Improved Design and Use of Shower and Plunge Dipping Equipment for the Eradication of Sheep Body Lice (*Bovicola ovis*)

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**ABSTRACT:** Considerable evidence was available indicating that wet dipping practices were failing to eradicate lice on sheep and that ineffective wetting was believed to be a major contributory factor. To examine wetting of sheep in plunge and shower dips, a series of experiments were undertaken to investigate both the mechanical and management opportunities which might improve the efficiency and efficacy of wet dipping of sheep for the eradication of the sheep body louse *Bovicola ovis*. Results indicated that significant improvements could be made to both shower and plunge dipping equipment and practices which would enhance the likelihood of eradication of sheep body lice. On shower dips there was no significant difference between modified nozzle arrangements and the existing Buzacott® single slot arrangement provided the pump pressure was maintained at >390 kPa at a flow rate >18 l/s (nozzle pressure >230 kPa). Pipe diameter had a substantial effect on pressure losses. Wetting of sheep was significantly affected by their position. Wetting of the sheep in a plunge dip was significantly improved by fully immersing the sheep twice during the course of their swim. Swim length was also significant. The work has also identified a number of issues associated with pesticide residues in raw wool, concerns over pesticide concentrations in the dip wash and a number of occupational health and safety issues. Email: roger.lund@agric.nsw.gov.au

**Key Words:** Sheep dipping, Shower dips, Plunge dips, Sheep lice eradication.

**INTRODUCTION**

A number of field trials and surveys (Roth and Plant, 1992) (Morcombe and Young, 1993) (Anon, 1993) indicated that few shower dips examined in the field, including new units, achieved thorough, uniform application of dip wash to the sheep. It was also suspected that lack of wetting in plunge dips could be contributing to eradication failures and that the problem of wetting was a matter of technique that needed to be clarified.

A field trial of a number of mobile plunge dips (Downing and Lund, un-dated) also showed that not all sheep were being wetted to skin level and that the length of swim and possibly the method of dunking could be responsible. Work in Western Australia (Higgs et al, 1994) using a Sunbeam® shower dip showed that not all sheep were fully wetted and that varying results were achieved in eradicating lice, dependant on the dip wash formulation used. The work showed that incomplete wetting would not eradicate lice unless the pesticide applied after treatment. Consequently the degree of wetting was a factor in the successful treatment of lice.

Pesticide residues in raw wool are an associated issue, having significant marketing and occupational health and safety (OH&S) consequences (Pattinson, 1995).

**RESEARCH OBJECTIVES**

To address the issues outlined above, a research project was initiated by NSW Agriculture with IWS grower supported research funding (Lund et al, 1997). The principal aim was to investigate the distribution, movement, persistence and efficacy of pesticides on fleece and skin of Merino sheep following dipping in shower and plunge dips.

**METHODOLOGY**

The work was divided into five experiments:

- **Experiment 1,** to determine the mechanical characteristics of various shower dip arrangements;
- **Experiment 2,** to determine the efficacy of selected treatments from Experiment 1 on sheep wetting and behaviour, using full pens of sheep in a commercial flock;
- **Experiment 3,** to assess the efficacy of selected treatments from Experiments 1 and 2 on lousy sheep;
- **Experiment 4,** to determine the effects of design and operation of plunge dips on wetting of sheep;
- **Experiment 5,** to assess the efficacy of selected treatments from Experiment 4 on lousy sheep.

**ASSESSMENT OF WETTING**

In all experiments sheep were identified and measured after dipping and assessed for thoroughness of wetting. To aid mapping of the movement of dip fluid through the fleece, a blue dye, Permicol Blue® (Speciality Flavours & Fragrances, Dandenong, Vic), was mixed into the dip wash at 100 g/1000 L. An alpha numeric grid mesh was used to identify 136 measurement sites over the sheep and a ruler was used to measure the full fleece length and length of staple remaining white, indicating the dry length of fleece.

From the wetting measurements, mean dry length was selected as the most appropriate criterion in that it gave a sensitive discrimination between dipping treatments.

**DIP WASH**

The dip wash used for Experiments 1 and 4 (except for a number of selected runs) was a blank formulation of an emulsifiable concentrate diazinon-based sheep dip,
Topclip Blue® (Novartis Australia, Sydney). For all other work, commercially available diazinon-based formulations were used, Topclip Blue® and Di-jet® (Coopers Animal Health, Mallinckrodt Veterinary Limited, North Ryde, NSW), at the rates specified on the label. In Experiment 2, samples of dip wash were taken for analysis of diazinon concentration.

PESTICIDE DYNAMICS

Wool and dip wash samples were taken for analysis of diazinon concentrations in Experiments 1, 3 and 5. Samples of wool were collected from the back, upper and lower flanks and the neck, using a grid to precisely determine the location of each sample site. Groups of sheep heavily infested with lice were treated by shower and plunge dipping during Experiments 3 and 5.

SHEEP

All sheep used were medium type Merino wethers, except for two mobs of ewes in Experiment 2, carrying four to six weeks fleece.

SHOWER DIPPING

Three different shower dips were used (two Buzacott 60R® and one Buzacott 30R®), each having been modified to incorporate a range of plumbing, pumping and spray arrangements. In Experiment 1, seven sheep were strategically placed within the dip enclosure in order to assess the wetting characteristics of six mechanical variables: pipe size, nozzle design, spray boom height, pump pressure (and therefore volume), spray boom rotation speed and spray angle. Sheep position was a co-variate as was days off shears. Time in the shower was set at six minutes for top sprays only. Wool samples were taken from selected sheep to assess concentrations of diazinon in the wet and dry areas.

In Experiment 2, sheep were divided into mobs in order to achieve two densities, full (60 sheep) and 80% full (48 sheep). Four sheep in each mob were marked and randomly distributed during filling. Two plumbing / nozzle arrangements and eight top and bottom spray time combinations were tested. After dipping, the marked sheep were removed and assessed for wetting. Dip wash samples were taken at various times.

In Experiment 3, full pens of lousy sheep were subjected to three spray arrangements, all operated for three minutes on top and three minutes on the bottom. Lice counts were conducted prior to dipping and at various times post dipping.

PLUNGE DIPPING

Experiment 4 tested the effects of operation and design of plunge dips on wetting, namely length of swim, methods of submerging (dunking) and number of manual dunks. Swim time was also recorded.

A 14.5 m long straight steel plunge dip was constructed and installed in the ground. A hydraulically powered ‘VF’ sheep handler was set up at the entry to the plunge dip to ensure, as near as possible, a consistent entry of the sheep into the dip. A movable exit ramp allowed adjustment to three swim lengths: 6 m, 9 m and 12 m.

Five dunking methods were tested: none, one, two and three manual dunks and two spray bar arrangements. Three variations on manual dunking techniques were used: backwards, down and forwards. Experiment 5 tested three combinations of treatments used in Experiment 4: 6 m and one dunk, 6 m and two dunks and 9 m and two dunks.

RESULTS AND DISCUSSION

The work showed that substantial improvements can be made to the design and operation of both circular shower dips and plunge dips to improve wetting and the eradication of lice.

SHOWER DIPS

Pipe size. There were no statistically significant mean dry length differences between the two piping systems of 50 mm and 80 mm nominal bore (nb).

Pump pressure was highly significant (P<0.05). The extent of this effect varied over all levels of Nozzle and Boom Height. Best results over the three experiments were achieved when the pump was operated at a pressure of 390 kPa.

Pressure losses indicated by the pump and nozzle pressure gauges in the modified 50 mm nb system showed no obvious improvement over the standard system by the use of a modified rotating head. A substantial reduction in pressure losses was however achieved by increasing the pipe diameter to an 80 mm nb system and modified rotating head.

Nozzles. Although the High Impact nozzles gave best results over all pressures, there was no significant difference (P=0.05) between all four nozzles at the high pressure, 5 rpm and existing height settings. In Experiment 2, best wetting was independent of top nozzle type and plumbing size.

Boom height and speed. Boom height and speed were confounded with nozzle type. The existing (Buzacott®) boom height of 1.74 m in combination with the High Impact nozzles gave best results and at that setting, boom speed of 5 rpm was significantly better than 10 or 15 rpm (P<0.05).

Sheep position. Wetting of individual sheep was affected by position within the dip. Sheep adjacent to the (wire) exit gate, were significantly (P<0.05) drier when using the Buzacott® nozzles. Sheep adjacent to the dip wall were particularly sensitive to boom speed with mean dry length increasing significantly (P<0.05) with increase in speed.

Days off shears. Days off shears was a significant factor increasing mean dry length with respect to time. Some variation from day to day was also identified.

Pesticide residues. The highest concentrations of diazinon (1100 to 1530 mg/kg) occurred in areas where the whole staple was saturated by the dip wash. Concentrations were lower in areas where there was dry wool (75 to 370 mg/kg), with levels down to 5 mg/kg towards the belly where there were extensive areas of dry fleece. The results suggested that while there was some disposition of the pesticide into small dry areas (about
50 cm² or less), there was little movement into extensive dry areas.

In Experiment 2, despite the dip sump being charged and managed according to label directions, one dip wash sample collected immediately before reinforcement and topping up, contained diazinon at a concentration of 7 mg/L, which was only marginally above the minimum level of 5 mg/L required to kill susceptible lice (Johnson pers com). The concentration of diazinon in sludge taken from the bottom of the sump was 360 mg/L, more than three times the initial charging concentration of the dip, indicating that some diazinon was being lost through binding to the organic material and settling to the bottom of the sump.

**Treatment time.** Best wetting was achieved when sheep remained in the shower for a total of 15 min.; 6 min. top then 3 min. bottom then 6 min. top again (Fig. 1). Analysis of these results also shows that there is a strong correlation ($r^2=0.95$) between the wetting scores and total time in the dip, irrespective of whether the bottom nozzles are used or not. There was no significant difference between the 6 min 3 min 6 min top, bottom, top treatment and the 12 min. top only treatment.

**Eradication of lice.** Final inspections showed all lice were eradicated ie no differences between treatments.

**PLUNGE DIPPING**

Swim length was significant with respect to wetting and improved linearly over the range of swim lengths (Fig. 2).

Type and number of dunks influenced wetting. Three dunks, backwards, achieved best wetting. There was no significant difference (P=0.05) in wetting between two dunks and three dunks (Fig. 3).

Results using a spray bar or nozzle indicate that a single large spray nozzle, at a pressure of 200 kPa and flow rate of 7.9 L/s, was better than one manual dunk, supporting, in principle, the findings of Morcombe and Young (undated).

**Eradication of lice.** Final inspections showed all lice were eradicated ie no differences between treatments.

**CONCLUSIONS**

Improvements can be made to shower and plunge dipping equipment and practice which will substantially improve wetting of sheep for the eradication of lice.

**SHOWER DIPS**

The results showed that improved hydraulic performance, using existing single slot Buzacott nozzles in conjunction with a slow boom speed of 5 rpm, improved wetting.

Although length of time of showering showed best results were achieved using a showering regime 6 min. top, then 3 min. bottom and then 6 min. top again, the 12 min. top only treatment was not significantly different and is therefore recommended.

Although sheep density at the levels tested did not have an effect, covering the exit gate appeared to improve spatial distribution and movement.

Pesticide concentrations in the dip wash, dip sludge and in the fleece were of concern, particularly the high concentration of diazinon in the sludge which is seen as a serious hazard to operators who regularly need to clean the dip sump.

The OH&S study (Smith, 1997), conducted as part of Experiment 2, highlighted a number of other hazards for operators.

**PLUNGE DIPS**

The results showed that length of swim and method of dunking had significant effects (P<0.05) on wetting. To achieve effective wetting of sheep and ensure eradication of lice in plunge dips, mobile or otherwise, there should be a sheep swim length of >9 m and the sheep should be dunked at least twice, not including the 'splash' entry, with a preference towards backward dunking.

A large spray nozzle can be used to replace one dunk and would be advantageous in maintaining dip wash circulation.

**ACKNOWLEDGEMENTS**

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**REFERENCES**


Morcombe P. W. and Young G. E. Undated. Evaluation of a jetting bar modification to a plunge dip. Final report Project No. 94/1. Agriculture Western Australia.


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**Shower dip results: Exp. 2**

**Treatment times**

<table>
<thead>
<tr>
<th>Treatment times</th>
<th>0</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean dry score (mm)</td>
<td>a</td>
<td>ab</td>
<td>ab</td>
<td>ab</td>
<td>ab</td>
<td>b</td>
<td>b</td>
<td>[3]</td>
<td></td>
</tr>
<tr>
<td>Total shower time in mins shown [##]</td>
<td>[16]</td>
<td>[12]</td>
<td>[10]</td>
<td>[9]</td>
<td>[6]</td>
<td>[6]</td>
<td>[6]</td>
<td>[3]</td>
<td></td>
</tr>
</tbody>
</table>

Treatments (mins.), top/bottom/top etc.

Figure 1 Wetting scores for the various time treatments (results with the same letter are not significantly different, P=0.05).

**Plunge dip results: Exp. 4**

**Swim length**

<table>
<thead>
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<th>Swim length</th>
<th>Mean dry score (mm)</th>
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<tbody>
<tr>
<td>6 m</td>
<td>a</td>
</tr>
<tr>
<td>9 m</td>
<td>b</td>
</tr>
<tr>
<td>12 m</td>
<td>a</td>
</tr>
</tbody>
</table>

Figure 2 Wetting score for the various swim lengths with two dunks (results with the same letter are not significantly different, P=0.05).

**Plunge dip results: Exp. 4**

**Dunking**

<table>
<thead>
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<th>Mean dry score (mm)</th>
</tr>
</thead>
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<tr>
<td>Nil Dunk</td>
<td>c</td>
</tr>
<tr>
<td>1 Dunk</td>
<td>b</td>
</tr>
<tr>
<td>2 Dunks</td>
<td>a</td>
</tr>
<tr>
<td>3 Dunks</td>
<td>a</td>
</tr>
</tbody>
</table>

Figure 3 Wetting score for the various manual dunk treatments at 9 m swim length (results with the same letter are not significantly different, P=0.05).