompson (1970). It has three basic components: 1) a Michigan Float Hitch (developed by the Michigan Department of Natural Resources' Equipment Development Centre in Roscommon), 2) a modified SIECO Heavy Duty Fire Suppression Plow (unmodified version manufactured by the Southern Iron and Equipment Company in Chamblee, Georgia), and 3) a modified International Seeder (unmodified version manufactured by International Harvester in London, Ontario). Figure 1 portrays the various components of the scarifier-seeder as it was tested in 1975.

The unit is used in conjunction with a light crawler tractor (50-100 DBHP) and a V-blade mounted on the C-frame of the tractor (Cameron 1978). The V-blade is used to part slash and remove major debris from the path of the tractor and seeding unit. The fire plow is attached to the rear of the tractor by means of the hydraulically operated, bolt-on Michigan Hitch. The hitch is placed in "float" mode during operation to allow the plow vertical movement independent of the tractor, and thereby enable it to follow ground contours readily. The hydraulically operated fire plow clears minor debris from the path of the seeder and prepares the seedbed by continuous scalping. The seeder is attached to the fire plow by means of a sandwich hitch which permits vertical and horizontal movement of the seeder. The seeder is basically a rotating horizontal plate, with

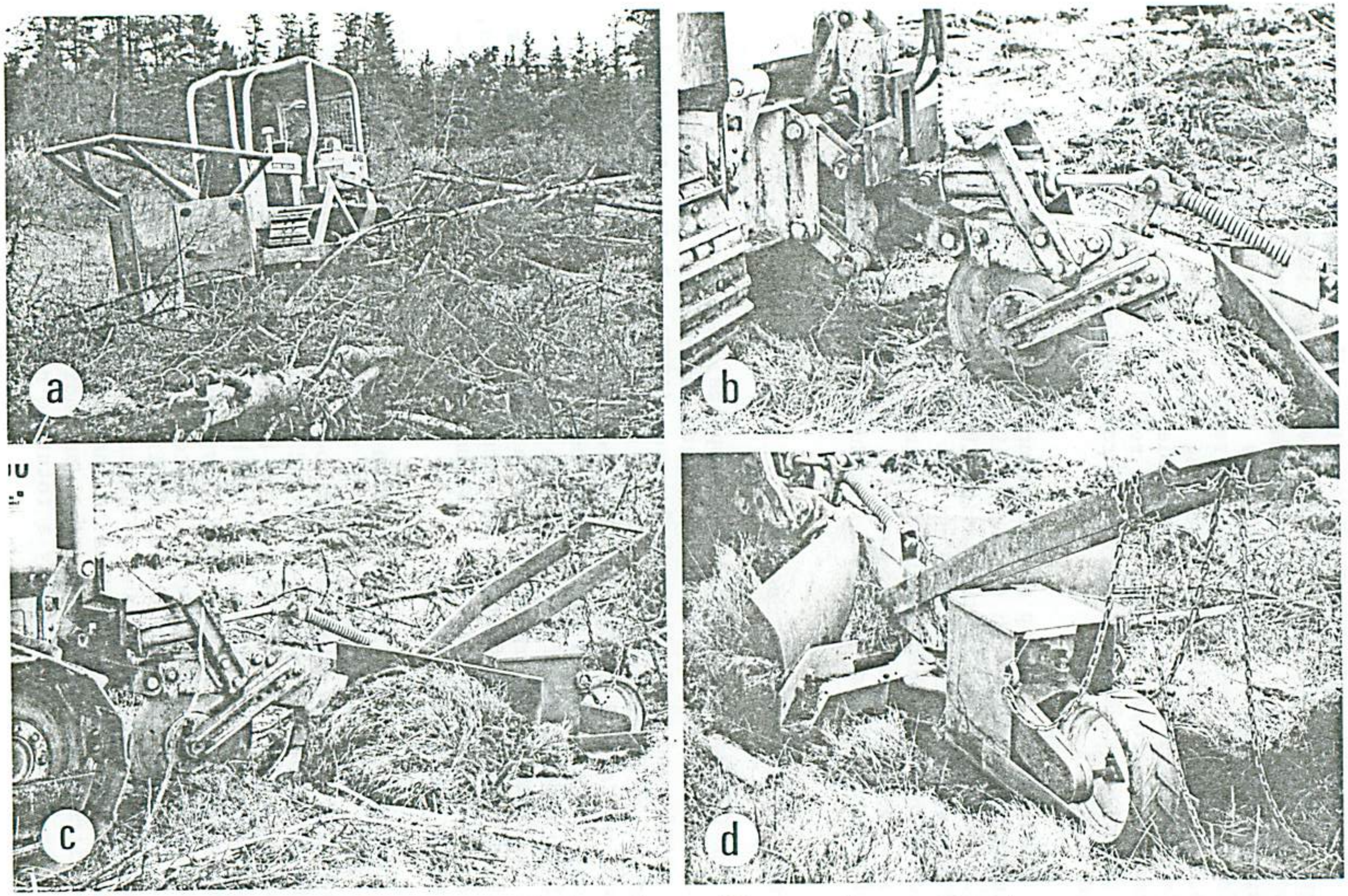

Fig. 1. CFS V-blade and scarifier-seeder components.

a) CFS V-blade
b) Michigan Float Hitch
c) modified SIECO Heavy Duty Fire Suppression Plow
d) modified International Seeder

holes drilled around its periphery, mounted at the base of a hopper. Seed in the hopper fills the holes and drops out by gravity as each hole is rotated over an escape slot. Rotation is accomplished by a trailing land wheel and chain drive system. The frontispiece shows the complete assembly of the 1975 prototype ready for operation.

Although the scarifier-seeder has been tested operationally, its development is not considered complete. More development is required to strengthen the hitch and fire plow, and to reduce the frequency of seeder breakdown by incorporating it in the fire plow and activating it by electric or hydraulic power.

TEST SITES

The unit has been tested as both a scarifier-seeder and a scarifier only, on a wide range of sites varying from flat outwash sand plains to moderately broken shallow-soil till uplands[1], to clay lowlands overlain by deep peat. However, it is only jack pine (*Pinus banksiana* Lamb.) sites treated in the period 1972-1975 that are dealt with in this report. Test sites are referred to by the name of the township in which they are located. Scarification and seeding of the Fawn and Haughton sites was a one-pass operation, whereas the Cosens-Topham site was scarified for aerial seeding.

Most of the tests were on the Haughton sites. The equipment was tested during the period 1972-1975, with areas of 12, 40, and 10 hectares treated. All sites are on a virtually flat, deep, medium to coarse sand. Several of these sites had been scarified and planted previously with little success. The Fawn Township test took place during May, 1972 with approximately 10 hectares of recent cutover scarified and seeded. The soil is a deep, medium sand with occasional large boulders and very little slash. Relief is moderately broken with gentle-sloping terrain on the test site. The third site straddles the Cosens-Topham Township boundary immediately west of The Shoals Provincial Park. In 1973 and 1974, 18 and 24 hectares, respectively, were treated. Sites were clearcut immediately before scarification. The terrain is flat and the soil is a deep, gravelly, medium to coarse sand. There were numerous high stumps.

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[1]Virtually all of the site-related descriptive terms originate from G.A. Hills' site research (Hills 1955).

EXPERIMENTAL PROCEDURES

The basic purpose of the trials was to test the operational capabilities of the scarifier-seeder and to continue modifying it as necessary until it performed satisfactorily. Consequently, ground sampling procedures were not an integral part of the trials but were conducted subsequently to assess seed and seedling distribution and biological success. Sample plots were established only temporarily and could not be relocated precisely at each remeasurement. Elaborate statistical analysis of results is not justified under such circumstances. However, the consistent success achieved warrants publication if only to illustrate the potential of row seeding as an effective regeneration technique.

On the Fawn and Haughton sites, sampling up to 1975 was conducted along the scarified rows created by passage of the unit. A sampling quadrat was defined by scalp width and desired spacing between established trees, i.e., 2 m. Groups of consecutive quadrats were established for the assessment of scarification, stocking and density. Scarification was assessed to determine how consistently the test unit prepared a "suitable seedbed" (defined by Riley (1975) as "exposed mineral soil with a firm base, a thin duff/mineral soil mix which will readily settle to a firm base, or form mineral soil with a very thin duff layer"). Percent scarification is the percentage of quadrats with suitable seedbed. Percent stocking is the percentage of quadrats with at least one seedling. Seedling density is based on a total count on every tenth quadrat and is expressed in terms of mean number of seedlings per quadrat. Seedling height is the mean total height of the tallest seedling in each stocked quadrat.

Measurement of seeding rate under operational conditions required careful scrutiny of the freshly seeded site, counting exposed seeds and sorting through small piles of loose soil (these were quite minimal) in the scalp to find any buried seed. Seeds were recorded on every 30-cm interval of scalped rows for 20 consecutive intervals. In this report seed distribution is shown only for 1.8 m intervals.

Sampling along the row as described above does not permit estimation of the percentage of the total treated area that is in the acceptable seedbed category, because it does not measure the effect of variations in interrow spacing. Consequently, in 1976 all remeasurements on the Fawn and Haughton sites were conducted across the rows. Since the assessments of Cosens-Topham were concerned with the effectiveness of scarification for aerial seedling they were initiated across the rows in 1975. This provided a continuous line-plot sampling of the treated area. In the Cosens-Topham assessment the sample plot was 50 consecutive quadrats, approximately 2 m x 2 m. Each quadrat was assigned to one of six classes on the basis of the percentage of its surface area regarded as suitable seedbed.

RESULTS

Scarification

Percent scarification (along the row) attained during the 1972-1974 testing is shown in Table 1. These results reflect the performance of the unit prior to the incorporation of the Michigan Float Hitch. With its addition, percent scarification along the row consistently exceeded 90%; therefore, no more measurements of this parameter were taken after 1974.

Table 1. Percent scarification on Fawn and Haughton sites, 1972-1974.

Location (Twp)	Seeded (mo/yr)	Assessed (mo/yr)	No. of quadrats	Mean percent scari-fication	Soil horizon exposed	
					Ah/Ae	B
Fawn	5/72	7/74	180	81.0	45.4	35.6
Haughton	5/73	6/74	420	78.5	43.0	35.5
	5/74	6/74	200	93.5	45.5	48.0

Table 2 shows the distribution of plots in six degrees of scarification for the 1973 and 1974 trials in Cosens and Topham townships. By multiplying the mid-point of each percent scarification class by the number of quadrats in each class, the mean was derived for each year of treatment. For 1973 and 1974 they were 24.5% and 24.9%, respectively. The results show that, although furrow width was variable, more than 90% of the quadrats had some acceptable seedbed and an overall seedbed availability of about 25% was attained.

Table 2. Variation in percent scarification on Cosens-Topham sites.

Scarified (mo/yr)	Assessed (mo/yr)	No. of quadrats	Degree of scarification (%)					
			0-5	6-15	16-25	26-35	36-45	46+
8-9/73	10/75	500	27.2	18.5	12.1	18.1	10.0	13.0
8/74	10/75	350	20.6	18.6	24.9	13.7	9.1	13.1

Seeding

Percent stocking, seedling density, and the mean height of the tallest seedling in each quadrat are shown for the four tests in Fawn and Haughton townships (Table 3). Apparent increases in percent stocking and density in 1977 probably reflect the measurement of different plot areas rather than additional germination.

Table 4 shows the variation in seedling density at the time of the most recent assessment. Some of the variation in seeding rate reflects a change of seed plates and gear arrangements in the drive mechanism at different points in the seeder's development.

Table 3. Percent stocking, density and total height of plantations seeded during the 1972-1975[a] period.

Location (Twp)	Date seeded (mo/yr)	Date assessed (mo/yr)	Percent stocking		Seedling density		Total height (cm)
			No. of quadrats	%	No. of quadrats	Seedlings /quadrat	
Fawn	5/72	7/73	400	84	40	4	-
		7/74	180	81	-	-	-
		7/75	80	91	80	3	62.5
Haughton	10/72	8/73	300	94	30	6	-
		7/75	40	82	33	6	34.3
		9/77	120	95	114	8	84.4
	5/73	8/73	100	100	10	6	-
		6/74	420	78	-	-	-
		7/75	80	80	64	3	23.5
		9/77	137	87	119	4	76.3
	5/75	5/76	40	70	28	4	-
		9/77	113	64	72	3	32.4

[a] Seeding during the 1974 tests was accomplished using the Stanhay S870 (Mark II Model) - a belt seeder. Consequently these seeding results are excluded from this and subsequent tables.

Table 4. Variation in seedling density resulting from use of International Harvester plate seeder.

Location (Twp)	Date seeded (mo/yr)	Date assessed (mo/yr)	Percentage quadrats by seedling density					Mean number of seedlings/quadrat
			1	2	3	4	5+	
Fawn	5/72	7/75	29	25	23	11	12	3
Haughton	10/72	9/77	8	11	5	7	69	8
	5/73	9/77	10	21	13	24	32	4
	5/75	9/77	23	23	21	14	19	3

The effectiveness of the seeder in metering tree seed, and the number of seeds required to produce an established tree seedling, are critical factors in determining the potential of row seeding to minimize seed requirements. Table 5 shows the number of seeds found along 1.8 m segments of scarified row and the number of seedlings resulting. These two counts, unfortunately, are not for the same plot areas. In the seed count study, 883 seeds were found on 53 quadrats for a mean of 17 seeds per plot. In the seedling count 247 seedlings were found on 73 quadrats for a mean of four seedlings per plot. This suggests that, on the average, four seeds are required to produce one established seedling.

Table 5. Seed and seedling distribution for 1.8 m row segments (Haughton 5/75).

Percent of seed distribution		Percent distribution of seedlings	
No. of seeds	% distribution of quadrats	No. of seedlings	% distribution of quadrats
0- 5	0	None	0
6-10	9	1	23
11-15	30	2	23
16-20	42	3	21
21-25	19	4	14
26+	0	5+	19
	100		100

The mean inter-row spacing for this seeding was 2.6 m. This results in approximately 3,850 m of row per treated hectare of cutover. Therefore, a mean seeding rate of 17 seeds per 1.8 m plot represents application of 35,700 seeds per hectare.

DISCUSSION AND CONCLUSION

The data collected during the developmental testing of this unit suggest that reasonably good stocking and density can be obtained quite consistently by row seeding. The low stocking obtained from the May, 1975 seeding probably reflects the effect of adverse weather during the early germination stage and it is suggested that this represents about the poorest performance that might be expected.

There is some evidence that seed movement along the scarified row can reduce seedling stocking, although this occurred only rarely on the sites tested. A more effective method of pressing seed into the soil or shallowly burying it might alleviate this problem.

If, on the average, approximately four seeds dropped on suitable seedbed produce one established seedling on these sandy sites, there is considerable potential for reducing seed consumption by using ground seeding equipment which can direct seed to receptive seedbed consistently and accurately. Approximately 4,000 m of prepared row per hectare would require only 16,000 seeds per hectare. This is considerably lower than the 50,000 seeds per hectare applied in aerial seeding. Even a built-in safety factor of two would mean that only 32,000 seed per hectare are necessary, a reduction of almost 40% over the normal aerial application rate. Furthermore, the reduced density and more uniform distribution of the resulting stands would permit growth rates approximating those of plantations.

A number of successful operational techniques have been developed for regenerating jack pine sites. We are now in a position with this species to seek improved technologies in terms of either superior biological performance or cost savings. For jack pine sites where severe plant competition does not develop, and seeding is feasible, there is strong evidence that row seeding offers considerable advantages over aerial seeding.

This study indicates the potential of row seeding for reducing sowing rate of jack pine to perhaps 15,000-20,000 seeds per hectare, and for obtaining consistently acceptable stocking and density. It should encourage continued development of a reliable seeding unit, and the subsequent operational use of this technique.

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