GROUND COVER CONTROL WITH HERBICIDES TO ENHANCE TREE ESTABLISHMENT ON OIL SANDS RECLAMATION SITES[1]

by

Martin Y.P. Fung[2]

Abstract. A dense vegetative ground cover of grasses, legumes and weeds, essential for stabilization and amelioration of reconstructed soils, is detrimental to the establishment of tree seedlings on oil sands reclamation sites. Trees are required to meet the land reclamation productivity targets set for Syncrude Canada Ltd. Two herbicides[3], amitrole and glyphosate, were evaluated for their efficacy in releasing tree seedlings from competing herbaceous vegetation. Glyphosate was the most effective in reducing ground cover density. Five-year results showed that seedlings on glyphosate treated plots had significantly better survival rate and annual growth increment than did either the seedlings on the amitrole or the control plots.

Additional Key Words: amitrole, glyphosate, surface mining, herbaceous vegetation, tree seedling, growth increment.

Introduction

Syncrude Canada Ltd. is the largest oil sand extraction operation in the world and the second to produce synthetic crude oil from the Athabasca oil sands deposit on a commercial basis. It is located in Fort McMurray, Alberta, Canada. Today, one of every ten barrels of crude oil produced in Canada comes from this plant (Texaco Canada Inc. 1983).

As with all surface mining operations, lands are drastically disturbed. At Syncrude, two major "soil" types requiring restoration are overburden spoils and tailings sand. Syncrude is bonded by legislation to reclaim all disturbed lands to meet standards set by the Land Conservation and Reclamation Council of Alberta; the general reclamation guidelines being the establishment of a self-sustaining forest ecosystem compatible with the surrounding unmined areas.

At Syncrude's reclamation sites, restoration of disturbed areas necessitates soil reconstruction and nutrient supplement. This is followed by rapid establishment of pioneer herbaceous ground cover (grasses, legumes and weeds) for erosion control and soil amelioration. After a year or more, large scale plantings of forest tree seedlings are carried out. However, such reclamation practice has often resulted in the seedlings being suppressed and even killed by the more aggressive herbaceous plants.

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[2]Martin Y.P. Fung is Reclamation Research Scientist, Land Reclamation and Wildlife Department, Syncrude Canada Ltd., Edmonton, Alberta, Canada.

[3]This paper reports the results of research only. Mention of herbicide names does not constitute endorsement of the products by Syncrude Canada Ltd.

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The objective of this study was to evaluate the efficacy of two herbicides, amitrole and glyphosate, for releasing tree seedlings from competing vegetation and to document seedling survival and growth after the initial release.

Site Description

The study site was located on the level surface of an overburden spoil. The soil was structurally heterogeneous. In 1976, after the spoil was graded, it was fertilized with N, P and K and hydro-seeded at 112 kg/ha with a seed mixture shown in Table 1.

In the fall of 1980, the area was deep ploughed to alleviate soil compaction. Containerized white spruce (*Picea glauca* (Moench) Voss) seedlings were planted soon after ploughing.

The climate of the area is generally cool-temperate with long, cold winters and short summers, often with only brief periods of 24°C and above. There is a growing season of about 95 days from June through August with an extended period of daylight during June and July. The total annual precipitation is approximately 44 cm and of that 30 cm is recorded as rainfall (Longley and Janz 1978).

Material and Methods

Two systemic herbicides, amitrole and glyphosate, were used in this study. Systemic herbicides were selected because of their capabilities to demolish the entire plant. This could be advantageous on deep rooted plants such as bromegrass and sweet clover where a complete kill is desirable to prevent subsequent sprouting.

The experiment was laid out in a randomized block design with three replications. The treatments implemented were: control (no treatment), amitrole at 20 and 30 l/ha, and glyphosate at 4.75 and 9.50 l/ha.

Using a hand-held sprayer, the herbicides were applied in strips 2 meters wide by 50 meters long, with a 2-meter buffer between treatment plots. The strips were oriented perpendicular to the rows of planted seedlings to include as many seedlings as possible within each plot. To prevent herbicide damage, each seedling was covered with a plastic cone during spraying. The effect of the herbicides on the vegetation was assessed from all the treatment plots six weeks after the date of application.

Two permanent ground cover monitoring stations (2 meters x 2 meters) were randomly established within each treatment plot. From these stations, visual estimates of percent ground cover were made annually in mid-July. In the fall, annual seedling survival and growth increment were assessed from all seedlings within all the treatment plots.

Results and Discussion

Ground Cover

The mean ground cover percent estimates over a 5-year period are presented in Table 2. Visual assessment of the total vegetation killed six weeks following the herbicide application, indicated that the glyphosate was more potent than the amitrole. The glyphosate was more effective in eradicating the grass than the legume species at both rates of application. The opposite effect was true for amitrole. As well, glyphosate was capable of killing the entire plant whereas amitrole was only partially effective.

The effect of the herbicide treatment was short lived. By the following year, the ground cover percentages on the treated plots had increased to approximately 50 percent. They were nevertheless still much less than those of the control plots. On the amitrole treated plots, the vegetation present was mainly regrowth from the partially killed mature plants, whereas on

Table 1. Seed mixture sown in the study site.

Common Name	Scientific Name
Slender wheatgrass	*Agropyron trachycaulum* (Link) Malte.
Pubescent wheatgrass	*Agropyron trichophorum* (Link) Richt.
Smooth bromegrass	*Bromus inermis* Leyss.
Creeping red fescue	*Festuca rubra* L.
Timothy	*Phleum pratense* L.
Canada bluegrass	*Poa compressa* L.
Birdsfoot trefoil	*Lotus corniculatus* L.
Alfalfa	*Medicago sativa* L.
Sweet clover	*Melilotus alba* x *officinalis*
Sainfoin	*Onobrychis viciaefolia* Scop.

Table 2. Summary of mean percent live ground cover over a 5-year period.

TREATMENT (l/ha)	YEAR AFTER TREATMENT 0	1	2	3	4
Control	70.0	78.3	85.0	77.5	75.5
Amitrole 20	48.4	52.5	74.2	76.7	75.3
Amitrole 30	43.7	49.2	73.3	73.3	68.3
Glyphosate 4.75	22.2	55.8	74.2	79.2	78.7
Glyphosate 9.50	7.7	52.5	77.5	85.8	65.0

the glyphosate treated plots, the vegetation was mainly young seedlings. Clearly, the mature plants on the control and amitrole treated plots competed more agressively with the tree seedlings than did the juvenile plants on the glyphosate treated plots. The consequences were apparent in the survival and growth increment of the tree seedlings.

The effect of the herbicide treatments had disappeared by the second year after treatment and ground cover density returned to the pre-treatment level.

Seedling Survival

The mean percent tree seedling survival is summarized in Table 3. The survival rates dropped substantially on the control and amitrole 20 treated plots. Seedling mortality was attributed to the high density of mature ground vegetation present during the initial phase (Year 0 and 1) of seedling establishment. On the amitrole 30 and glyphosate 4.75 and 9.50 treatments, where the initial ground cover was less than 50 percent, seedling survival had been excellent. The reduced competition for the first two years facilitated tree seedling root development and egression, enabling them to compete successfully for soil moisture during critical drought periods frequently experienced in the oil sands region.

At the conclusion of the study, statistical analysis of seedling survival showed that seedlings on both the glyphosate 4.75 and 9.50 treatments survived significantly better than seedlings on the control plots. However, no differences were detected in seedling survival between any of the amitrole and glyphosate treatments.

Mean Annual Growth Increment

At the oil sands reclamation sites, tree seedling field performance cannot be rated solely on seedling survival since seedlings often remained alive but chlorotic and stunted over a long period of time. A more reliable method is survival supplemented with annual growth increment.

The seedling mean annual growth increment is shown in Table 4. Growth increment on the glyphosate 9.50 treatment had been consistently more than the increment found on the other treatments since the initial release from the competing vegetation. Analysis of covariance of growth increment measured on the fourth year after the herbicide application showed that the glyphosate

Table 3. Mean percent seedling survival over a 5-year period.

TREATMENT (l/ha)	YEAR AFTER TREATMENT 0	1	2	3	4
Control	100.0	65.3	55.1	52.0	52.0 a*
Amitrole 20	100.0	75.5	67.2	62.1	62.1 ab
Amitrole 30	100.0	92.3	81.1	75.0	71.2 ab
Glyphosate 4.75	100.0	86.0	86.0	80.0	78.4 b
Glyphosate 9.50	100.0	83.0	77.8	80.0	76.0 b

*Means followed by the same letter are not significantly different ($P \leq 0.05$) from one another.

Table 4. Mean annual seedling growth increment (cm) over a 4-year period.

	YEAR AFTER TREATMENT				
TREATMENT (l/ha)	0	1	2	3	4
Control	-	1.09	2.52	3.40	5.54 a*
Amitrole 20	-	2.57	4.10	4.69	7.53 a
Amitrole 30	-	0.87	3.60	3.90	7.89 a
Glyphosate 4.75	-	3.16	5.42	6.90	7.74 a
Glyphosate 9.50	-	3.49	7.60	8.96	10.51 b

*Means followed by the same letter are not significantly different ($P \leq 0.05$) from one another.

9.50 enhanced significantly better growth increment than all the other treatments. Superior growth coupled with excellent survival rates make glyphosate 9.50 a preferred ground cover control treatment in order to achieve the reclamation objectives set for Syncrude Canada Ltd.

Summary

One of the problems encountered during the initial phase of woody plant seedling establishment on oil sands reclamation sites is competition by the more agressive herbaceous vegetation for light, soil moisture and nutrients. Ground vegetation is essential for erosion control and soil improvement. However, it must be properly managed to minimize its adverse impact on tree seedlings. Two herbicides, amitrole and glyphosate, were evaluated for their abilities to control herbaceous cover. Glyphosate at 9.50 l/ha was effective in maintaining vegetative cover density at or below 55 percent for two consecutive years. At this level, seedling survival and growth were significantly improved.

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