Improved design and use of shower and plunge dipping equipment for the eradication of sheep body lice (*Bovicola ovis*).

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Summary

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. The work 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.

Keywords

Sheep ectoparasites, shower dip, plunge dip, dip-wash, lousicides.

Introduction

It was often suspected that the major reason for wet dipping failing to eradicate lice was poor wetting. A number of field trials and surveys (Roth & Plant, 1992; Anon, 1993; Morcombe & Young, 1993) indicated that few shower dips examined in the field, including new units, achieved thorough, uniform application of dip wash to the sheep. 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 moved after treatment. Consequently the degree of wetting was a factor in the successful treatment of lice.

More recently Sinclair (1995) discussed the design, use and maintenance of sheep shower, raising the issue of bottom sprays, pump power and time in the dip, emphasising the importance of top nozzle output volume. It was also suspected that poor wetting could result from plunge dipping. A field trial of a number of mobile plunge dips (Downing & Lund, un-dated) 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.

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

To address the issues outlined above, a research project was initiated by NSW Agriculture with International Wool Secretariat (IWS) grower supported research funding (Lund *et al.*, 1997).

The principal aims were to investigate the distribution, movement, persistence and efficacy of pesticides on fleece and skin of Merino sheep following dipping in shower and plunge dips. To achieve this 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. This work also included a study of worker pesticide contamination;
- 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.

In all experiments sheep were identified and measured after dipping and assessed for thoroughness of wetting. To aid mapping of the movement of the dip wash through the fleece, a commercially available diazinon-based blue dye, Permicol Blue®[1], was mixed into the dip wash, a formulation of Topclip Blue®[2] or Di-jet®[3] at the rates specified on the label, at 100 g/1000L in to. In Experiment 2, samples of dip wash were taken for analysis of diazinon concentration.

Wool and dip wash samples were taken for analysis of diazinon concentrations in Experiments 1, 3 and 5 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.

The plunge dip was specially designed to test effects of length of swim, methods of submerging (dunking) and number of manual dunks on wetting. Swim time was also recorded.

Results summary 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 was not statistically significant. A substantial reduction in pressure losses was however achieved by increasing the pipe diameter to an 80 mm nominal bore (nb) system and incorporating a modified rotating head. This would have the effect of reducing the required pump input power.

Pump pressure was highly significant ($P<0.05$). Best wetting was achieved when the pump was operated at a pressure of >390 kPa.

Top Nozzles. Although the High Impact nozzles gave best results over all pressures, there was no significant difference between all four nozzles at a pressure >142 kPa. It is recommended that the single slot Buzacott® nozzles be used. The ***Bottom Nozzles*** had no significant effect on wetting and therefore should not be used.

Boom height and speed. 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 significant ($P<0.05$).

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. 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. It is therefore important that sheep are not crowded and are able to move whilst in the shower.

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. 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. From a practical point of view the 12 min top only is therefore recommended.

Days off shears. Days off shears was a significant factor effecting mean dry length.

Wool 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

[1] Permicol Blue® - Speciality Flavours & Fragrances, Dandenong, Vic.
[2] Topclip Blue® - Novartis Australia, Sydney.
[3] Di-jet® - Coopers Animal Health, Mallinckrodt Veterinary Limited, North Ryde, NSW.

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 cm^2 or less), there was little movement into extensive dry areas.

Dip wash pesticide concentrations. 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. 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.

OH&S issues. Work by the National Health and Safety Commission (Smith, 1997) has shown that there are concerns with operator safety. All operators should wear personal protective equipment; overalls, PVC gloves, waterproof boots and a washable hat. The work showed that the design changes were necessary to reduce operator exposure to spray drift. The key design changes were removal of the bottom sprays and increasing the height of the side walls adjacent to the pumping site.

A preferred design is indicated in Figure 1.

Plunge dipping

Swim length was significant with respect to wetting and improved linearly over the range of swim lengths. The results showed that length of swim 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.

Method of dunking also had significant effects ($P<0.05$) on wetting. Three dunks, backwards, achieved best wetting although there was no significant difference between two dunks and three dunks. Therefore the sheep should be dunked at least twice, not including the 'splash' entry, with a preference towards backward dunking. The work also showed that a large spray nozzle can be used to replace one dunk and would be advantageous in maintaining dip wash circulation, supporting, in principle, the findings of Morcombe and Young (undated).

A further dip wash concentration experiment

Following the apparent adverse findings with respect to dip wash concentrations in Experiment 2 above, a literature search was conducted to determine whether or not similar effects were being reported elsewhere. Two records are cited. Robinson *et al* (1998), in work concerning the disposal of dip wash, reported final dip wash concentrations of diazinon significantly lower than calculated concentrations and, in three cases, the levels present, in their opinion, were below the minimum effective concentration; one as low as 3.1 mg/L. Sherwood *et al* (1999) also found concerningly low levels of diazinon whilst undertaking a series of commercial field trials using both constant replenishment (CR) and traditional methods of replenishment.

As a result of this mounting evidence, a further experiment was conducted, using the modified Buzacott 60R® at Trangie Agricultural Research Centre, showering the sheep for 12 min top only sprays, to determine the dip wash concentration profile during dipping, using both the conventional top-up and replenish system and the constant replenishment (CR) system. Again, the dip wash used was the commercially available diazinon-based formulation Topclip Blue®.

Results. The results of the conventional reinforce and top-up technique indicate that the recommendations are appropriate, with a minimum concentrations ranging from 18 – 36 mg/L. Of note are the top-up concentration results. Although we followed label instruction only once did the top-up concentration reach ≥ 100 mg/L; the others ranged between 92 and 70 mg/L.

Of some concern however were the results from the CR treatments. The first 12 min treatment immediately following the initial charging of the dip resulted in a curve taking the sump concentration down to a mean 26.6 mg/L (n=3). However we on one run we dipped a second mob as if to carry on with a days dipping. The concentration began at 22 mg/L and settled at 14 mg/L.

A further study

These inconclusive / concerning results re CR have now prompted us to go further. In May 2001 we undertook a series of dip wash concentration measurements in conjunction with a commercial dipping contractor where ≈5000 sheep were plunged dipped over two days using a RippaDippa® mobile dip (Lund and Levot, 2001).

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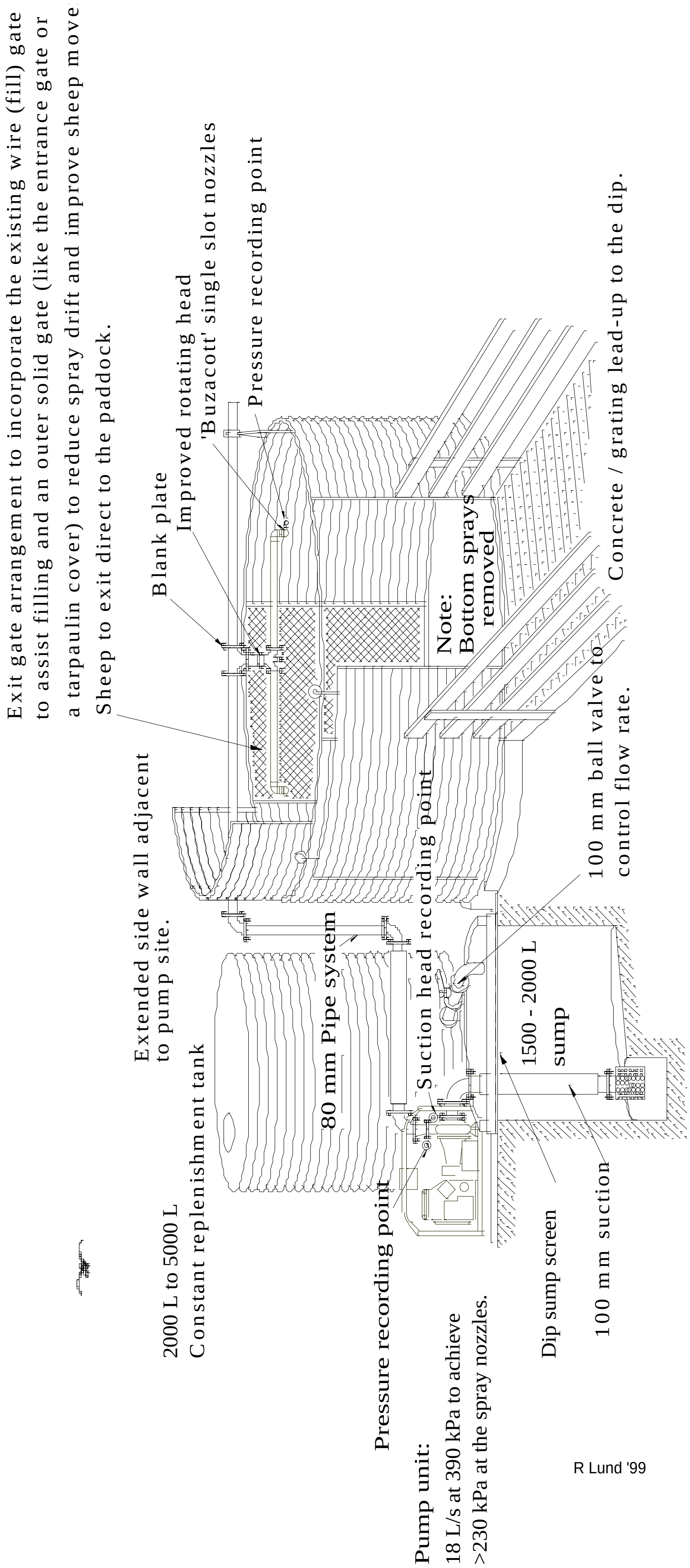

Figure 1. Preferred dip design.