RATING THE OFF-TARGET HAZARDS OF HERBICIDES

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Summary. To assist in controlling the off-target movement of herbicides, which is of public concern, a proposal is made to label herbicides with an off-target hazard rating. Currently available herbicides are grouped into 15 categories based on those herbicide characteristics which govern potential off-target hazards, namely volatility, site of uptake by plants, mode of action and soil mobility. The herbicides are further grouped according to their activity against three plant classes namely grasses, herbaceous broad-leaved plants, trees and shrubs. On the basis of the herbicide category and plant groups affected, safe distances between a treated area and various vegetation types are proposed for representative herbicides.

INTRODUCTION

There is public concern about the environmental effects of agricultural chemicals and unless herbicides are used in a more responsible manner there will be increasing pressure to curtail or discontinue the use of certain herbicides. In particular the off-site movement of herbicides, whether to the air or into potable water supplies, must be minimised. Label advice on how to minimise environmental hazard when using a herbicide is not always adequate. For example references to off-site movement of spray or vapour rarely include safe distances from sensitive plants. Reliable information on this topic is fragmented and in literature which is not available to most users of herbicides. This paper will attempt to define the more important factors involved in potential off-target hazards, rationalise a system to judge their impact and suggest a chart which will give the user guidance on safe distances between the treated and sensitive areas.

FACTORS INVOLVED IN OFF-TARGET MOVEMENT

It can be rationalised that the factors involved on off-target movement can be grouped into four distinct categories:-(i) herbicide characteristics, (ii) the type of plants affected by the herbicide, (iii) the application variables, and (iv) the prevailing meteorological conditions. Of these factors the latter two have received considerable attention by way of reviews and extension activity. Delineating the hazards by assessing the characteristics of the herbicide and the range of plants affected has only previously been attempted in a limited way (1).

The properties of a herbicide which influence its potential to cause off-target damage are:-

(a) volatility, which determines the amount of herbicide which can move from the target in the vapour phase. Such movement can occur for some time after application and can cause off-site damage, irrespective of correct application. Volatility, which increases with temperature, is measured as vapour pressure. Herbicide vapour pressures at 20-25^{o}C range from 210mm Hg for the highly volatile acrolein to 5.5 10^{-14}mm Hg for the non-volatile sulfometuron methyl. The volatile esters of 2,4-D are in the range of 10^{-3} to 10^{-5}mm Hg. It is suggested that any herbicide formulation that has a vapour pressure less than 10^{-6} mm Hg at 25^{o}C could be considered as having negligible volatility.

(b) the mode of entry into plants which determines whether uptake is through the foliage or via the soil or through both.

(c) the mode of action, whether systemic or contact. This influences the amount needed to impart damage.

(d) mobility in the soil which affects its safety in use because more mobile herbicides can more readily leach into or wash across the soil surface into the root zone of desirable plants. Soil mobility is affected not just by the solubility of the herbicide in water, but also by its ability to bind to soil particles.

PROPOSED CLASSIFICATION SYSTEM

The above four factors can be used to classify herbicides. With two classes for volatility (volatile and negligible volatility), three for site of uptake (foliar, soil, and foliar plus soil), two for mode of action (systemic and contact) and two for mobility (significant and negligible) it is possible to classify all herbicides into 24 categories. The currently available herbicides can be fitted into fifteen of these (Table 1). Since the potential of a herbicide to cause damage depends upon the susceptibility of the off-target species, it is necessary to classify herbicides according to the plant groups they affect. Using the three groups, grasses, herbaceous broad-leaved plants, and trees and shrubs, a herbicide (or mixture) can be allocated into one of six categories affecting only (a) grasses, (b) only herbaceous broad-leaved plants, (c) only trees and shrubs, (d) grasses, herbaceous broad-leaved plants, trees and shrubs, (e) herbaceous broad-leaved plants, trees and shrubs, and (f) grasses and herbaceous broad-leaved plants. The damage potential of a herbicide is thus categorised by a number (1 to 15) and a letter (a to f).

It is suggested that non-target plants could be grouped into fruit crops, grape vines, broad-leaved crops, cereals, vegetables and desirable vegetation. A partial listing is given in Table 2. The crop groups could be expanded to give greater precision. The potential for any given herbicide to damage a given plant community will depend upon the characteristics of the herbicide being used, such as its volatility, how it enters plants, its mode of action, its mobility in the soil and on what types of plants it affects. These factors are incorporated in the number and letter which define each herbicide. From this information it is possible to suggest the relative safety of a category (e.g.6e) to each of the plant communities. These estimations can be translated into estimated safe spray distances from each community. See Table 2 for sample suggestions. This process has been carried out for all registered herbicides for the 'crop' groups listed above. It is suggested that all herbicide labels could be coded in this way to reflect hazard to non-target species. This code could then be translated into suggested safe distances on an agreed chart which would be similar to Table 2.

It is recognised that there will be debate on the category in which some herbicides belong and on the correct distance for each of the categories. Further, there will be concern that the distances given will only reflect good application practices under suitable environmental conditions. It is possible to make the recommended safe distances greater, to accommodate less precise users, or less to reflect better applicators. Of concern to many, but particularly to herbicide manufacturers, users and government advisers is the relevance of such recommendations in litigation cases. There is a fear that such recommendations would lend themselves to increased litigation from off-site movements. It should be understood that such litigation is already possible (2) as the user is in essence liable for the movement of the applied material from the application site. Appropriate disclaimers could be worded to exonerate the users, manufacturers or advisers. It is felt that the system offers a relatively simple solution to a complex problem. Further, while it is recognised that as presented the system has flaws, many of which can be rationalised by further consideration, the advantages to users are considered to outweigh the disadvantages which mainly relate to fear of litigation and of setting restrictively large distances from sensitive crops.

Table 1. Category of herbicide according to volatility, site of uptake, mode of action and soil mobility.

CAT.		
1.	PROPERTIES	Volatile: Root Activity: Systemic: Significant Soil Mobility:
	EXAMPLES	EPTC, molinate
2.	PROPERTIES	Volatile: Foliar and Root Activity: Systemic: Significant Soil Mobility:
	EXAMPLES	triclopyr ester, metsulfuron methyl, metribuzin, terbutryn, 2,4-D L.V.ester, MCPA L.V.ester,
3.	PROPERTIES	Volatile: Root Activity: Systemic: Negligible Soil Mobility:
	EXAMPLES	propachlor, dichlobenil, propyzamide, chlorthiamid, triallate, pebulate, chloridazon
4.	PROPERTIES	Volatile: Foliar and Root Activity: Systemic: Negligible Soil Mobility:
	EXAMPLES	chlorpropham, metolachlor, pendimethalin
5.	PROPERTIES	Negligible Volatility: Foliar Activity: Systemic: Significant Soil Mobility:
	EXAMPLES	amitrole
6.	PROPERTIES	Negligible Volatility: Root Activity: Systemic: Significant Soil Mobility:
	EXAMPLES	oryzalin, TCA, tetrapion
7.	PROPERTIES	Negligible Volatility: Foliar and Root Activity: Systemic: Significant Soil Mobility:
	EXAMPLES	terbacil, metoxuron, bromacil, 2,4-D salts/amines, 2,4-DB salts/amines, dicamba, 2,2-DPA, clopyralid, fluometuron, picloram, hexazinone, MCPA salts/amines, MCPB salts
8.	PROPERTIES	Negligible Volatility: Foliar Activity: Systemic: Negligible Soil Mobility:
	EXAMPLES	glyphosate, pentanochlor, phenmedipham, flamprop-methyl, fluazifop, alloxydim, fluroxypyr, barban, sethoxydim, diclofop-methyl
9.	PROPERTIES	Negligible Volatility: Root Activity: Systemic: Negligible Soil Mobility:
	EXAMPLES	ethidimuron, propazine, chloroxuron, simazine
10.	PROPERTIES	Negligible Volatility: Foliar and Root Activity: Systemic: Negligible Soil Mobility:
	EXAMPLES	cyanazine, ethofumesate, chlorsulfuron, imazapyr, ametryn, linuron, carbetamide, karbutilate, diuron, methabenzthiazuron, napropamide, prometryn, secbumeton, thiobencarb,#asulum, atrazine
11.	PROPERTIES	Volatile: Foliar Activity: Contact: Negligible Soil Mobility:
	EXAMPLES	aromatic hydrocarbons, acrolein
12.	PROPERTIES	Negligible Volatility: Foliar Activity: Contact: Negligible Soil Mobility:
	EXAMPLES	DSMA, MSMA, paraquat, propanil, diquat, ioxynil, cacodylic acid, bentazone, bromoxynil
13.	PROPERTIES	Volatile: Root Activity: Contact: Negligible Soil Mobility:
	EXAMPLES	trifuralin, chlorthal, benfluralin
14.	PROPERTIES	Negligible Volatility: Root Activity: Contact: Negligible Soil Mobility:
	EXAMPLE	bensulide
15.	PROPERTIES	Negligible Volatility: Foliar and Root Activity: Contact: Negligible Soil Mobility:
	EXAMPLES	acifluorfen, oxadiazon, oxyfluorfen

Table 2. Distance guidelines (metres) when applying herbicides by ground application other than by misting machine.

Herbicide Example	Hazard Category	Fruit Crops		Grape Vines		Broad leaved Crops		Cereal	Vegetables	Desireable Vegetation	
		Decid. orch.	Others	Dormant	Non-Dormant	Tomatoes Tobacco	Others			Trees & Shrubs	Herbs & Grasses
2,4-D low vol. ester	4e	100	100	20	1000	1000	100	10	100	100	100
2,4-D amine	7b	20	20	20	100	100	100	10	100	20	20
hexazinone *	7d	100	100	50	50	50	50	50	50	50	50
chlorsulfuron & atrazine	10f	20	20	20	20	20	20	20	20	20	20
diclofop methyl	8a	NR	NR	NR	20	10	10	20	20	NR	20
glyphosate	8d	20	20	NR	50	50	50	50	50	100	50
paraquat	12f	10	10	NR	20	20	20	20	20	10	20
trifuralin	13f	NR	NR	NR	NR	NR	10	10	10	NR	10
dicamba *	7e	50	50	50	100	100	100	10	100	50	50

NR = No restriction

* These herbicides are taken up from the soil by the roots of plants, and therefore should not be applied near the roots of desirable plants.

NOTE: These distances assume that there is no wind blowing towards the off-target crop.

REFERENCES

1. Anon. 1983. Recommendations for the Control of Noxious Weeds in Victoria, Bulletin 3F. Dept. of Crown Lands & Survey, Victoria.
2. Irvine, F.N. 1984. Proc. 7th Australian Weeds Conference, Perth, pp 89-92.