PESTICIDE USE REDUCTION - LOGICAL DECISION MAKING

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SUMMARY

The general approach to pesticide use reduction has been to measure reduction in tonnage of pesticide or in the number of sprays applied. Both mask the fact that pesticides vary in their properties and their effect on consumers, environment and applicators, and ignore the reality that applications can vary by 200% between growers and that active ingredient can vary ten fold between different compounds. A rating index has been devised whereby the properties of a pesticide are rated. It is suggested that specific pesticide/use situations be targeted for reduction and that the use of pesticides among growers be brought to a uniform level.

Keywords: pesticides, fungicides, insecticides, reduction, IPM

INTRODUCTION

Consumer concerns about pesticides and other chemicals in food have led to action by government, industry and individuals. The reactions to these concerns have varied from the individual who decides to grow fruit organically through industry targets for reduction in pesticide usage (Anon 1991) to government enacted legislation banning certain chemicals, and in some cases requiring growers to reduce the use of pesticides (Evans and Rowland 1993).

Where industry or governments have established goals or requirements for pesticide use reduction, they appear to be based on reducing either the tonnage of pesticide used, the number of sprays applied or both (Evans and Rowland 1993). There are problems associated with these approaches which may mean that the real goal of pesticide reduction, that of reduced impact on health and ecosystems, may not be achieved.

The assumption implied in these approaches is that there is uniformity across the industry in terms of the number of applications and quantity of pesticide used by the individual growers which comprise the industry. It is likely, however, that the amount of pesticide used will vary with pest or disease pressure, which in turn is a function of weather, location, inoculum levels and plant susceptibility. But also, because of the variability in acceptance of risk, the amount of pesticide also varies between growers with similar pest and disease pressures within the same district. The level of activity of different pesticides also affects the amount of active ingredient (a.i.) applied per hectare. This paper discusses some of these issues and outlines an alternative approach to pesticide use reduction.

FACTORS IN PESTICIDE REDUCTION

Variability between orchards in amounts of pesticide used

Twenty orchards were surveyed for pesticide usage over three seasons as part of an integrated pest and disease management (IDPM) program for apples in NSW (Bower *et al.* 1993). All orchards were located in the one apple growing district and were exposed to the same range of pests, diseases and climate.

In the first season (1990/91), a spring with average rainfall which resulted in moderate apple scab pressure was followed by a dry summer which favoured codling

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moth and mite infestations. The 1991/92 season was characterised by a dry spring and a cool and dry summer, resulting in little pest or disease potential. Apple scab was favoured by a wet spring in the 1992/93 season, but low temperatures delayed codling moth development.

Fungicide applications per orchard varied over the three seasons from 10.3 sprays in 1991/92 to 16.7 in 1992/93. The range between orchards in the number of sprays applied was from 7 to 24 in 1990/91, 5 to 16 in 1991/92 and from 9 to 25 in 1992/93.

There was less variability in the number of insecticide applications between seasons (11 to 12), although there was considerable variation between individual orchards. In 1990/91 and 1991/92 the range between orchards was 7 to 17 and in 1992/93 from 7 to 15.

Variability in dosage of active ingredient

An examination of a selection of the range of fungicides and insecticides used on apples and their concentration and use rates showed that the concentration of a.i. in the fungicides can vary from 100 g/litre to 900 g/kg and for insecticides from 250 to 800 g/litre. The recommended rate of application of a.i. per 100 litres can vary from 2 g to 120 g for fungicides and 11 g to 104 g for insecticides.

Variability between amounts of pesticides applied per hectare

As part of the IPDM project the output of twenty six spray machines was measured using standard methods. The output varied from 1600 to 3300 litres/ha with a mean of 2200 litres/ha. This mean volume is regarded as suitable for moderately sized trees in high density plantings. Growers were surveyed for the amount of azinphos-methyl incorporated in the spray liquid. Using the figures for volume of output, and the amount of azinphos-methyl placed in the vat, the application of azinphos-methyl per ha was calculated. This varied from 0.82 to 1.66 kg/ha, with a mean of 1.15.

TABLE 1: Example of rating system to compare two fungicides for use in apples for control of apple scab through the season.

Characteristics	Mancozeb (800 g a.i./kg)	Ratings	
		Flusilazole (200 g a.i./kg)	
		Rating x weighting ^a	Rating x weighting ^a
Activity (A)	150 g x 0.8 a.i. = 120	3 x 2 = 6	10 g x 0.2 a.i. = 2
Site of application (S)	Leaves & fruit	5 x 2 = 10	Leaves & fruit
Timing of application (T)	Through season	3 x 3 = 9	Through season
Persistence (P)	WHP ^b 14 days	3 x 3 = 9	WHP 7 days
Potential for Residues Index (PRI)		34	30
Efficacy (Ef)	Good	1 x 2 = 2	Good
Cost (Cs)	Moderate	3 x 1 = 3	High
Environmental effects (En)	Low	1 x 2 = 2	Low
Mammalian toxicity (T)	6750	1 x 2 = 2	1100
Compatibility with IPM (Cp)	Affects predatory mites	4 x 1 = 4	No effects
Availability of alternatives (Aa)	Some	3 x 2 = 6	Some
Value Index (VI)		19	17
Pesticide Index (PI) ^c		53	47

^aThe weightings applied to both fungicides are the same.

^bWHP, withholding period.

^cOn the basis of this assessment there would be less need to reduce the use of flusilazole than that of mancozeb (Penrose *et al.* 1994).

Pesticide Rating Index

A rating index to compare the properties of pesticides (Table 1) has been developed and published elsewhere (Penrose *et al.* 1994) but is raised here to further discussion on pesticide reduction. The pesticide index (PI) is comprised of two parts - a 'potential for residues index' (PRI) and 'value index' (VI). These indices are derived by applying a rating from one to five to the properties of each pesticide and pest/disease situation. The PRI is made up of ratings for activity of the a.i., site of application, timing of application and persistence. The VI is made up of ratings for efficacy, cost, environmental effects, mammalian toxicity, compatibility with IPM, and availability of alternatives. Weightings of one to four are applied to each of the ratings. The weightings are set by the user of the index depending on a subjective view of the relative importance of the various factors. Therefore these weightings will vary between users. Nevertheless, the index assists with choices within these set parameters.

Thus, when comparing two compounds for the same use, the compound with a low PI would be, on balance, the more desirable product to use.

DISCUSSION

In our surveys the mean number of applications of fungicides varied between seasons by over 50% whilst mean insecticide use was more stable from season to season. Even greater levels of variability occurred in pesticide use between growers within each season. Again fungicide use appeared more variable than insecticide use, but both showed greater than 100% variation. This is consistent with observations in New Zealand where the cost of chemicals used on apples in one season ranged from \$1313 to \$3633/ha in different orchards (Wilton 1993). The variation in output of spray machines also accounts for significant variations in application of pesticides per hectare. There appears, therefore, that there is little to be gained from overall industry targets for pesticide reduction in terms of numbers of sprays when there is so much variation between orchards in the amount of pesticide used. Further, to have such targets without a baseline against which achievements can be measured make the process undefinable.

The variation in the amount of a.i. applied arising from the different level of activity of products essentially of the same efficacy, means that the 'tonnage' approach is also unworkable, and again there is no baseline against which to measure achievements. Reductions in the amount of pesticide applied by changing to a more highly active compound have been called 'phantom reductions' (Evans and Rowland 1993). In some cases an increase in the amount of a.i. may be desirable where the less active compound has less deleterious effects.

We consider the goals for pesticide use reduction should be to:

- 1) bring pesticide use by all growers to an acceptable and more uniform minimum
- 2) make decisions on pesticide programs and reductions in pesticide use on the basis of the properties of the pesticides, balancing the various attributes to arrive at the most suitable program.

We consider the 'pesticide index' (Penrose *et al.* 1994) offers one means of balancing the various advantages and disadvantages of one pesticide against another so that a logical decision can be made on which material to use. We acknowledge that in some areas our rating index is subjective, but consideration of the features of the pesticides does at least have to be made when using this approach.

There is potential for the concept to be extended to other crops and pesticides (eg. herbicides) and to develop a decision support system, either paper based or computer based, to assist with this approach in the field.

CONCLUSION

The general reduction of pesticide usage is seen as a worthwhile goal, although greater benefits probably arise from the reduction or elimination of particular pesticides rather than a non discriminatory reduction in the tonnage or number of sprays. Reductions should be made by attempting to bring heavier users of pesticides to a level

found to be generally adequate for pest and disease control. Within this framework, growers may then be able to make specific choices of pesticides for each use situation using some form of comparative system along the lines of that discussed here.

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