

ENVIRONMENTAL ISSUES FACING THE COTTON INDUSTRY RELATED TO PESTICIDE USE

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INTRODUCTION

The Australian cotton industry is heavily dependent on the use of chemical insecticides and herbicides. The off-farm movement of these pesticides has created a number of "environmental" issues for the industry. The major ones are related to:

- the presence of pesticides in the riverine environment;
- the contamination of pasture and fodder crops leading to residues in livestock, particularly related to the use of Helix^R (chlorfluazuron) and endosulfan;
- community health concerns related to droplet drift and odour.

Since 1990 the NSW Department of Land and Water Conservation has been monitoring the levels of pesticides in central and north west New South Wales rivers, supported by funds from the irrigators of the region. The Central and North West Region's Water Quality Program (CNWRWQP) has regularly detected certain pesticides during the cotton growing season, particularly endosulfan. The levels of endosulfan in the rivers have often exceeded the current accepted water quality guideline for the protection of Australian aquatic ecosystems. This information, together with a report by Barrett *et al.* (1991), provided the major impetus for the establishment of a \$5 million R&D program in July 1993 by the Land and Water Resources Research and Development Corporation, the Cotton Research and Development Corporation and the Murray Darling Basin Commission.

The Joint Program is entitled "Minimising the Impact of Pesticides on the Riverine Environment using the Cotton Industry as a Model" and its goals are:

- to determine the transport and fate of pesticides applied to cotton;
- to assess the impact, if any, of current pesticide use on rivers;
- to develop practical and economic methods to minimise the transport of pesticides from application sites;
- to provide a sound scientific basis for the development of management guidelines and regulatory codes.

Most of the information generated by the Joint Program is also relevant to general environmental issues associated with cotton pesticides, including the contamination of other crops and pastures. Additional investigations on the latter are being carried out by State departments of agriculture, and a CRDC funded project on the degradation of endosulfan in pastures will be conducted in 1996/97. The Cooperative Research Centre for Sustainable Cotton Production has also been conducting research on the environmental fate and dissipation of pesticides from cotton.

TRANSPORT AND FATE OF PESTICIDES

Pesticides are applied to cotton by both aircraft and ground rigs. Most are applied as sprays from aircraft, while sprays and granules are applied from the ground. Once a spray is emitted the following mechanisms can play a role on the movement of the pesticide:

- spray (droplet) drift;
- volatilisation (conversion of the pesticide to vapour) followed by wind dispersion;

- wind dispersion of pesticide contaminated dust;
- movement of pesticides in surface water, particularly related to uncontained run-off following storm events.

Generally, movement in ground water is not considered important due to the low hydraulic conductivity and chemical adsorption characteristics of the heavy grey clays which make up 90% of cotton soils. However, areas of loam, or lighter soils, may need investigation.

The Joint Program has paid special attention to the fate and transport of cotton pesticides, as a basis for developing best management practice for pesticide use. Research has concentrated on cotton pesticides that have been found in river systems by the CNWRWQP, particularly endosulfan which is the most frequently detected cotton pesticide. Major field sites have been established at Warren and Emerald where the behaviour of pesticides has been closely monitored. Rainulator studies to investigate run-off have also been carried out at these and other sites. Atrazine continues to be the most widely detected pesticide by the CNWRWQP, except in the Macquarie Valley. However, it is no longer used in cotton and consequently has not been included in the Joint Program.

Considerable progress has been made in understanding and quantifying the processes involved in the fate and transport of pesticides. The main points to emerge to date can be summarised as follows:

Fate

- the levels of cotton pesticides do not build up in the soil from year to year;

- most of the endosulfan applied to cotton is lost from the plant and soil by vaporisation (volatilisation) within a few days of spraying;
- some endosulfan is converted to the sulphate which is more persistent than the parent compound (α and β isomers) and persistence is greater on dry plant material.

Run-off

- soil samples taken down the soil profile have confirmed that the loss of pesticides from cotton fields is associated with run-off rather than leaching;
- significant quantities of pesticides can move along the furrows in water and on sediment following irrigation and storm events, particularly the latter;
- the risk of pesticide movement due to run-off is greatest immediately after spraying, and is related to crop cover and plant residue cover on the soil surface;
- pesticides from the furrows enter the tail drains and they can be readily transported off-farm unless tailwater and recycling systems are adequate to deal with normal irrigation and moderate storm events.

Aerial transport

- endosulfan volatilises from the crop and soil and the vapour is moved by the wind which may result in low level contamination of adjacent water bodies by diffusion from the gaseous phase;
- the movement of endosulfan contaminated dust is a potential source of environmental contamination, but its importance is limited and is likely to be mainly restricted to the on-farm distribution of endosulfan due to local disturbance by vehicles and earth moving equipment;

- spray drift (droplet movement) is the major form of aerial transport, appearing to be an order of magnitude more significant than volatilisation, or dust movement;
- spray drift from cotton has the potential to cause significant contamination of adjacent crops, pastures and water bodies, particularly if spraying is carried out under adverse weather conditions, or if there are errors in targeting during aerial application;
- the impact of drift diminishes rapidly from the point of application, but bare earth favours the movement of small droplets.

Research is being undertaken to minimise drift, including the manipulation of droplet size and the use of buffer zones.

ENVIRONMENTAL IMPACT OF COTTON PESTICIDES

The off-farm movement of cotton pesticides has the potential to impact adversely on natural ecosystems, particularly the riverine environment. To assess the effects of pesticides on river biota, the CNWRWQP was expanded in 1992/93 to include biomonitoring in the Namoi, Gwydir, Macquarie and Border rivers. In this study aquatic macroinvertebrates, such as insect larvae, shrimps, snails and worms are monitored throughout the year at a large number of sites above and below cotton growing areas.

The data collected to date do not indicate a significant impact of pesticides on the macroinvertebrate community structure, abundance and diversity. Often large and apparently healthy communities of these animals are found at sampling sites, in spite of the presence of pesticides, including endosulfan at levels far exceeding the environmental guideline. It must be emphasised, however, that this study can only

detect broad temporal and spatial changes in macroinvertebrate communities and that the overall effect of pesticides is confounded by other factors, such as turbidity, erosion and flow. The Joint Program is funding more detailed ecotoxicological studies which should be completed by July 1997.

On rare occasions fish kills can be attributed to cotton pesticides, but these are associated with very high level local contamination. There is no evidence to suggest that cotton pesticides are directly impacting on birds and mammals.

The application of cotton pesticides can contaminate adjacent crops and pastures due mainly to spray drift. This can create residue problems in livestock, particularly when the pesticide is extremely persistent on vegetation and in livestock. Helix^R falls into this category and its use in mixed farming situations is clearly not advisable. The problems with Helix^R have led to increased residue testing which has resulted in the detection of a number of endosulfan maximum residue limit violations in cattle. Some of these have been due to spray drift from cotton contaminating adjacent pastures. Forage crops have also been contaminated.

Generally, there is a significant level of public concern regarding health issues related to the use of chemical pesticides. High profile users of pesticides, such as the cotton industry, are coming under increased scrutiny, particularly when spraying is carried out close to urban areas, or in mixed farming situations. For instance, a number of complaints associated with odour and pesticide drift from cotton in the Upper Namoi have been made over the past two seasons. These complaints have received wide media coverage and reflect adversely on the cotton industry.

DEVELOPMENT OF BEST MANAGEMENT PRACTICE

An integral component of the Joint Program is the translation of research results and existing information into best management practice for pesticide use by the cotton industry. The adoption of best practice is essential to demonstrate to the community and regulators that the industry is adopting an informed and responsible attitude to pesticides. Ultimately, accreditation appears to be the likely outcome of this process. The Joint Program has established a best practice management model for the cotton industry (Doak 1995). Funds have also been provided to the Executive Officer of the ACGRA to develop a best practice manual for pesticide use in consultation with researchers, industry representatives and regulatory authorities before the 1996/97 season.

CONCLUSIONS

- **The Australian cotton industry is likely to remain heavily dependent on the use of pesticides over the next decade and restricted access due to environmental issues could seriously threaten economic viability.**
- **The widespread use of pesticides by the cotton industry has sometimes resulted in levels of environmental contamination that are no longer acceptable and the industry must recognise that change is essential.**
- **The level of scrutiny of the industry regarding pesticide use will be maintained, or enhanced by increased residue monitoring, and the actions of regulatory authorities and community groups.**

- **The use of chemical pesticides, particularly insecticides, must be significantly reduced in cotton over the next few years by the development of integrated pest management programs.**
- **Strategies to minimise the off-farm movement of pesticides must be developed and be adopted as part of best management practice.**
- **Additional information is urgently required on methods to reduce spray drift, particularly by the manipulation of droplet size and the use of buffer zones, both within and outside the crop.**
- **Realistic environmental guidelines need to be established for pesticides, particularly endosulfan in water which is currently set at the level of detection by modern analytical equipment.**

REFERENCES

Barrett, J.W.H., Peterson, S.M. and Batley, G.E. (1991). The impact of pesticides on the riverine environment with specific reference to cotton-growing. A report to the Cotton Research and Development Corporation and the Land and Water Resources Research and Development Corporation, 91 pp.

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