

Risk of pesticide contamination in cotton seed and livestock

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Our research had two main goals. Primarily, it sought to identify pesticides at risk of potentially contaminating cotton seed and therefore cotton seed oil.

We also assessed the indirect risk to cattle feeding on pastures adjacent to cotton fields subject to possible drift. An additional benefit of this research has been the identification of the data and knowledge that would be needed to continue proactive residue management in the Australian cotton industry.

The results presented here include those of endosulfan and chlorflurazuron (Helix) residues to provide a comparative basis for the development of a model "Residue Risk Index" by which other cotton chemicals could be benchmarked. A graph of the relative risk scores identifies those chemicals at highest risk of exceeding MRL, given the respective rates of chemical usage in the cotton industry.

To confirm this risk ranking, some targeted sampling for residue analysis would

Introduction

Mindful of previous chemical residue problems in livestock, the University of Sydney, on behalf of the Cotton Research and Development Corporation, reviewed all plant protection chemicals used for cotton growing. This study sought to provide information that could be used to support hazard management regarding chemical residues in livestock and in cotton seed. Potentially, the approach could be extended to the Best Management Practice (BMP) program.

be required. Our study helped to improve understanding of the issues and could help provide forewarning of potential problems in the future.

Relative risk ranking

MRL values for 60 chemicals were collected, both for domestic and international markets. This survey included 56 pesticides registered for cotton production, three compounds under registration and

one (chlorflurazuron) that has been withdrawn, but is included here for comparative purposes.

Data for 28 of these chemicals was incomplete, particularly for meat. This lack of data limited the scope of the study, since zero tolerance therefore occurs for 50 per cent of all cotton chemicals.

For this study, risk was defined as the probability of finding pesticide residues in cotton seed, oil and meat products above the established MRLs. Apart from the MRL data, a thorough search was carried out of relevant information on the 60 pesticides considered, including all available data on application, residues, metabolism in animals, half-life, physical and chemical properties, and evidence of possible translocation (movement throughout animals or plants). Interestingly, it was found that for some compounds, significant data gaps exist highlighting an important challenge with respect to risk management.

A set of consistent parameters was used to estimate the risk of pesticide residues in cotton products and meat consumed from pastures adjacent to cotton fields.

The risk index considered the following parameters to indicate the likely degree of exposure:

- Rate of application (%R);
- Frequency of usage (F — from Cotton Consultants Australia data);
- Timing of application (T);
- Partitioning into lipid (fatty) phases from water (KOW);
- Persistence in plants (half-life); and,
- Biomagnification factors (Bm).

This was compared with the MRL values for cotton seed or oil, and meat.

Equation A

$$R_s = \frac{\%R \times F \times T \times t^{1/2} \times B_m}{MRL}$$

Equation B

$$R_m = \frac{\%R \times F \times Kow \times t^{1/2} \times B_m}{MRL}$$

Residue risk scores were calculated separately for cotton seed/oil (R_s) and meat (R_m) by using equations A and B respectively. The Residue Risk index gives equal weight to all factors considered. But the final scores were largely dependent on the MRL values used.

THE REGULATORS

A Maximum Residue Limit (MRL) for a pesticide is established by the regulatory authorities of each country to ensure "acceptable" residue levels in produce farmed in accordance with Good Agricultural Practices (GAP). MRL values are, in effect, the statutory check that the farmer has followed GAP.

The detection of a residue concentration greater than the MRL would be considered as non-compliance. In countries that have not established an MRL, the detection of any residue may equate with non-compliance.

Although cotton fibre is not regarded as a food commodity, MRLs are an important industry consideration with regard to contamination and risk management of neighbouring properties and cotton byproducts, such as seed and oil. Many readers will recall the "Helix" (chlorflurazuron) contamination incident of 1994.

The Australian Pesticides and Veterinary Medicine Authority (APVMA) reviews all the available data provided by the chemical companies, grants approval for MRLs and establishes the withholding periods and other conditions for the proper use, or GAP, of the pesticide prior to registration. While the label for new chemical products must specify the latter conditions clearly, MRLs are not included on the label.

In Australia, MRLs are established by the APVMA, in conjunction with Food Standards Australia New Zealand (FSANZ), for agricultural and veterinary products in produce, particularly for produce entering the food chain. The National Residue Survey (NRS), conducted by the federal government Department of Agriculture, Fisheries and Forestry (DAFF), undertakes various monitoring programs on behalf of various industries.

These programs include random and targeted monitoring, compliance

For compounds with high MRL values, the risk for a particular commodity decreased, as compliance would be easier to achieve. Scores were calculated for two cotton seasons (2000–01 and 2002–03) using MRL values for Australia and the most sensitive international value.

RESULTS

Figures 1 and 2 present the Residue Risk scores for the highest ranked 30 pesticides, using the lowest Australian or international MRL value, for residues in meat and cotton seed respectively. These results show changing risk scores, as a result of changes in pesticide applications between the two seasons. A clear example of how IPM can shift application practice can also be observed. For example, observe the marked decrease in score of profenofos or parathion methyl (Figure 2), and the increase in the scores of abamectin, emamectin and indoxacarb in both assessments.

Some chemicals could not be scored because of a lack of readily available data. The risk management principle used in such cases is to expect the worst case, using only real evidence to lower such expectations.

A lack of data is evident with respect to pesticide residues in cotton seed. Although the full suite of MRL values is available, the mechanisms for seed contamination are not clear. No clear relationship between the rates of application of different chemi-



Rate of application is part of the risk index.

icals and existing data for their residue levels in seed or oil could be found, although systemic pesticides tend to appear in higher concentrations than non-systemic chemicals. This is one area where future targeted sampling would improve industry knowledge and might prevent another episode of costly contamination.

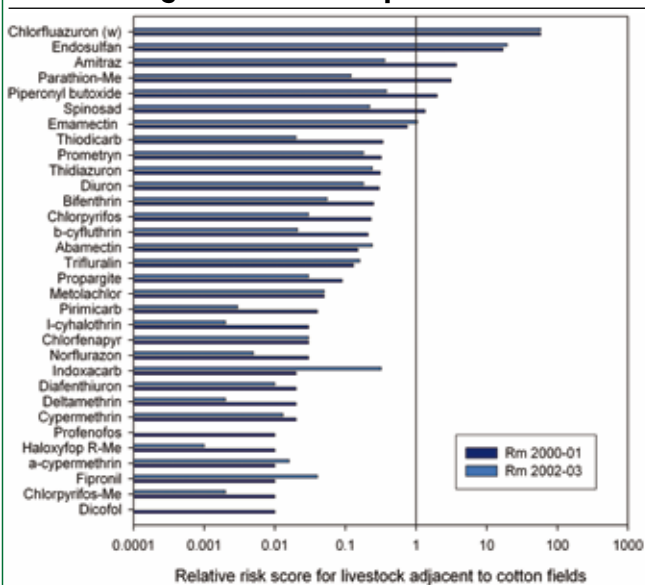
A comparison was made using computer modelled estimates of pesticide drift residues in two distinct zones, 50 metres and 1500 metres downwind of application. It was found that endosulfan, b-cyfluthrin and emamectin benzoate had the poten-

tial to produce non-compliant residues in livestock bound for both national and international markets at distances up to 1500 metres downwind from the sprayed cotton fields if applied from an aircraft.

For the downwind deposition closer to the sprayed field (within 50 metres) where the higher contamination occurs, 11 out of the 17 compounds studied could result in non-compliant residues concentrations in domestic or international markets. A lack of information regarding the transfer of residues from pasture to animals for a

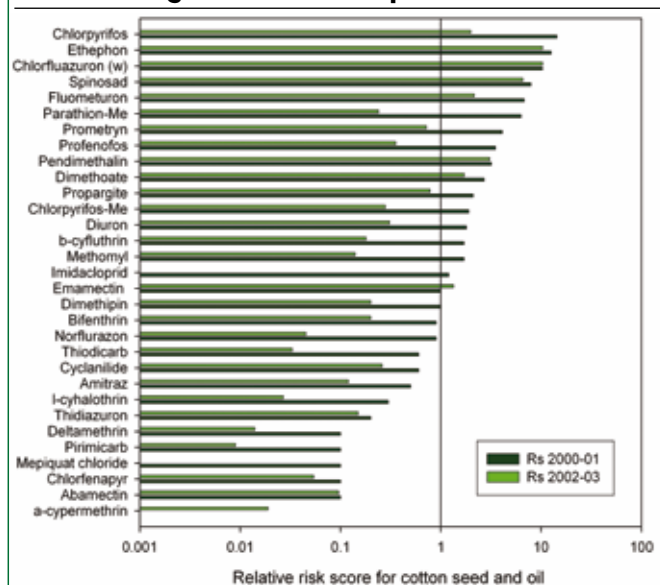
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FIGURE 1: Meat residue risk scores (Rm) for 30 chemicals registered in cotton production



- Risk ranking is shown for two seasons, 2000–01 and 2002–03;
- Chlorfluazuron (Helix) is included for comparative purposes;
- The lowest Australian or international MRL is used for comparison; and,
- No score indicates missing MRL information.

FIGURE 2: Seed residue risk scores (Rs) for 30 chemicals registered in cotton production



- Scores are shown for application data for two seasons (2000–01 and 2002–03);
- Chlorfluazuron (Helix) is included for comparative purposes;
- The lowest Australian or international MRL is used for comparison; and,
- No score indicates missing MRL information.

further 24 chemicals impeded the evaluation of these risks.

Communication and chemical companies

During this study we approached chemical companies for additional data and information. It is well known that often the best environmental data is privileged and “commercial in confidence” for many varied reasons. Each manufacturer was shown the data and rank of the chemicals under their jurisdiction and asked to comment and, if possible, provide data to reduce the ranking of their chemicals.

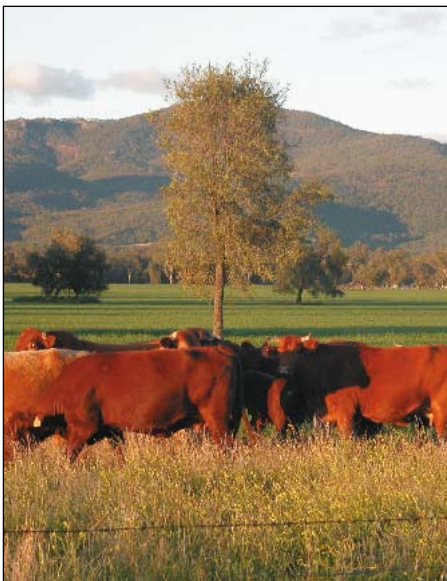
The outcome was encouraging in part, as most companies were keen to supply data and some provided valuable feedback regarding the approach used. Such interaction between industry groups, including chemical companies, working towards a common goal would be beneficial for better management in future.

Endosulfan and chlorflurazuron as case studies

Past experience of meat contamination provided the main impetus for the current study. These two cases differed in both their causes and solutions.

The case of endosulfan represents a scenario by which contamination of meat by many chemicals used in agricultural crops could occur. Contamination by spray drift onto pasture can presumably apply to many pesticides, and is the major route of contamination in grazing animals or adjacent crops.

Adverse consequences associated with drift are not restricted to insecticides — 2,4-D or glyphosate drift onto non-toler-



Pasture contamination is the major risk of contamination in cattle.



There is a shortage of information about residues in cotton seed.

ant varieties can equally cause commercial loss, even within the farm boundary. So the lessons learnt from endosulfan are valuable to prevent further similar occurrences.

But Chlorflurazuron illustrates how an uncommon practice under unusual circumstances can increase risk. The case differed by exposure route when contaminated cotton trash was fed to cattle during the 1994 drought. To ensure such risks are satisfactorily reduced in the future, improved trash management and assurance of minimal residue contamination would be required.

CONCLUSION

Although we have a list that prioritises “riskiness” of pesticides, we cannot estimate the exact magnitude of these risks. From past experience, we understand that the nature of Helix required different management practice. The introduction of genetically modified cotton varieties also affects contamination risk.

In cases where the scale of chemical use is reduced, the risk is also reduced. Conversely, new chemicals, or increases in chemical use, can be objectively assessed and monitored if necessary. With such information, appropriate selection and application of Best Management Practices, costly contamination issues should be avoided.

The Residue Risk Index is applicable to all pesticides applied to any crop as long as a maximum residue limit has been established for a commodity. Its aim is to provide the cotton industry with a tool to

help determine the possible residue risk of current or new chemicals.

This study on risk from chemicals used in the cotton industry estimates the overall industry risk. For BMP, a simplified, possibly electronic, version of the approach to be added to the Best Management Practices guidelines for cotton growers would be of benefit.

By complying with best practices growers can avoid residue violations in meat. Additional caution should, however, be applied for those pesticides identified as more hazardous by the Residue Risk Index.

At present the BMP manual does not fully consider the possibility of pesticide residues appearing in cotton seed and oil and we recommend some targeted testing of chemicals showing higher risk, as part an industry strategy. This testing will require a financial commitment from cotton producers and chemical companies.

The study has shown that the degree of risk has declined substantially now that the rate of application of certain chemicals has been reduced. But we recommend assessment for chemical risk with adequate targeted monitoring to consolidate this trend.

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