Plot trials to assess the potential of using pulpmill wood waste in land reclamation

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Abstract

In 1986, a field trial was established near Second Falls, N.B. to assess the potential of using pulpmill wood waste as a soil ameliorant for land reclamation. Three types of wood waste were spread on mineral soil and subsequently planted with black spruce (*Picea mariana* (Mill.) B.S.P.). After one growing season, it became evident that either a fertilizer application or nitrogen-fixing vegetation was necessary for seedling survival and growth. The design was upgraded to a series of plot trials that included fertilizer applications and nitrogen-fixing vegetation. This report includes the growth rates of plants in different plots and provides potential direction for future research and development activities to facilitate reclamation and reforestation of degraded and unproductive sites.

Résumé

En1986, on a procédé à un essai près de Second Falls (N.-B.) pour évaluer le potentiel des déchets ligneux industriels d'une usine de pâte comme produit d'amendement pour l'assainissement des terres. Trois types de déchets ligneux ont été épandus sur du sol minéral avant la plantation d'épinettes noires (*Picea mariana* (Mill.) B.S.P.). Au bout d'une saison de croissance, il était manifeste que soit l'épandage d'un engrais, soit la plantation d'une végétation fixatrice d'azote s'imposait pour assurer la survie et la croissance des semis. Le projet a ensuite donné lieu à une série d'expériences englobant l'épandage d'engrais et la plantation de végétation fixatrice d'azote. Le présent rapport fait état des taux de croissance des végétaux sur différentes placettes et donne des directives au sujet des activités de recherche-développement futures visant à faciliter l'assainissement et le reboisement de sites déclassés et improductifs.

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Introduction

A typical eastern Canadian pulp mill produces over 385 m^3 of wood waste daily. Traditionally, this primarily organic material has been treated as an industrial waste with disposal costs in excess of $6/$m^3$ (West and Bishop 1987). Incineration and landfill dumping are the most common disposal methods. However, environmental concerns and stricter government regulations have made it increasingly difficult and expensive to locate and operate suitable landfill sites (Campbell *et al.* 1993). In 1985, the Canadian Forest Service and Fraser Inc. initiated a partnership to investigate the potential of using some or all of the components of pulpmill waste to reclaim degraded and unproductive sites. Such sites would include abandoned haul roads and log landings, where the organic matter has been depleted or removed. Using waste to reclaim these sites is seen as an environmentally acceptable method of converting a disposal problem into an asset.

The most common types of wood wastes created are knots, grit (a combination of bark, branches, stones, and dirt that is removed as a residual from the grit chamber), sludge (the broken wood fiber that collects in the bottom of the clarifier), and bark. Bark collected in the debarking operations and knots, which cannot be used in the pulping process, are now used as hog fuels and, therefore, are no longer disposed of as waste products. Sludge, which represents 10% of the waste products, is unsuitable as a fuel because of its high moisture content. Grit represents 80% of the waste and is unsuitable as a fuel because of its high content of stones and dirt.

In the winter if 1985, a 29-week greenhouse trial was conducted to test the feasibility of using knots, grit, and clarifier sludge as growing media for black spruce seedlings. The initial tests were conducted in the Acadia Forest Experiment Station greenhouse using wooden boxes (120 x 120 x 30 cm) as simulated transplant beds. Each waste type, and a composite of all three, was tested separately. A fifth box was filled with nursery soil as a control. Each box was divided in two, one half containing only the component being tested, and the other the material spread over 10-13 cm of gravel. Although knots are primarily used as hog fuel, they were included in the tests to see if they might have a higher value as a land reclamation ameliorant.

The greenhouse trials demonstrated that black spruce seedlings could grow in the pulpmill wood wastes (West and Bishop 1987). Even though the height growth of seedlings in the waste materials was considerably less than that in the control, the waste materials showed good potential as soil ameliorants for reclamation of unproductive sites. Other trials by Monnon (1988) have shown that European black alder (*Alnus glutinosa*) will grow under greenhouse conditions, in sludge, and in a composite of the three waste types.

This report documents the findings of an elaborate series of demonstration plots established to evaluate the potential of these wood wastes as soil ameliorants. Fertilizer applications and nitrogen-fixing vegetation were also included in most of the plots.

Field Trials

A field trial was established in 1986 to assess the potential of using pulpmill waste in land reclamation with minimal cultural treatments. An unproductive log landing site adjacent to the main haul road near Second Falls, N.B. (47.57 N, 68.13 W) was used for the trials (Fig. 1). Each of the three waste types (knots, grit, and sludge) was spread to a depth of 25 cm on adjacent blocks, which ranged in size from 18 x 13 m to 16 x 10 m. The blocks were spaced approximately 7 m apart. The design

Figure 1. Overview of study area

was replicated on an adjacent area where the mineral soil substrate was first loosened to a depth of 60 cm using a bulldozer ripper tooth. Within the ripped area, an 18-m strip of undisturbed substrate was left for an 8 x 10 m control where seedlings were planted directly into the undisturbed mineral soil substrate.

Each block receiving the waste material was divided into four quarters. Two of the quarters in each block were planted on June 12, 1986 at a 0.6-m spacing with over-wintered black spruce seedlings grown in Can-AmR hard-walled containers. The remaining quarters were planted with similar stock on June 18, 1987. Half the control area was planted in the spring of 1986, the other half in the spring of 1987. The height of all seedlings was approximately 13 cm at the time of planting.

In the fall of 1986, all seedlings planted in the waste material were chlorotic and their survival seemed unlikely. These results suggested that pulpmill waste might require additional cultural treatments for use in land reclamation activities. It was decided to upgrade the original design to a series of plot trials to field test the potential of applying fertilizer or planting nitrogen-fixing vegetation in wood waste to enhance its usefulness in land reclamation.

Plot Trial Design

To facilitate upgrading the study to a series of plot trials, the control had to be further divided into four quarters. Fertilizer applications and seeding with nitrogen-fixing vegetation were included in the trials. Except for two of the wood waste block quarters and two of the control quarters, all the quarters received a minimum of one application of fertilizer. Half of the quarters were planted with Dutch white clover (*Trifolium repens*) . The distribution of waste material, cultivation, fertilizer, and seed distribution are shown in Figures 2-8.

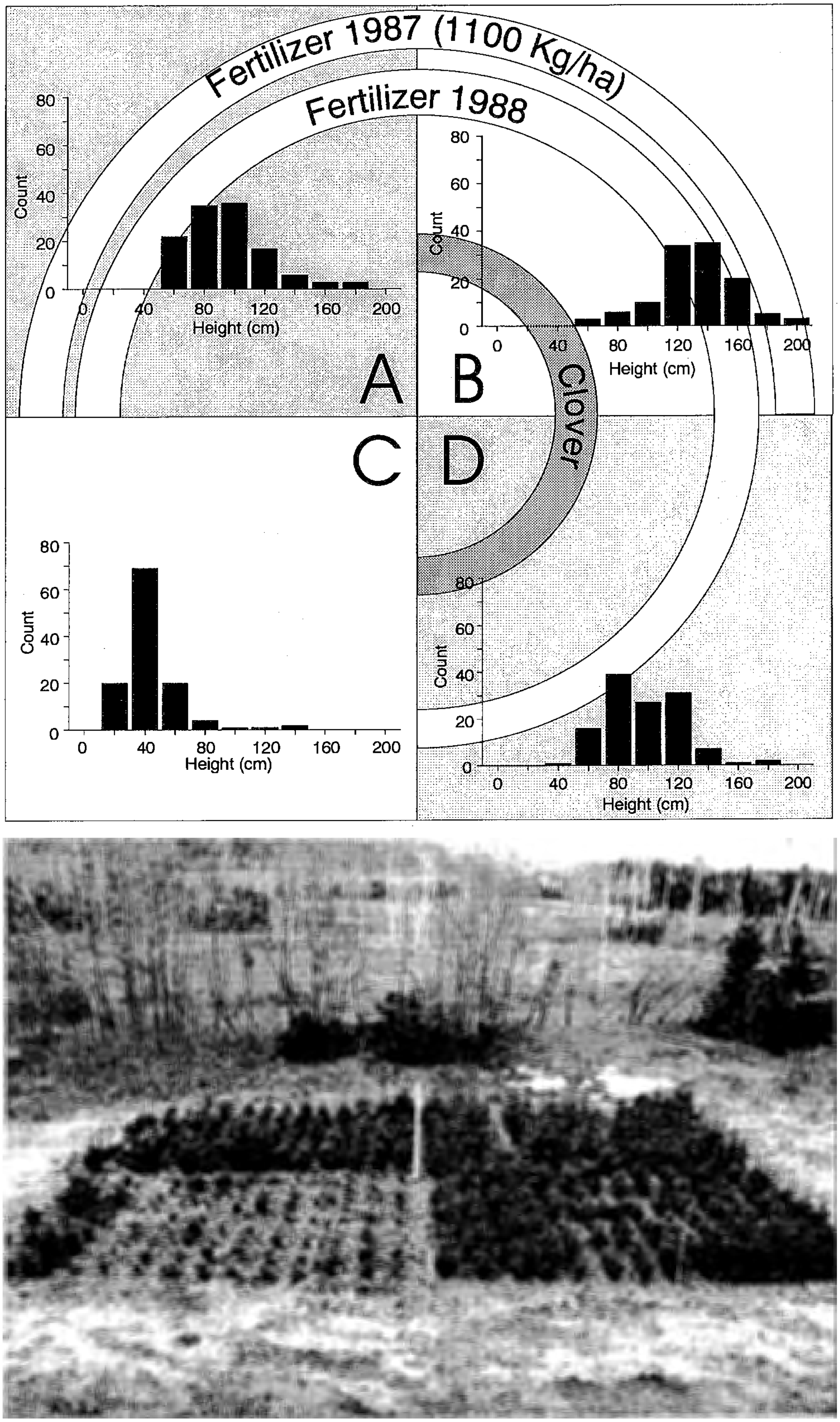


Figure 2. Block 1 utilizing ripped sludge. Shaded squares were planted in 1987, unshaded squares were planted in 1986. Photo was taken May 5, 1994.

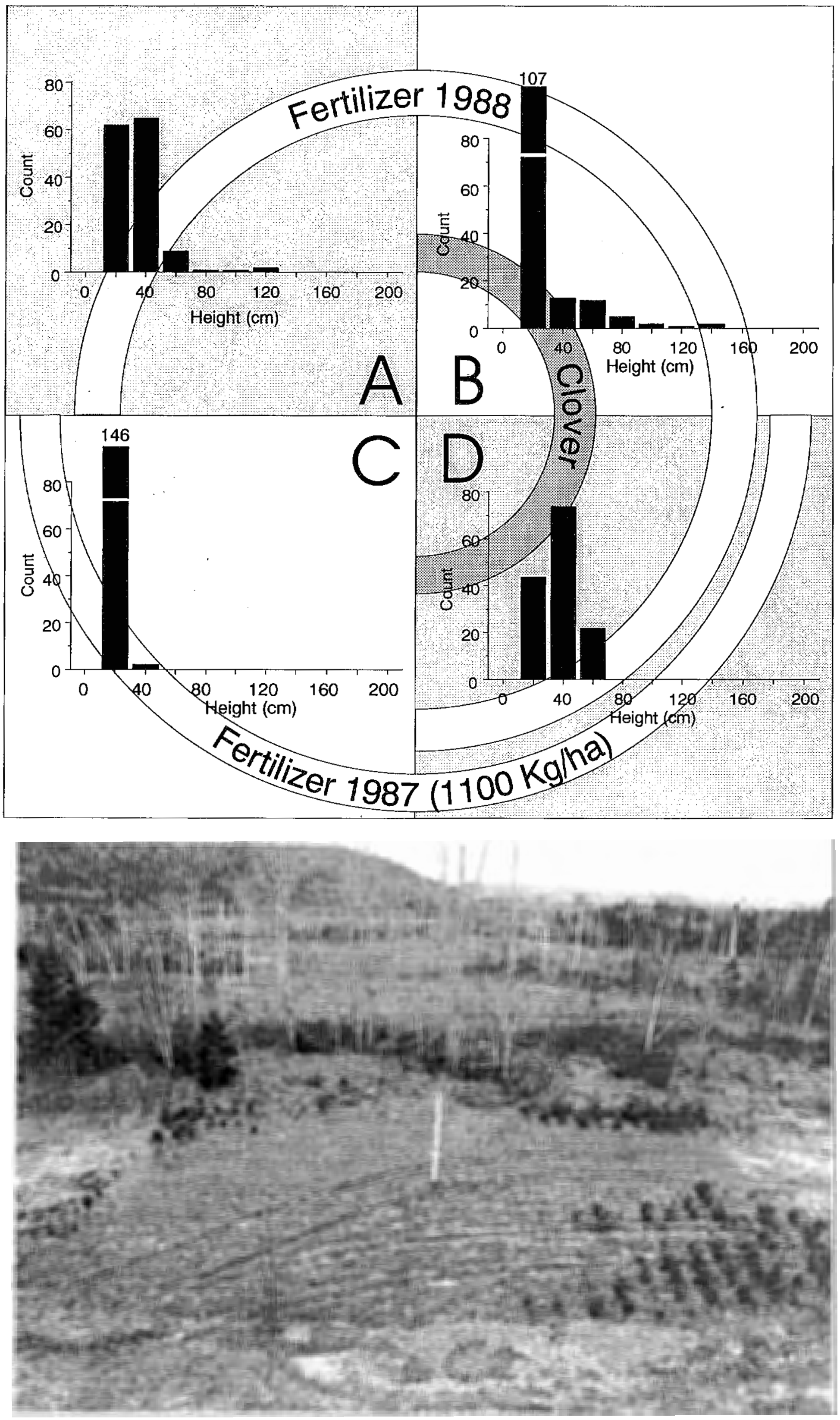


Figure 3. Block 2 utilizing ripped knots. Shaded squares were planted in 1987, unshaded squares were planted in 1986. Photo was taken May 5, 1994.

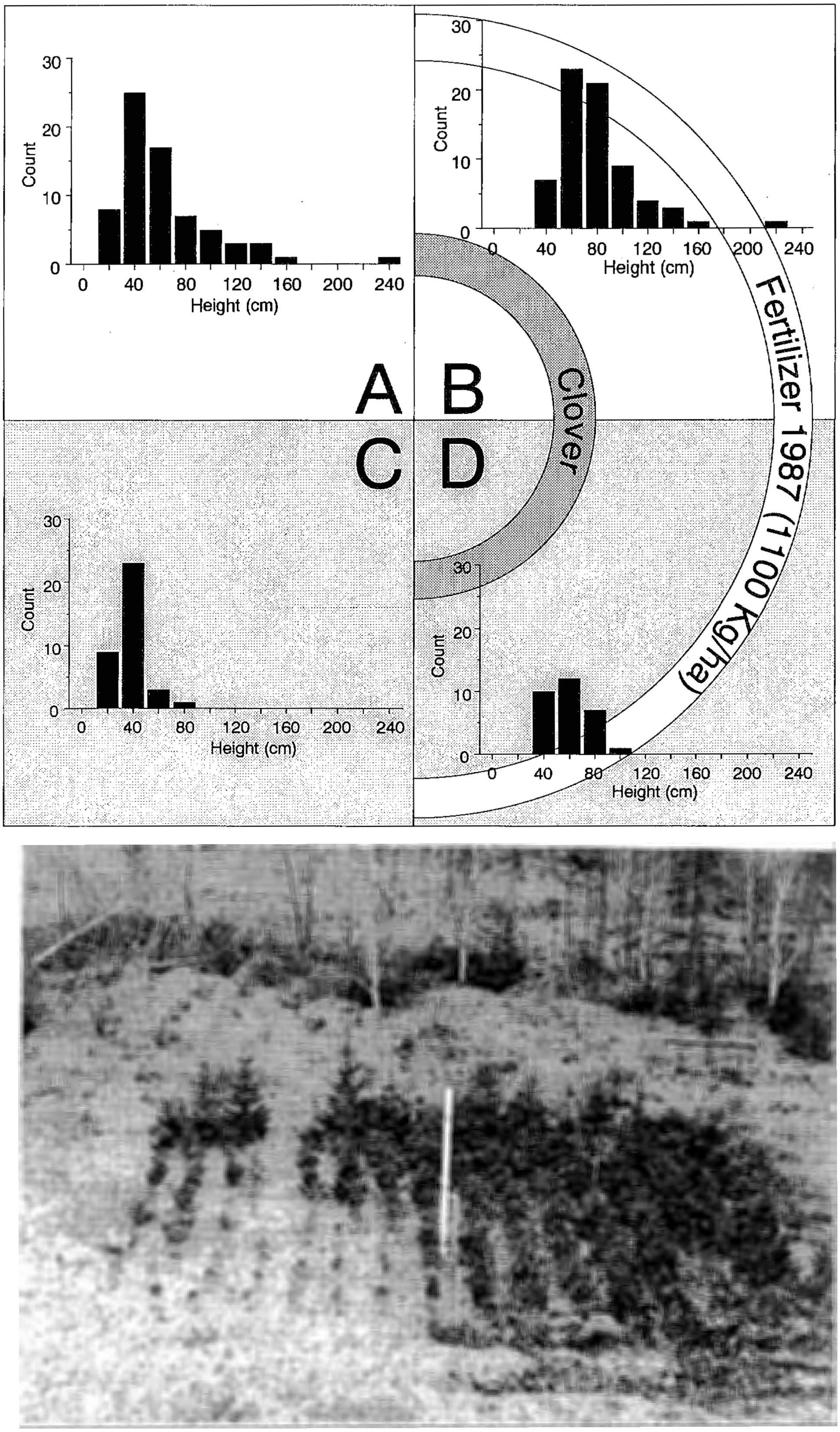


Figure 4. Block 3 (control block). Shaded squares were planted in 1987,unshaded squares were planted in 1986. Photo was taken May 5, 1994.

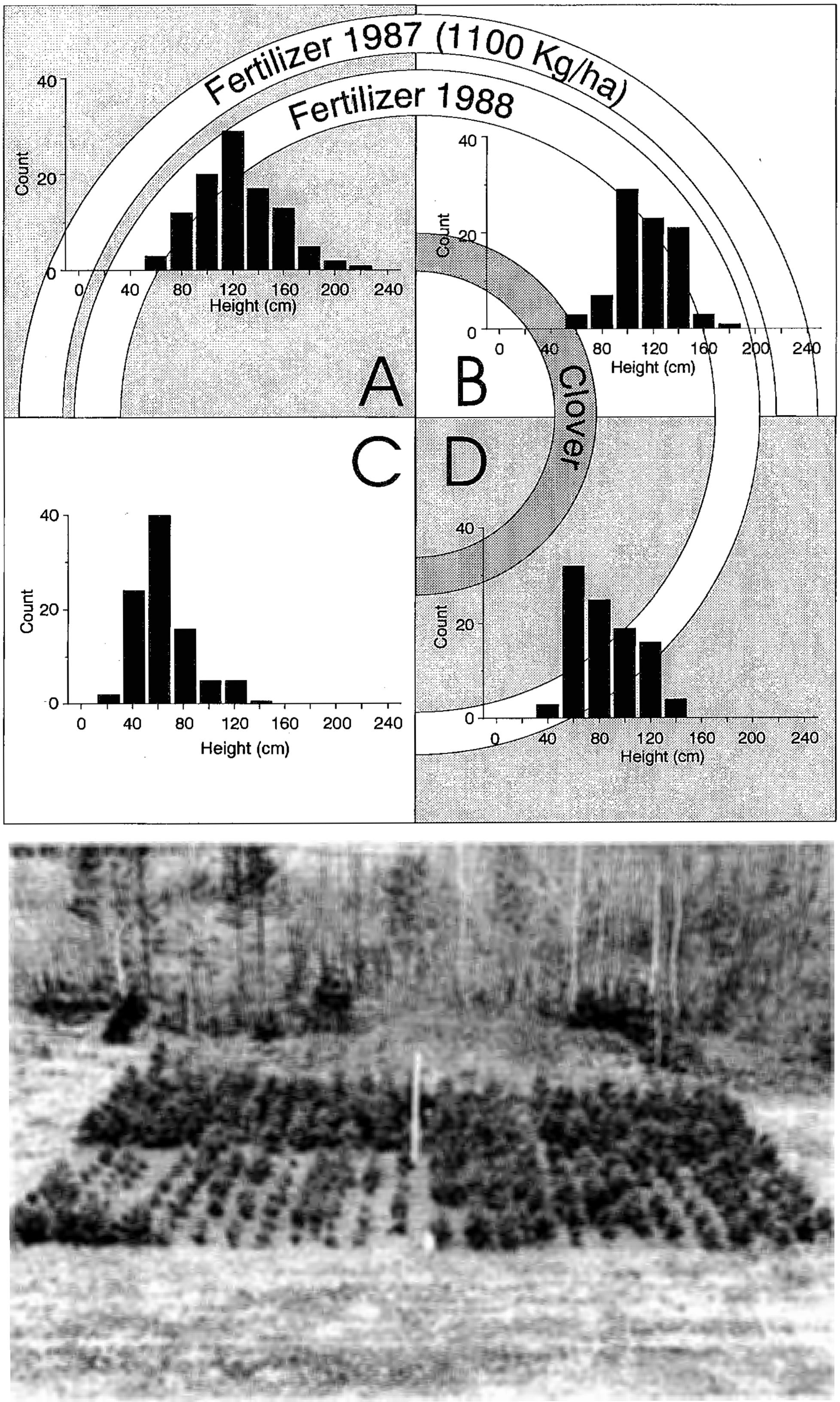
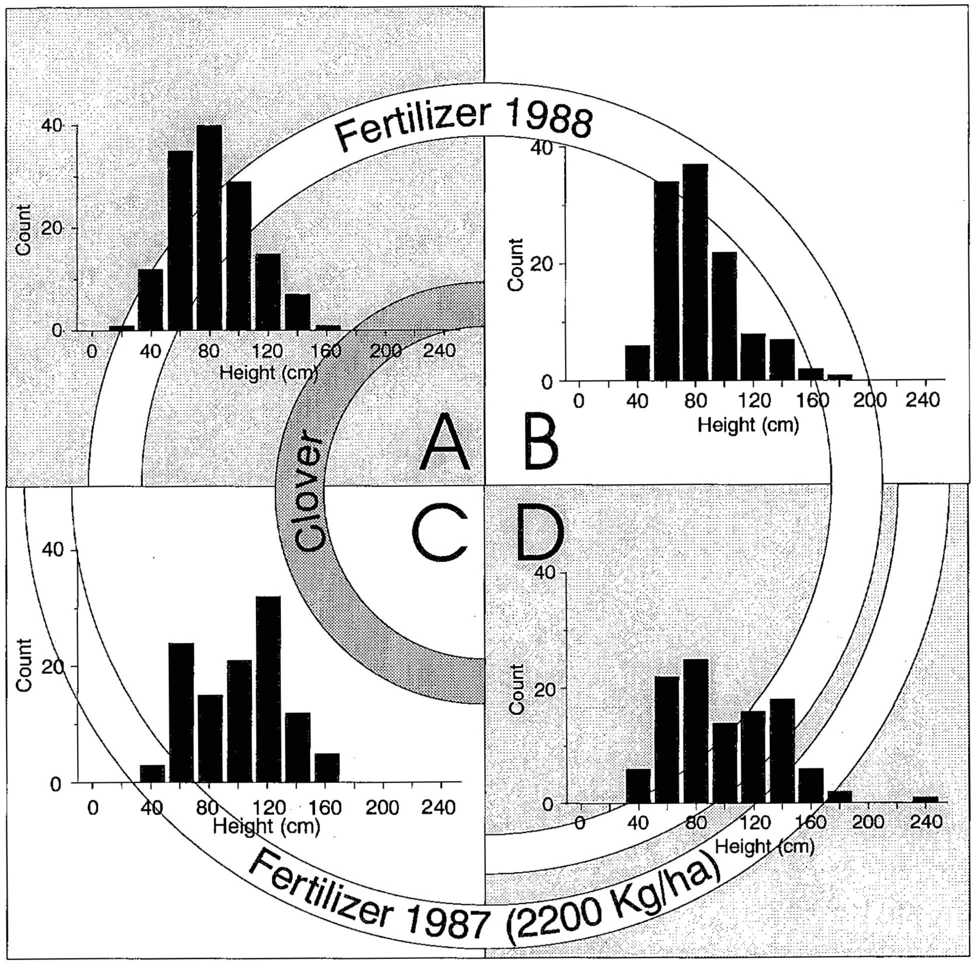


Figure 5. Block 4 utilizing ripped grit. Shaded squares were planted in 1987, unshaded squares were planted in 1986. Photo was taken May 5, 1994.



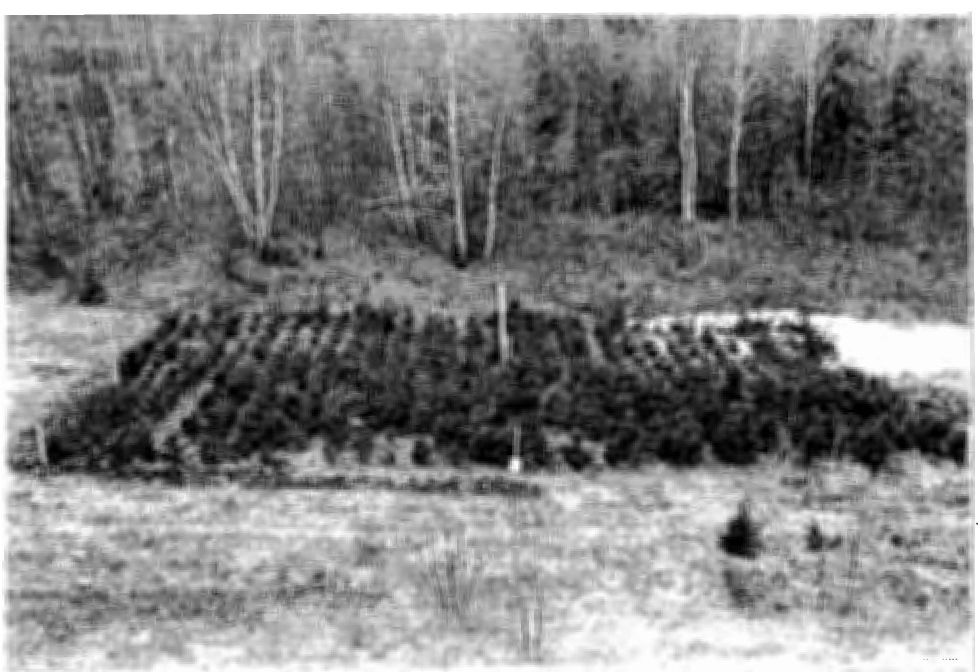


Figure 6. Block 5 utilizing unripped sludge. Shaded squares were planted in 1987, unshaded squares were planted in 1986. Photo was taken May 5, 1994.

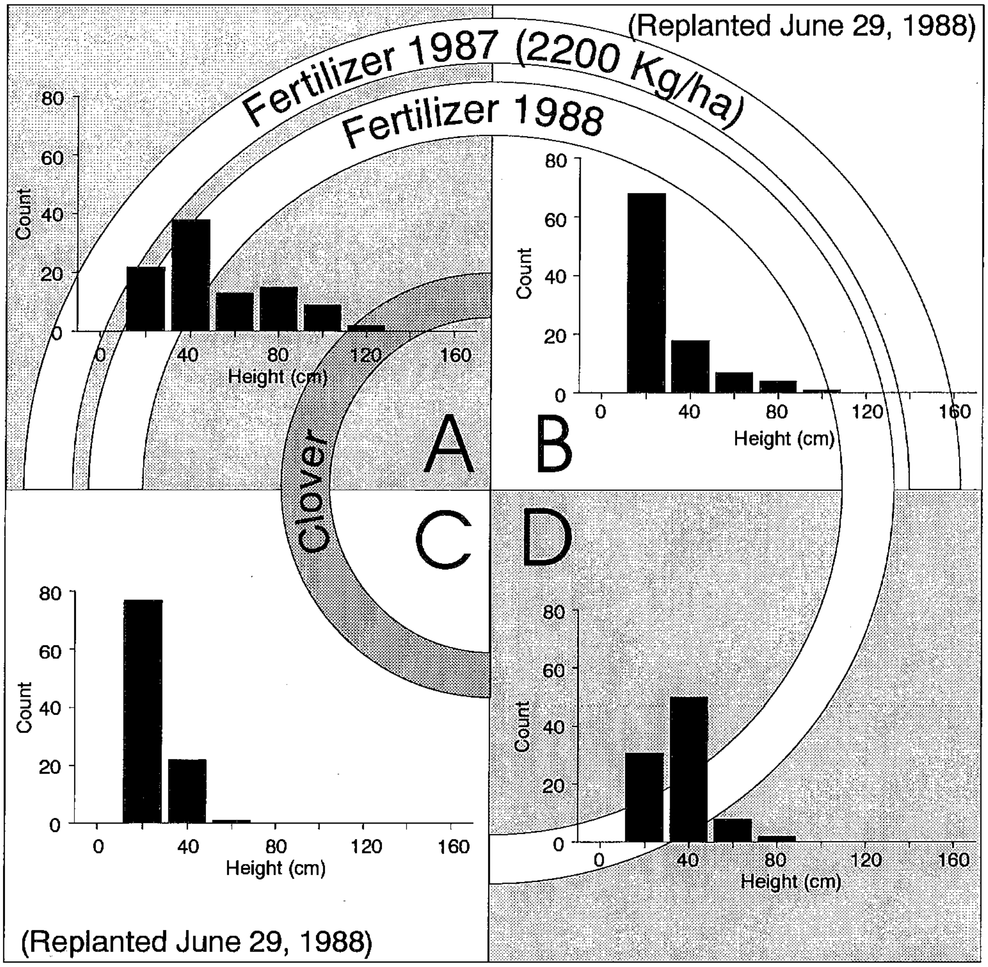
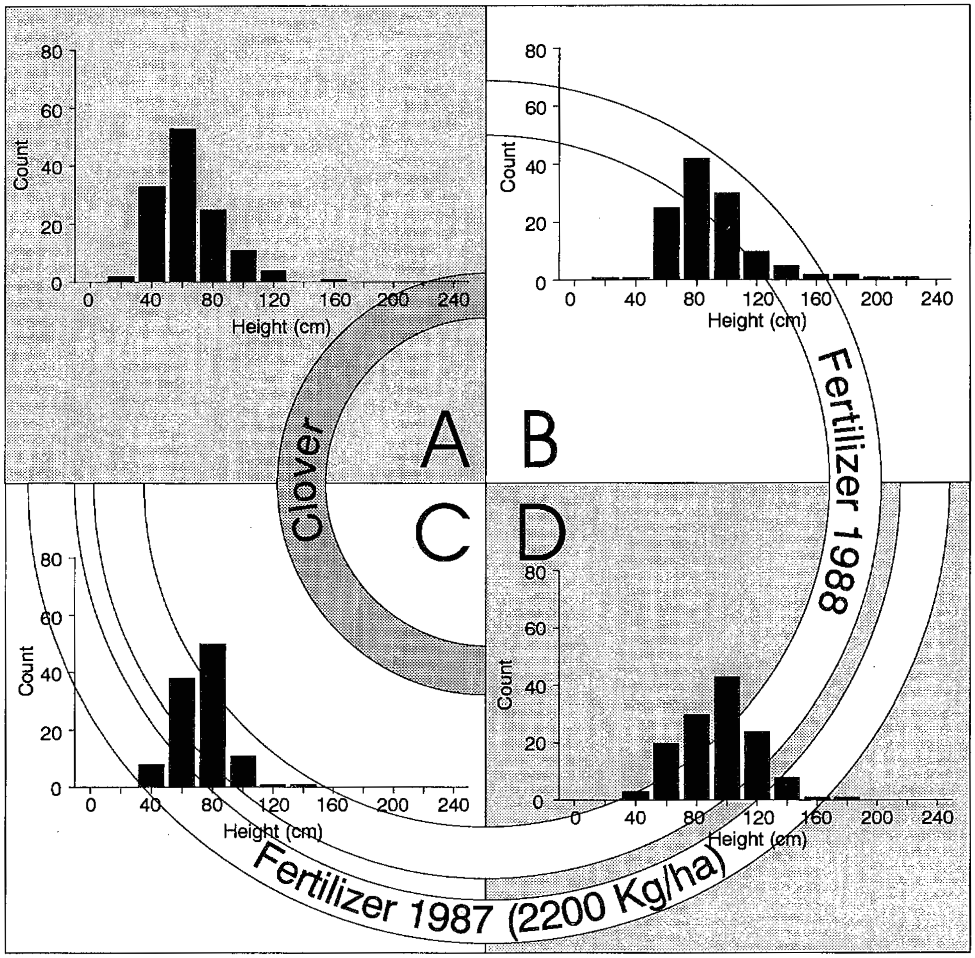


Figure 7. Block 6 utilizing unripped knots. Shaded squares were planted in 1987, unshaded squares were planted in 1986. Photo was taken May 5, 1994.



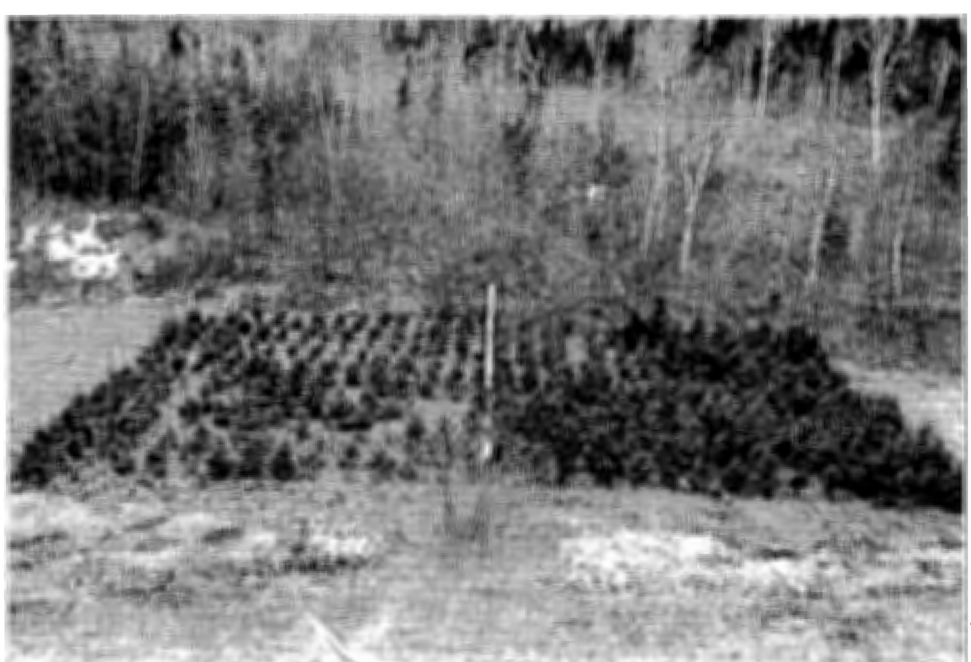


Figure 8. Block 7 utilizing unripped grit. Shaded squares were planted in 1987, unshaded squares were planted in 1986. Photo was taken May 5, 1994.

Table 1: Percentage of seedlings achieving or exceeding 0.75 m[1] after five growing seasons

Block	Quarter A %	A #	Quarter B %	B #	Quarter C %	C #	Quarter D %	D #
1	20	(122)	22	(117)	2	(118)	15	(124)
2	1	(146)	0	(151)	0	(152)	0	(146)
3	8	(71)	6	(70)	3	(36)	10	(30)
4	40	(103)	15	(95)	0	(93)	3	(100)
5	5	(143)	1	(124)	1	(117)	37	(111)
6	11	(101)	1	(98)	0	(100)	0	(98)
7	2	(130)	6	(121)	1	(116)	36	(131)

[1] NBDNRE standard for 5-year-old spruce plantations (1989)

Table 2: Percentage of seedlings achieving or exceeding 0.75 m[1] - 1993 measurements

Block	Quarter A		Quarter B		Quarter C		Quarter D	
Growing seasons	(7)		(8)		(8)		(7)	
	%	#	%	#	%	#	%	#
1	75	(122)	95	(116)	6	(117)	84	(124)
2	2	(140)	6	(142)	0	(150)	0	(140)
3	27[1]	(70)	51	(69)	3[2]	(36)	23	(30)
4	96	(102)	95	(87)	24	(93)	61	(99)
5	59	(140)	56	(117)	69	(112)	68	(110)
6	18	(99)	4[3]	(98)	0[3]	(100)	2	(91)
7	26	(129)	70	(120)	47	(109)	77	(130)

[1] 1986 planting - 8 growing seasons

[2] 1987 planting - 7 growing seasons

[3] 1988 planting - 6 growing seasons

The fertilizer treatments included Osmocote 18:6:12 slow-release (8 to 9 months) applied at 1100 or 2200 kg/ha to various quarters in June 1987, and 10:10:10 granular fertilizer applied at the rate of 2000 kg/ha in June 1988. Two quarters in each block were seeded in July 1988 with Dutch white clover at the rate of 12.8 kg/ha.

Results and Observations

The series of plot trials with fertilizer and nitrogen-fixing vegetation was designed to assess growth trends and was not intended for scientific evaluation. The wide range of results with the different waste/treatment combinations are illustrated in the diagrams and accompanying photos in Figures 2-8.

The height growth of all planted seedlings was monitored annually. The results of these surveys are compared in Tables 1 and 2 using the New Brunswick Department of Natural Resources and Energy's (NBDNRE) standard for height growth (0.75 m) (NBDNRE 1989) 5 years after planting.

In addition to assessing height growth, the field crews made the following observations:

1) A large number of natural balsam fir (*abies balsamea*) seedlings germinated on the sludge in Block 5 in 1985. These seedlings did not survive into the following growing season.

2) Dutch white clover failed to germinate following seeding on the control and on quarter blocks containing knots or unfertilized sludge. Clover that successfully germinated survived 2 to 4 years.

3) As the clover was not treated with rhizobial inoculum before seeding, the nitrogen-fixing capacity was probably minimal.

4) There was a light cover of clover and a significant amount of natural vegetation present in Blocks 5 and 7 in 1989. Field crews observed evidence of red-backed voles (*Clethrionomus gapperi*) in these blocks. Given favorable habitat, rodent damage can be a significant factor in tree seedling mortality.

5) The ripped and unripped areas between the treatment blocks have remained unvegetated throughout the trial period (Fig. 1).

6) Smothering fungus (*Thelephora terrestris*) has been common in Blocks 4 and 7 (grit) since 1991. The fungus did not appear to have any impact on seedling growth. There may be a need for further investigation to determine if the occurrence of this fungus has any long-term effect on seedling growth and development or nutrient availability.

7) With the exception of two quarter blocks, seedling mortality in all treatment types has been less than 10% throughout the period of the trials. Quarters B and C in Block 6 had 90% mortality in the year after planting. The mortality of seedlings replanted in these quarter blocks in June 1988 remained at less than 10%. The overall mortality for the plot trials is 5%.

8) Sludge and the underlying mineral soil requires more time to thaw in the spring than the other treatments. This could be a significant factor influencing winter drying of out-planted stock.

9) Seedlings in Blocks 2 and 6 are so small that most are not detectable on the photographs.

Conclusion

The growth and development of seedlings outplanted in some of the plots in this series of trials have been very encouraging. These results support the need for more elaborate and properly replicated research trials using both grit and sludge in land reclamation activities. Fertilizer application or nitrogen-fixing vegetation is necessary to ensure tree seedling growth meets NBDNRE standards. Research will be necessary to determine the most desirable nitrogen-fixing vegetation and rates of fertilizer application.

Although not specifically tested in these trials, the positive effects of fertilizers and nitrogen fixers would suggest that composting of wood waste prior to application may provide a suitable growing medium. This could be an approach that would address the biological, economic, and environmental aspects of the project and should be seriously considered as a research option.

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