27 # Extension Note

August 1998

A Comparison of Mulch Mat and Herbicide Treatments for Reducing Grass Competition in the IDFww

G.J. Harper, P.G. Comeau,
B.S. Biring, W.J. Reid, P. Fielder
Forest Dynamics Section
Research Branch
B.C. Ministry of Forests
P.O. Box 9519 Stn Prov Govt,
Victoria, BC V8W 9C2
(250) 387-6721

IDFww - Wet Warm Interior Douglas-fir Subzone

"…This subzone represents the wettest and mildest part of the IDF zone… Forests are dominated by Fd with minor amounts of low-vigour Hw and Cw. The understorey is characterized by a well-developed shrub layer containing a diverse mixture of species…" (Green and Klinka 1994)

Introduction

In the warm wet Interior Douglas-fir biogeoclimatic subzone (IDFww), mechanical and herbicide site preparation and brushing treatments have been used to establish planted conifers. These silviculture treatments have been prescribed to control grass and shrub competition which rapidly develops after harvesting. Many of these sites, especially those with a southern aspect, have experienced poor survival of planted Douglas-fir. Poor plantation establishment has been attributed to poor stock quality and severe grass and shrub competition for soil moisture. Innovative brushing methods are needed for the establishment of Douglas-fir on these dry sites. Herbicide and mulch mat treatments have been used with some success.

Glyphosate herbicide has been widely applied in forestry as an effective vegetation control treatment. Hexazinone herbicide has also been used. Both herbicides have been shown to effectively control grass if applied while the grass is actively growing (Boyd et al. 1985; Fahlmann and Herring 1985). However, conifers are also very sensitive to herbicide application during the active growing period. Consequently, growing-season treatments must be applied either before conifer seedlings are planted (pre-plant application), before conifer growth begins, or the planted seedlings must be protected during application.

Research has suggested that the use of mulch mats can reduce grass and herbaceous competition for water and improve the initial survival and growth of conifer seedlings. Mulch mats are best applied during the spring, soon after planting, to avoid installation on top of the developing vegetation. The ideal silvicultural mulch mat should be opaque, dark, porous to permit water infiltration, able to retard evaporative water loss, supportive of favorable soil temperatures, sufficiently strong and durable to last until seedlings are established, low in cost and lightweight, non-toxic, and of a colour that blends into the landscape (McDonald and Helgerson 1990).

During 1993, a research trial was established to explore vegetation management options that may improve conifer survival and growth within the idfww. The objectives of this study were to compare the effectiveness of the herbicides hexazinone and glyphosate and plastic mulch mat treatments for reducing grass competition and improving Douglas-fir seedling performance. Two separate experiments were established, representing dry and mesic environments within areas of homogenous terrain and vegetation.

This extension note summarizes the five-year results from these two experiments.

Study Area

The study was established on a south-facing clearcut located in the Interior Douglas-fir warm wet (IDFww) biogeoclimatic subzone, above the Nahatlatch River, northwest of the town of Boston Bar, within the Chilliwack Forest District (Figure 1) (slope 50%, elevation 700 m). The site was divided into two separate areas or experiments. The main study (Experiment 1) was established within an area of slightly dry soil moisture regime (mesic) and medium soil nutrient regime. Experiment 2 was located upslope from Experiment 1 within a dryer area of submesic to subxeric (dry) soil moisture regime. Soils of both areas were loamy Orthic Eutric Brunisols with a high coarse-fragment content (40%).

The original Douglas-fir stand was clearcut (1985–1987) and planted with Douglas-fir and lodgepole pine in 1987 and again in 1989. The block was subsequently treated with an aerial glyphosate application (1.4 kg ai/ha) in September 1991 and replanted with lodgepole pine during the early spring of 1992 (poor 1987 and 1989 plantation survival). By the spring of 1993, most of the opening was considered not satisfactorily restocked (NSR) due to high mortality of the seedlings planted in 1992. During early May 1993, the two experiment areas were selected and planted with Douglas-fir seedlings (1+0 psb 415b). A climate station was established to monitor site climatic conditions and to collect soil temperature and soil moisture measurements within each of the following treatment areas: untreated control, glyphosate at 2.1 kg ai/ha, hexazinone at 2.1 kg ai/ha, and 90 × 90 cm Tredegar® plastic mulch mats.

During the early summer of 1993, the vegetation community of Experiment 1 (mesic site) consisted of approximately 20% shrub cover of *Acer glabrum*, *Corylus cornuta*, and *Mahonia aquifolium*. Grass species (*Elymus* spp. and *Festuca* spp.) were about 50 percent cover, and the herbaceous vegetation (*Smilacina racemosa*, *Disporum hookeri*, *Lathyrus* spp., and *Epilobium angustifolium*) approximately 30 percent cover. Significantly less vegetation cover was found in Experiment 2 (dry site). The vegetation community of this dryer area was composed predominately of grass (20 percent cover of *Elymus* spp. and *Festuca* spp.) and herbs (20% cover of *Smilacina racemosa, Disporum hookeri, and Lathyrus spp.)*.

figure 1 *View of research site located above the Nahatlatch River, Boston Bar (fall 1996).*

Experimental Design

The objectives of this study were to compare the effectiveness of:

1) glyphosate, hexazinone, and porous mulch mats;
2) different rates of glyphosate application (1.0 and 2.1 kg ai/ha); and
3) 2 types and 2 sizes of porous plastic mulch mats (Arbortec® Brush Blanket, and Tredegar® Tree Mat)

for reducing grass competition and improving the survival and growth of planted Douglas-fir seedlings (1+0 psb 415b).

Experiment 1 consisted of a completely randomized design of five treatments (Table 1) replicated four times. Treatment plots were 12 × 12 m with 3 m untreated buffer zones between plots. Within each plot, 10 Douglas-fir seedlings were tagged for crop tree assessments. Pre-plant herbicide treatments were broadcast applied May 4th, 1993. Mulch mats were installed around individual Douglas-fir seedlings with metal staples.

Experiment 2 consisted of seven treatments (Table 2) randomly assigned to 20 single Douglas-fir seedlings in a completely randomized design. Post-plant spot applications of herbicide were applied within a 60 cm radius circle around each seedling using a backpack sprayer (May 5th, 1993). Seedlings were covered at the time of spraying with a capped plastic tube.

Seedling height, groundline diameter, crown width, height to live crown, and seedling condition were recorded immediately after planting in May 1993. Seedlings were measured each year during the fall (1993, 1994, 1995, 1996, and 1997). Vegetation assessments were completed in June of 1993, 1994, 1995, and 1997. Percent cover and height were recorded for each table 1 *The five treatments applied to plots in Experiment 1*

Block	Treatment	Rate/Method
A	control	untreated
B	glyphosate	2.1 kg ai/ha (Vision®) pre-plant application*
C	glyphosate	1.0 kg ai/ha (Vision®) pre-plant application*
D	hexazinone	2.1 kg ai/ha (Velpar L®) pre-plant application*
E	Tredegar® mulch mats	(90 cm x 90 cm) installed after planting

* to ensure even ground coverage, a dye was added to the spray solution.

table 2 *The seven treatments applied to seedlings in Experiment 2*

Block	Treatment	Rate/Method
A	control	untreated
B	Tredegar®	90 X 90 cm mat
C	Tredegar®	120 X 120 cm mat
D	Arbortec®	90 X 90 cm mat
E	Arbortec®	120 X 120 cm mat
F	glyphosate (Vision®)	1% solution post-plant spot application*
G	hexazinone (Velpar L®)	1.5% sol'n post-plant spot application*

* to ensure even ground coverage, a dye was added to the spray solution.

of the following vegetation: grasses, herbs, *Mahonia aquifolium*, and other shrubs. Treatment differences in vegetation percent cover and height were considered significant at $p \leq 0.10$ and seedling measurements significant at $p \leq 0.05$

Results

The herbicide spot applications used in Experiment 2 resulted in higher local active ingredient concentrations around each Douglas-fir seedling than was found in Experiment 1. The local active ingredient concentrations of hexazinone and glyphosate may have been more than twice that of Experiment 1.

Vegetation Response

A similar vegetation response was observed in both experiments. Treatment with glyphosate and hexazinone effectively controlled the grass community for three growing seasons (1993–1995). The percent cover of herbs was reduced for only one growing season after herbicide treatment. The herbicide treatments did not significantly affect shrub percent cover, except a first growing season reduction in *M. aquifolium* cover. The mat treatments significantly reduced herb cover for three growing seasons after treatment.

In Experiment 1, all herbicide treatments effectively controlled the grass, herbs, and *M. aquifolium* for one growing season. Grass cover continued to be reduced for three growing seasons after treatment (Figure 2). Neither glyphosate application rate controlled herb and *M. aquifolium* cover after one growing season. The hexazinone herbicide treatment did result in a significantly lower herb percent cover than the control three to five growing seasons after treatment. The Tredegar 90 × 90 cm mats did not significantly reduce grass cover for the first two growing seasons due to grass inclining into the mat area (Figure 3). However after three growing seasons, mats provided a reduction in grass cover. The mats were effective in controlling the herb cover for three growing seasons and *M. aquifolium* cover for two growing seasons. The mats did not reduce shrub cover. Five growing seasons after treatment (1997), no significant treatment differences in grass, *M. aquifolium*, or shrub cover were found. However, the 1997 results suggested the hexazinone treatment had substantially less herb cover.

In Experiment 2, both the herbicide

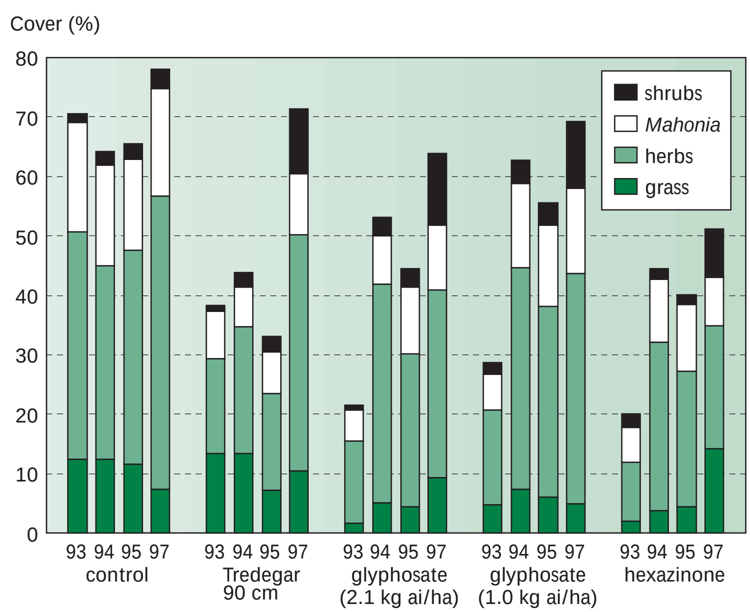

figure 2 *Experiment 1 vegetation percent cover by treatment and post-treatment year.*

figure 3 *Douglas-fir seedling with Tredegar 90 × 90 cm mat (June 1993), Experiment 1. Note well-developed herb and grass competition.*

and mat treatments effectively reduced grass cover for the first three growing seasons (Figure 4). Five growing seasons after treatment, only the hexazinone and 120 × 120 cm mat treatments continued to significantly reduce grass cover. Herb cover was significantly reduced by the glyphosate and mat treatments for three growing seasons. *M. aquifolium* cover was unaffected by the mat and herbicide treatments. The rare occurrence of shrub species within Experiment 2 did not provide sufficient data to compare shrub treatment response. Of all the treatments, hexazinone appeared to provide the greatest control of grass for a full five growing seasons. The 120 × 120 cm mat treatments were also found to reduce grass cover for a full five growing seasons. No differences in grass cover were observed between mat sizes or mat types.

Douglas-fir Seedling Response

Survival In Experiment 1, significant treatment differences in Douglas-fir survival were found (Figure 5). One growing season after treatment and planting (fall 1993), both the untreated control and hexazinone treatment areas suffered significant mortality when compared to the glyphosate treatments (10% and 15% first season mortality, respectively). However, from planting until the fall of 1997 (five growing seasons) the hexazinone treatment suffered relatively minor mortality losses (77.5% survival in 1997) and had significantly greater survival than the untreated control three to five growing seasons after planting. The glyphosate treatments did not sustain any significant mortality during the 1993–1997 period and resulted in significantly improved survival over the untreated control. The Tredegar mat treatment survival remained at 72.5% from 1995 through 1997. The untreated control continued to suffer mortality, with only 52.5% survival after five growing seasons.

In Experiment 2, after one growing season Douglas-fir seedlings in the hexazinone treatment had suffered 65% mortality. For the same period in all other treatments and the untreated control, survival exceeded 90% (Figure 6). By the end of 1994 (after two growing seasons), seedling survival was further reduced in the hexazinone treatment to 25%, which was significantly lower than the untreated control (65%) and the mat treatments. Mortality in the glyphosate treatment (50%) was significantly different from the mat treatments but not from the control. No other significant differences in seedling survival were noted in 1994. During 1995 through 1997, no further seedling mortality occurred in the hexazinone treatment. All other treatments (except the Arbortec 120 × 120 cm, Tredegar 90 × 90 cm mat, and hexazinone treatments) continued to suffer mortality four growing seasons after planting (fall of 1996). No additional mortality in any treatment was noted during 1997. By the end of 1997, the only treatments with greater than 50% survival were the 90 × 90 cm and 120 × 120 cm Tredegar and the 120 ×

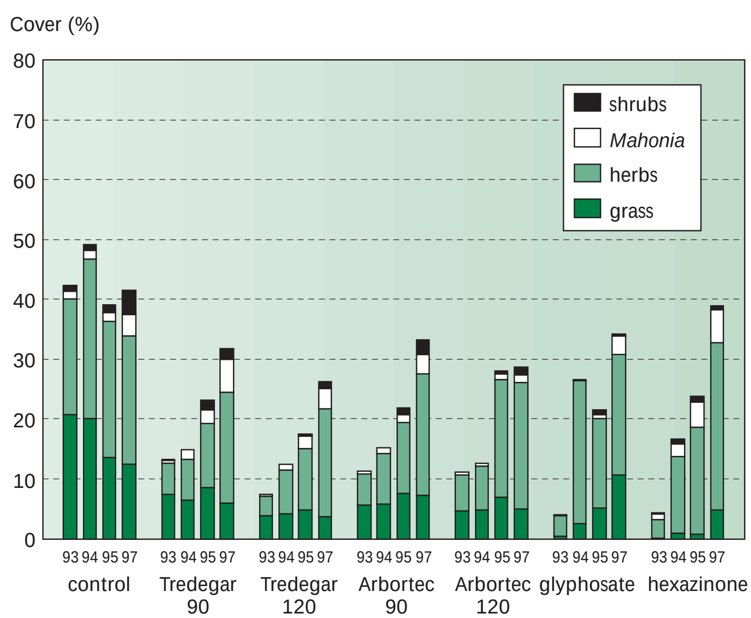

figure 4 *Vegetation percent cover, by treatment and year, Experiment 2.*

120 cm Arbortec mat treatments with 55, 70 and 55% survival, respectively.

Growth In Experiment 1, on average the Douglas-fir seedlings grew less than 10 cm in height per year (Figure 7). No statistically significant height differences between treatments were found during the first four growing seasons (to fall 1996). However, in 1997 Douglas-fir height was significantly larger in the hexazinone and glyphosate (both application rates) treatments when compared to the untreated control.

In Experiment 1, diameter growth of Douglas-fir seedlings from 1993–1997 in the hexazinone treatment was significantly larger than in the control (Figure 8). From 1994–1997, seedlings treated with 2.1 kg ai/ha glyphosate were also significantly larger in diameter than those in the control. At the end of five growing seasons (1997), only the hexazinone and the 2.1 kg ai/ha glyphosate treatments had seedlings of significantly larger diameter than the untreated control.

The dryer environment of Experiment 2 did not significantly favour any treatment method, although all brushing treatments appeared to provide some diameter and height growth increase over the control (data not shown). In Experiment 2, diameter measurements taken in 1997 suggested Douglas-fir seedlings from the mat treatments, in particular the Tredegar type, were larger than the control (ANOVA p=0.0954).

Browse A considerable amount of ungulate browsing was noted throughout the two experimental areas. From 1993–1996, seedling browse damage ranged from 6 to 43% of the planted Douglas-fir annually.

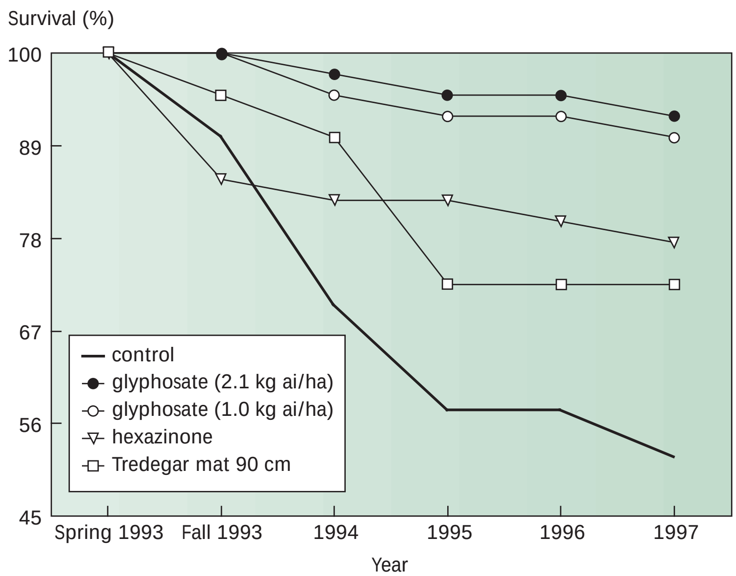

figure 5 *Douglas-fir seedling survival (%), Experiment 1.*

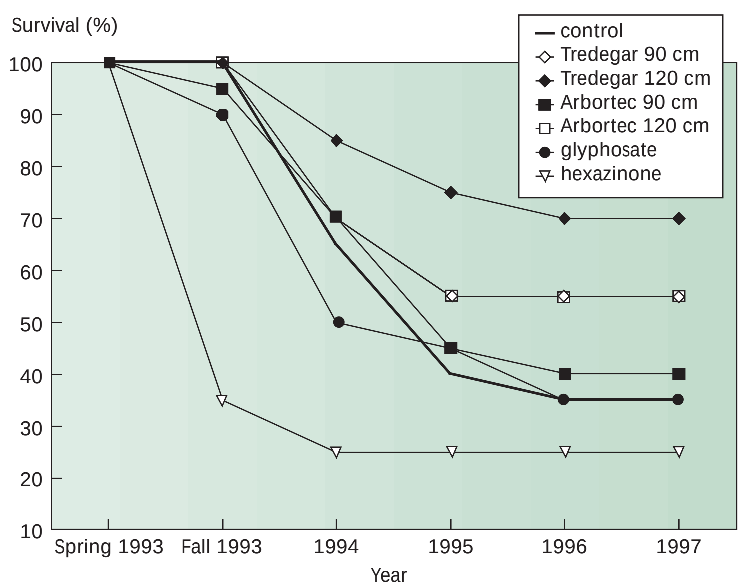

figure 6 *Douglas-fir seedling survival (%), Experiment 2.*

Climate Monitoring

Periods of seasonal soil moisture deficit were recorded by the soil moisture sensors located in the Experiment 1 treatments: 2.1 kg ai/ha glyphosate, hexazinone, Tredegar 90 × 90 cm mat treatments, and untreated control. Soil moisture deficit or soil drought was categorized as soil moisture tension exceeding 15 bars. At tensions greater than 15 bars, soil water is considered unavailable to plants. The soil moisture sensors recorded a soil drought period starting as early as the third week of May for 1994 and 1995. In 1996 and 1997, the earliest drought period started in mid-June and mid-July, respectively.

A consistent pattern of annual soil drought was evident, suggesting the herbicide and mat treatments improved soil moisture availability through delaying soil moisture loss. From 1994–1997, the untreated area consistently had the longest drought period. During 1997, the mat, glyphosate, and hexazinone treatments appeared to reduce the drought period from 86 days in the untreated to 36, 33, and 52 days, respectively.

Conclusions

- Results from this study indicate that a spring application of glyphosate or hexazinone herbicide immediately prior to planting can provide effective control of perennial grasses for at least three growing seasons, and can provide effective control of herbs and some shrubs during the first growing season. These herbicide treatments resulted in improved Douglas-fir seedling survival and diameter growth.

- Post-planting spot application of hexazinone resulted in substantial seedling mortality during the first year (65%) even when seedlings were protected from direct herbicide application. Considerably less first-year mortality (15%) occurred with the pre-plant application of hexazinone. The high mortality associated with the spot treatments was probably due to the higher localized concentrations of hexazinone in the soil.

- Glyphosate treatments in both experiments provided a superior level of survival than the hexazinone treatments, one growing season after treatment (Figure 9). Seedlings in the 2.1 kg ai/ha glyphosate treatment (Figure 10) were consistently larger than those from the 1.0 kg ai/ha treatment.

- The 120 × 120 cm mats were found to reduce grass cover for five years. However, the 90 × 90 cm mats failed to consistently reduce grass cover. No significant differences between mat size or mat type were noted in Douglas-fir growth and survival. Larger mat sizes than those tested may be required to promote significant early growth and survival within these established grass and herb communities. McDonald and Helgerson 1990 suggest a minimum mat size of 190 × 190 cm for grass control.

- The high incidence of ungulate damage found in all treatment areas suggests that early seedling protection from browse may lead to improved early growth of Douglas-fir.

Establishing conifers within the well-developed grass, herb, and shrub communities of these drought-prone sites poses a silvicultural challenge. The results of this study and other studies (McDonald et al. 1994; Newton and Preest 1988; McDonald 1986) offer suggestions and direction for the reforestation of these backlog areas. Of particular importance is

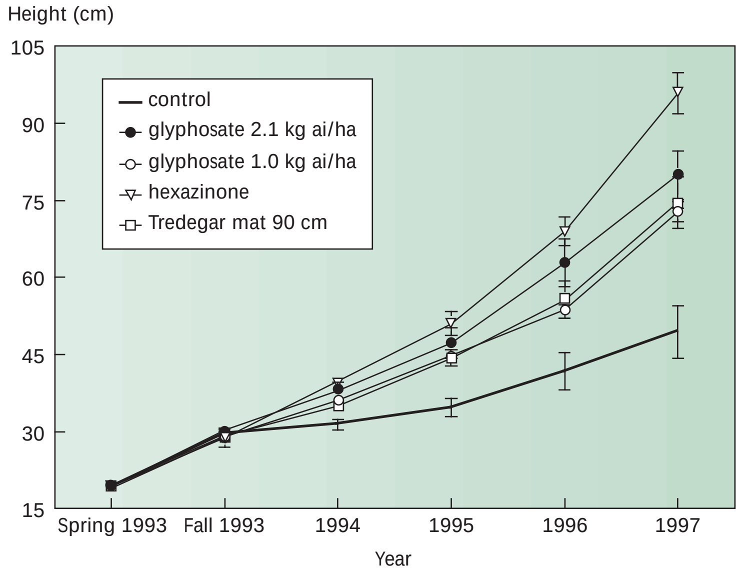

figure 7 *Douglas-fir seedling height (cm), Experiment 1. Bars represent standard error of the mean.*

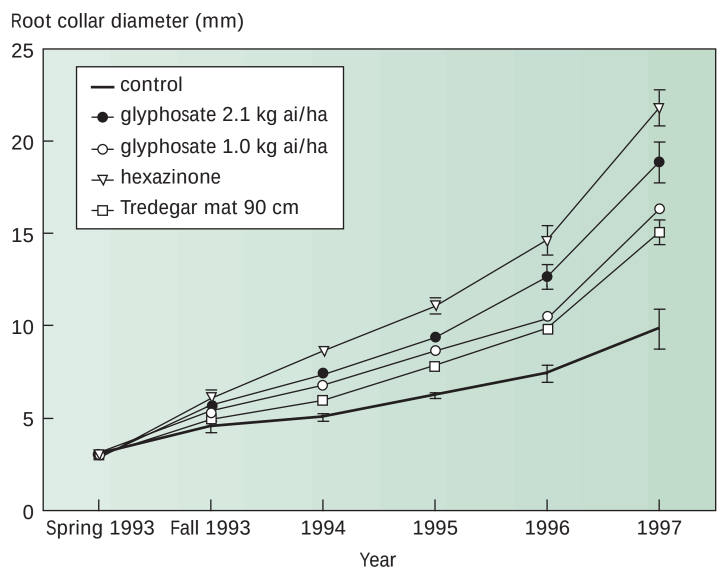

figure 8 *Douglas-fir seedling diameter (mm), Experiment 1. Bars represent standard error of the mean.*

figure 9 *Spot application of glyphosate around Douglas-fir seedling (June 1993), Experiment 2.*

figure 10 *Douglas-fir seedling from the 2.1 kg ai/ha glyphosate treatment four growing seasons after application (April 1997), Experiment 1. Seedling height 77 cm.*

the prompt early-spring planting of new cutblocks to maximize seedling growth, while there is abundant soil moisture and before grass, herb, and shrub competition has become established. Delays in planting of even one or two months may result in poor survival and growth due to the onset of soil drought exacerbated by grass and herb competition for soil moisture and nutrients.

Continued vegetation and conifer assessments are planned for this research trial during 1999 and 2002. Future monitoring is required to evaluate the effectiveness of the mats and herbicides for enhancing long-term Douglas-fir seedling survival and growth, and to determine if there will be a differentiation between mat size and mat type. Further studies are needed to determine optimal mat sizes, to evaluate the effectiveness of lower rates of hexazinone application and of using browse protection systems in the idfww.

References

Boyd, R.J, D.L. Miller, F.A. Kidd, and K.A. Ritter. 1985. Herbicides for forest weed control in the inland Northwest: A summary of effects on weeds and conifers. U.S. For. Serv. Ogden, UT., Gen. Tech. Rep. int-195.

Fahlmann, R. and L.J. Herring. 1985. Grassy site preparation using four herbicides, Second year results. Expert Committee on Weeds. Res. Rep. Western Canada Section Meeting. 3:217

Green, R.N. and K.Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. B.C. Min. For., Victoria, B.C. Land Management Handbook 28.

McDonald, P.M. 1986. Grasses in young conifer plantations – hindrance and help. Northwest Science 60(4):271–8.

McDonald, P.M., G.O. Fiddler and H.R. Harrison. 1994. Mulching to regenerate a harsh site: Effect on Douglas-fir seedlings, forbs, grasses, and ferns. U.S. Dep. Agric. For. Serv., SW Res. Sta., Albany, CA. Res. Pap. psw-rp-222.

McDonald, P.M. and O.T. Helgerson. 1990. Mulches aid in regenerating California and Oregon forests: Past, present, and future. U.S. Dep. Agric. For. Serv., Pac. SW Res. Sta. Gen. Tech. Rep. psw-123.

Newton, M. and D.S. Preest. 1988. Growth and water relations of Douglas-fir (*Pseudotsuga menziesii*) seedlings under different weed control regimes. Weed Science 36:653–62.

Acknowledgements

The authors would like to thank Jacob Boateng, Brian D'Anjou, Monty Locke, Cheryl Pehl, Vera Sit, Teresa Newsome and Ron Gladiuk for their valuable assistance and support.

Financial support provided by Forest Renewal BC (Project hq96403-re).