A COMPARISON OF CONTROLLED DROPLET APPLICATION AND HYDRAULIC NOZZLES TO CONTROL BLUE-GREEN LUCERNE APHID AND ARGENTINE STEM WEEVIL

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SUMMARY

A controlled droplet applicator producing either 250 µm or 75 µm droplets and a conventional hydraulic nozzle spray boom were used to apply insecticides to control blue-green lucerne aphid (*Acyrthosiphon kondoi*) and Argentine stem weevil (*Listronotus bonariensis*). The controlled droplet applicators gave equivalent control to the conventional boom with systemic insecticides but generally inferior control with contact insecticides. The use of an anti-evaporant oil with the 75 µm droplet did not increase the efficacy of the insecticide.

INTRODUCTION

Various workers (Mapother and Morgan 1969; Matthews 1977; Waller and Howitt 1969) have shown that agricultural chemicals including insecticides can be effectively applied to crops through controlled droplet application (CDA) or ultra-low volume spray equipment. A droplet size of about 50-100 µm is generally recommended for insect control rather than the 250-300 µm droplet which is recommended for herbicide applications. Lauren *et al* (1980) determined that on average a greater amount of active ingredient (a.i.) is deposited on pasture foliage when applied by a 250-300 µm droplet ("Micromax" unit) than either a 75 µm droplet unit or conventional hydraulic flat fan spray nozzles.

In this study insecticide applications were made through a conventional hydraulic nozzle boom and also by controlled droplet applicators ("Micromax" units). Thiometon, fenvalerate, pirimicarb and demeton-S-methyl were applied to control blue green lucerne aphid in lucerne and oxamyl and chlorpyrifos were applied to control Argentine stem weevil in pasture.

METHOD

The conventional hydraulic nozzle spray boom and the "Micromax" unit boom were essentially the same as those used by Lauren *et al* (1980).

All trials, which were situated near Hamilton, had factorial split plot designs. In each trial the main plots were split between the methods of application at equivalent rates of a.i./ha. Subplot sizes ranged between 16 x 10 m and 8 x 5 m with buffers of at least 5 m between either three, four or five replicate blocks. While spraying the trials, temperature ranged from 12 — 27°C, relative humidity from 64 to 95% and wind speed from 0 to 5 m/second.

All insect counts were log. transformed for statistical analysis. Results presented in the tables are back-transformed means.

Blue-green lucerne aphid trials

Thiometon (100 and 50 g/ha), fenvalerate, pirimicarb and demeton-S-methyl (125 and 62 g/ha) were applied in four separate trials. All chemicals and rates were applied by the conventional hydraulic nozzle boom, CDA 250 and CDA 75, except thiometon where CDA 250 was excluded. In all trials, except demeton-S-methyl, 25% anti-evaporant oil ("Ulvapron" B.P. NZ Ltd.) was added to the spray mix in the CDA 75

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treatments. Aphids were sampled by taking 20 lucerne (*Medicago sativa*) stems/subplot (10 stems/subplot in the thiometon trial) at various intervals after spraying.

To trace the spray pattern (demeton-S-methyl trial) in the CDA 250 and CDA 75 treatments, the 125 g/ha rate contained 0.03% of liquid spray marker dye. This stained a strip of glossy card approximately 50 mm wide and 6 m long placed across one swath width at the end of one plot in each of these treatments. The droplet distribution was assessed by counting droplets (under UV light) at 250 mm spacings along the strip from areas of 30 mm x 30 mm and 30 mm x 15 mm for CDA 250 and CDA 75 methods respectively.

For fenvalerate residue analysis about 20 stems/subplot were cut from all treatments soon after spraying.

Argentine stem weevil trials

In the first trial oxamyl was applied at two rates (Table 3) onto short dairy pasture by the three spray methods. A pre-spray larval assessment was made 4 days prior to spraying by cutting tillers with a motorised dagging unit from ten points per untreated subplot. From this two hundred ryegrass (*Lolium* spp) tillers per subplot were counted and the larvae extracted using heat extraction as described by Goldson (1978). Similar post-spray assessments from the inner 7 x 7 m of all subplots were made 7, 13 and 22 days after spraying.

The second trial compared two rates of chlorpyrifos (Table 3) on similar pasture to the first trial. The adult stem weevil population was assessed by taking 7.5 cm diameter soil cores from each subplot (20 cores per subplot 4 days before spraying; 35 cores per subplot 7 days after spraying) and extracting the adults by salt flotation.

The spray pattern in the CDA 250 and CDA 75 treatments at the 600 g/ha rate was traced by a similar method to that used in the demeton-S-methyl trial. The glossy card was placed half in the plot being sprayed and half in the adjacent downwind plot.

For chlorpyrifos residue analysis foliage was clipped (and then frozen) from ten sites per subplot from one replicate 2, 4 and 6 days after spraying.

RESULTS

Blue-green lucerne aphid trials

Both thiometon ($P \ll 0.01$) and demeton-S-methyl ($P \ll 0.05$) reduced aphid numbers with no significant differences between methods or rates of application (Table 1). The data presented in the table are pooled for the two rates of each chemical.

The glossy card strips indicated a mean droplet density of 41 and 24 droplets/cm² for the CDA 250 and CDA 75 demeton-S-methyl treatments respectively. The droplet deposits were only moved slightly sideways due to the wind, however, variation across the swath was marked (Fig. 1).

TABLE 1: Lucerne aphid control with thiometon and demeton-S-methyl (No. aphids/stem).

Days after spraying:	thiometon			demeton-S-methyl		
	0.5	7	14	1	8	14
Conventional boom	2.8	0.3	0.2	1.6	0.4	0.
CDA 250	-	-	-	0.9	0.4	0.2
CDA 75	4.4	0.5	0.3	1.9	0.3	0.1
untreated	88	106	4	3.5	0.7	0.4

Initially, all fenvalerate treatments significantly ($P \ll 0.01$) reduced the aphid population below that in the untreated, with the conventional boom treatments maintaining a high level of control for at least 13 to 21 days depending upon application rate (Table 2). CDA 250 and CDA 75 treatments gave significantly poorer control ($P \ll 0.01$) than the conventional boom treatments at equivalent rates throughout the trial

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Fig. 1: Droplet distribution across the swath with wind direction and speed, and CDA positions indicated (demeton-S-methyl trial).

period. On days 7 and 21 CDA 250 gave significantly ($P \leq 0.05$) greater control than CDA 75.

A significant ($P \leq 0.01$) rate effect of fenvalerate was apparent from day 7 onwards, the higher rates giving greater control. A significant ($P \leq 0.05$) interaction between rate and application method was maintained from day 3 to day 21, by which time the CDA 250 and CDA 75 treatments at the 6.25, 12.5 and 25.0 g/ha rates had, on average, 2.3, 8.8 and 55 times as many aphids respectively as the conventional boom treatments at equivalent rates.

Compared to the conventional boom applications the CDA 250 and CDA 75 and 1.5 and 0.6 times the fenvalerate residue deposit respectively, averaged over application rates.

All pirimicarb treatments significantly ($P \leq 0.01$) reduced and maintained aphid numbers below that of the untreated plots for the period of the trial (Table 2). The

TABLE 2: Lucerne aphid control with fenvalerate and pirimicarb (No. aphids/stem for fenvalerate; No./20 stems for pirimicarb).

Days after spraying:	g/ha	fenvalerate			g/ha	pirimicarb	
		7	13	21		6	19
Conventional boom	25	0	1	0.2	125	3	9
CDA 250	25	2	8	10	125	1	9
CDA 75	25	3	6	12	125	13	10
Conventional boom	12.5	1	2	3	62	3	11
CDA 250	12.5	7	14	20	62	8	15
CDA 75	12.5	12	22	33	62	24	24
Conventional boom	6.25	2	7	18	31	7	14
CDA 250	6.25	6	17	30	31	15	32
CDA 75	6.25	9	33	55	31	30	43
untreated		50	82	110		53	75

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conventional boom treatments at all rates of insecticide, and the CDA 250 at 125 and 62 G/ha generally gave similar levels of control; other treatments gave reduced levels of control. From day 6 an overall significant rate effect developed ($P \leq 0.05$) with the high rate treatments having lower aphid numbers. There was a significant interaction ($P \leq 0.05$) between rate and application method, due to the relatively poor performance of CDA 250 at 31 g/ha and CDA 75 at 62 g/ha and 31 g/ha.

Argentine stem weevil trials.

The larval population in the oxamyl trial declined, due to pupation, from 26 larvae/800 tillers in the pre-spray sample to 19, 19 and 4 larvae/800 tillers in the untreated, 7, 13 and 22 days respectively after spraying. The results in Table 3 are the average counts in the three post-spray assessments. Pooled oxamyl treatments significantly reduced ($P \leq 0.01$) the larval population by 69% when compared with the untreated but there were no significant differences between the three spray application methods, the rates of oxamyl or the "with" or "without" anti-evaporant oil treatments.

The pre-treatment stem weevil adult population in the chlorpyrifos trial was 86/m². Pooled spray treatments significantly reduced ($P \leq 0.01$) the number of adults by an average of 69% compared with the untreated (Table 3). The 600 g/ha rate gave

TABLE 3: Argentine stem weevil control with oxamyl (No. larvae/800 tillers) and chlorpyrifos (No. adults/m²).

Rate (g/ha):	oxamyl		chlorpyrifos	
	480	240	9	24
CDA 250	1.3	3.7	17	16
CDA 75	3.0	5.3	16	51
CDA 75 (no anti-evaporant oil)	2.4	-	-	-
conventional boom	3.7	2.7	600	300
untreated	10.3	± 1.6*	71	± 25*

* Standard error of mean.

significantly higher ($P \leq 0.05$) control (80%) than 300 g/ha (57%). There was no significant differences between methods of application or significant interactions.

The droplet distribution data indicate that the 75 µm droplet was susceptible to drift, travelling up to 2 m into the adjacent downwind plot whereas the majority of 250 µm droplets landed within the plot being sprayed (Fig. 2).

Compared to the conventional boom applications the CDA 250 and CDA 75 had 1.3 and 0.9 times the chlorpyrifos residue deposit respectively, averaged over application rates and sampling times.

DISCUSSION

In the lucerne aphid trials with thiometon and demeton-S-methyl (systemic aphicides) the CDA systems used gave equivalent control to the conventional boom applications (Table 1). With fenvalerate and pirimicarb (contact aphids), the CDA systems gave generally inferior control to conventional boom applications except for CDA 250 at the higher rates of pirimicarb (Table 1). In the trials with Argentine stem weevil the three methods of spray application all gave equal levels of control for both oxamyl (systemic) and chlorpyrifos (contact) (Table 3).

The addition of anti-evaporant oil to CDA 75 was of little advantage as effective control of Argentine stem weevil larvae with oxamyl as well as blue-green lucerne aphid with demeton-S-methyl was achieved without its use.

CDA 75 residue deposits of fenvalerate and chlorpyrifos were lower than either CDA 250 or conventional hydraulic nozzle boom applications, as found by Lauren *et al* (1980), and CDA 75 applications of fenvalerate and pirimicarb gave less control than CDA 250 and conventional boom applications. Lauren *et al* (1980) showed insecticide deposits across the swath of the CDA boom to be more variable than across the

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Fig. 2: Droplet distribution across and beyond the plot. Wind speed was 2.3 and 3.0 m/sec for CDA 250 and CDA 75 respectively (chlorpyrifos trial).

conventional boom. The glossy card spray marker strips (Fig. 1 and 2) indicated an uneven droplet distribution. The effect of the spray vehicle on air turbulence and the resultant effect on the droplet deposition were not investigated.

The two trials with systemic aphicides indicate that these were less affected than contact insecticides by the less uniform distribution produced by the two CDA systems evaluated. A similar result has been observed with the systemic fungicide, benomyl (Wrenn, unpublished data). Pickin *et al* (1980) suggested that with phloem feeding insects the mass of systemic insecticide deposited is more important than the droplet density.

When applying CDA 75 to small plots, consideration must be given to the wind strength and direction in relation to plot size and layout. Although the "Micromax" units offer no advantage over the conventional hydraulic nozzle spray system with respect to insecticide rate, they do have the advantage that less water is required, 30 and 3 litres/ha for 250 μ m and 75 μ m droplets respectively, compared with 300 litres/ha for the conventional hydraulic nozzle system. This implies reduced spraying time and lower costs.

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