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STUDIES ON THE AERIAL APPLICATION OF PESTICIDES

Nicholas Woods
Director
The Centre for Pesticide Application & Safety
The University of Queensland Gatton College

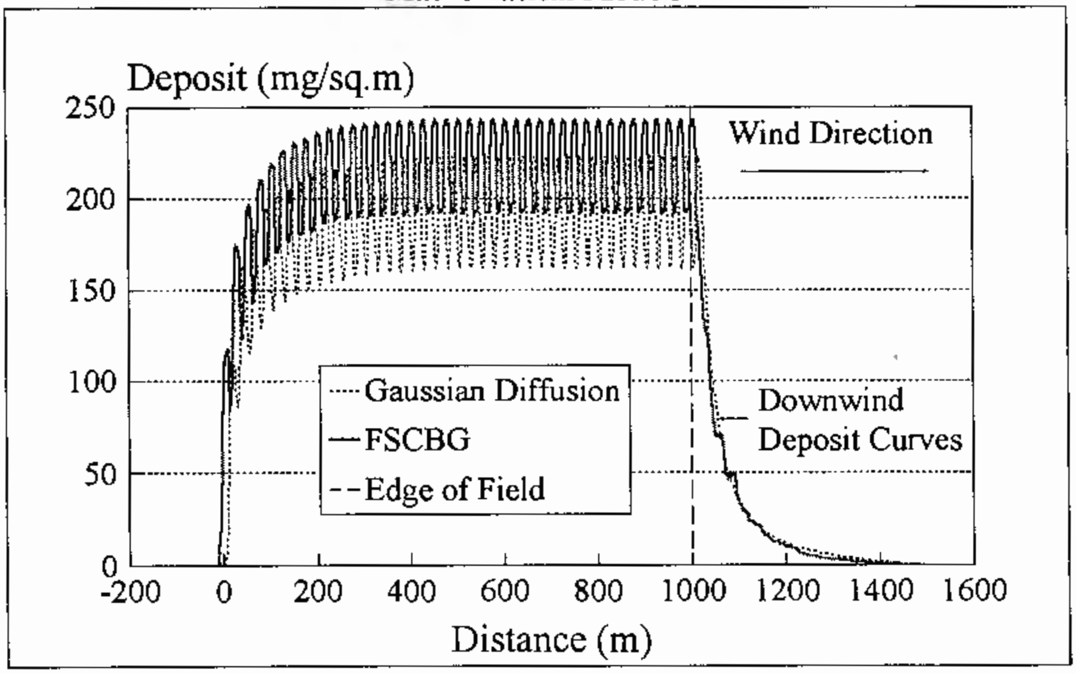
Introduction

The irrigated cotton industry in Australia has been developed around major river systems to allow water to be pumped to farm storages and then recirculated on farm using flood irrigation techniques. Recent work conducted by the Department of Water Resources NSW, showed that levels of some pesticides, particularly endosulfan, exceeded ANZECC guidelines for the protection of aquatic ecosystems in river systems in northern NSW. Because of the close proximity of natural water courses to cotton paddocks, a major national research programme was established in 1993, jointly funded by the Land & Water Resources Research and Development Corporation (LWRRDC), the Cotton Research & Development Corporation (CRDC) and the Murray Darling Basin Commission (MDBC). An important part of this program has been a project designed to estimate the contribution that the aerial application of pesticides (specifically endosulfan), makes to chemical loads in the riverine environment by primary droplet transmission (drift), subsequent volatilisation and transmission on dust particles.

Aerial Application of Pesticides

Pesticides are applied from both ground sprayers, especially in young cotton and by agricultural aircraft. Pesticide drift, which is the off target movement of material, can occur from both types of spray platform however, since aircraft are used predominantly in irrigated cotton throughout the growing season and deliver the greater proportion of pesticide, the research emphasis has focused on airborne delivery systems. Figure 1 shows the results of a theoretical analysis undertaken to predict the downwind deposit level of insecticide moving away from a hypothetical cotton field sprayed using an aircraft. Using suitable mathematical models the Figure shows clearly that there is a decreasing concentration of material deposited on the ground on the downwind side of a paddock in a 3 m/s wind. What must be determined is the significance of this drift and what management procedures must be put in place to significantly reduce levels when susceptible areas are located downwind of the paddock.

Figure 1. Simulated Spray Deposition Analysis : Comparison of Mathematical Models



Volatilisation is also an issue that can determine the effective lifetime of a pesticide in a target area and like drift, is a transport mechanism that theoretically can cause dispersal in the general environment. Most pesticides evaporate into the air from soil and plant surfaces and vapour can then be dispersed in the environment by diffusion and turbulent mixing in the atmosphere. Naturally losses of material through volatilisation are not restricted to pesticides that have been applied using aircraft.

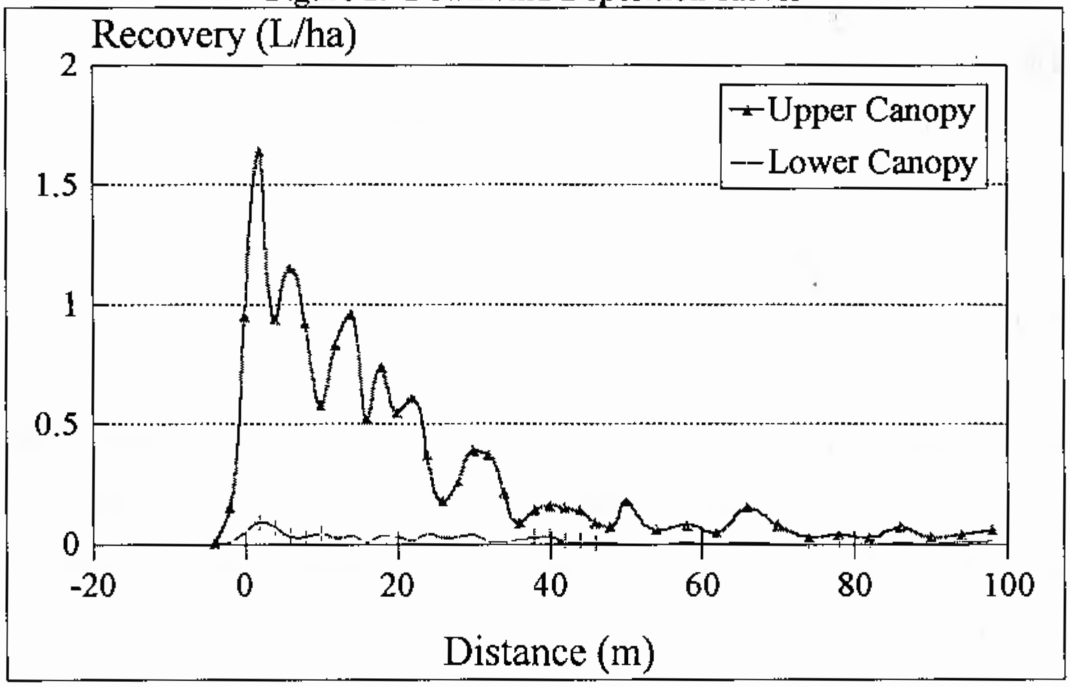
Does volatilisation of insecticides (endosulfan) occur in the cotton industry in Australia? The simple answer is yes. Laboratory tests have shown that products such as endosulfan volatilise off leaf and soil surfaces, indeed the mechanism is a well known breakdown pathway. Whether this process does contribute significantly to pesticide levels in river systems is being evaluated in the research project.

The field programme was initiated during the 93/94 season to estimate the contribution that airborne spraying makes to chemical loads in the environment through drift. Using mobile drift measuring towers, fluorometry and gas chromatography, a limited number of profiles of spray deposits moving away from both commercial spray activities and from controlled experiments have been measured. A laboratory based programme designed to determine the range of droplet sizes emitted by common nozzle and insecticide combinations used in the cotton industry is now underway (with Spraysearch, Victoria) and aircraft used at both Emerald and Narrabri research areas are being calibrated and pattern tested as part of the programme.

During the season, a pilot study was also conducted at the Narrabri trial site (Auscott) in conjunction with NSW Agriculture (BCRI Rydalmere). Post application volatilisation and deposition in water is being assessed using a series of water filled trays and air samplers placed strategically around commercial cotton fields to quantify residue levels.

Figure 2 illustrates the thrust of the drift aspect of the research project. The downwind deposit of spray (measured using a fluorescent dye added to the insecticide), is shown as recovered from an upper and lower cotton canopy. The deposit profile is formed from a single pass of an aircraft. Analysis of the data from this test shows that approximately 50% of the material was deposited on the plant, 2% was deposited on the soil and about 45% was recovered as drift 30 metres downwind of the release point. This complex area requires detailed research.

Figure 2. Downwind Deposition curves



Aerial Application Technology: Management for Sustainable Production

Of the 275 specialised agricultural aircraft working in Australia about one third are used in the cotton industry, applying pesticides to some 250,000 ha of irrigated cotton. These aircraft, now predominantly turbine powered, account for many of the largest and most sophisticated agricultural aircraft currently in operation in

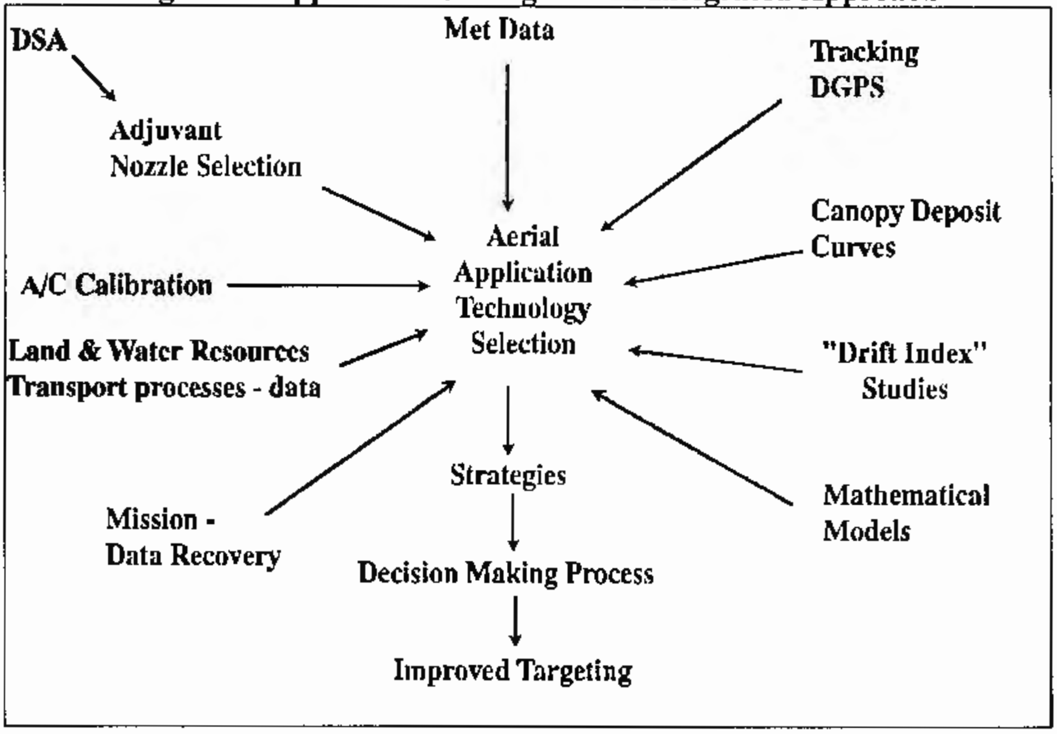
Australia. This season has seen the commercial operation of satellite based Differential Global Positioning System (DGPS) equipment for accurate position fixing and swath marking.

The cotton industry can be proud of a high quality, viable and well organised aerial application industry. However this asset and support service must be better managed by the industry as a whole.

The aim of the research programme is to understand in more detail the physical mechanisms and processes which contribute to pesticide drift. It is of course known that factors such as droplet size, meteorological conditions, release height and crop structure influence the recovery of insecticide sprays. However the effect on a pesticide drift profile of current and alternate management practices must be quantified to enable more effective and disciplined application.

By quantifying the effect of current application practices, the industry has a significant opportunity in this project to develop and adopt management strategies capable of sustaining efficient airborne delivery of pesticides. The current programme should be continued over the next two years to establish a sound and scientific base to current practices and determine the effect of alternative procedures. Equipped with this information, guidelines and management support packages should be developed to ensure correct technology is applied across the whole industry in a disciplined fashion. The chart in Figure 3 shows how this and existing information must be pulled together. Droplet size information, single flight line deposit curves (as in Figure 2), meteorological and drift data should enable decisions to be made regarding the best application technology for pest management in sensitive environmental areas.

Figure 3. Application Strategies : An Integrated Approach



If mathematical models simulating pesticide behaviour can be validated in Australia as part of this test programme, it is possible that such algorithms in conjunction with DGPS technology can be used in the near future to estimate drift and enable aircraft to be positioned on tracks which will reduce the off target movement of pesticide.

Agrochemicals such as endosulfan will be needed for sustainable cotton production for many years to come. This should be possible with improved management practices. However a few important points must be made. When insecticides are applied as droplets (particularly small droplets), zero drift options are not going to be available. The community must realise that off target movement of material is a function of quantity and effect. Secondly there may be some scenarios where the aerial application of pesticides as liquid formulations may not be possible and perhaps conventional cotton production not feasible. In some circumstances a grower may have to use alternative application technology such as ground rigs or tolerate a lower than normal level of control or efficacy in the interests of environmental safety.

To assist pesticide selection and usage, it is likely that technology and application strategies, along with cotton farms, will have to be categorised. Individual paddocks may have to be rated to establish the techniques, buffer distances and pesticides that can be used as permitted by their proximity to rivers, water courses, other crops and habitation.

More effective management of pesticide delivery will be required over the next few years for productive and sustainable cotton production in the riverine environment.