INSECT PEST MANAGEMENT IN SWEET CORN

Insect Pest Management in Sweet Corn

(HRDC Project VG 97036)

Report: Milestone 4

(April 1999)

Commonly used pesticide application techniques have been tested for efficiency in targeting of insecticides to silks of sweet corn. Improved application techniques have been identified and promoted at farm walks and field-days.

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MILESTONE 4 REPORT

Milestone Number 4. **Commonly used pesticide application techniques have been tested for efficiency in targeting of insecticides to silks of sweet corn. Improved application techniques have been identified and promoted at farm walks and field days.**

a) **Improved application equipment and/or techniques will have been identified and promoted. These techniques and equipment will enable improving targeting of insecticides to the silks of sweet corn.**

b) **Farm walks will have been conducted in all major production areas to demonstrate the efficiency of pesticide application equipment and techniques.**

Due date:- 30/4/99

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Executive Summary

All major sweet corn production regions in Australia have some requirement to apply insecticides to manage *Helicoverpa armigera* (Heliothis) in fresh market or processing sweet corn production. Heliothis larvae have the potential to cause damage at all stages of sweet corn growth however the silking stage is critical, as once larvae enter the tips of cobs they can not be controlled. Best management options are being evaluated in a number of regions and compared with conventional practices to help reduce Heliothis damage. Best management options consider a range of strategies that can be employed in combination such as improved targeting of insecticides, improved timing of application through monitoring and using more selective insecticides that preserve beneficial insects. This report presents some of the work undertaken to test commonly used application techniques for sweet corn production in Australia. As part of this, improved application techniques have been identified and promoted at grower farm walks in a number of major production districts.

Aircraft and a range of ground based spraying equipment are used throughout most production areas in Australia. Some of the equipment evaluated to date include aircraft, ground sprayers with over the top booms and droppers, ground based air assisted sprayers and air-shear ground based sprayers with side delivery heads. Equipment performance was assessed using a fluorescent tracer. Quantitative data was collected by extracting the fluorescent tracer from various parts of the sweet corn canopy that is leaves, tassels and silks. Spray recoveries were expressed either as microlitres (µL) of spray volume or nanograms (ng) of dye recovered per unit target area.

Even though equipment plays a significant role in the effectiveness of coverage, particularly on the silks, the interaction between the plant canopy and application equipment is also important. Unfortunately if the silks are critical targets, only small proportions of spray released from over the top will actually find it way to the silk (approximately 0.5%). Leaves filter out a large proportion of spray applied from overhead. Equipment that directs spray closer to the silks has a much better chance of getting greater and more even deposits.

There is tremendous scope for improvement in application techniques with both aerial and ground based spray equipment. Although aircraft are heavily scrutinised they will continue to be an important tool for sweet corn growers. The volumes applied by aircraft (40 to 60 L/ha) are much higher than application volumes in broad acre cropping systems such as cotton. In some areas the swath width flown by aircraft are up to 30% less than what they would be in other crops.

Many sweet corn growers and contract spray operators use high clearance sprayers fitted with droppers. A comprehensive trial was conducted using droppers set up to specifically target the silks and this was compared with a conventional boom spraying over the top. The sprayer equipped with droppers gave up to 4 times the spray recovery on the silks. Droppers have problems if the crop is lodging or rows are not particularly straight and leaves brush past nozzles preventing spray droplets from reaching the silks. Of those operators using droppers there is a large variance in the water volumes applied per hectare. Contractors generally tend to apply much lower volumes (200 to 500L/ha) than growers using their own spray equipment (200 to 1300 L/ha). Further work needs is required to determine if this variation in water volumes is important in pest management and to determine optimum nozzle configuration for droppers.

Air-assisted sprayers are used for spraying sweet corn as they have considerable benefits including spray drift management and spray penetration. Further testing is required with air-assisted sprayers using silks as targets to determine if there are significant differences in the spray deposit for the different settings (air velocity and angle) that can be used on this equipment.

1. Assessment of Commonly Used Pesticide Application Techniques for Efficiency in Targeting of Insecticides to Silks of Sweet Corn.

· *Background to application equipment used for insect pest management in sweet corn.*

Aircraft

Aircraft are extensively used in many sweet corn production areas in Eastern Australia. There is considerable debate as to the effectiveness of aircraft compared with ground based sprayers. The discussion should revolve around “over the top spraying” (ground and aircraft) versus “directed spraying” (boom + droppers). Table I lists several important factors that should be considered when comparing various equipment types. Using this comparison, aircraft application scores well because it receives the greatest number of ticks in most categories. When interpreting Table I, a grower or operator who ranks achieving good spray penetration as very important, would be seeking equipment capable of directing spray onto the target zone to improve pest control.

Table I. Advantages of different types of equipment.

	Standard Boom	Air-assisted Boom	Boom + Droppers	Aircraft
Penetration		✓✓✓	✓✓✓✓	
Timing (work rate)				✓✓✓✓
All weather access				✓✓✓✓
Crop Lodging	✓✓✓✓	✓✓✓✓		✓✓✓✓
Crop Height	✓	✓		✓✓✓✓
Labour Input				✓✓✓

The application volumes used by aircraft when spraying sweet corn may range from 40 to 60L/ha. These volumes are very high compared to conventional volumes applied by aircraft when low volume spraying (20 to 30 L/ha) or ultra low volume (ULV) spraying, (2 to 5 L/ha) in cropping systems such as cotton.

The types of nozzles used to deliver this volume are either CP nozzles or the Microinair AU5000. The CP nozzle is a hydraulic nozzle that gives the operator a great deal of flexibility. This nozzle has multiple orifice sizes (that can be used to alter flow rate) and a selection of three angles on a deflector plate (that are used to alter droplet size).

The Micronair AU5000 falls into the category of controlled droplet application (CDA) equipment. It consists of a cage that can be made to spin at a range of speeds by altering the pitch on three blades. Faster rotational speeds produce smaller droplets and slower speeds larger droplets.

There have been many recent advances in the technology associated with precision application of pesticides with aircraft. Differential global position systems (DGPS) have enabled aircraft to apply pesticides to fields with a pre-selected swath with an accuracy of less than 1m. With DGPS technology aerial operators can also store flight paths allowing them to produce print outs of a spray job showing every swath flown.

Ground Based Sprayers

The sprayers used to apply insecticides to sweet corn by ground rigs are:-
i) over the top booms with hydraulic nozzles or air-shear outlets,
ii) over the top booms with hydraulic nozzles and air-assistance,
iii) over the top booms with hydraulic nozzles plus droppers or
iv) spray directed from the side across multiple rows using an air-shear cannon.
The two main principles used for droplet formation on these booms are hydraulic pressure and air-shear. Hydraulic pressure is used to produce droplets from nozzles such as flat fans and hollow cones. Sprayers using the air-shear principle produce droplets by using high velocity air (> 200 km/hr) to shatter the spray liquid into droplets.

· *Useful Techniques for Assessing the Performance of Spray Equipment*

Numerous tools are available for checking the performance of spray application equipment used in sweet corn. Some techniques that are used by researchers can also be used by growers for assessing the efficiency of application equipment in sweet corn.

i) Fluorescent dyes for visual observation

Fluorescent dyes that show up under black lights are ideal for visually inspecting the spray deposit throughout a sweet corn canopy. These dyes were used to view the spray deposits from selected equipment in the farm walks at Gatton, Cowra, Lindenow and Bowen. A pink coloured dye is best for observing the droplet deposits on silks. Yellow coloured dyes show up well on leaves but are very hard to see on silks. The spray deposit is best viewed on the crop in the field and at night. This requires a ‘black’ light and generator or power supply nearby. Viewing deposits in the paddock makes it possible to observe the interaction between adjacent plants on the spray deposit. For instance, leaves from adjacent plants may be completely covering the silks on some cobs thus making spray deposits on these silks near impossible to achieve. If plants are removed and taken back to a dark room an appreciation of the influence of neighbouring plants is difficult and may lead to misleading evaluation of the equipment’s performance.

ii) Water Sensitive paper

Although water sensitive paper (WSP) is useful, it has many limitations and the interpretation of spray deposit results can be misleading. WSP is produced on small cards of varying sizes depending on the situation where they are to be used. WSP has a yellow surface and when water based droplets hit the surface the droplet leaves a blue stain. Although WSP is relatively cheap and can be placed almost anywhere in the sweet corn canopy, they should be cut to size to match the target.

Some keys points to remember when using water sensitive paper:

- The card surface is sensitive to moisture and high humidity. Care must be taken when handling cards (wear gloves) and the cards must be stored in sealed plastic bags if you wish to keep them for extended periods.
- Spray droplets impacting the surface of the card leave a stain that is larger than the actual droplet size. This is called the spread factor. A spread factor of 2 means that the stains size is twice the true droplet size. For water sensitive paper the spread factor varies and depends on droplet size. Water sensitive paper should not be used to determine droplet size.
- Droplets smaller than 50µm will evaporate before leaving a stain on water sensitive paper. The card is therefore biased towards collecting larger droplets and will not give a true indication of the fine end of the droplet spectrum.
- To give a true indication of spray deposit and penetration, cards need to be the same size and orientation as the target. Simulating the silk with WSP is very difficult.

iii) Quantitative recovery of fluorescent tracer

Fluorescent tracers can be used to provide a relatively cost and time effective method for obtaining quantitative spray deposits. They are generally used at very low rates (30 to 50g/ha). This was the main technique used to assess spray deposits on various parts of the corn canopy, including silks, tassels and other artificial targets placed above, in or at ground level. When a fluorescent tracer is applied to a crop, the target of specific interest can be collected and washed using a solvent that extracts the tracer. The quantity of tracer present on the target can then be quantified using a fluorometer. The process is similar to pesticide residue testing however in this case the residue is the tracer. The technique has inherent disadvantages, ie the tracers used are sensitive to sunlight and will break down over time. This makes it is important to collect samples quickly usually within 1 hr of spraying. The spray deposit can then be expressed as the volume or quantity of tracer recovered per unit target size (cm^2 or weight).

iv) Relating Spray Deposit to Control

A useful technique for relating spray deposit to insect mortality is the bio-assay. A technique was developed in this project where silks collected from a sprayed field were used to assess the level of mortality in Heliothis larvae. Further work is being undertaken to refine these techniques. Even though a fluorescent tracer can be used to determine the quantity of spray deposit high levels of tracer deposit do not guarantee 100% kill. When washing tracer residues from a silk or leaf surface the total tracer recovered can be established however this does not give an indication of the distribution and uniformity of the spray deposit on the target.

· *The Basics of Application*

Know your product

Insecticides used to control insect pests in sweet corn have different modes of action. A sound knowledge of the mode of action for a particular product may help in understanding the application requirements. Contact insecticides kill insects by direct contact at the time of application or by contact with the insect, after application, with the spray residue layer on the plant surface. Other products that have a stomach poison action need to be eaten by the larvae and the pest must consume a lethal dose of the pesticide for it to work and the dosage required relates to the size of the larvae. Larger larvae require higher doses than smaller larvae. After application, pesticides will persist for varying periods of time on the plant before breaking down.

Another consideration is the impact of insecticides on beneficial insects. Products that have a broad action can decimate a range of beneficial insects. The contribution that beneficial insects play in controlling Heliothis larvae should not be underestimated. Data is being collected in various growing regions on the significance of beneficial insects in controlling Heliothis larvae and other insect pests in sweet corn.

What is Your Target?

The target will vary depending on the plant growth stage and this can change from leaves, to tassels, to silks or even the actual pest. Ultimately the aim of growing processing or fresh market sweet corn is to produce cobs with minimal larval damage and cobs free from live larvae. Once larvae entrench themselves in the tips of cobs they are impossible to control. Therefore it is important to control larvae early when they are exposed on the silks. Other growth stages such as seedling emergence, the vegetative growth stage and tassel emergence may be equally important in certain production regions.

Spray deposit uniformity will influence the ability of insecticides to effectively control insect pests. There are several issues which influence spray uniformity:

1. The influence of application equipment on spray distribution.
2. The influence of crop canopy on spray distribution.
3. The influence of silk position on spray distribution.

If the application equipment used to spray the crop is not delivering a uniform dose across the paddock then you are probably wasting your money by overdosing some sections and underdosing others. Blocked nozzles, worn nozzles or even subtle changes in travel speed are factors that will contribute to variable application across the paddock.

The crop canopy has a large influence on the spray penetration and spray distribution on the plant. The distribution on the plant is very difficult to manipulate when spraying over the top with a boom. When spraying from over the top, the deposit is highest in the top part of the canopy and reduces rapidly as you move down the canopy. Unfortunately the cob is a long way down in the canopy and a large proportion of the spray volume will be filtered out by leaves before getting anywhere near the cob.

Some sweet corn varieties have large flag leaves surrounding the tops of cobs, others produce more tillers. There is also significant variation in canopy height amongst sweet corn varieties. All these factors will have an impact on the spray efficiency especially when there is additional foliage sheltering the silk or a greater distance for droplets to travel before they reach the silk.

The total spray recovered on silks has been measured, but the distribution of spray deposits on individual silks has not. Visual inspection of fluorescent tracer deposits at farm walks has shown that the undersides of silks receive limited spray deposits. Depending on where egg lays occur on the silk, emerging larvae may easily escape contact with pesticide deposits.

Know Your Equipment

The most expensive sprayer will perform poorly if used inappropriately. Regular calibration of equipment is important, (measuring individual nozzle outputs, replacing worn nozzles and calculating the sprayer output), so the correct quantity of pesticide can be added to the tank. A range of nozzle types are available and each have specific operating requirements such as pressure, spacing and height to perform optimally. Controlled droplet application (CDA) equipment and sprayers using the air-shear principle for generating droplets have specific operating parameters to work efficiently.

2. Identification of Improved Application Methods

· *Where is the spray distributed in the crop?*

Often the expectation is that most of an applied spray hits the intended targets. Unfortunately if the targets are the silks, then leaves above the silks filter out most of the spray applied. Only a small proportion finds it way to the silks. Table II shows a comparison of the deposit levels on various parts of a sweet corn canopy relative to the deposit on the silks. This data was collected from a sweet corn trial conducted using an aircraft delivering 60 L/ha. These values may vary for different application systems. These data show there is large variation in the deposit level between each of the surfaces, including the silks. The leaves above the cob collect a large proportion of the spray, the deposit on these leaves is equivalent to that on 117 silks. The deposit recovered from 1 square metre of soil is equivalent to the amount recovered from one silk. If the deposit were recovered from all the silks in one hectare of sweet corn, it would be less than 0.5% of the total spray applied to the crop.

Table II. Silk deposit compared to canopy and ground deposits (Aircraft 60 L/ha)

	Silks	**Leaves above cob**	**Tassel**	**Soil**
Units	Individual silk	cm²	Tassel	cm²
Average deposit*	64.6	1.02	346	0.06
Range	7 – 177	0.07 – 5.8	64 – 859	0.01 – 0.26
Deposit relative to silk		Deposit leaves above cob = 117 silks	Deposit on 1 tassel = 5 silks	Deposit on 1m² = 1 silk

* In nanograms of dye recovered per unit of target for every gram of dye applied per hectare.

· ***Droppers direct more spray to the silks***

Emerging silks are an important target site for insecticide coverage. Equipment that directs spray to this region more precisely will give higher levels of spray deposits to this site. Several trials have been conducted using spray booms fitted with droppers. One trial was been conducted comparing the effectiveness of similar spray volumes with over the top spraying and directed spraying with droppers. This trial compared the amount of spray collected on silks using a boom fitted with droppers containing 4 nozzles directed at each plant in the cob region applying 564 L/ha and another sprayer applying a similar volume (600L/ha) but from above only. A Hardie linkage sprayer was modified with long droppers and the standard sprayer was a Hardie Twin (used without air). The spray volume collected from silks for each treatment is presented in Figures 1 and 2.

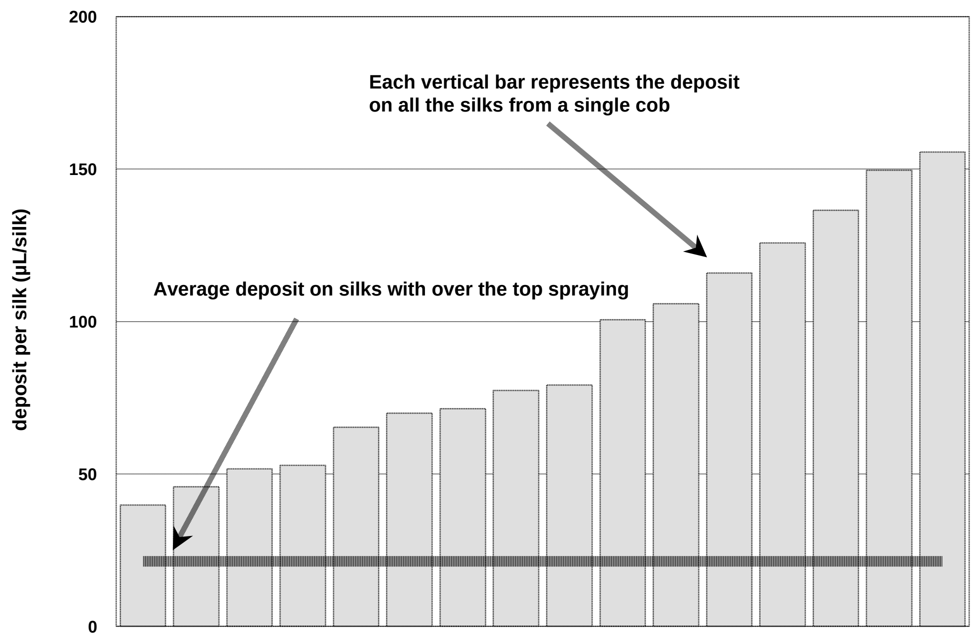

Figure 1. Range of deposit volumes collected from silks with a sprayer delivering 564 L/ha and equipped with droppers directing spray on to the cob regions (4 nozzles per plant). The heavy line shows the average deposit for over the top spraying.

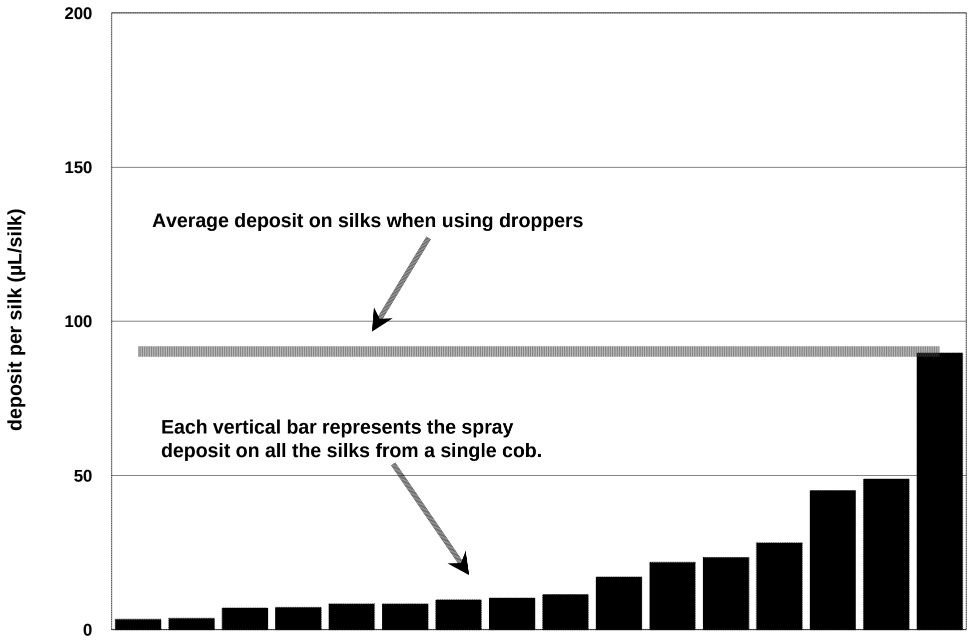

Figure 2. Range of deposit volumes collected from silks with a conventional boom delivering 600 L/ha over the top of the crop. The heavy line shows the average deposit for sprayer fitted with droppers.

There was a four-fold difference in the average deposit on silks between the two treatments. The average spray deposit on silks using droppers was 90.2 µL/cob and 21.4 µL/cob without droppers. Not only was the average deposit level higher with droppers but it was also more uniform. The coefficient of variation (CV) is a relative measure of variation between treatments. Lower CV values indicate greater uniformity. In this trial the CV for droppers was 51.4% and for over the top spraying the CV was 92.7%. Although droppers have the advantage of directing more of the spray to the desired target (cobs and silks), they cannot be used in all circumstances. Lodged crops are the greatest obstacle to their use.

· *Improving application when using aircraft*

The main areas where the performance of aircraft can be improved are (i) improving the uniformity of a single deposit pattern (ii) flying an appropriate swath width (iii) maintaining a consistent swath across the field and (iv) selecting nozzles that produce an appropriate droplet size range. Aircraft set up to apply insecticides to broad acre crops are not necessarily optimised for spraying sweet corn. Aerial operators should have their aircraft calibrated (pattern tested) so that the swath width they select for applying insecticides to sweet corn produces uniform deposits across a field.

An example of the **ground deposit pattern** from a single pass of an aircraft is shown in Figure 3. This deposit pattern was determined using a fluorescent tracer recovered from filter paper sections, (26x72mm) placed on a horizontal flat surface 20-40cm above the ground. Thirty-six collectors were positioned 2m apart and the aircraft flew once across this array at right angles.

From Figure 3, it can be seen that the spray deposit occurred in the pattern from 12m to 52m (over an approximate distance of 40m). The ideal swath width is much less than this distance as the pattern tapers off at both ends. The appropriate swath for this aircraft can be determined by taking the single pattern and theoretically overlapping the deposit data using a computer. A range of swath distances are selected, and the swath width that gives a low coefficient of variation (approximately 30%) is regarded as the most appropriate to use to produce uniform coverage. For this aircraft set up and this deposit pattern, the ideal swath width is 12m. The cumulative deposit that would be achieved across a field when flying 12m and 14m are shown in Figures 4 and 5 by the solid line. The dashed lines show the individual deposit patterns.

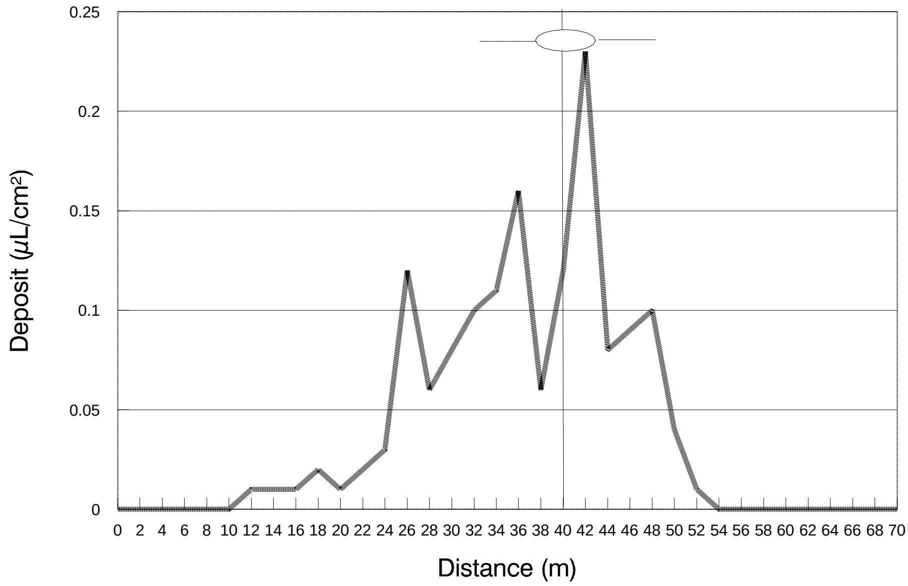

Figure 3. Deposit pattern of flat plates from a single pass of an aircraft (Cessna Ag Truck). The vertical line show the aircraft flight pass.

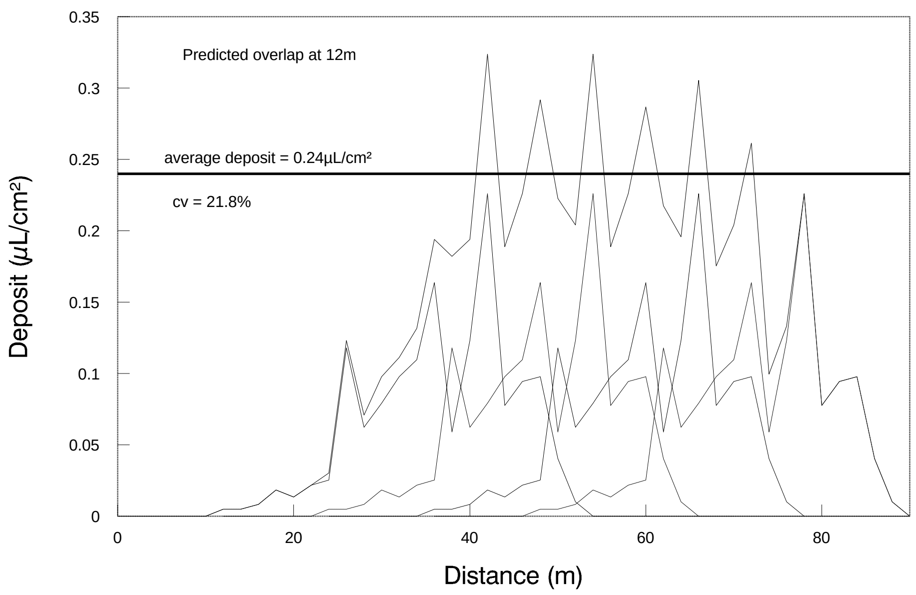

Figure 4. The cumulative deposit pattern computer simulated by overlapping a single deposit pattern at 12m intervals (data used from Figure 3).

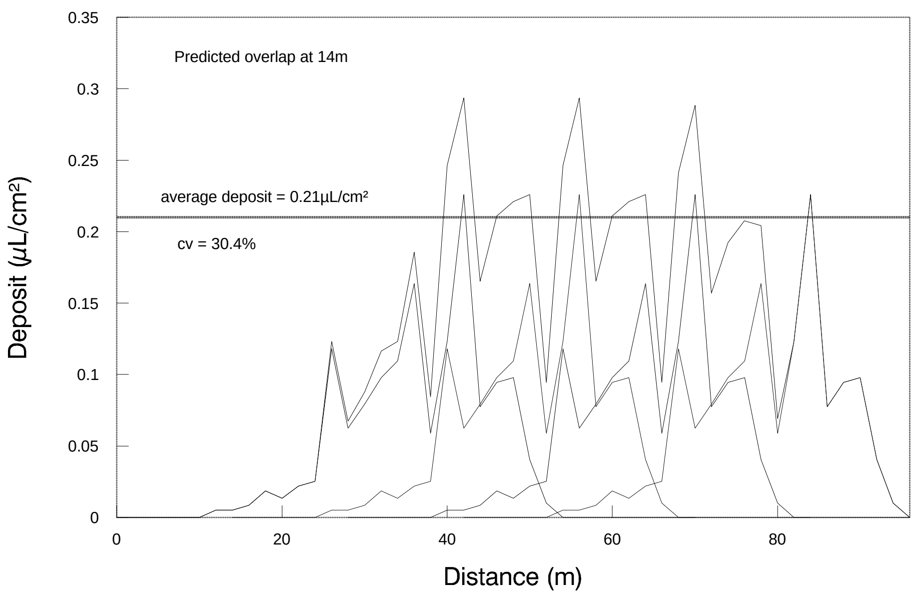

Figure 5. The cumulative deposit pattern computer simulated by overlapping a single deposit pattern at 14m intervals (data used from Figure 3).

There is a large difference in the uniformity of the overlapped deposit pattern between 12m and 14m swath widths as shown by Figures 4 and 5. In this instance an aerial operator using a

12m-swath width would produce a more even deposit than a 14m-swath width. At a swath width of 12m the CV is 21% and at a 14m-swath width the CV is 30%. Reducing swath width may assist improving penetration and deposition of sprays from aircraft onto key target areas such as the silks. Some aerial operators use this technique. Ensuring that a consistent swath width is flown across a paddock is also very critical. Reducing the swath width will reduce the aircraft work rate and result in increased operational charges. To maintain swath width it is imperative that markers or differential global positioning systems (DGPS) are used.

The **deposit pattern at cob height** using filter paper sections placed on flat plates in a crop for the same aircraft that produced the deposit pattern in Figure 3 is shown in Figure 6. Two treatments were flown, one using a swath of 12m and the second using a swath of 14m. There was very little difference in coefficient of variation for the spray deposit on the flat plates, 60% at 14m and 63% at 12m. The arrows indicate positions where leaves where partially or totally covering the flat plates. Even though some plates were covered by leaves there was spray deposited at all positions. The presence of spray on plates sheltered by leaves could be due to the turbulence created by the aircraft downwash moving leaves and allowing passage of larger droplets onto the flat surface, or smaller droplets moving in the turbulent air. Figure 6 shows that with the 14m swath there are three large peaks in the deposit pattern occurring at regular intervals across the paddock (12m, 26m and 40m). Regular peaks in deposit are also evident in the simulated overlap (Figure 4) using the single deposit pattern shown in Figure 3. There is scope to improve this pattern by reducing the height of the peak between positions 40-44m (Figure 3).

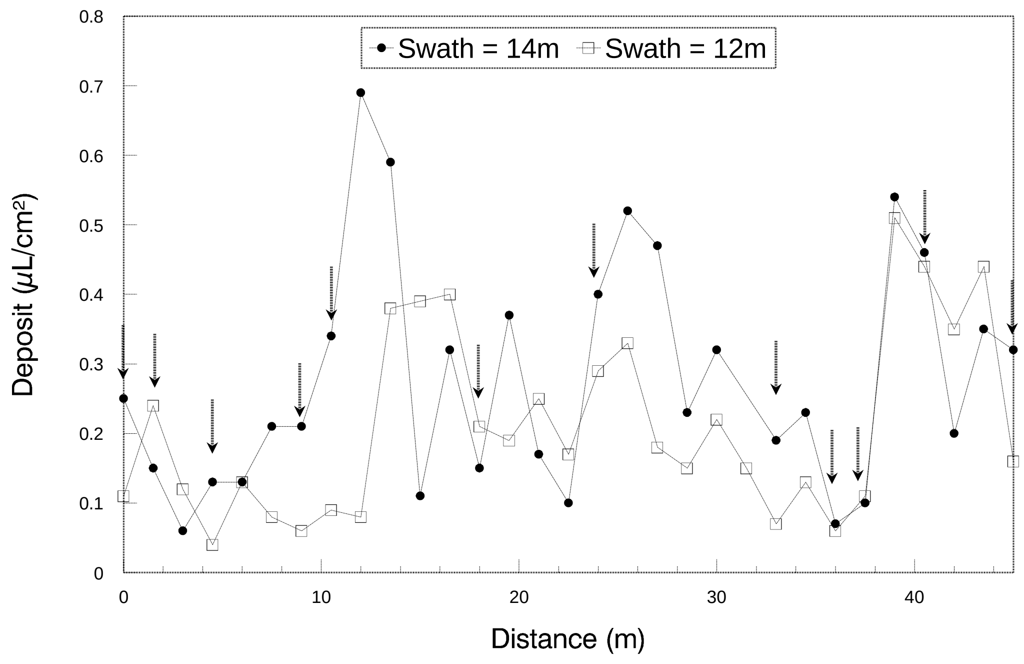

Figure 6. Deposit profiles recovered on flat plates placed across rows in a mature sweet corn crop. The two lines show the deposit profiles for 2 swath widths (12 and 14m).

· *Air-assisted sprayers improve penetration and coverage*

Air-assisted sprayers offer many advantages compared to conventional spray booms. An axial flow fan, usually hydraulically powered, is used to create air and this is then ducted through a bag attached along the boom. Along the bottom of the air bag this air is released as an air curtain. The air curtain produced by these sprayers assists in the reduction of drift and improves spray penetration into the canopy of crops. The air curtain also produces turbulence within the crop which can result in improved coverage on the undersides of leaves and hard to get at targets such as the silks on cobs. Some sprayers have the capability to alter the direction of the air curtain. Rather than straight down it may be orientated forward or backward to the direction of travel. This enables spraying to be undertaken in less than optimum conditions when strong wind may otherwise cause large spray losses. Even under ideal spraying conditions, spray penetration and coverage may also be improved in parts of some crops by having the air curtain directed forwards or backwards.

A field trial was conducted using a Hardie, Twin force air assisted sprayer to evaluate the spray deposit on artificial targets (pipe cleaners) placed in a sweet corn canopy (variety H5). The trial was conducted to assess the effect on air velocity and angle of air penetration on spray deposit at various heights within a sweet corn canopy. The sprayer was operated without air and at two air velocities as regulated by the fan speed, these were i) 50% of maximum fan speed which produced an air velocity of 11.6 m/s at the duct outlet on the boom and ii) 100% fan speed which produced an average air velocity of 16.2 m/s at the duct outlet. The air curtain was directed i) straight down, ii) half forward (15 degrees) and iii) full forward (30 degrees). The travel speed in this trial was 5.6 km/hr and the application volume was 106 L/ha. The artificial targets were placed at three heights in the sweet corn crop, tassel height (≈2.3m), cob height (≈1.4m) and just above ground level (≈0.2m). A fluorescent tracer was used to quantify the spray deposit on individual pipe cleaners. Silks were not collected as they had all browned off in this crop.

There were significant differences in the average deposit levels on the pipe cleaners between the 3 heights sampled. When deposits were averaged across all tests there was a 54% reduction in the deposit on pipe cleaners between the top and middle canopy positions and an 86% reduction in deposit between the top and bottom positions. There was no significant difference in the deposit levels recovered between the different air velocity and angle settings in the middle and bottom positions. The air curtain angled full forward with at the reduced air velocity produced higher deposit levels in the top position compared with all other settings. The highest average recovery across all zones was achieved using the reduced air setting and the air curtain angled full forward. The treatment with no air gave the second lowest average recovery (Table III).

Table III. Average spray deposits on pipe cleaners placed at 3 heights on sweet corn plants.

Test Configuration	Deposit (µL/cm²) Bottom (0.2m)	Middle (1.4m)	Top (2.3m)	All*
50% Air - full forward	0.121	0.306	1.085	0.504
50% Air - straight down	0.133	0.364	0.65	0.382
100 % Air - half forward	0.115	0.498	0.874	0.496
100 % Air - full forward	0.092	0.358	0.828	0.426
100 % Air - straight down	0.119	0.396	0.781	0.432
No Air	0.097	0.367	0.734	0.399

* Average across all positions

It would have been better to compare the deposit levels directly on the silk using these equipment settings. The silks were not sampled as they had already dried off in this crop. The zone of primary importance is the middle zone as this is where the cob is located. No firm conclusions can be drawn from this trial regarding air velocity and angle. The results showed that increased air velocity angled 15 degrees forward gave higher recoveries in the cob zone. Further testing is required using fresh silks as targets to determine if there are significant differences in the setting used on this equipment.

3. Promotion of Application Techniques at Farm Walks

What did we do?

The demonstration and promotion of improved application techniques at **farm walks** occurred in all major sweet corn production areas. These farm walks were all conducted during the district's sweetcorn season. Each farm walk commenced in the late afternoon and extended into the evening with the length of the farm walks ranging from 3 to 6 hours. A presentation on general spray application and trial results was followed by a field walk to look at the coverage of different application techniques using fluorescent dye. The evening was finished by an open forum discussion after a BBQ. Evaluation forms were distributed at the Gatton field day to provide feedback. The locations, dates and attendance at farm walks are listed in Table IV.

Table IV. Application technology farm walks.

Location	Bowen	Gatton	Cowra	Lindenow
Date	1st October, 1998	5th February, 1999	18th February 1999	24th February 1999
Attendance	30	22	~20	25-30
No. sweet corn growers	2	15	~20	25-30
Contact	Ross Wright	Brendan Nolan	Clarrie Beckingham	Rob Dimsey

Growers were also informed about improved application techniques through regular **newsletters, media releases, application information kits (see Appendix I).**

What did we find?

Night walks were popular and generated a lot of discussion and interest. This follows similar experiences with similar activities in other cropping systems and regions. This type of activity has shown to be a very effective means of delivering information and demonstrating equipment through the use of fluorescent dyes in the field. The meal provided social interaction and alternative opportunities for discussion to that of the 'open forum' that followed presentations.

4. Changes in Application Techniques

Anecdotal evidence to date suggests there has been interest from all regions in alternative spray application techniques to what was previously used by the industry as documented in Milestone 2 report.

South East Queensland
One major production group has bought an air-assisted boom sprayer and another has trialed droppers on a standard boom. A survey taken at the Gatton farm walk indicated that no-one was going to change to droppers immediately, however there was considerable interest in the results, and much discussion about alternative modifications to the prototype demonstrated. At present aerial spraying of sweet corn is undertaken in the Lockyer Valley with volumes ranging from 40-60 L/ha. Aircraft are either equipped with Micronairs or hollow cone nozzles in the case of the helicopter operator. Due to the small block sizes sprayed and abundance of obstacles such as powerlines the use of a flight path guidance system such as DGPS is not all that feasible in the Lockyer Valley.

North Queensland
There is an increasing use of ground based sprayers equipped with droppers used in North Queensland to apply insecticides to sweet corn. One grower is using and over the top booms with air-shear outlets are being. Aircraft are continuing to be used for spraying sweet corn, where appropriate.

New South Wales
Large areas of processing sweet corn are sprayed using aircraft. Aerial operators all are using very narrow swaths and track guidance systems. Contractors are using ground rigs equipped with droppers spraying large areas.

Victoria
Contract sprayers are available using high clearance equipment with and without droppers. Project team members have had a number of enquires following the workshop regarding specifications for dropper modification.

Western Australia
Project team members have had enquires on alternative techniques and droppers.

5. Conclusions

Many commonly used pesticide application techniques have been evaluated for their efficiency in targeting insecticides to silks or artificial targets placed near silks. Using fluorescent tracers, spray deposits on silks have been collected for a range of equipment types. Some of the techniques tested have produced significant improvements to conventional application methods. Even though the equipment used is important when applying insecticides to sweet corn the sweet corn canopy also has a large influence on the spray penetration and spray distribution on the plant. The distribution on the plant is difficult to manipulate when spraying over the top with a boom. The following conclusions can be drawn for the field trials undertaken so far.

- Calibration of agricultural aircraft used for spraying sweet corn is very important. Spray penetration and uniformity of spray deposition across a paddock may be improved with aircraft by using reduced swaths. This technique is used by some aerial operators. Ensuring a precise swath width is flown across a paddock is also critical. This can be achieved by using track guidance (differential global positioning systems DGPS) or by placing markers in the field so pilots know where to fly each pass.

- Boom sprayers fitted with droppers have the ability to direct more spray onto silks compared with conventional over the top boom sprayers and aircraft. Further trials will be undertaken to address comments raised by growers and contractors currently using droppers. These comments concern:

  (1) Dropper length.
  No broad recommendations can be made on the length of droppers required, as length will vary depending on the height of the variety and distance from the cob to the tassel. Some spray operators are using short droppers, with the nozzle placed above the top cob but directed downwards towards the cob. Longer droppers are more likely to become tangled and break off in crops that lodge. More trials are required with short droppers to assess their efficiency in targeting sprays on silks.

  (2) The number of nozzles required on each dropper
  The results reported in this report used droppers fitted with four nozzles directed to the cob region of a plant. Four nozzles are likely to give better spray deposition than two nozzles especially if leaves are constantly brushing up against nozzles and preventing droplets from reaching the target.

  (3) The type of nozzles to use.
  Most of nozzles used on sprayers with droppers employed to spray commercial sweet corn crops are wide-angle flat fans. The reason for using flat fan with a spray angle of 110^o is the width of the spray pattern at a set distance (ie. 50cm) is wider than most conventional hollow cone nozzles that have typical angles of 70^o. There is considerable scope to investigate a range of different nozzle types (hollow cones, twin-fans and even fan nozzles) to determine whether they produce better spray deposit levels on silks compared to tapered flat fan nozzles.

(4) Application Volumes
Wide ranges of application volumes are used when applying insecticides to sweet corn (200 L/ha to 1300 L/ha). Increasing volumes will not necessarily increase spray deposit on the silks especially if the silks are drenched and run-off occurs. Further trials are required to assess the efficiency of different application volumes.

- Further testing is required with air-assisted sprayers using silks as targets to determine if there are significant differences in the spray deposit for the different settings (air velocity and angle) that can be used on this equipment.

- As additional spray application trials are conducted the results will be disseminated to growers through future project workshops, the Sweet Corn Ear and farm walks.

Appendix I (Newsletters, media releases and application information kits)