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Phenoxy Herbicides in Alberta Rainfall: Cause for Concern?

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Abstract

A survey for herbicides in air was conducted by analyzing rainfall at eight Lethbridge-area locations. Rainfall samples were collected at weekly intervals from May 30 to August 17, 1998 and analyzed for 2,4-D, bromoxynil, dicamba, MCPA, diclofop, fenoxaprop, quinclorac, triallate and trifluralin using a MSD-GC method. With few exceptions, herbicides were detected at every sample date, at every location. 2,4-D was detected most frequently, and in the highest amounts, with bromoxynil and dicamba usually also present. The other herbicides were not detected. On June 12, 2,4-D was detected at two rural locations at 5.1 and 3.6 ppb compared with the Canadian Aquatic Life guideline of 4 ppb. Some high herbicide levels (2.0 and 4.3 ppb) also occurred in early July. Levels at the three city residences (maximum 1.0-1.6 ppb) were lower than at the rural locations. These herbicide detections results raise several concerns.

Keywords: 2,4-D, rainfall, crop effects, water quality, health concerns.

Introduction

In past studies on herbicides in ground and surface waters (CAESA 1998), detections usually represented 1-2% of the amounts applied. Flux calculations (Cessna, pers. comm.) indicate there could be 18% of applied herbicides in the air. Thus, to date, we may have been 'ignoring' the largest sink of herbicide residues in the environment. We conducted an initial 1998 survey of herbicides in the air by analyzing the rainfall at eight Lethbridge-area locations. Our objective was to determine whether significant amounts of herbicides could be detected in the rainfall.

Herbicides in the air (Majewski & Capel 1995) can be in: 1.) vapor form, 2.) dry particulate form, 3). attached to dust, 4.) dissolved in atmospheric moisture. We did not differentiate between dry and

wet deposits; we simply used the rainfall to collect total herbicide amounts in the air. The trapping efficiency of rainfall in 'capturing' the total herbicide amounts is unknown.

Materials and Methods

We used a 25-cm i.d. funnel, setup 60 cm above ground over a 4 liter amber bottle, to sample the rainfall. The eight sampling locations were: 3 Lethbridge city residences (backyards), 2 Lethbridge Research Centre (LRC) locations, 2 county golf course/rural locations, and 1 farm location near Tempest, AB.

Rainfall samples were collected at approximately weekly intervals from May 30 to Aug 17. Some samples were intentionally collected during dry periods to check for dry deposition in the funnels. We analyzed for the following 9 herbicides using a MSD-GC method with ion-ratio confirmation: 2,4-D, bromoxynil, dicamba, MCPA, diclofop, fenoxaprop, triallate, trifluralin and quinclorac.

Results and Discussion

Herbicide detections are expressed a ppb (ug/liter) basis which depends on the amount of rainfall but relates to the Canadian Water Quality guidelines and to other reports.

With few exceptions, herbicides were detected in the rainfall at every sample date, at every location. 2,4-D was detected most frequently and in the highest amounts, with bromoxynil and dicamba usually also present. On June 12, 2,4-D was detected at the county golf course and at the Tempest-area farm at 5.1 and 3.6 ppb, respectively, compared with the Canadian Aquatic Life guideline of 4 ppb. Some high herbicide levels (2.0 and 4.2 ppb) also occurred in early July at the two LRC locations; these high levels corresponded to known, nearby spray events. In general, levels (max. 1.0-1.6 ppb) at the three city locations were lower than at the rural locations. MCPA, diclofop, fenoxaprop, quinclorac, triallate, trifluralin and quinclorac were <u>not</u> <u>detected</u> in any rainfall samples in 1998. The dry sample collections yielded only traces of 2,4-D, bromoxynil and dicamba.

The herbicides are entering the air via: 1.) application drift, 2.) volatilization from plant and soil surfaces, 3.) erosion dust. Although less obvious than application drift, Majewski & Capel (1995) suggest that volatilization and erosion may contribute just as much to herbicide levels in the air as drift. Larney et al. (1998) recently reported 4.5% of applied herbicides in erosion dust in southern Alberta during the 3-6 month period after application.

Our results raise several concerns and questions:

1. The 1998 herbicide amounts detected in Lethbridge-area rainfall seem unusually high, especially 2,4-D amounts, which were 10-50x higher than the herbicides reported at other Canadian locations (see Table). Why?
2. Are the 1998 results unique or will they be repeatable in subsequent years? (There was 192 mm rain in June/early July of 1998; 'normal' is about 100 mm.)
3. Are the 1998 results specific to the Lethbridge chinook region (hot, windy, dusty)? (Frequent June rainfalls in southern Alberta may desorb herbicide residues from plants and soil, then promote herbicide evaporation via co-distillation, evaporated herbicides then attach to dust?)

4. Do the detections in rainfall correlate to herbicide sales/use patterns? (Sales of 2,4-D and in the County of Lethbridge were among the highest in Alberta in 1993. Also, some of the high detections at LRC in 1998 did appear related to specific spray events.)
5. Are the maximum herbicide levels in Lethbridge-area rainfall high enough to cause sub-lethal effects on certain plants species? (Kudsk et al. (1998) estimated that 23-82 ug/m2 of mecoprop over 14 d would cause injury to sensitive plants in Denmark. We detected 26-76 ug/m2 of 2,4-D over several different 14-d periods.)
6. Could the herbicide amounts detected in rainfall [0.3-0.8 g/ha 2,4-D over 14 d] negatively impact surface water quality? (especially ponds, dugouts.)
7. Could the herbicide amounts in Lethbridge-area air have chronic effects on public health? (increased asthma?)

Maximum Herbicides in Rainfall at Various Canadian Locations

Alberta	(Hill et al. 1998;	2,4-D	5.1	ppb
	this report)	bromoxynil	0.8	ppb
		dicamba	0.8	ppb
Ontario	(Hall et al. 1993)	atrazine	0.5	ppb
		metolachlor	0.3	ppb
Manitoba	(Rawn et al. 1996)	MCPA	0.3	ppb
		bromoxynil	0.2	ppb
		2,4-D	0.1	ppb
		dichlorprop	0.1	ppb
		atrazine	0.1	ppb

Conclusions

Significant amounts of 2,4-D, bromoxynil, dicamba were detected in the Lethbridge-area rainfall. The amounts seem unusually high and may be unique to the southern Alberta chinook region.

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