THE AERIAL APPLICATION OF GLYPHOSATE IN AUSTRALIA - A REVIEW

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Summary. The aerial application of pesticides in Australia is discussed and the most recent research by Monsanto Australia Limited in 1984 is outlined. Some variables affecting behaviour of aerially applied spray droplets have been identified and guidelines for the correct aerial application of glyphosate are proposed.

INTRODUCTION

The majority of aerial application of pesticide in Australia has been application of insecticides and fungicides for crops such as cotton and potatoes, as well as in crop weed control with selective herbicides. In these situations with crops of medium to high catching surfaces, technology has evolved towards controlled drift spraying using small droplets.

Spray drift onto non-target crops has occasionally been reported for products such as 2,4-D (Anon 1976) but is relatively unheard of for insecticides and fungicides. These latter compounds do not usually have visible effects on non-target vegetation.

Application of non-selective knockdown herbicides such as the bipyridyls and glyphosate in broadacre spraying require a somewhat different approach to application. Good coverage of target plants is essential for good efficacy while drift onto non-target plants can have severe and immediate effects.

Knockdown herbicides such as glyphosate are now commonly used for the control of annual and perennial weeds in broadacre agriculture prior to sowing crops. In 1983 over one million hectares of pasture and fallow were treated with glyphosate prior to establishing cereal crops.

The demand for aerial application is often accentuated under certain seasonal conditions. When prolonged wet conditions occur aerial application is the only viable option for knockdown weed control. In Northern New South Wales and Queensland during autumn 1983 the extremely wet ground conditions resulted in the aerial application of knockdown herbicide to approximately 500,000 hectares.

Under these conditions, farmers often place excessive demands on aerial agricultural operators to apply chemicals and consequently, herbicides are occasionally applied under adverse climatic conditions or with poorly adjusted application equipment. Under these circumstances reports of damage from drift onto desirable crops have been received. While the area affected is a very small percentage of the total area treated, the impact of this misapplication can often be much greater.

Using knowledge gained from several years of experience with aerial applications of herbicides particularly glyphosate in the United States and Australia a positive attempt was made during 1984 by Monsanto to ensure correct aerial application of herbicides. Procedures were developed not only to improve herbicide efficacy but also to minimize possible drift.

While the major emphasis of this work involved glyphosate application many of the principles discussed apply to all herbicides.

PROCEDURE FOR MODIFYING AERIAL SPRAYING EQUIPMENT

The application requirements for accurate and effective application of broad spectrum, translocated herbicides are very different from the requirements for applying other agricultural chemicals like fungicides and insecticides. In general, droplet sizes in the range of 250 to 350 micron (VMD) provide adequate weed cover (20 to 40 droplets cm^{-2}) to effect maximum herbicide efficacy while minimizing the drift potential when spray application volumes of 15 to 30 L ha^{-1} are used.

Extensive training was provided for two Monsanto Product Development representatives to assist aerial agricultural operators in adjusting application equipment settings to ensure correct application of glyphosate. The methods used to achieve this include :

1. Fluorometric analysis.

A continuous 48 m by 50 mm paper tape with adhering 50 mm^2 chromcote cards placed at 1 m intervals was laid out at right angles to the spray path of the aircraft. The aircraft made a single spray run over the paper tape applying a solution of water, surfactant and Rhodomine B fluorescent dye. This solution has similar flow characteristics to Roundup herbicide (Richardson, N. pers. comm., 1984). A sample of the droplets deposited on the chromcote cards was counted and measured. The width of effective spay swath was determined by passing the paper tape through a Turner Model III fluorometer connected to an Apple II computer plus Itoh printer and Omni-scribe chart recorder (Richardson and Brooks, 1984). This provided the following information:

(i) the uniformity of the spray pattern across the spray swath,
(ii) the optimum swath width for the "race track" and "tear drop" flying pattern options,
(iii) the droplet density distribution indicating the degree of coverage achieved, and
(iv) the droplet size distribution particularly the proportion of fine droplets less than 150 micron which indicates drift potential.

2. Video recorder observations.

Aircraft application equipment was positioned so that a uniform deposit of spray material occurred across the swath at weed target level. The use of video recorder equipment provided a fast method of identifying areas of uneven spray deposition in the swath. The technique involved the aircraft flying toward the video camera directly into the wind so that lateral movement of the spray cloud occurred only as a result of the slipstream characteristics of the aircraft. The video film replay was viewed by the operator, and areas of variable deposition identified, and alterations made by changing nozzle/ atomizer type or orientation/position.

1984 RESULTS

Sixty observations spanning fifteen aerial agricultural operators were made throughout Australia. Initially it was thought that this number of observations would yield sufficient quantitative data to make generic recommendations on the best equipment and equipment settings to use. In practice however, the droplet spectrum at target level is influenced by many variables. These include :

(i) Aircraft equipment variables: aircraft type, nozzle/micronair type, nozzle orientation, pump pressure, water volume output, boom placement, wingtip adaptations.

(ii) Environmental variables: wind, relative humidity, atmospheric temperature, adiabatic conditions.

(iii) Operational variables: flying height, flying speed, flying relative to wind direction, spray adjuvants used.

Given the large number of interacting factors quantitative conclusions are, at best, ambitious. However, as an initial attempt in this country to investigate the parameters influencing the aerial application of glyphosate, some statements based on the observations are considered useful.

1. Climatic conditions.

Unsuitable conditions for the application of glyphosate include : temperature inversion, still air conditions and crosswinds greater than 12 kph. High atmospheric pressures will exacerbate problems in the latter two situations, and low relative humidity and high temperatures increase the risk of drift and reduced efficacy because of droplet evaporation. The preferred climatic conditions are a light cross wind (2 to 12 kph) combined with low atmospheric pressures.

2. Aircraft design and swath width.

The main aircraft design characteristics affecting the spray swath width are the underwing outwash and the wingtip vortices. Spray droplets entering the wingtip vortices are commonly elevated above the aircraft which increases the potential for drift. Aircraft with high positive wing dihedral have an inherent narrow swath width when only the underwing outwash is used to achieve spread of the spray swath. Operators of these aircraft sometimes rely on the wingtip vortices to achieve increased swath width. This practice should be discouraged for the application of glyphosate.

3. Equipment type and settings.

Regardless of the type of spray equipment used, droplets susceptible to drift (usually less than 150 micron in diameter) are always generated. Our observations indicate that the drift potential is greatest in instances where small orifice nozzles of all types are operated at high pump pressures. Forward orientation of the nozzles into the slipstream exaggerates this problem. The equipment used should be positioned to avoid depositing droplets in the wingtip vortices and where possible nozzles should be angled back to the slipstream.

Poor positioning of Micronair equipment or setting Micronair blade angles which cause high rotational speed results in an unacceptable level of fine droplets.

4. Water volumes.

In Australia most glyphosate applied by air has been in low water volumes (9 to 13.5 L ha^{-1}). Some recent work in Queensland (Thompson and Thompson 1983, unpublished data) showed that there was a significant correlation between efficacy on seedling sorghum and volume of spray application of glyphosate when applied under adverse conditions (eg. high temperature and low humidity). They concluded from their work that for these conditions water volume of 30 litre per hectare and droplet size of 350 μm was desirable.

It should be pointed out however that raising the application volume by increasing the nozzle orifice size or Micronair VRU setting does not necessarily reduce the number of fine droplets susceptible to drift.

DISCUSSION

A number of technical issues require further research to provide quantitative information to the aerial agriculture industry. Most importantly the effect of climatic conditions on droplet survival and movement requires clarification. In addition, quantitative field information on the effects of nozzle type and orientation on droplet characteristics is required as is the effect of spray adjuvants, a topic of increasing interest but as yet little foundation. Issues needing attention at the aerial operator level include product knowledge and awareness of the effect of climatic conditions on the application of chemicals.

Correct and effective aerial application of glyphosate is achievable when the basic guidelines, as stated above, are adhered to. At present however, high workloads and pressure from farmers to get the job done combined with intense inter-operator competition causes some operators to use extended swaths and low water volumes in climatic conditions unsuitable for the application of agricultural chemicals. Aerial operators who adopt low drift potential techniques are placed at an economic disadvantage.

It is up to the Aerial Agricultural Industry, chemical industry personnel and Government organizations to unify their approach to the application of agricultural chemicals. They should be encouraged to provide correct extension and education to all those involved from the farmer to the contractor.

In doing this they will ensure the best possible application of pesticides such as glyphosate by the aerial operators most able to apply them.

LITERATURE CITED

Anon, 1976, Drift from Aerial Spraying (Bayer Report to Australian Aerial Operators).
Richardson, N. and Brooks, N. (1984). Australian Weeds Research Newsletter (In Press).