ASSESSING PESTICIDE RISKS TO NON-TARGET TERRESTRIAL PLANTS

OBJECTIVE SEVEN: RISK MANAGEMENT TO PROTECT KEY SPECIES

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7.1 INTRODUCTION

Risk management for protection of key non-target plant species can be organised in a variety of ways. Essentially, most of the risk to non-target plants is posed by herbicides, because fungicides and insecticides often have little or no herbicidal activity. Spray drift represents a greater threat than other forms of pesticide movement, although vapour drift can have serious consequences. The different types of risk management procedures can be grouped into four main categories; application methods, timing methods, spatial methods and area methods. These may be used singly or together, but not all are available for regulation purposes.

7.1.1 Application methods for risk management

Application methods concern the composition of the spray solution and the equipment used to apply it. Precision in delivery of pesticide to the target is essential.

Sprayer design: a great many different types of sprayers are in use, and as many other types have been fashionable in the past. A main aim of designers has been to reduce drift, both because it can result in contamination and because it represents a loss of active ingredient. As described in Section Five, drift of droplets is a consequence of needing to cover the crop and weeds thoroughly, and small droplets of solution are essential for this. Other designs, such as electrostatically charged droplets have been tried, but have encountered problems in use and have been replaced by the hydraulic system. Air-assisted sprayers, in which the spray solution is blown downwards into the crop, may lower drift. Sprayer calibration, management, and operation in correct windspeed are all essential in reducing spray drift, as is the use of the lowest feasible boom height.

Precise spatial application might be achieved by weed mapping and patch spraying which, potentially, could lead to reduced spray drift and overall pesticide use. This area is currently under development in order to improve reliability. However, probably not all species of weeds are suitable for this sort of approach.

Another development which can reduce herbicide use and thereby the amount of drift, is the incorporation of mechanical weeding into control systems. Weeds can be managed entirely by mechanical means, e.g. weed rakes. Alternatively, a combination of hoeing and reduced herbicide use can be successful. Between-row mechanical weeding is particularly suited to row crops, where within-row control can be achieved by directed sprays.

Active ingredient: with a large number of possible chemicals in use, there is sometimes an opportunity to use one with a specification which may be less damaging to certain types of plants than to others. Particular herbicides might be targeted more precisely to the weed spectrum present in fields. However, precise dose responses are needed before this can be used, and at present, such data are not generally available.

There is often an opportunity to vary the spraying volume of water; higher volumes lead to a lower concentration of active ingredient, and for these, a larger droplet diameter is effective. This in turn would give a lower fraction of droplets of driftable size, thus reducing spray drift potential. Tank mixes giver greater flexibility in obtaining specific weed control requirements. Pre-emergence herbicide applications can utilise larger drop spray spectra and are to be preferred for drift limitation.

There are a number of adjuvants available which are claimed to lower spray drift by preventing the formation of very small droplets. A problem with these is that claims by makers may require specific testing. Adjuvants can also lower the dose of pesticide needed for control.

The need to avoid contamination, as well as for economic reasons, has resulted in the use of lower doses of many pesticides and the finding that these can often achieve adequate control. In fact the question of the right amount of pesticide to use in a given set of circumstances has not been answered satisfactorily, because the recommended doses tend to be generally greater than is usually required, especially for weeds. There is some information on the degree of weed infestation that can be tolerated without loss of economic yield, but this, together with a robust method to calculate precise doses for a crop, would be extremely useful for risk management. At present, growers have usually little more than previous experience or the recommendation of a consultant to rely upon. Not all pesticides can achieve control at low doses; on the other hand, there are some that can achieve control at less than half the recommended amount.

7.1.2 Timing methods for risk management

There is often an opportunity to apply pesticides later or earlier within a given season, or (particularly with herbicides) to apply in either Autumn or Spring. In an autumn application, a soil-incorporated pre-emergence herbicide could be used, further reducing the risk of spray drift, because large droplet spray spectra can be used. An outline of the timing of the main pesticide applications for several crops is given in Appendix One. The key to risk management by manipulating timing is to have a thorough understanding of agronomy, the target and precision control operations. Nevertheless, it is potentially very effective because it can remove risk altogether.

7.1.3 Spatial methods for risk management

Separating crop from non-target organisms by buffer zones is potentially effective (although these may be a difficult regulatory option). De Snoo & de Wit (1998) demonstrated that an unsprayed crop edge could reduce the drift of pesticides to ditch banks and to water to negligible amounts. Similar results are shown by the herbicide deposition studies of Longley *et al.* (1997), who showed that conservation headlands could reduce drift to field margins. Some evidence for the damaging effect of drift on field margins is reviewed in Section 5. The buffer technique is particularly valuable for preventing the contamination of water, although it addresses the symptoms of drift and non-target effects, rather than addressing the underlying causes. The development of sown margin strips as buffers has been investigated by Willmot Pertwee Ltd in conjunction with IACR - Long Ashton. Sown buffer strips of native grasses and flowers are reasonably cheap, effective and provide other benefits on farms, particularly enhanced biodiversity and weed control (Marshall & Moonen, 1998). Buffers may take up valuable cropping land, but are often placed in less-productive headlands. A range of options for field margin strips are supported by the UK Countryside Stewardship Scheme and further options are developed in the Arable Stewardship Pilot Scheme. Landowners may need financial support to develop these options, but advice on their creation and management is available (Marshall, 1998). Where buffers also contain shrubs or tree species, biomass may provide a return for landowners. Studies of sown margin strips indicate few adverse agronomic effects and little spread of weeds (Marshall & Moonen, 1997; West *et al*., 1997; Smith *et al.* 1999).

To summarise, there is evidence that unsprayed buffer zones can reduce drift to non-target habitat and they can enhance on-farm biodiversity. There is also evidence that buffers sown to perennial grassy vegetation reduce weed ingress to fields. However, creating buffers reduces the productive area of the field. The requirement for buffer areas is already present on product labels in regard to aquatic habitat. Extension to terrestrial habitat would seem achievable, though attention to the management of unsprayed but cropped buffer areas would be required. The argument that the removal of the margin habitat might ensue, may be true for aquatic habitat, but in the terrestrial margin situation further analysis of likely responses is required. Under the Hedgerow Protection Regulations, farmers are not allowed to remove hedges without approval from their local authorities. This will provide protection for many field boundaries.

7.1.4 Area methods for risk management

Some pesticides, especially volatile ones, may represent little or no risk if used in small amounts over relatively small areas. However, widespread use, and application at the same time (due to the same favourable conditions occurring) could present an increased hazard, though there is little information on this. The main use could be with volatile pesticides. Exactly how this could be achieved in practice is difficult to judge. Maintenance of crop diversity and crop rotations is essential, to limit possible landscape-scale application events.

7.2 PRACTICALITY OF RISK MANAGEMENT METHODS

The advantages and disadvantages of the various risk management methods are given in Table 1. Some of these methods can be used together; suitable combinations are shown in Table 2, together with an estimate in the reduction in contamination which might be expected. The adoption of such methods by growers is likely to be related both to the effectiveness and cost of each method, and an indication of this is shown where appropriate. From the tables, application methods appear to be superior and generally cheaper for the grower (unless re-equipping with a new sprayer is needed). Timing methods require considerable skill and are restricted in many cases, and buffer zones or windbreaks reduce the cropping area and by themselves, do not reduce the amount of drift but merely restrict its spread. Such passive methods are, however, simple to implement, and require no special knowledge. Lowered doses may give financial savings. The potential risk to crop yield due to pest infestation has not been considered but it would be of concern when using low doses or timing methods. Tables 1 and 2 assume that the equipment used is correctly calibrated and that application takes place in the recommended conditions of windspeed.

The quantitative reduction in drift or contamination due to each of the risk management methods can be estimated approximately in some cases. The difference between a correctly calibrated sprayer and an unserviced one is of the order of 100% or more. Changing the active ingredient according to the susceptibility of non-target species clearly has very great benefits, although the opportunity to do this may be limited. Similar benefits and restrictions apply to timing methods. Buffer zones and windbreaks, when used alone, may reduce contamination at the edge of the field by a substantial amount, perhaps by as much as 50%.

The choice of risk management method would be assisted by a thorough knowledge of pest control and pesticides in most cases. Often, the necessary information is not available, and others (including sprayer design, adjuvants and windbreaks) are not a regulatory option.

7.3. REFERENCES

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Table 1. Advantages and disadvantages of different risk management methods

Method	Advantage	Disadvantage	Comment
<u>Application methods</u>			
Sprayer design	Reduces drift	No reduction in amount applied	Manufacturers claims may be optimistic
Active ingredient	Avoids susceptible species	Necessary information may not be available; not possible in many cases	Requires detailed information and knowledge
Adjuvants	Reduce drift; permit low doses	Conflicting information from suppliers	Simple and effective in some cases
Low dose	Cheaper; less contamination	Less pest control	Detailed information needed
<u>Timing methods</u>			
Within season	Minimises risk; may be very effective	Difficult to achieve; few opportunities	
Between seasons	Could avoid risk	If Autumn control fails then Spring application essential	Herbicide only
<u>Spatial methods</u>			
Buffer zones	Effective	Reduce drift; do not prevent it; uses cropping land	Simple but passive methods
Windbreaks	Effective	Maintenance around field	Possibly unpredictable effects
<u>Area methods</u>			
Avoidance of simultaneous application	Reduce damage	Difficult to achieve in practice	Only needed if large scale use of pesticide with recognised volatility problems. Difficult to organise.

Table 2. Costs and effectiveness different risk management methods and combinations

	Method	Cost	Effectiveness	Combinations
	Application methods			
1	Sprayer design	Very high	High	any others
2	Adjuvants	Low	Very high	with 3, 1
3	Low dose	Save	Very high	with 2, 1
4	Active ingredient	Low	High	any others
	Timing methods			
5	Within season	Low	Good	any others especially 1 - 3
6	Between seasons	Small	Good	any others especially 1 - 3
	Spatial methods			
7	Buffer zones	Moderate	Good	any others possibly 8
8	Windbreaks	High	Good	any others possibly 7