Off-target deposit and environmental impact from silvicultural aerial triclopyr applications

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1. Introduction

Spray cloud dispersal modelling has been carried out at the request of M. Mihajlovich, Field Development Forester, Dow Elanco Canada Inc., to assist in obtaining an aerial registration for the silvicultural use of triclopyr. The calculations provide an assessment of the off-target deposit and environmental impact to be expected on water bodies and deciduous foliage downwind of aerial triclopyr applications using a boom and nozzle and Thru Valve Boom fixed-wing applications employing a relatively fine dropsize spectra.

2. Methods

The calculations of off-target deposit and estimates of biological impact are based on the technique published by Payne et al. (1988, 1990). This spray cloud dispersal modelling technique employs experimental measurements and swath superposition to obtain integrated deposits from a multiple swath application. Where appropriate worst case assumptions have been made about application parameters, e.g. the active ingredient application rate is the maximum likely for commercial applications.

Two types of aerial applications were modelled. The first used a boom and nozzle dispersal system comprising D8-46 hollow-cone hydraulic nozzles oriented 45° back and down, mounted on a Cessna 188B Ag-truck aircraft flying at 45 m/s at 10 m above ground level (Payne, 1991). Aqueous tank mix was applied at 35 l/ha with a total flow rate of 3.1 l s^{-1}, using a 20 m swath width. The droplet spectrum had a $D_{V0.1}$, $D_{V0.5}$ and $D_{V0.9}$ of 65, 147 and 249 microns at release, providing a relatively fine spray cloud. The wind speed at spray release height averaged 8 km/h, and the air temperature at this height was 20°C, providing conditions close to operational limits. Relative humidity was 90% and the stability of the atmospheric boundary layer was near-neutral. An active ingredient rate of 2.4 kg/ha a.e., equivalent to 5 l/ha of commercial formulation, was used for the calculations, being the maximum likely recommended rate, and a 100 ha treatment area was selected as being at or near the largest individual treatment area size.

The second application modelled employed a Thru Valve Boom ™ (TVB ™) dispersal system with '030' nozzles, mounted on a Cessna 188B Ag-truck aircraft flying at 45 m/s, 10 m above ground level (Payne, 1991). Aqueous tank mix was applied at 20 l/ha with a total flow rate of 1.8 l/s, using a 20 m swath width. The droplet spectrum had a $D_{V0.1}$, $D_{V0.5}$ and $D_{V0.9}$ of 75, 157 and 294 microns at release, providing a relatively fine spray cloud. The wind speed at spray release height averaged 9 km/h, and the air temperature at this height was 23°C, providing conditions close to operational limits. Relative humidity was 60% and the atmospheric boundary layer was stable. As before, an active ingredient rate of 2.4 kg/ha a.e. was used for the calculations, and a 100 ha treatment area.

3. Results

Calculated triclopyr concentrations in downwind water bodies 0.5 m deep, and foliar deposits on broad leaf vegetation are presented in Tables 1 and 2. Triclopyr toxicities to coho salmon and rainbow trout juveniles were used to assess the biological effect of this off-target triclopyr in water bodies. The average (± SD) values of 96h LC_{10} were 933 ± 102 and 430 ± 155 ppb respectively (M. Mihajlovich, pers. comm.). Calculations using the toxicity to rainbow trout indicate that at 25 m from the treatment area less than 10% mortality in S. gairdneri populations would be expected from D8-46 and TVB applications, implying that a buffer zone of 25 m around water would be adequate to protect these and less sensitive fish species from the toxicological effects of triclopyr from these types of applications. Aquatic plant species, e.g. algae, may be more susceptable to triclophyr than fish species, in which case a larger buffer zone would be needed to prevent unacceptable impact on these plant spp than that required for fish.

Phytotoxicity was assessed using data for the species Cherokee rose and Lambsquarters. Both these species showed 10-15% phytotoxicity with a triclopyr application rate of 0.07 kg/ha (M. Mihajlovich, pers. comm.). Using a leaf area index of two (Rauner, 1976) converts this ground area application rate to 0.035 kg/ha for foliage, or 3.5 mg/m^2. This level was not reached over the range of downwind distance modelled for the D8-46 application, indicating that phytotoxicity in excess of 10% would be expected within 250 m of the treatment area, ranging from 100% at 25 m to about 40% at 250 m. These calculations suggest that a buffer zone width of 250 m would be needed for this type of application, where phytotoxic effects on this type of vegetation must be limited. For the TVB application the suggested tolerable level of foliar triclopyr deposit was reached between at 50 and 75 m from the treatment area, suggesting that a buffer zone width of 75 m would be sufficient to prevent significant phytotoxic effects from this application method. It should be noted that the differences in off-target deposit and estimated biological effect from the two application types do not result solely from differences in the methods but also from somewhat different meteorological conditions during the field trials.

References

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TABLE 1. Predicted triclopyr concentrations (a.e.) in water bodies 0.5 m in depth at various distances from 100 ha application

Distance (m)	Concentration (ppb)	
	D8-46	TVB
25	195	28
50	121	22
75	86.9	18
100	68.6	16
150	47.5	12

TABLE 2. Predicted triclopyr deposits (a.e.) on foliage at various distances from 100 ha application

Distance (m)	Deposit (mg/m^2)	
	D8-46	TVB
25	78.9	6.4
50	48.0	3.8
75	34.4	2.6
100	26.6	1.9
150	18.2	1.3
200	13.5	0.94
250	10.6	0.73