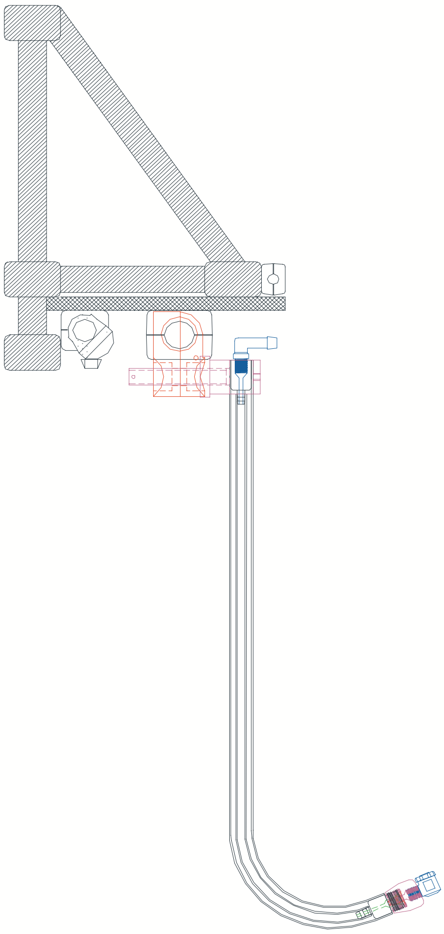
DROPSPRAY SYSTEM

Trials Results



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Summary

Biological and application performance trials have been carried out by agronomists, application specialists, and independent bodies since 1992.

Trial work was carried out in parallel with engineering and design development. Indeed, findings from the trials and experience from growers has contributed considerably to developments in the design of the DropSpray system.

Independent organisations that have been involved include:

ADAS	ARC Arable Research Centre
Bishop Burton College	Harper Adams College
Morley Research Centre	NIAB
SAC	

In the period 1992 to 1997, a total of 17 independent trials were carried out with the above organisations. In comparison with conventional hydraulic sprayers used in the trials, the overall results were as follows:

Significantly better	11 trials
Slightly better	1
Equal	3
Inferior	2*

*Note: these trials were carried out with early 1993 prototype sprayers.

Additionally, in 7 trials, the DropSpray system was compared with commercially available air assisted systems. In 4 cases the DropSpray system proved superior and in one case it was equal in performance.

Further trials have since been undertaken, as well as practical use, which essentially confirm the advantages shown in these early trials.

SPRAY DRIFT MEASUREMENT IN WHEAT

Scottish Agricultural College W. A. Jeffrey and R. G. McKinlay (1994)

Notes

The results presented here are for droplegs combined with boom nozzles as this represents general use. Droplegs alone produce lower levels of drift.

The drift cloud was sampled by three masts at 10m intervals set in a line at right angles to the direction of travel. Each mast had mounted 10 pairs of horizontally disposed pipe cleaners, spaced at 0.5m intervals from 0.7m to the mast top at 5.2m above ground.

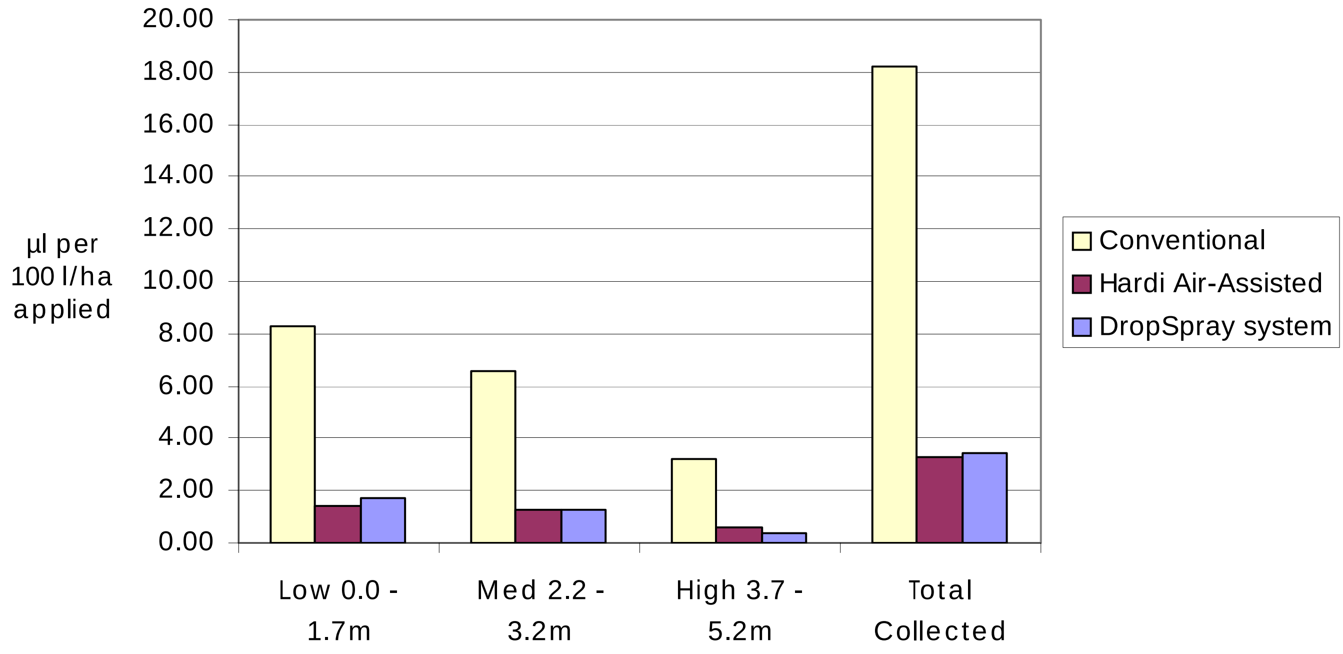
The sprayers were driven along a path parallel to the masts on the upwind side, with the boom end 5m from the line of masts. Four passes were made in each test (two in each direction), while a hand held hot wire anemometer (with averaging facility) monitored wind speed at boom height immediately up wind of the sprayer. The wind direction varied nominally from 45º to 75º from the sprayer path.

Fluorimetric analysis determined the amount of spray captured on each pipe cleaner, based on samples taken from the respective sprayers to calibrate the instrument.

From the wind speed coefficients of variation it is clear that the wind was pretty unsteady except during test 3, so small differences can be discounted. The DropSpray system produced a similar level of drift to the air-assisted system, and the drift from both was less than half that produced by the conventional system.

Operating the droplegs alone produced virtually no visible drift.

Spray Drift Collected at 3 Heights



COMPARISON OF DROPSPRAY SYSTEM WITH CONVENTIONAL AND AIR-ASSISTED APPLICATIONS FOR APHID CONTROL IN POTATOES

Scottish Agricultural College: W. A. Jeffrey and R. G. McKinlay (1994)

Summary of Results

Pre-spray sample:
The pre-spraying sample found no significant difference (P>0.05) in the distribution of aphids across the site. Total aphids averaged 28 aphids per 20 leaf sample with numbers evenly distributed between upper, middle and lower leaves. The dominant aphid species at the experimental site was *Macrosiphum euphorbiae* which made up more than 90% of the aphids found. The majority of the remaining aphids found at the experimental site were *Myzus persicae*, but *Aulachorthum solani* and *Myzus ornatus* were also found.

Spraying:
The crop (cv Maris Berd) had closed along and across the rows. Application volume was 250 l/ha for the air-assisted and conventional, and 450 l/ha split between boom and droplegs for the DropSpray system.

2 days post-spraying:
Two days post-spraying the sample showed that all the spraying systems had achieved significant (P<0.01) reductions in aphid numbers. For total aphid numbers plots treated with conventional systems, air-assisted and the DropSpray system achieved reductions of approximately 70%, 85% and 95% respectively when compared with untreated plots. For the two species analysed individually (*Marcosiphum euphorbiae* and *Myzus persicae*) the ranking of the three systems was identical and their performance, in terms of reducing aphid numbers, was similar.

7 days post-spraying:
The leaf samples taken 7 days post-spraying showed that all sprayer systems continued to have aphid populations significantly (P<0.001) lower han untreated plots. The plots treated with the DropSpray system continued to have the lowest aphid populations.

14 days post-spraying:
The leaf samples taken 14 days post-spraying showed that all sprayer systems continued to have aphid populations significantly (P<0.001) lower than untreated plots. The plots treated with the DropSpray system continued to have the lowest aphid and *Marcosiphum euphorbiae* populations. However populations of *Myzus persicae* had recovered and there was no significant difference (P>0.05) between numbers of untreated and treated plots.

Notes

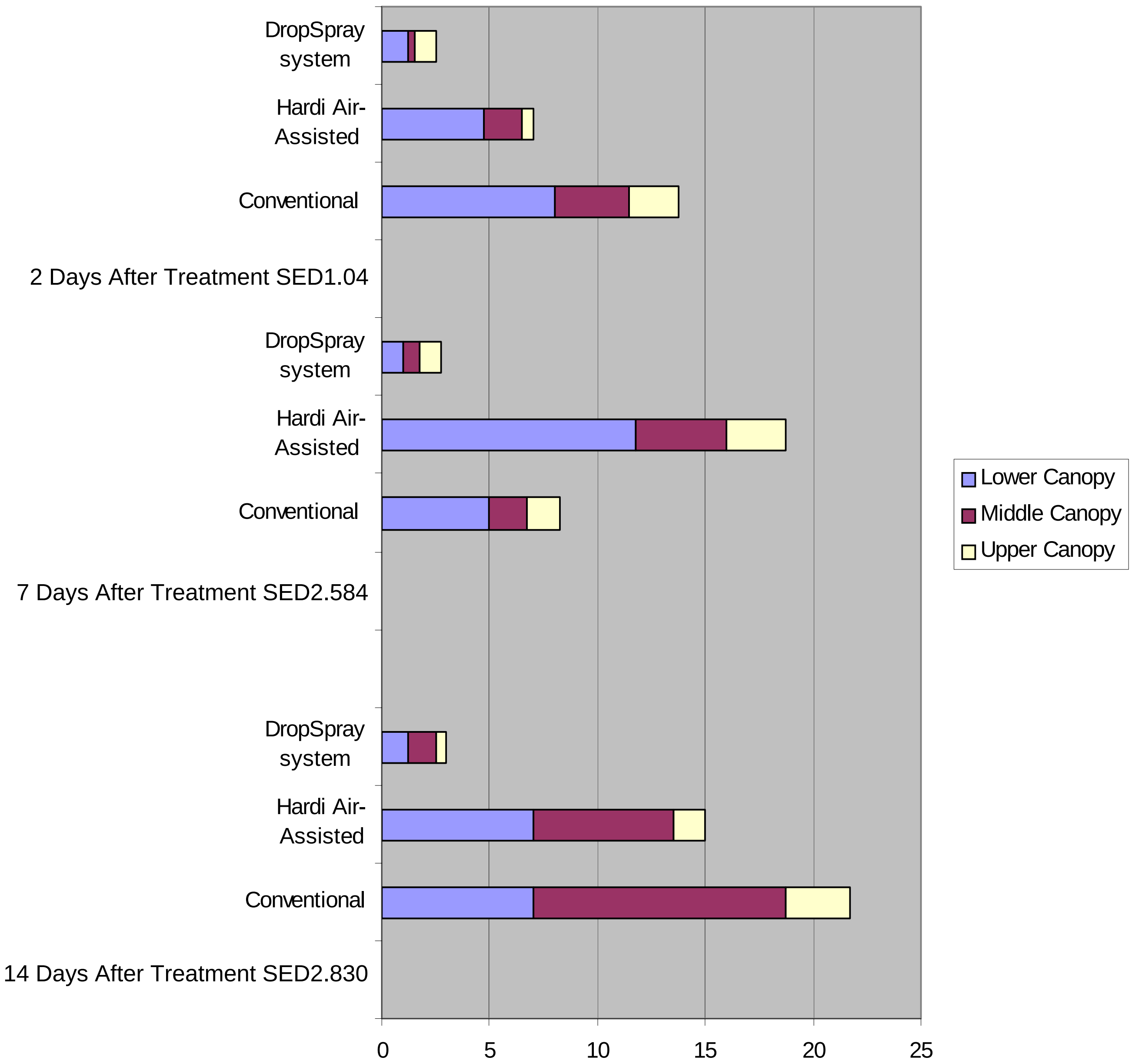
1) Aphid control is clearly better with the DropSpray system than with the other systems and unlike the other systems the population remains below a treatable level. This is likely to have saved at least one application if not two.

2) Crop cover is the other way to look at this set of results. This information shows that lower canopy cover is better and that where control in the lower canopy is poor, the population can regenerate providing a source of reinfestation for the whole plant. It is reasonable to assume that this could be the case for diseases (other trials confirm this).

- The economic benefit of potentially reduced pesticide use is obvious.
- There is a benefit for 'Grower Protocols' - Most effective use - Minimum pesticide use.
- Integrated Pest Management - the choice of pesticide may be wider, a more selective material might replace a general one or a reduced dose may be used.
- There is the less obvious benefit of reducing the risk of resistance build up by avoiding declining dose selection down the crop profile and by minimising repeated doses of the same or similar pesticides in a short period to the same population.

Aphid Count - *M. persicae and M. euphorbiae* at 2, 7 and 14 Days Post Application Assessment

Trial: 4 Replicates - Product: Decisquick @ 300 ml/ha



THE POTENTIAL FOR BETTER CONTROL OF LATE BLIGHT OF POTATOES BY THE IMPROVED DEPOSITION OF FUNGICIDES

Scottish Agricultural College: G. L. Ligertwood (1994)

Tuber Blight at Harvest

Tuber blight was recorded from all treatment programmes at harvest, with the highest levels being recorded from the Conventional/Trustan/14 day programme and the lowest from the DropSpray system/Trustan/14 day. There were no significant differences between the sprayers in any of the fungicide/timing combinations.

Tuber Blight Post-Storage

Tuber blight was recorded from all treatments with exception of the DropSpray system/Trustan/10 day programme. The low levels recorded from the untreated control is not uncommon. With Trustan, the DropSpray system produced lower levels of tuber blight than the conventional sprayer at both 10 and 14 day intervals. At 10 days this difference was significant.

Combined Tuber Blight Assessment Results

With the combined assessment results, the DropSpray system gave significantly lower tuber blight with Trustan programmes at both 10 and 14 day on a “by weight” basis when compared with the conventional sprayer.

Discussion and Conclusions

The DropSpray system significantly reduced tuber blight levels in the Trustan programmes compared with the conventional sprayer. Extending the spray interval to 14 days did not increase the levels of tuber blight obtained with either sprayer.

When these combined tuber blight levels are allowed for in the yield data they produced a blight-free yield benefit in favour of the DropSpray system of 6.54 and 1.91 t/ha with Trustan at 10 and 14 day intervals in comparison with the conventional sprayer.

In conclusion, this trial has shown that the DropSpray system can significantly reduce tuber blight levels when compared with conventional application, and there may be opportunities to extend spray intervals with the DropSpray system when using systemic materials in the spray programme.

Notes

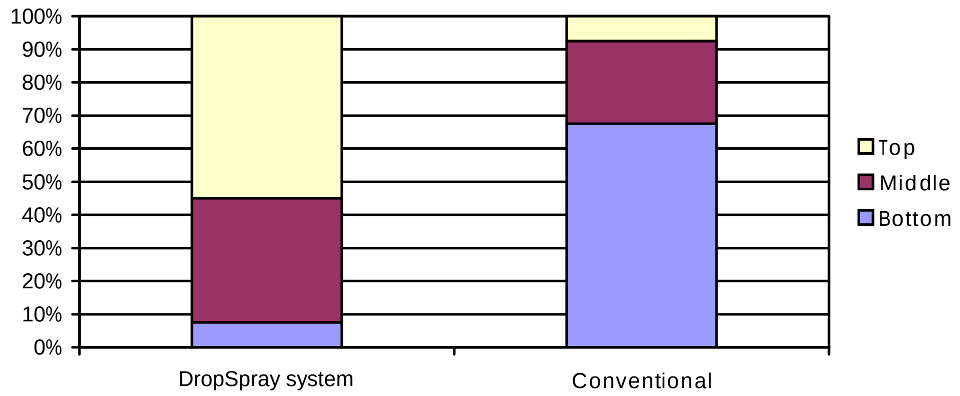
The amount of pesticide deposited by the DropSpray system in this trial was about one-quarter from the boom and three-quarters from the dropleg. Differences in performance could be seen throughout the trial. Using information from this and other trials led to the recommendation to split the spray volume half from the boom and half from the dropleg.

Overall the total blight found at all 3 heights in the table below was similar but tuber blight is lower where the lower stem has less disease. The amount of blight on the lower stem is regarded as more important as the source of tuber blight than is upper plant blight, this is demonstrated by this and other trials.

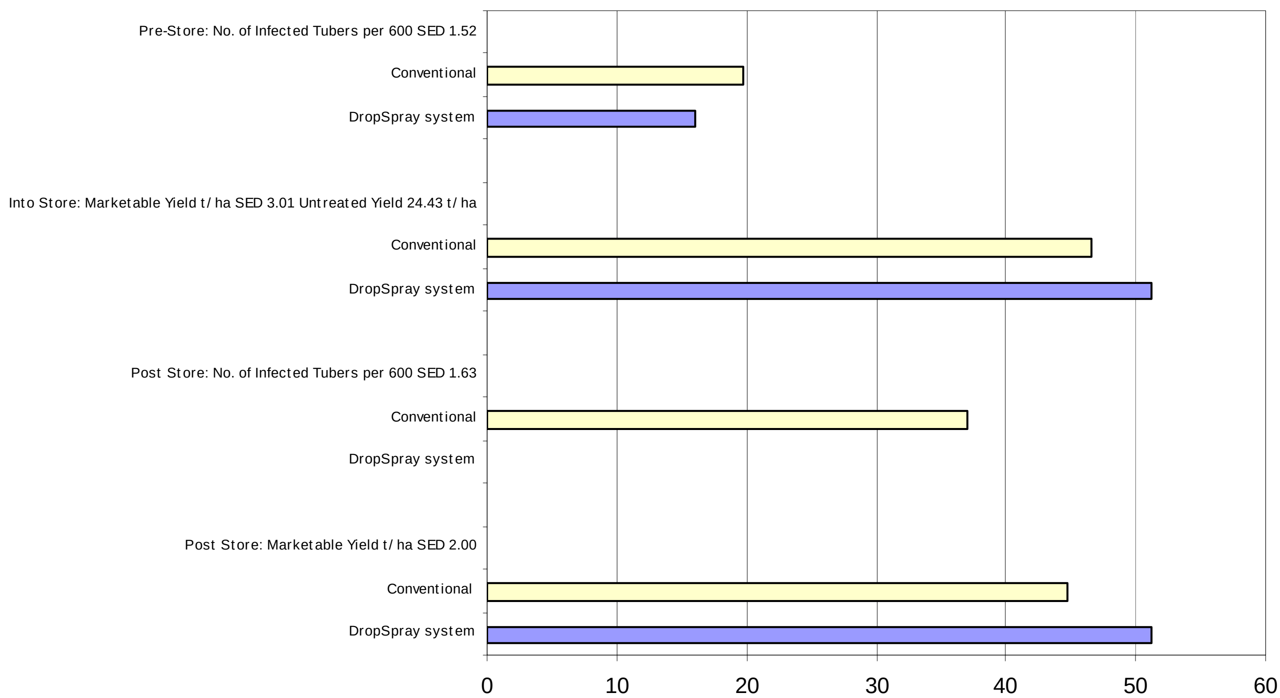
Please note the robust reliability of the system when looking at this and other trials.

Proportion of Stem Blight Lesions Found

Conventional system gave marginally higher totals overall.



Tuber Blight 10 Day Programme. Pre and Post Store



BIOASSAY STUDY TO COMPARE THE DEPOSITION OF INVADER BY DIFFERENT SPRAYERS FOR THE CONTROL OF POTATO LATE BLIGHT

Scottish Agricultural College: G. L. Ligertwood (1996)

Introduction

Bioassay studies were carried out to compare the deposition of Invader (dimethomorph plus mancozeb) when applied to potatoes (*cv* King Edward) by different sprayers or the control of potato late blight (*Phytophthora infestans)*. Applications of fungicide (4 replicates) were made using the DropSpray system, a Hardi air-assisted sprayer and by conventional application at 300-350 l/ha.

Leaf Bioassay 1

Four replicated field plots were treated by each sprayer on 16/17 July as the crop met along the drills with dimethomorph plus mancozeb (Invader 2.0kg/ha) in volumes of application for each sprayer equivalent to 340 l/ha (the DropSpray system) and 320 l/ha (Hardi and Conventional). At this growth stage the crop was approximately 60cm tall with 75% ground cover. 24 hours after application, five stems per plot were selected at random and the terminal three leaflets of leaves from upper, mid and lower stem position were sampled.

Stem Bioassay

In addition to the leaf bioassay a stem bioassay was carried out at full crop canopy on the selected stems.

Discussion

The results from leaf bioassay 1 indicate enhanced fungicide deposition throughout the potato crop canopy with the DropSpray system in comparison with conventional application at this application timing. The levels of infection recorded from the conventional application are perhaps surprising in that they are relatively similar at all three positions in the canopy, whereas it might have been expected to record lower levels in the upper canopy and higher levels lower down on the premise that conventional application gives good top coverage but poorer canopy penetration. Equally surprising are the high levels recorded from the bottom of the canopy with the Hardi air-assisted sprayer. Sprayer calibration and air strength and direction were as directed by sprayer instructions but there would appear to be poor deposition, or retention, on lower leaves. Protection of top and mid position leaves was better than conventional application.

It is probable that the stem bioassay reflects a movement of fungicide down the canopy for the DropSpray system treatment, with the greatest protection again being recorded in the canopy base. In contrast, there would appear to be no improvement in control over conventional application by using air-assistance, both these treatments recording somewhat similar and uniform levels of infection throughout the canopy. Overall, the DropSpray system produced a greater degree of control than the other sprayers.

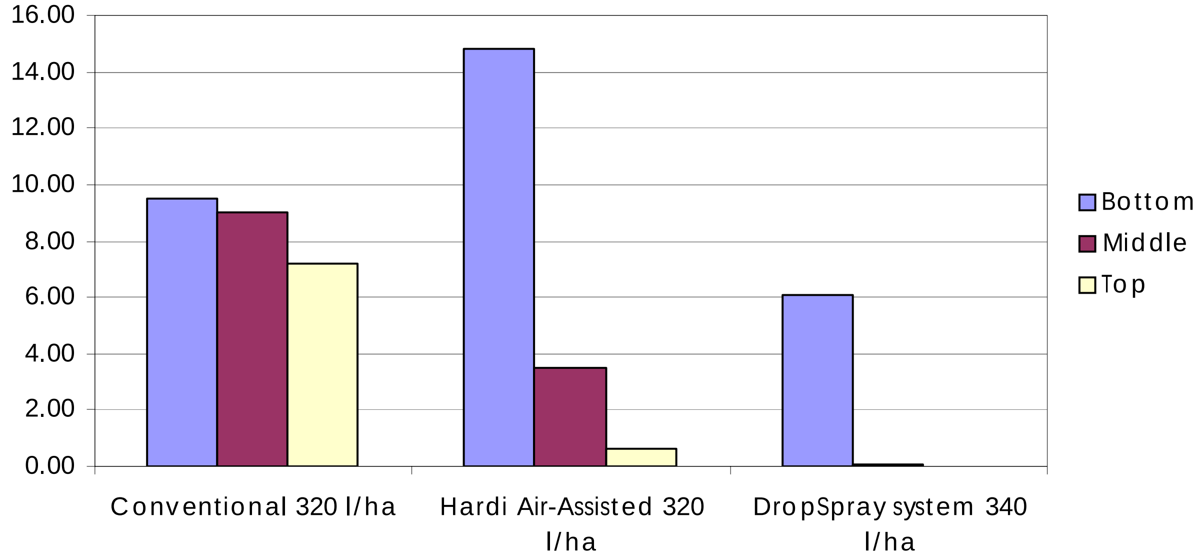
Notes

The amount of pesticide deposited by the DropSpray system in this trial is one-quarter from the boom and three-quarters from the dropleg. Differences in performance at the top of the plants could be seen in the full canopy assessment. Using information from this and other trials led to the recommendation to split the spray volume half from the boom and half from the dropleg.

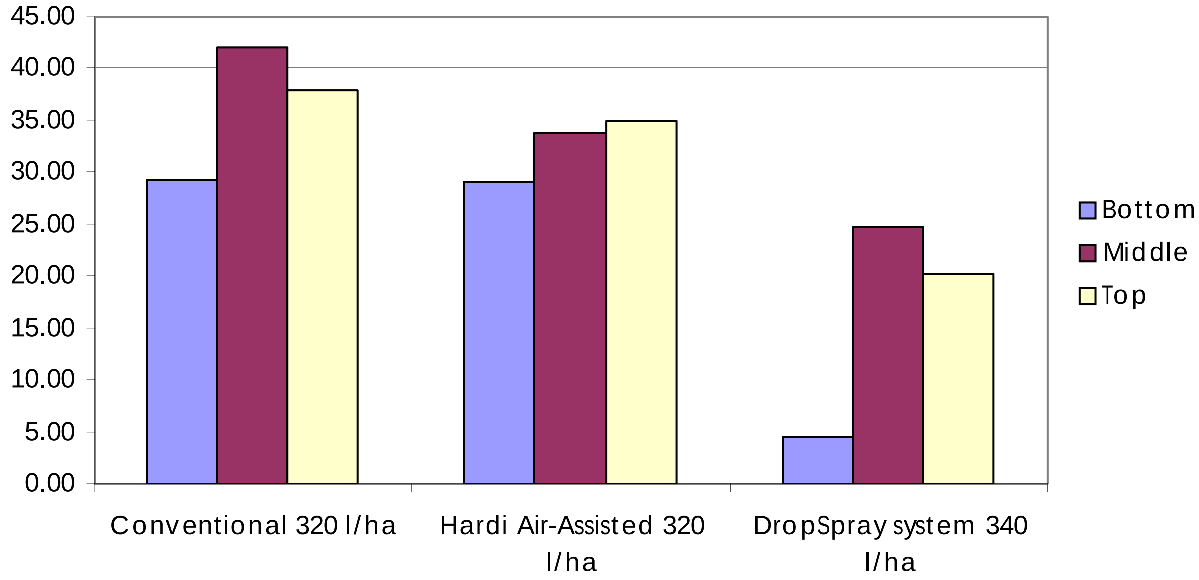
The amount of stem blight is regarded as more important in terms of likely tuber blight, than is the amount of leaf blight in relation to the resulting amount of tuber blight.

Please note the robust reliability of the system when looking at this and other trials.

SAC 1996 Bioassay Leaf (half canopy) SED 5.73
% Infection. 2kg/ha application of Invader



SAC 1996 Bioassay Stem (full canopy) SED 9.13
% Infection. 2kg/ha application of Invader



BIOASSAY EVALUATION OF FUNGICIDE IN POTATO CANOPIES USING DIFFERENT SPRAY APPLICATION EQUIPMENT FOR CONTROL OF POTATO LATE BLIGHT

Scottish Agricultural College: G. L. Ligertwood (1997)

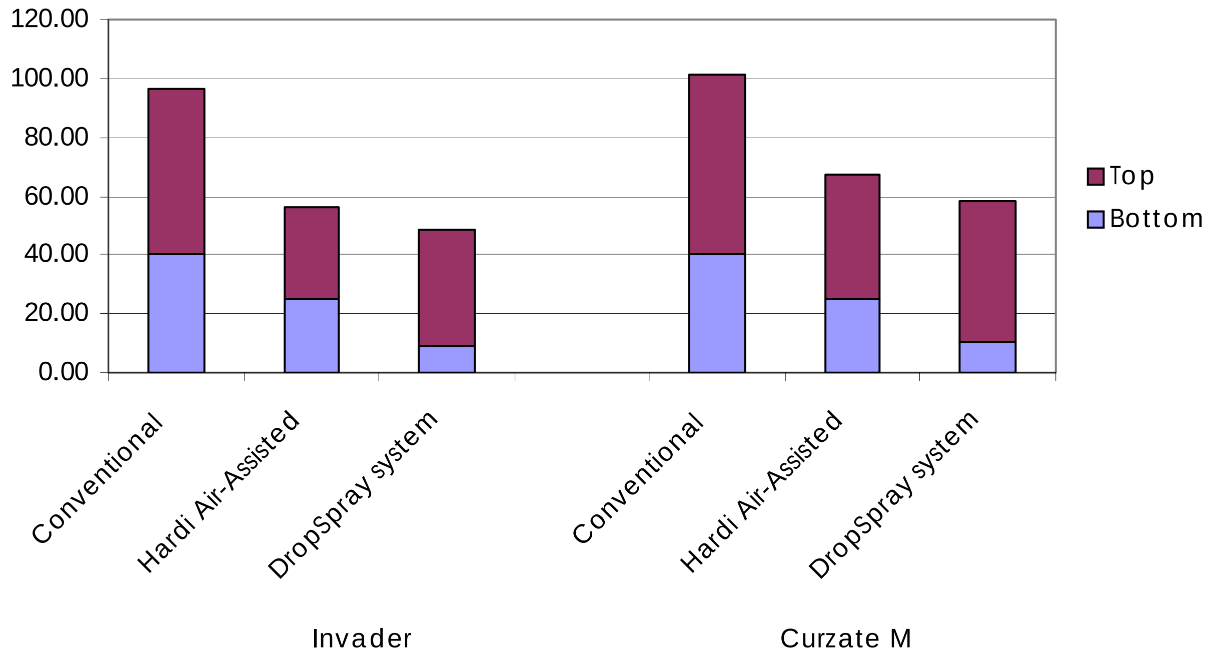
Bioassays were carried out at two crop growth stages: the first as the crop met along the drills following the first spray application, and the second at full crop canopy following four applications of fungicide (4 replicates) at 300-350 l/ha total spray volume. After spray application at each of these timings, leaf and stem samples from upper and lower haulm positions were collected three and seven days after treatment (DAT) and challenged with blight sporangia suspension in the laboratory. After seven days of incubation in the growth rooms, the frequency of infection was assessed.

The results in general indicate that improved deposition, and hence protection, can be afforded with the alternative techniques, especially the DropSpray system, but also the importance of achieving adequate spray deposition on the upper canopy during the early stages of growth. Differences between fungicides were also apparent. The trial also highlighted the weakness of conventional application. Note: The results conflict with other deposition work indicating an exponential decrease in fungicide deposition down the canopy with conventional application.

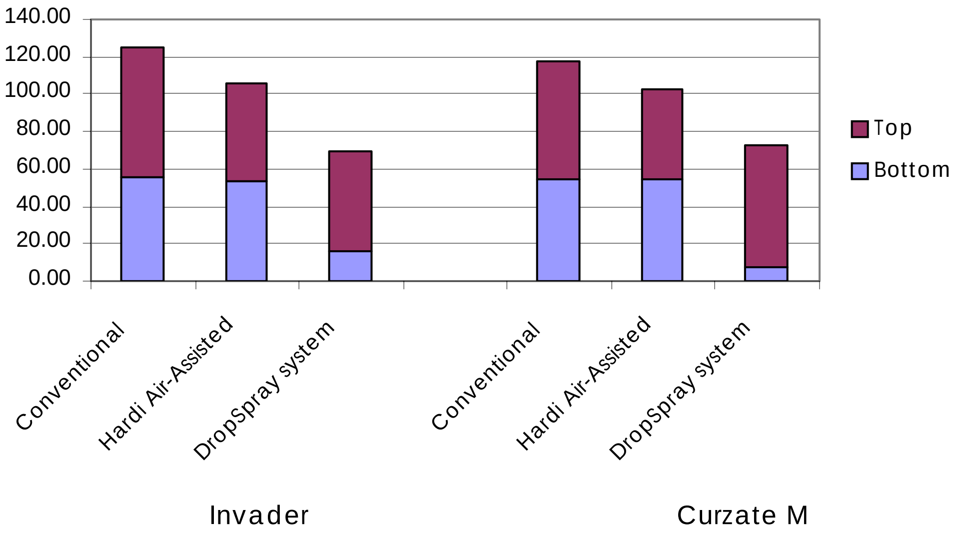
Notes

The amount of pesticide deposited by the DropSpray system in this trial is one-quarter from the boom and three-quarters from the dropleg. Differences in performance at the top of the plants could be seen in the first assessment of the first application but diminished in the later assessments. Using information from this and other trials led to the recommendation to split the spray volume half from the boom and half from the dropleg.

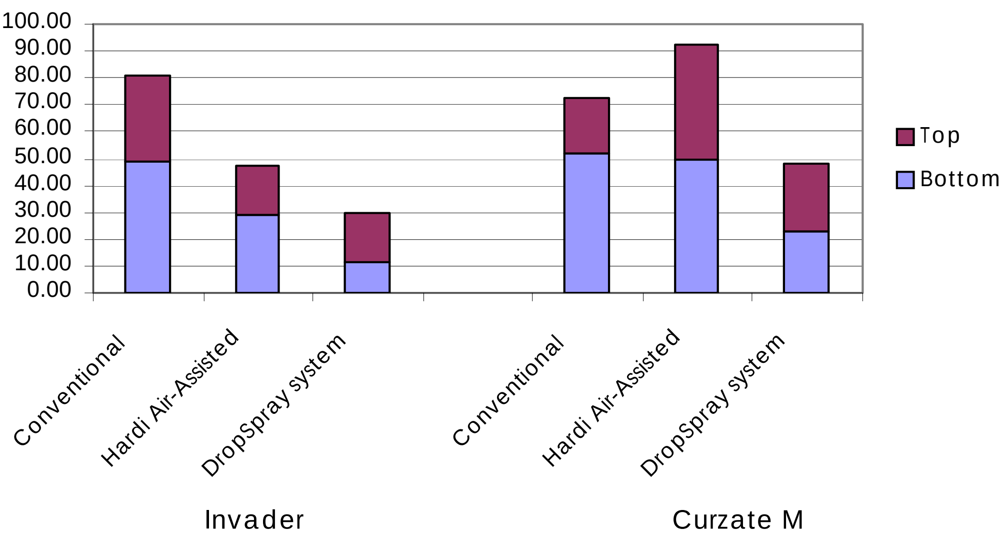
SAC 97 Bioassy. Stems % Infection 7 DAT (Half Canopy) SED 9.65



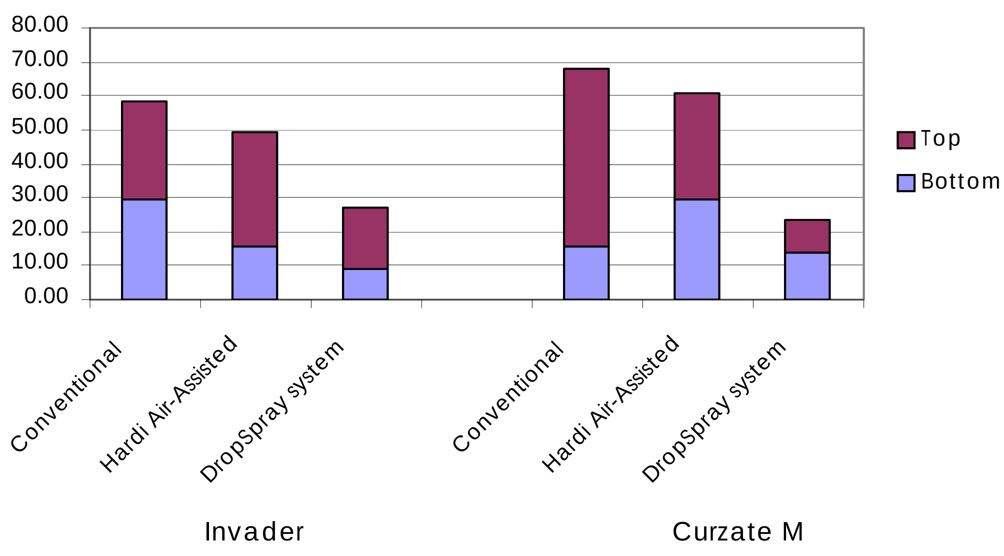
SAC 97 Bioassay. Leaves % Infection 7 DAT (Half Canopy) SED 10.91



SAC 97 Bioassay. Stems % Infection 7 DAT (Full Canopy) SED 10.57



SAC 97 Bioassay. Leaves % Infection 7 DAT (Full Canopy) SED 8.75



SPRAY DEPOSITION MEASUREMENTS OF APPLICATION SYSTEMS IN POTATOES

Harper Adams (Report: H. Hinds, Benest - 1996)

Methods: Application
Spray volume for each system was standardised at 220 l/ha. The DropSpray system applied 80 l/ha from flat fan nozzles over the crop combined with 140 l/ha from droplegs (I.e. spray volume split about one-third from the boom and two-thirds from the droplegs)

Discussion
A clear pattern emerged from the results of this trial with respect to the spray deposition characteristics of the application systems tested.

As might be expected, conventional application concentrates much of the spray in the upper part of the foliage and is not very successful at targeting lower leaves and stems which tend to be shielded by the upper leaf foliage.

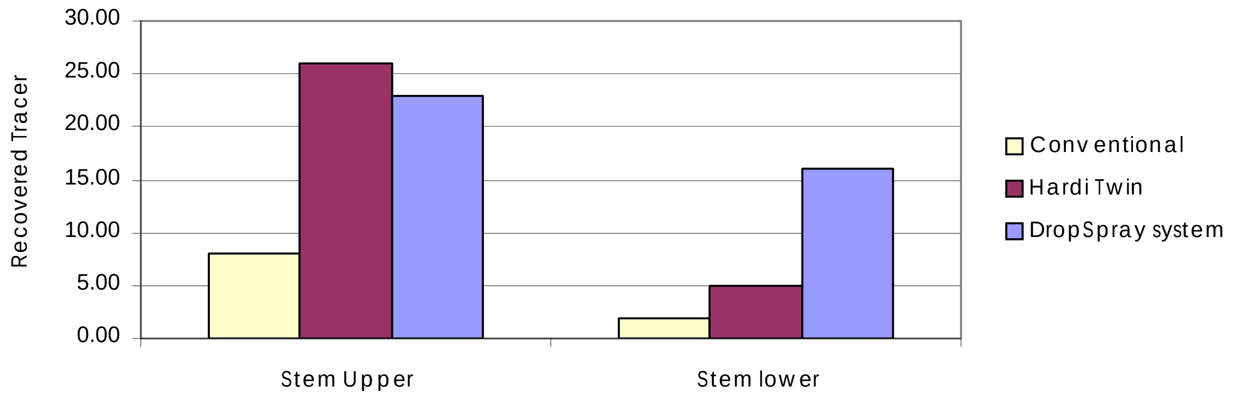
Air-assisted application does better than conventional at delivering spray to the bottom of the crop, however the improvement is less of a difference when lower stems and leaf terminals are considered. This could be due to the blowing action causing lower leaflets to be pushed against each other, thus creating a barrier to spray penetration.

Application with the DropSpray system produced the greatest uniformity of spray deposition throughout the canopy. Because the system divides the spray volume almost equally from above and below, the deposition on the top of the crop is lower than the other systems but is much higher in the bottom of the crop. Biological studies have shown (e.g. Ligertwood 1996), that putting a lower volume (150 l/ha) on the top canopy with the DropSpray application does not affect the level of late blight control compared to conventional and air-assisted spraying (300 l/ha). The higher deposition levels in the lower canopy by dropleg application, as shown in this trial, could also explain the increased control in this part of the crop in work referred to above.

Spray deposition to the stem has particular significance in potatoes in relation to tuber blight infection (e.g. Fairclough 1993). The increased levels of spray cover to the lower stem given by the droplegs in this work supports in the theory that this factor is involved in reducing tuber blight infection (e.g. Ligertwood 1995).

The ground deposit results in this trial are interesting because of the relatively high levels shown by the air-assisted sprayer. An explanation for this result could be that as the crop is blown forward, bare ground is exposed for the spray to target. It is also claimed that air-assisted sprayers use the ground to bounce off to hit lower foliage. If this is the case then some of this spray is remaining on the soil.

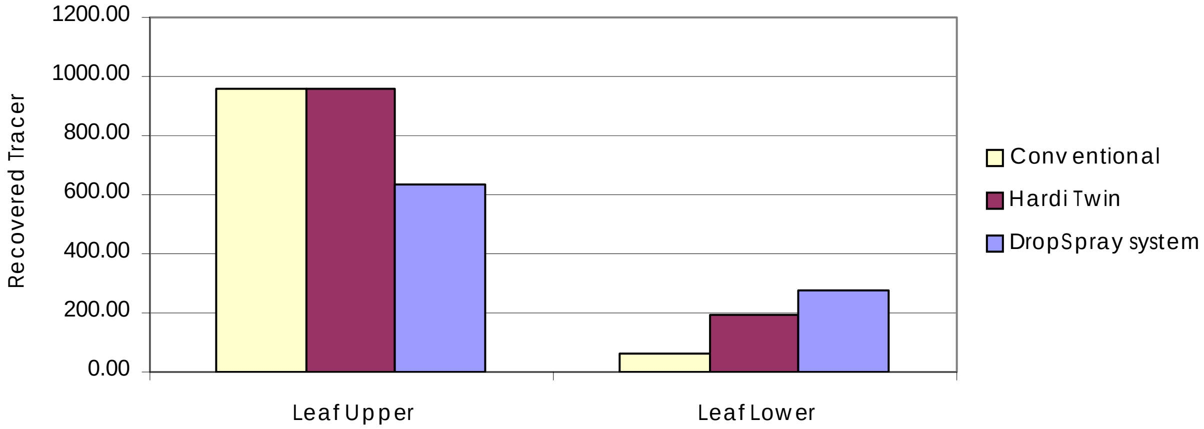
Mean Tracer Deposits on Potato Stems

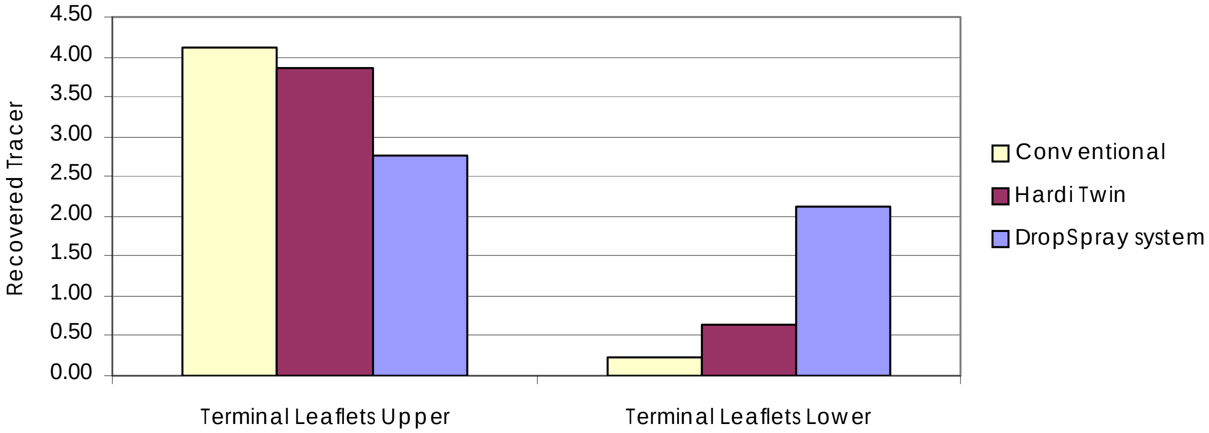


Notes

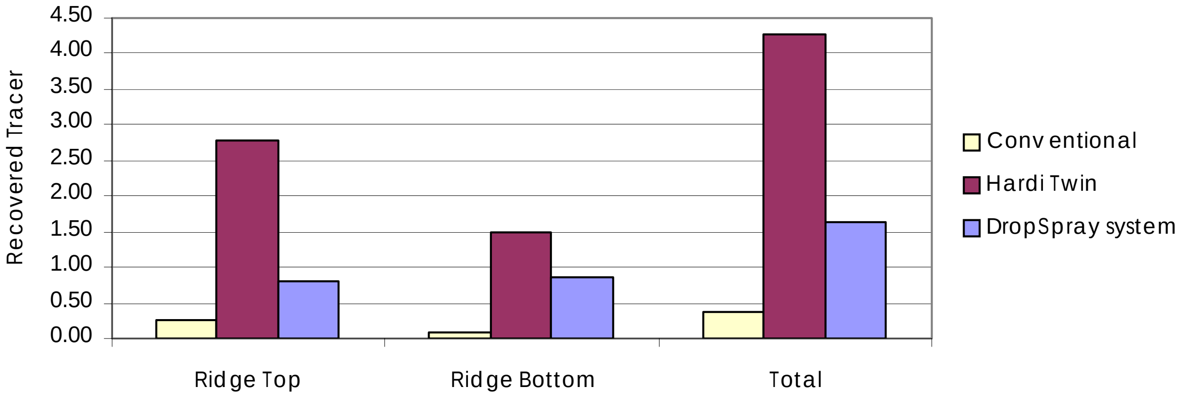
The degree of deposit onto the top of the leaf canopy by the conventional and air-assisted sprayer is higher than from the DropSpray system, as one would expect (with only one-third of the volume applied from the top). Part of the deposit recorded in the DropSpray system treatment will be on the underside of the leaf. Biological studies demonstrate that the higher coverage at the top is not required to achieve good control i.e. this is an overdose and potentially wastes chemical.

Mean Tracer Deposits on Potato Leaves





Mean tracer on Potato Ridges (Ground Deposits)



A COMPARISON TRIAL BETWEEN A CONVENTIONAL BOOM-SPRAYER AND THE DROPSPRAY SYSTEM

Bishop Burton College (Report: G. Basil, Benest - 1994)

Application Assessment 1:
As can be seen in the results, a significant increase was found with the DropSpray system for both area of coverage and number of drops per square centimetre. Although roughly twice the volume was applied with the DropSpray system the mean area of coverage was approximately seven times higher than the conventional application and the mean number of droplets over three times higher.

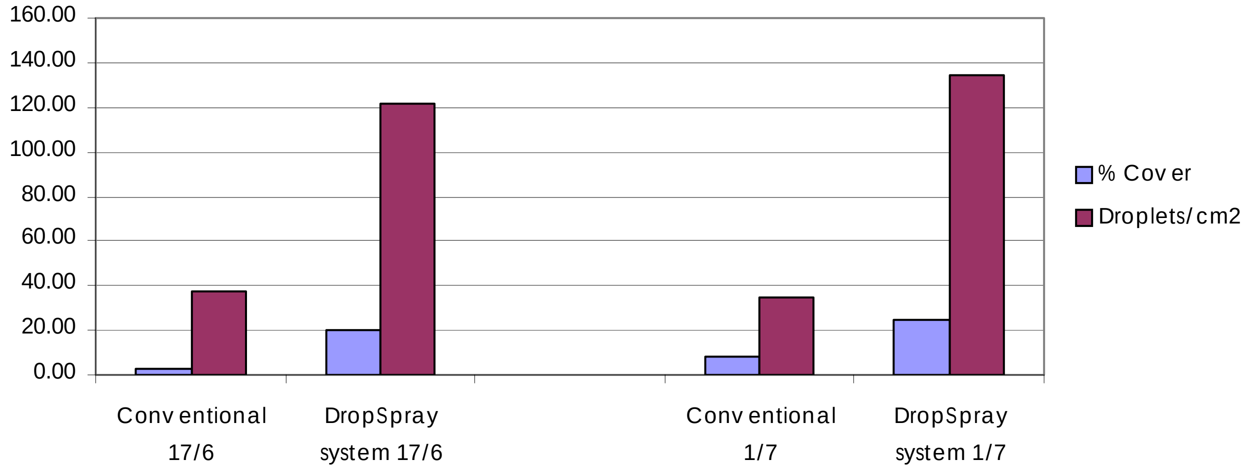
Application Assessment 2:
The DropSpray system area of coverage showed a significant increase compared to the conventional. The mean area of coverage was three times that of the conventional. The number of drops was not significantly different, but the mean difference was a ratio of four to one.

Discussion: Equipment:
The general impression was that it worked well. The droplegs did not snag in the crop at any time, even when the crop of Saturna, a long haulmed variety, was at its most difficult to walk through. The droplegs ran well below canopy level. The legs were fairly easy to remove (a few minutes for the complete set), returning it to conventional mode, ready for other uses.

Conclusion: Application:
With the DropSpray system, there was a significant improvement in spray coverage compared to conventional application at the first two application timings, though the margin was smaller at the second application. The fourth and sixth were not significantly different, though the mean results were still better with the DropSpray system than with the conventional application. The differential between the DropSpray system and conventional continued to decline, from a ratio of 7:1 at the first application to 1.4:1 at the sixth application. Note that the application volume applied with the DropSpray system was approximately double that of the conventional application.

The decline in differential may in part be due to the position of the sample point which was in the worst case position for coverage half way between two droplegs (with an increasing haulm bulk as the season progressed). The conventional application was not similarly disadvantaged (on the contrary, as the season progressed and the haulm above ridge level decreased, there is likely to have been a reduction of screening from above).

Mean % Spray Cover and Number Cm²
For % Cover 17-06-94 LSD 9.9 & 01-07-94 LSD 9.61
For Number cm² 17-06-94 LSD 79.8 & 01-07-94 LSD 107.1



Three Rep. Mean of in crop sample cards, Fore, Aft, Left, Right, Up & Down

COMPARISON OF APPLICATION METHODS OF DIQUAT (REGLONE) FOR POTATO HAULM DESICCATION

Scottish Agricultural College 1992

Crop Cara sprayed September 5 to a previously irrigated crop.
In general, diquat applied by all methods desiccated the crop well, giving a 90% kill of leaf material by 7 days. The DropSpray system at 260 l/ha ranked consistently higher than other treatments, significantly better than Hardi Air-Assisted 500 l/ha treatment for leaf necrosis at 7 days and significantly better than both the Hardi Air-Assisted 500 l/ha and Hardi Air-Assisted 200 l/ha treatments for stem necrosis at 3 and 7 days.

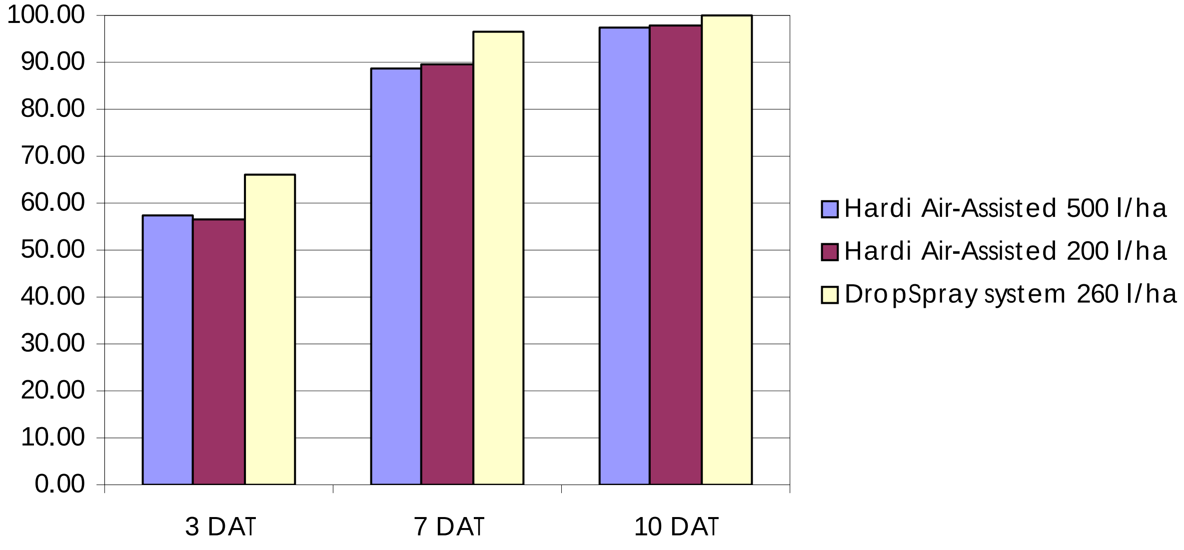
Faster haulm death was associated with better skin set although no statistically significant effects were measured. The DropSpray system at 260 l/ha and Hardi Air-Assisted 500 l/ha treatments gave highest combined scores for leaf and stem necrosis at 10 days and both scored highest for skin set.

Notes

Differences here do not appear large but the speed of kill is important in terms of blight exposure time and the evenness of skin set.

Work has also been done with acid showing improved results and less visual drift.

Diquat Potato Haulm Desiccation
% leaf necrosis assessment, at 3,7 and 10 Days After Treatment (DAT)
SED: 3DAT 1.95 7DAT 4.32 10 DAT 4.09



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