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APPLICATION OF THE
HERBICIDE GLYPHOSATE ON
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Application of the Herbicide Glyphosate
on Bigleaf Maple - Pender Harbour
SX83408V

by

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Province of British Columbia
Ministry of Forests
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1. INTRODUCTION

The purpose of this SX trial is to study the effectiveness of the herbicide glyphosate (Roundup) on bigleaf maple (*Acer Macrophyllum* Pursh.) coppices on a recently logged and planted site near Pender Harbour, B.C.

The objectives of the trial are:

1. Examine the effect of glyphosate, at three concentrations (0.75, 1.0* and 1.25% by volume) on a coppice stand of bigleaf maple.

2. Recommend the most effective concentration of glyphosate, of the three tested, based on subsequent crop tree performance and bigleaf maple growth.

This final report will summarize the effects of glyphosate on bigleaf maple one growing season after treatment, response of neighbouring conifers, and the results of the stream and sediment sampling.

2. MATERIALS AND METHODS

2.1 Site Description and History

The trial location was 2 km east of Pender Harbour's north arm (Map 1), between 60 and 120m above sea level, with slopes ranging from 5 to 20%. The entire 9.2 ha site was located within the Wetter Coastal Douglas-fir Biogeoclimatic Subzone (*Nuszdorfer*, 1983).

Soils in the study area vary in type and are described in detail in Appendix 6.1. Soil moisture as well as nutrient regime also varied considerably on the site. Where there was soil water influence, soil nutrient regime was medium to good and conversely

* 1.0% by volume is equal to 1 litre of Roundup in 99 litres of water
MAP 1. Location of Roundup Herbicide Trial

* TRIAL LOCATION

Sechelt

Pender Harbour

Texada Island

Strait of Georgia

Vancouver

SCALE 1:380,160
where there was little soil water influence, nutrient regime was poor to medium. The moisture regime of the area varied depending on topography and soil type although the area was generally rated as mesic.

The original stand, a mixture of Douglas-fir and bigleaf maple, was harvested as a site rehabilitation project in 1981 and was planted in the spring of 1982 with Douglas-fir (2+0 BR and 1+1 PSB 415/BR stock types) and grand fir (Abies grandis (Dougl. ex D. Don) Lindl.) (2+0 Bareroot). Approximately 2,000 trees per hectare were planted, with a resulting survival rate of 92% a year later.

The bigleaf maple stumps began to sprout vigorously after logging and quickly grew 2-3 meters in height in one growing season with up to 100 stems originating from a single stump. Since there was a danger that the stems would become detrimental to conifer growth they were cut with power saws in the fall of 1982 but by the summer of 1983, the sprouts had regrown up to three meters in height. Since the manual removal of the stems proved unsuccessful, the herbicide Roundup was considered as a possible control method for the maple coppices.

2.2 Experimental Design

The study area was divided into 3 blocks (Appendix 6.2). Each block contained four plots to facilitate the three application rates and one control (herbicide free). Prior to spraying, all maple stumps within the study area were identified with paper tags. Based on this survey, the site contained approximately 120 actively coppicing stumps per hectare.

Fifty bigleaf maple stumps were randomly selected in each plot. Stumps near plot boundaries or in slash piles were not
considered. Each selected stump was tagged and stump height, diameter and number of stems recorded. Fifty planted conifers were randomly selected in each plot and tied into the closest stump. Each tree was staked; species, seedling height and diameter, pathological remarks and herbicide damage, if any, was recorded. Soil and water samples (from Kleindale Creek) were taken prior to spraying and continued to take place up to 6 months after spraying to test for herbicide residue (Table 1).

2.3 Herbicide Application Method

The herbicide spraying operation commenced on August 11, 1983 at 10:00 a.m. involving six workers, using SANEX spraymate backpack hand pumps with 15 litre capacity. Water was pumped from a local stream into a portable storage bin where the workers filled their sprayers with water before receiving herbicide.

Spraying began on Block A, proceeded on Block B and finished on C. Since there were six workers spraying, two sprayers worked together on the larger two plots in a block, with the other two sprayers working alone in the remaining two plots. The workers were instructed to spray only maple sprout clusters and spray for coverage of all foliage, but not to apply so much herbicide that it would run off the foliage. The amount of spray mixture applied in each plot was noted. 1.5 litres of Roundup concentrate was applied in the entire operation, equivalent to 0.72 kg of active ingredient.

Fall assessment revealed only 13 conifers (2% of the trees sampled) displayed symptoms of herbicide damage in the form of a dead lateral and/or terminal growth.
TABLE 1 Sampling regime for Glyphosate/AMPA residues

<table>
<thead>
<tr>
<th>Sampling Intervals</th>
<th>Water Sample</th>
<th>Sediment Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treated</td>
</tr>
<tr>
<td>Pre-spray</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Post-spray</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 to 4 hours</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>1 to 2 days</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>1 week</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>2 months</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>4 months</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>6 months</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

Grand Total = 10 water samples and 10 sediment samples

3 RESULTS AND DISCUSSION

An assessment of all sampled maple coppices was completed in August, 1984 (Appendix 6.3). Maple coppices were classified as:

1. completely sprayed - all stems show signs of herbicide damage;
2. partially sprayed - at least one unsprayed stem;
3. unsprayed - no signs of herbicide damage and assumed to have been missed by the applicators.

For all completely sprayed stumps, the number of green stems (stems with small, distorted leaves indicative of herbicide damage) was counted as well as dead stems.

The assessment revealed 22% of all sampled stumps within the treated blocks received no herbicide treatment, with another 22% only partially sprayed. The poor quality of herbicide application reflected in these results make the comparison of the efficacy of the three concentrations of
glyphosate difficult. A positive relationship seems to exist between percentage of stumps sprayed within a plot and the percentage of dead stems, a reflection of quality of herbicide application rather than efficacy.

Conard (1984) suggests the effects of glyphosate at rates ranging from 1 to 2% on bigleaf maple would be severe (60-90%) for late summer application. Based only on stumps completely sprayed in this trial, the results are comparable for all three application rates, with 7 out of 9 treatments showing mortality of at least 66% of the stems within a stump. The other green stems, made up of dwarfed and deformed leaves, showing signs of mortality in late fall assessment, are no longer brush threats to local conifers. Basal sprouting was noticeably absent on all treated maple stumps.

The application rates employed in this study (.75, 1.0 and 1.25%) are generally near the minimum of those suggested in the literature. Conard (1984) suggest rate of 1 - 2% by volume of glyphosate in water for spot treatments of bigleaf maple. The Oregon Weed Control Handbook (1983) indicates glyphosate is intermediate or variable in its effectiveness on bigleaf maple and suggests higher rates of herbicide are warranted to ensure control. Newton (1981) suggest rates of 2 to 4% by volume for general use under forestry conditions. Monsanto suggests in their users manual that higher rates of glyphosate should be used when weed growth is heavy and dense, as was the case on some maple coppices in this trial. Higher concentrations may have reduced the percentage of stems which survived the lower concentrations employed in this trial.

The overlooked stumps were sometimes blocked from the view of the applicator by other vegetation. In other cases the missed stumps were in plain view. Several suggestions can be made which would reduce the percentage of unsprayed stumps in an operational environment.
1. Smaller treatment units - units in this trial were up to 90 meters wide and over 1 hectare in size, making coordination between two sprayers difficult. Units 10-15 meters wide with well ribbed boundaries would allow single applicators to apply herbicide on a spot treatment basis more efficiently.

2. Marking treated stumps - flagging or marking the stumps in some other fashion would allow easier identification of treated stumps.

3. More training of applicators - more training of the applicators prior to the operation was warranted in this case, considering their lack of experience.

The stems of the maple were up to 3 meters in height at the time of the treatment with up to 100 stems emanating from a single stump. Vegetation of this height requires the applicator to extend the spraying nozzle over his head and increases the amount of herbicide drift. Herbicide coverage on foliage at this height is also less than optimum, especially on dense clusters of stems. An alternative to the manual spraying of such vegetation is an aerial method, making the treatment potentially more efficient but also more effective due to better coverage of herbicide.

Another option to the manual herbicide treatment of bigleaf maple coppices is a direct application of full strength glyphosate on freshly cut stumps. This operation, most effective in August and September, could be done in association with logging operations in that the chemical must be applied at the outer edge of the wood within 20 minutes after felling. Proper coordination with the fallen is imperative in this type of treatment.

All sampled conifers were assessed for degree of overtopping by competing vegetation (Appendix 6.4). Overall there was a large increase in percentage of trees overtopped since the 1983 growing season, a result
of the increased prominence of other weed species. Assessment of the site revealed a rapid invasion of species such as salmonberry, thimbleberry and red alder to the detriment of the planted conifers. Growing space created by dead bigleaf maple was often invaded by dense growth of these species. Pre-spraying assessment of the site did not fully recognize the future threat of these brush species because of the dominance of bigleaf maple prior to spraying. A more extensive study of similar sites near the test site may have indicated the future prominence of other brush species, especially on disturbed sites such as this one where mineral soil was exposed extensively. Spot treatments must only proceed when the possibility of other weed species becoming dominant on the site is considered remote. Otherwise a complete broadcast spray is deemed the only effective method of control.

Appendix 6.5 is a graphical summary of the results of water and sediment residue analysis of glyphosate and its soil metabolite, AMPA (aminomethyl-phosphonic acid). Minimum detectable level is 5 ppb, therefore the graphs never go below this limit.

4. RECOMMENDATIONS

This trial explored the manual application of the herbicide glyphosate on a coppice stand of bigleaf maple near Pender Harbour, B.C. Three rates were tested (.75, 1.0 and 1.25% by volume) and along with a control were replicated three times.

The poor quality of application, with 22% of the sampled maple stumps not sprayed and 22% only partially sprayed, made a comparison of the efficacy of three rates difficult. Application of glyphosate at rates tested in this trial, which are on the low side as suggested by available literature, are comparable to results achieved by Conard (1984) on bigleaf maple. The trial emphasized the need when using glyphosate on bigleaf maple to apply over all stems within a cluster for complete control of all stems.
This trial suffered from some shortcomings in application procedure and pre-assessment of the site. Suggestions on methods to modify procedures on an operational basis are discussed in the result and discussion section of the report.

The site in question requires further treatment not only on the untreated bigleaf maple but also on the other brush species which have become established since the herbicide treatment. A broadcast application of glyphosate in late summer would be one management option. No further work will be done on this trial due to the poor quality of herbicide application and the invasion of the other species of brush.

Future research in glyphosate on bigleaf maple should involve higher application rates (1 - 4% by volume). Application of glyphosate directly onto freshly cut stumps is another management option for the control of bigleaf maple. Future trials should investigate the effectiveness of this treatment.

5. REFERENCES


APPENDIX 6.1

Soil Description

1. Northwest corner of study area - Rego Gleysol - associated with concave surface. Where soil water influence is slightly less a Gleyed Humo-Ferric Podzol is present.

2. Above this depressional area in a midslope topographic position - Duric Humo-Ferric Podzol.

3. Adjacent to Kleindale Creek - Orthic Regosol.

4. Northeast - Central portion of study area - Gleyed Dystric Brunisol, below this area is a Duric Humo-Ferric Podzol.

5. Northeast edge of study area - Duric Humo-Ferric Podzol.
APPENDIX 6.2 PLOT LAYOUT FOR ROUNDPUP TRIAL

Plot 1-Control
2- 0.75%
3- 1.0%
4- 1.25%

SCALE 1:3,100
APPENDIX 6.3  Assessment of Sampled Bigleaf Maple Coppice Stumps

<table>
<thead>
<tr>
<th>Plot</th>
<th>rate of Herbi-cide</th>
<th>% of stumps completely sprayed (% completely dead)</th>
<th>% of stumps partially sprayed *</th>
<th>% of stumps unsprayed</th>
<th>% of stems on sprayed stumps</th>
<th>Green **</th>
<th>Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>.75</td>
<td>66 (15)</td>
<td>6</td>
<td>28</td>
<td>32</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>1.0</td>
<td>78 (36)</td>
<td>2</td>
<td>20</td>
<td>28</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>1.25</td>
<td>52 (8)</td>
<td>28</td>
<td>20</td>
<td>53</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>.75</td>
<td>60 (10)</td>
<td>18</td>
<td>22</td>
<td>32</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>1.0</td>
<td>88 (27)</td>
<td>10</td>
<td>2</td>
<td>26</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>1.25</td>
<td>64 (9)</td>
<td>18</td>
<td>18</td>
<td>35</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>.75</td>
<td>44 (32)</td>
<td>40</td>
<td>16</td>
<td>27</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>1.0</td>
<td>30 (20)</td>
<td>28</td>
<td>42</td>
<td>34</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>1.25</td>
<td>26 (23)</td>
<td>44</td>
<td>30</td>
<td>41</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>56 (20)</td>
<td>22</td>
<td>22</td>
<td>34</td>
<td>66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* At least one unsprayed stem.
** Show signs of being sprayed (small, green leaves of distorted shapes)

1 Based on number of stumps completely sprayed.
APPENDIX 6.4  Assessment of Brush Competition on Sampled Conifers

<table>
<thead>
<tr>
<th>Plot</th>
<th>Free-to-Grow</th>
<th></th>
<th>Threatened</th>
<th></th>
<th>Overtopped</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>30</td>
<td>26</td>
<td>54</td>
<td>36</td>
<td>16</td>
<td>36</td>
</tr>
<tr>
<td>A2</td>
<td>50</td>
<td>30</td>
<td>26</td>
<td>26</td>
<td>24</td>
<td>44</td>
</tr>
<tr>
<td>A3</td>
<td>60</td>
<td>46</td>
<td>28</td>
<td>20</td>
<td>12</td>
<td>34</td>
</tr>
<tr>
<td>B1</td>
<td>64</td>
<td>10</td>
<td>20</td>
<td>32</td>
<td>16</td>
<td>56</td>
</tr>
<tr>
<td>B2</td>
<td>56</td>
<td>22</td>
<td>30</td>
<td>42</td>
<td>14</td>
<td>32</td>
</tr>
<tr>
<td>B3</td>
<td>80</td>
<td>38</td>
<td>12</td>
<td>42</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>B4</td>
<td>72</td>
<td>44</td>
<td>20</td>
<td>30</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td>C1</td>
<td>8</td>
<td>12</td>
<td>32</td>
<td>38</td>
<td>60</td>
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<tr>
<td>C2</td>
<td>62</td>
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<td>48</td>
<td>31</td>
<td>29</td>
<td>29</td>
<td>23</td>
<td>40</td>
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</tbody>
</table>
APPENDIX 6.5  GLYPHOSATE AND AMPA RESIDUE LEVELS IN WATER AND SEDIMENT OVER TIME

WATER

GLYPHOSATE

AMPA

DAYS AFTER SPRAYING

SEDIMENT

GLYPHOSATE

AMPA

DAYS AFTER SPRAYING