THE PERFORMANCE OF A PROTOTYPE MICRODROP (CDA) SPRAYER FOR HERBICIDE APPLICATION

A. J. Mayes and T. W. Blanchard

The Boots Company Limited, Lenton Research Station, Lenton House, Nottingham, NG7 2QD.

Summary The performance of six herbicide products applied at volumes of 20 and 40 l/ha and a drop size range of 200-300 µm through a prototype Microdrop* (CDA) Sprayer was compared with that achieved through a conventional sprayer at 200 l/ha in a series of replicated trials in 1977. Weed control at 20 l/ha, although somewhat less effective than that at 200 l/ha was generally acceptable. At 40 l/ha the biological results were better than at 20 l/ha but this volume is not currently practical due to the low forward tractor speed involved. Biological differences observed between the two types of application were similar for all products tested. The freedom from drift and the reduced water requirement associated with the prototype Microdrop Sprayer are commercially very attractive advantages which should compensate for any deficiency in weed control.

INTRODUCTION

Herbicide trials comparing the performance of spinning disc equipment with that of conventional sprayers fitted with standard hydraulic nozzles have been reported by Lush and Palmer (1976). In the majority of these trials the CDA equipment was fitted with twin disc units, and results were poorer than with conventional sprayers. Weed control was patchy and no correlation in relation to volume of application within the range 15-40 l/ha emerged. In three later trials, triple disc units were fitted and results with these were similar to those for conventional spraying. It was suggested that this modification of design might have overcome the problem of uneven distribution. The results were regarded as sufficiently encouraging to continue development of this technique.

For the 1977 season an improved tractor mounted CDA machine, the prototype model of the Microdrop Sprayer was made available. This was fitted with modified triple disc units to apply at a forward speed of 8 km/h, a volume of 20 l/ha with a drop size range of 250-300 µm, (Farmery 1978). A trials programme was planned for 1977 to test the performance of a range of widely used herbicides through this machine.

*Trademark of Horstine Farmery Ltd.

METHOD AND MATERIALS

Method

To compare the performance of the prototype Microdrop Sprayer and a conventional hydraulic nozzle crop sprayer, 14 sites were selected in winter and spring wheat and spring barley with even populations of the major weeds of cereals.

The herbicide products listed below were tested at appropriate growth stages of crop and weed at recommended and $\frac{2}{3}$ recommended rates, the latter rate being included specifically to show up treatment differences. The Microdrop Sprayer was calibrated to apply 20 l/ha at 8 km/h and, consequently, 40 l/ha at 4 km/h. The lower volume was tested at all sites and the higher at seven sites only. The calibration of the machine was frequently checked. A Hectacare 500 Sprayer* fitted with Lurmark F80 20 fan nozzles was calibrated to apply a volume of 200 l/ha at a pressure of 2.8 bar and a forward speed of 6.4 km/h.

Treatments at all sites were replicated 3x and plot size was a minimum of 500 m^2. Assessments of weed control and crop safety up to the time of harvest were made visually by scoring on an arithmetic 0-10 scale, and wherever possible by measurement of fresh weight of the weeds.

Materials

Ingredients of herbicide products	Product rate of use/ha
benazolin + dicamba + dichlorprop (K salt)	3.7 and 5.6 l
dichlorprop + MCPA + Dowco 290$^+$ (K salt)	4.7 and 7.0 l
dichlorprop + MCPA (K salt)	3.7 and 5.6 l
dichlorprop + MCPA (ester)	2.7 and 4.0 l
difenzoquat (w.s.p.)	1.0 and 1.6 kg

All products except difenzoquat are aqueous concentrates.

$^+$3,6-dichloropicolinic acid

RESULTS

The low temperatures, heavy rains and high winds experienced in the 1977 season provided very stringent conditions under which to compare herbicide treatments. CDA at 20 l/ha gave somewhat poorer weed control than conventional spraying, but despite the harsh climatic conditions, the standard achieved at this volume remained generally acceptable (Tables 1 and 2, Figs. 1 and 2). Inferior control at 20 l/ha frequently coincided with areas of thicker crop which shielded the weed from the spray, but on occasion, inexplicable patches of indifferently controlled weeds occurred. Results for 40 l/ha were closer to those for conventional treatment and control was more uniform than at 20 l/ha. This may well have been due to improved spray distribution at this volume. The formulations tested presented no problems in mixing or application through the Microdrop Sprayer, and differences of weed control efficacy observed between the two types of application were similar for all products (Figs. 1 and 2). In a season during which crop scorch from hormone weedkillers was more frequent than usual, this effect was more prevalent in CDA plots, but soon disappeared (Table 3).

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Table 1

Scores for weed control means of all species

Herbicide		method of application and volume (l/ha)						
		CDA	Conventional application		CDA		Conventional application	
		20	200		20	40	200	
benazolin + dicamba + dichlorprop	a	7.1	7.4	(7)	5.9	7.5	7.8	(8)
	b	8.6	9.1	(8)	6.7	7.7	8.6	(7)
dichlorprop + MCPA + Dowco 290	a	6.9	7.4	(4)	-	7.3	8.0	(3)
	b	7.3	8.0	(4)	-	-	-	-
dichlorprop + MCPA	a	5.8	6.6	(8)	6.5	7.2	9.0	(1)
	b	6.6	7.3	(6)	6.5	8.5	9.0	(1)
difenzoquat	a	8.1	8.8	(3)	6.3	7.5	9.2	(2)
	b	8.7	9.7	(3)	6.5	9.2	9.5	(1)

Key to all Tables:

( ) number of comparisons

weed control scores (Table 1, Figs. 1 and 2):

0 = no effect
6-10 = satisfactory to good

crop scores (Table 3 only):

0 = no effect
5 = slight to moderate transient effects
5-10 = slight to severe damage

a = $\frac{2}{3}$ recommended rate
b = recommended rate

Table 2

Mayweed control - weed weights (mid-season assessment) expressed as percentage control

Herbicide		method of application and volume (l/ha)		
		CDA		Conventional application
		20	40	200
benazolin + dicamba + dichlorprop	a	32.9	58.4	64.1
	b	56.3	59.2	94.5
dichlorprop + MCPA + Dowco 290	a	-	48.5	64.5

Table 3

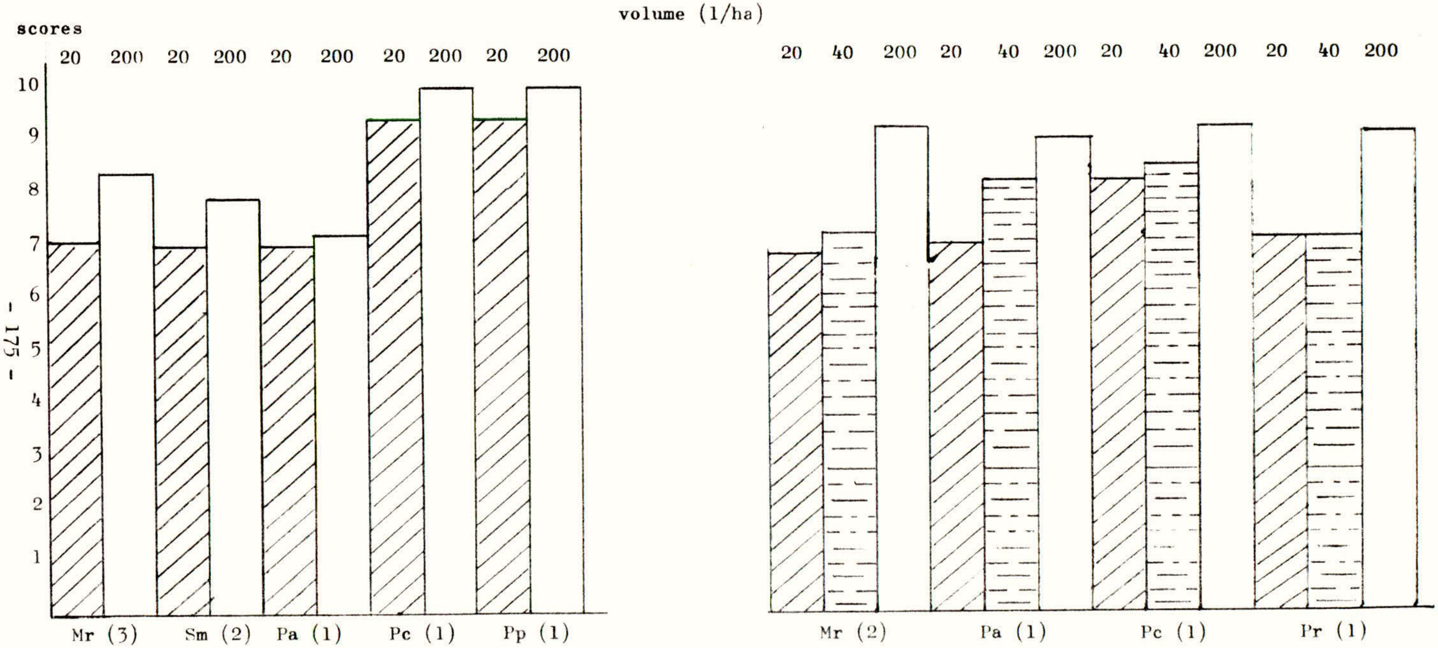
Score for crop scorch (3-13 days after treatment), range of scores (0-10)

Herbicide		method of application and volume (l/ha)		
		CDA	Conventional application	
		20	200	
benazolin + dicamba + dichlorprop	a	0.8-1.4	0.3-1.3	(4)
	b	0.3-2.0	0.3-1.8	(4)
dichlorprop + MCPA + Dowco 290	a	1.8-3.3	0-2.3	(3)
	b	1.3-3.3	0.8-2.0	(3)
dichlorprop + MCPA	a	1.7	0.3	(1)
	b	2.3	0.7	(1)

Fig. 1

Weed control scores (0-10) means for each species at recommended rate of product

benazolin + dicamba + dichlorprop



Key

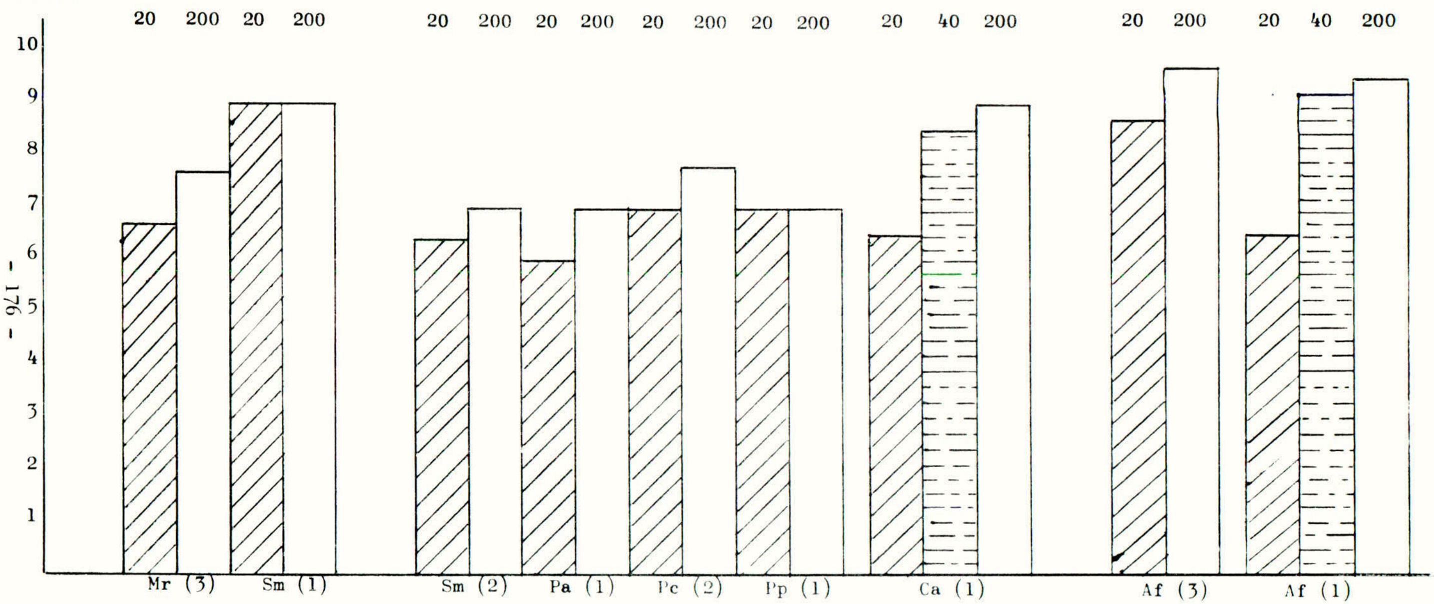
( ) = number of comparisons

Mr = Matricaria recutita
Sm = Stellaria media
Pa = Polygonum aviculare

Pc = Polygonum convolvulus
Pp = Polygonum persicaria
Pr = Papaver rhoeas

Fig. 2

Weed control scores (0-10) means for each species at recommended rate of product



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Mr = Matricaria recutita
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Pa = Polygonum aviculare

Pc = Polygonum convolvulus
Pp = Polygonum persicaria
Ca = Chenopodium album
Af = Avena fatua

In the course of the season, certain mechanical faults developed in the prototype machine. These were usually rectified fairly readily, those that were considered to have occurred as a consequence of design features being recorded with the manufacturers.

Operation of the prototype machine demanded a high level of spray operator skill. It is very difficult to see the spray produced by spinning disc units and for this reason it was essential to check the correct functioning of each component before adding chemical. As the spray solution was ten times the concentration used in conventional application, the penalties for overlapping and operating whilst stationary in the crops were severe. In addition there was a rapid build up of chemical deposit on the outside of the machine, not experienced with conventional application. This required careful washing off at frequent intervals.

The effect of side winds on the Controlled Drop Application through the prototype Microdrop Sprayer was interesting. On a number of occasions, winds arose during the progress of a trial and the usual drift problem occurred with the conventional sprayer. In marked contrast, the spray from the Microdrop Sprayer did not drift but was merely shifted slightly downwind. Furthermore, occasions occurred when it was judged to be suitable to spray with the Microdrop Sprayer but trials had to be postponed to avoid drift with the conventional machine.

DISCUSSION

In most seasons, the opportunities for spraying cereal herbicides are greatly reduced by windy conditions. It is clear from the trials conducted to date that the spray drops from the prototype Microdrop Sprayer are much less susceptible to wind drift than those from conventional spraying machines. Another problem facing the farmer in a busy spraying season is the cartage of large quantities of water around the farm. Use of the Microdrop Sprayer at 20 l/ha enables this requirement to be drastically reduced with consequent saving in time.

The 1977 trials have shown that the performance of the prototype model of the Microdrop Sprayer at a volume of 20 l/ha was generally acceptable and any reduction in the standard of weed control would be more than offset by the above advantages. It is anticipated that modifications incorporated into the 1978 production model will lead to improved performance at 20 l/ha. Certainly the advantage of improved weed control at 40 l/ha would generally be negated in the current model by the impracticably slow forward speed (4 km/h). In the longer term it would be of value to be able to spray at 40 l/ha at a more practical speed, if this can be achieved.

In all trials conducted with the Microdrop Sprayer and earlier models, the spray has been made up of drops within the range 200-300 µm, (200-250 µm was quoted for earlier models and 250-300 µm was specified for the Microdrop Sprayer). It would be interesting in further trials to examine the effects of a wider drop size range, say 150-300 µm if that can be achieved, as an increase in the number of drops per unit area could perhaps improve the chances of hitting all weed targets.

Trials with the Microdrop Sprayer have shown the need for particular attention to certain aspects of application and maintenance. For example because the spray can scarcely be seen and the concentration of chemical is much greater than with conventional volumes, extra care is necessary in matching up, particularly at headlands, and it is essential to move off immediately the machine is switched on, and to switch off immediately the tractor stops. The machine should frequently be washed down to remove spray deposits from the exterior. With due attention to these details, effective use of the equipment should be well within the capabilities of an experienced operator in commercial practice.

The application of commercial products through a machine such as the Microdrop Sprayer involves changes in factors that are the subject of registration procedures. To this end, application for clearance through the Pesticides Safety Precautions Scheme has been made for the broad-leaved weed herbicides referred to in this paper to be applied from 20 l/ha with a drop size range of 150-300 μm.

Acknowledgements

The authors wish to thank Horstine Farmery Ltd. for use of their prototype model of the Microdrop Sprayer and for their technical assistance in its operation, Mr. Lush of Lenton Research Station for his guidance in the planning of the trials and interpretation of the data, and all their colleagues at Lenton who have assisted in the execution of the programme.

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CONTROLLED DROP APPLICATION OF GLYPHOSATE, DIFENZOQUAT AND DICHLORPROP

D.J. Turner and M.P.C. Loader

Agricultural Research Council Weed Research Organisation
Begbroke Hill, Yarnton, Oxford, OX5 1PF, England

Summary Results from 13 pot experiments and two field trials are summarised. Controlled drop applications (CDA) of glyphosate in 15 l/ha of spray solution were at least as effective against perennial grasses and heather (*Calluna vulgaris*) as hydraulic nozzle applications at 150 l/ha. The use of CDA techniques significantly increased glyphosate phytotoxicity to *Agropyron repens* and *Calluna*. Difenzoquat activity against *Avena fatua* was reduced by the use of CDA, but phytotoxicity was partially restored when an oil-surfactant mixture was added. The mode of application had little influence on dichlorprop phytotoxicity to *Stellaria media*.

INTRODUCTION

During the past five years several research projects on herbicide formulations have been carried out at the Agricultural Research Council Weed Research Organisation. Much of the work has involved factorial experiments designed to test modified spray formulations under different climatic and application conditions. For example, the effects of low or high humidity and different spray volumes have been examined. While testing formulations we have acquired some incidental information about controlled drop application. Altogether, direct comparisons of standard formulations applied conventionally or as CDA treatments have been made in 13 pot experiments and two field trials. The results of these experiments are summarised in the following sections. Effects obtained with specially prepared formulations are only presented where they are of special interest, for example where the use of an additive markedly improved the activity of controlled drop sprays.

METHODS AND MATERIALS

1. Pot experiments In all experiments herbicides were applied with a laboratory cabinet sprayer which incorporated both hydraulic nozzles and a controlled drop applicator. Conventional (150 l/ha) sprays, provided by multiple hydraulic nozzles (Spraying Systems Teejets, 730039), consisted of relatively small drops, mostly of less than 100-150 µm diameter. This is of course below the drop size normally used for field spraying. The controlled drop equipment, designed and kindly loaned by Horstine Farmery Ltd, comprised two stacked discs rotating at 1800 rpm within asegmented metal shroud. The unit was set to deliver 15 l/ha as 220-280 µm drops: remarkably even application occurred over a 1.8 m wide swathe. Both types of spray generator were at least 1.5 m above the tops of

plants so that spray droplets were falling at near terminal velocity when they impacted on leaves. Spray solutions were prepared from deionised water and commercially formulated or technical herbicides, with added non-ionic wetting agent (0.05% - 0.5% v/v Agral or Tergitol NPX). Sprays were applied to dry foliage, thereafter plants were kept dry for 24 hours before being watered uniformly from above with a hand-held rose or with sprinkler irrigation equipment.

In separate experiments, glyphosate was applied to Agropyron repens and to four important forest weeds, Deschampsia caespitosa, Calamagrostis epigejos, Molinia caerulea and Calluna vulgaris. The grasses were grown outdoors in 100 mm or 150 mm pots, from rhizome segments or pieces of crown. At treatment, multiple tillers were present, each with 5-8 leaves. Agropyron plants had 5-10 g of rhizome at spraying. Calluna (Heather) seedlings, collected from a forest site and transplanted into 150 mm pots, were up to 150 mm tall at spraying. Difenzoquat was applied to glasshouse grown Avena fatua plants in 100 mm pots. About 20 seeds per pot were sown, seedlings being thinned after emergence to 5-10. Sprays were applied at the $2\frac{1}{2}$ - $3\frac{1}{2}$ leaf stage, or, in one experiment, when $1\frac{1}{2}$ leaves were present (Zadok's scale 13 and 11 respectively). The composition of the oil-surfactant blend added to CDA difenzoquat sprays varied slightly in different experiments, but a typical mixture was 1 part v/v of polyethylene glycol monooleate (Ethylan A2*), 1 part v/v of nonyl phenol ethoxylate (Ethlan TU*) and 4 parts v/v of paraffinic oil (Shellsol T†). This mixture was included in CDA solutions at 10% v/v of final spray volume. Stellaria media plants were grown in 100 mm pots in the glasshouse, about 20 seeds being planted and later thinned to leave populations of between 3 and 10 per pot. When sprayed with dichlorprop salt, seedlings had up to 6 stems, each with 6-10 pairs of leaves. Flower buds were sometimes present. At this stage individual plants could not easily be distinguished, the pots appearing as a mass of foliage 100-120 mm across and 50-70 mm tall.

At intervals after spraying, herbicide effects such as leaf injury and epinasty were assessed by scoring. At the termination of experiments, live weights of above- and below-ground growth were taken. In the experiment with Agropyron, bud viability was assessed by placing single-node rhizome segments on moist absorbent paper and observing shoot development. The duration of experiments was 10-20 days with Stellaria, 20-28 days with Avena and up to 10 months with perennial grasses and Calluna.

2. Field experiments with glyphosate were conducted on barley stubbles infested with Agropyron repens at two sites in North Oxfordshire. Both were sprayed with glyphosate under dry, sunny conditions on 8.10.75.. At treatment, numerous aerial shoots were present, mostly with 5-10 leaves. Conventional sprays were applied in 200 l/ha of solution using an Oxford Precision Sprayer fitted with Spraying Systems Teejets 8002, and operated at 2.04 bar (lb/in^2). Controlled drop applications were made with an experimental sprayer comprising two prototype Horstine Farmery spinning disc units mounted on a hand-held boom. These applied 15 l/ha of solution as 220-280 μm diameter drops. Spray solutions were prepared from deionised water and technical glyphosate-isopropylamine, with added non-ionic wetter (0.5% v/v Agral). The plot size was 2m x 6m. In the spring after spraying, herbicide effects were assessed by extracting six 170 mm core samples from each plot, removing and weighing rhizomes from the cores and testing bud viability as already described.

*Supplied by Lankro Chemicals Ltd
†Supplied by Shell Research Ltd

RESULTS AND DISCUSSION

The results of experiments with glyphosate are summarised in Tables 1-2. In some pot experiments, statistical analysis indicated high variability: the data relating to the forest grasses and Calluna was obtained from large screening experiments with few replications. Except for 1 kg/ha application to Deschampsia and Calamagrostis, low volume controlled drop glyphosate sprays were at least as phytotoxic as conventional treatments. In experiments with pot-grown Agropyron and Calluna, controlled drop application significantly improved glyphosate activity (Table 1). Effects on Agropyron were also significantly increased in one field experiment (Table 2). This enhancement of glyphosate phytotoxicity by CDA, reported previously by Caseley et al (1976), is of potential practical significance. With heather and forest grasses, the good response to CDA sprays has extra interest because these species often occur in plantations on broken terrain inaccessible to vehicles, where conventional high volume spraying is impossible.

Caseley et al (loc cit) suggest that the enhanced activity of low volume treatments can be due to improved retention of the drops on leaf surfaces. Other explanations are possible; the effect could, for example, be linked with differences in herbicide concentration or differences in the area of leaf surface wetted by the spray. Conceivably, CDA sprays which directly contact only a small proportion of the leaf may have slower or less drastic effect on metabolism and translocation than high volume sprays. It is not known whether both volume rate and drop size are important: however, spray volume undoubtedly plays a part. In separate studies to be reported elsewhere we have found that a given dose of glyphosate applied in 75 l/ha with hydraulic nozzles has significantly more effect than the same amount applied with the same equipment but in 300 l/ha (Turner and Loader, unpublished results). Phillips (1975) reported comparable effects which were attributed to the presence of calcium and other salts in tap water used to prepare solutions. When impure water is used, higher volumes of spray will obviously supply a proportionately greater weight of unwanted ions. In our experiments, however, this explanation does not hold as both conventional and CDA spray solutions were prepared from deionised water.

By contrast, controlled drop applications of difenzoquat were generally less effective than conventional applications (Table 3). This result agrees with field studies by Wilson (1976). In some circumstances, the activity of low volume sprays was improved by the addition of an oil-surfactant blend (Turner, 1975). This enhancement of activity is to be studied in more detail.

CDA dichlorprop treatments were as active against Stellaria as conventional sprays (Table 4). Again, comparable results have been obtained in field experiments with phenoxy-herbicide mixtures (Ayres, 1976). Results with dichlorprop-additive mixtures are not given in detail, but, in general, ammonium sulphate and related salts did not appreciably enhance the effects of low volume sprays. In some circumstances ammonium salts slightly increased activity but, more often, these additives had antagonistic effects, which appeared to be linked with increased contact injury.

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Table 1 Effects of glyphosate. Fresh weight as % of control

Species	Assessment	Dose kg/ha	Conventional application (150 l/ha)	Controlled drop application (15 l/ha)	S.E.
Calluna	Weight of aerial growth 10 months after spraying	0.5	95	99	
		1	101	89	± 18.4
		2	118	46	
Deschampsia	" "	0.5	60	39	± 20.9
		1	13	53	
Molinia	" "	0.5	45	24	± 9.4
		1	11	10	
Calamagrostis	" "	0.5	73	51	± 13.9
		1	18	30	
Agropyron	Weight of rhizomes and () bud viability, 3 months after spraying	0.2	29 (59)	11 (13)	± 4.4
		0.4	15 (32)	11 (22)	(4.6)

Table 2 Agropyron repens. Numbers of viable buds per m^2 6 months after spraying with glyphosate

Site	Dose kg/ha	Conventional application (200 l/ha)	Controlled drop application (15 l/ha)
Begbroke	0.25	1760	830
	0.5	920	500
	1.0	180	120
	Unsprayed control	2520	
	Standard error	± 140	
Leafield	0.25	260	190
	0.5	240	160
	1.0	70	100
	Unsprayed control	980	
	Standard error	± 54	

Table 3 — Avena fatua. Fresh weight of foliage 20-28 days after spraying with difenzoquat, as % of control

Experiment	Dose kg/ha	Conventional application (150 l/ha)	Controlled (15 l/ha) application Oil-surfactant blend -	+	S.E.
1	0.1	85	102	78	± 5.2
	0.2	58	93	82	
2	0.1	40	69	33	± 5.2
	0.3	23	65	33	
3	0.1	51	74	72	± 5.6
	0.3	19	56	40	
4	0.25	34	35	-	± 2.9
	0.5	28	32	-	
5	0.25	42	46	-	± 3.9
	0.5	42	46	-	

Table 4 — Stellaria media. Fresh weight of foliage 14-21 days after spraying with dichlorprop, as % of control

Experiment No.	Dose kg/ha	Conventional application (150 l/ha)	Controlled drop application (15 l/ha)	S.E.
1	0.25	54	74	
	0.5	49	51	± 7.3
2	0.25	75	75	
	0.5	75	52	± 5.6
3	0.25	57	58	
	0.5	42	42	± 3.5
	1	25	19	

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THE FIELD PERFORMANCE OF SOME HERBICIDES APPLIED BY ROTARY ATOMISER IN SPRAY VOLUMES OF 5-50 L/HA

R.C. Robinson

May & Baker Ltd., Ongar Research Station, Fyfield Road, Ongar, Essex.

Summary The biological performance of some herbicides applied by controlled droplet application (CDA) is compared with conventional treatment using hydraulic nozzles. Performance varies according to herbicide type, formulation, timing and method of application. Some present commercial formulations will suffice for low volume operations, others are completely unsuitable, may require restricted usage with respect to drop or weed spectrum, or may perform better after re-formulation. Field studies indicate the general type of performance to be expected but detailed laboratory investigations are required to understand cases of marginal performance.

INTRODUCTION

Low volume controlled droplet application (CDA) promises to be a useful technique for large scale use of herbicides. However, suitable farm scale equipment has not been generally available to date while small scale and experimental machines may exhibit a range of different spray characteristics. Intensive studies of low volume spraying are not considered desirable until commercial equipment is available. In consequence, observations on field experiments are presented here which appraise some more general aspects relating to herbicide type, formulation and CDA.

METHODS AND MATERIALS

Three trials, each at one site, were carried out using the following herbicides:

1. An ioxynil/bromoxynil e.c. mixture ('Oxytril CM') and an ioxynil/bromoxynil/dichlorprop e.c. mixture ('Oxytril P') in spring wheat.

2. Two carbetamide/dimefuron mixtures ('Pradone Plus' w.p. post-emergence and a second formulation with added carbetamide LFA 2237 w.p. pre-emergence) in winter rape.

3. Asulam a.c. ('Asulox') on heathland bracken.

For all herbicides controlled drop applications in spray liquid volumes of 5-50 l/ha were made with a small plot Horstine Farmery 'Microdrop' applicator. This consisted of two double-disc units spraying a 2.5m swath with drops of 200-300 µm (Farmery et al 1976). For the first two trials, medium volume (200-300 l/ha) treatments were applied by motorised precision small-plot sprayers using Spraying Systems 8003 nozzles. Treatments were applied in triplicate to randomized 20m^2 plots and assessment of weed control made after a suitable interval. For the first trial only, plots were treated either in a "dry" or "wet" condition. The latter was obtained by pre-spraying (Spraying Systems D10/25 nozzles) with water equivalent to a 0.15mm rain shower.

For the third trial on bracken, treatments were applied in duplicate to randomised $50m^2$ plots. Additional CDA treatments were made with the Micron Ulva and the Turbair Tot, producing drops <100 µm, utilizing drift spraying and forced draught techniques respectively. Conventional 200 l/ha treatment was applied with a Solo knapsack sprayer and hand-held boom fitted with Spraying Systems flood-jets. Reduced doses of asulam were used to allow treatment comparison, assessment being made one year after spraying. The effect of seven additives on the performance of the CDA treatments was also investigated.

RESULTS

Trial in spring wheat

a) Contact herbicide (ioxynil/bromoxynil). Control of four weed species is shown in Table 1. In all cases control at 300 l/ha was better than 20 l/ha which was very much better than 5 l/ha treatment. If weeds were sprayed when "wet", kill at 5 and 20 l/ha improved to the extent that 20 l/ha spraying approached the efficacy at 300 l/ha. "Wet" did not affect kill at 300 l/ha rates. "Wet" also increased kill for 5 l/ha treatment at half dose but less certainly for 20 l/ha. These trends were similar for all observed species.

b) Contact + translocated herbicide (ioxynil/bromoxynil/dichlorprop). Table 1 shows results for the four weed species as above. Control at 20 l/ha was generally better than at 5 l/ha, but neither treatment controlled P.convolvulus or P.rhoeas as effectively as the 200 l/ha treatment. Against P.aviculare and S.media, considerable variation was found between control at 20 l/ha and at 200 l/ha. There appeared to be a tendency for control at 20 l to be inferior under wet conditions. These results appear to have been partially invalidated by drought.

Trial in winter rape with soil-applied carbetamide/dimefuron mixtures

a) Pre-emergence. For the three broad-leaved weeds studied (Table 2), 50 l/ha was nearly as effective as 300 l/ha rates. There was little fall-off of efficacy at 6 l/ha using half dose. Control of grasses at these low volumes however, was not reliable.

b) Post-emergence. Control of Stellaria as well as grass species appeared equally effective at 20, 50 or 300 l/ha volumes (Table 2).

Trial on heathland bracken with asulam

The efficacy of asulam used with various applicators and spray additives is summarized in Table 3. Knapsack and 'Microdrop' applications were made during dry weather; Turbair and Ulva applications were made just prior to or during wet weather respectively. Ulva applications were also made under conditions of too little wind which severely reduced efficacy. Indiscriminate comparison between results using different equipment should not therefore be made.

Table 1

Activity of ioxynil, bromoxynil and dichlorprop mixtures in different volumes of spray liquid

Herbicide Mixture	Dose (kg a.i./ha)	Condition of foliage at application	Spray Volume (l/ha)	Percent control of weed species			
				Polygonum convolvulus	Polygonum aviculare	Papaver rhoeas	Stellaria media
Ioxynil + Bromoxynil	0.84	DRY	5	23	5	0	15
			20	68	43	62	40
			300	100	75	100	92
		WET	5	29	17	0	31
			20	98	60	80	62
			300	100	75	100	-
	0.42	DRY	5	19	0	0	30
			20	50	44	37	15
			300	93	63	95	80
		WET	5	47	31	-	43
			20	82	22	20	-
			300	97	55	97	58
Ioxynil + Bromoxynil + 2,4-DP	0.77	DRY	5	16	40	0	31
			20	37	38	50	64
			200	63	29	100	64
		WET	5	32	18	0	-
			20	22	30	0	16
			200	54	39	96	44
	0.38	DRY	5	14	0	0	-
			20	13	18	0	50
			200	63	62	85	50
		WET	5	13	31	3	24
			20	22	24	0	19
			200	74	28	-	10

Table 2

Activity of carbetamide/dimefuron mixtures in different volumes of spray liquid

Herbicide Application	Weed assessment date	Dose (kg a.i./ha)	Spray Volume (l/ha)	Percent control of weed species			
				Stellaria media	Chenopodium album	Galium aparine	Volunteer cereals and grasses
Pre-emergence sprayed September	October	1	6	51	66	36	5
		2	50	90	79	27	0
		2	300	98	91	27	65
	March	1	6	71	-	-	35
		2	50	87	-	-	8
		2	300	98	-	-	42
Post-emergence sprayed October	March	2.8	20	97	-	-	46
		2.8	50	98	-	-	42
		2.8	300	97	-	-	46

Table 3

Assessment of bracken 12 months after asulam treatments (% control)

Asulam dose (kg a.i./ha)	Spray additive	Spray Treatments			
		'Microdrop' (20 l/ha)	Turbair (20 l/ha)	ULVA (20 l/ha)	Knapsack (200 l/ha)
1	-	-	-	-	0
2	-	80	43	8	40
3	-	-	-	-	80
2	Sifren	78	55	10	-
2	Ulvapron	80	68	60	-
2	Arylan S90	85	70	60	-
2	Ethylan BCP	90	70	18	-
2	Diesel/Triton X	75	65	40	-
2	Arylan/urea	80	70	5	-
2	Ethylan/urea	85	70	8	-

'Microdrop' application gave markedly better control of bracken than with conventional knapsack spraying whereas (wet weather) treatment with other equipment produced no extra effect. None of the spray additives significantly increased the efficacy of treatment over asulam applied alone when using the 'Microdrop' applicator. Additives produced a general increase for the Turbair and some produced notable increases for the Ulva used during wet weather.

DISCUSSION

For the translocated herbicide asulam, 'Microdrop' application has given superior control to all other treatments while alternative CDA treatments could still be better or as good as conventional application in some cases despite rain washing. Use of additives (equivalent to formulation changes) affected spray performance in different ways according to application method or weather.

The performance of the contact herbicide was distinctly poor at volumes below 50 l/ha as has been observed by Merritt & Taylor (1977). Improved control was obtained when weeds were treated whilst wet, agreeing with the findings that foliage moisture can improve performance of couch and wild oat herbicides (Anon 1976) as well as fungicide applied at low volume (Mercer 1976; Quinn et al 1975). This suggests that cover of foliage by the spray deposit may be critical.

The contact/translocated mixture gave similar control with CDA as for conventional spraying for two out of the four broad-leaved weeds assessed (in contrast to control of species noted by Ayres, 1976). The poor control of some species out of assessed weed populations may explain the generally reduced control observed for this mixture by other workers (O'Keefe et al 1976; Evans & Kitchen 1976). Cussans & Taylor (1976) indicate that activity may be related to leaf surface area. Decreased weed control with CDA has also been noted for a similar ioxynil/mecoprop mixture (Bailey & Smart 1976; Harris 1977). There may be a need to restrict the use of such mixtures to just a few of the weeds controlled at conventional volumes.

Soil applied carbetamide/dimefuron w.p. mixtures gave encouraging control of broad-leaved weeds but changes of formulation and spray timing affected the degree of grass control with CDA. The extent to which wettable powders can be used with spinning discs needs further investigation. The post-emergence material could not be applied in volumes below 20 l/ha as sedimentation and clogging of spinning discs occurred. This problem was not observed for the pre-emergence formulation used at a lower dose rate and incorporating a greater proportion of carbetamide. A commercial w.p. formulation of isoproturon ('Tolkan') has also been applied successfully at 15 l/ha through similar equipment. Preparation of wettable powders for spraying at low volume however, is unpleasant and time consuming and a good case exists for developing "flowable" formulations for use instead.

There is evidence to show that formulation changes greatly influence the performance of low volume sprays (Merritt, 1976; Casely et al 1976; Merritt & Taylor, 1977). A whole range of properties may be affected such as retention and rain fastness, spreading and wetting, degree of leaf contact with active ingredient, penetration into the plant, spray drop size, while loss of cover associated with meagre quantities of spray liquid must be related to effects of increased chemical concentration. For any herbicide there is a need to show:

a) whether any crop damage will occur at decreased volume rates,
b) whether any loss of efficacy can occur in respect of a given weed species, and
c) which drop size will lead to greatest efficacy; whether there is a need for CDA to exploit low volume spraying.

There are few conventional nozzles suitable for non-CDA, low volume spraying. An exception is the Delavan D-0.5 flooding nozzle which can achieve 30 l/ha with an orifice size suitable even for use with wettable powders. The spray pattern achieved is poor however while still lower volumes are not easily obtainable. In this respect spinning discs offer a more flexible system even if there is little biological need for CDA. Spray output of spinning-disc equipment however can also be subject to variability. Disc and feed design, speed of rotation, disc surface wettability, feed rate and chemical viscosity may all affect drop sizes. In consequence, the degree of control over the size of drops produced by a spinning disc is not necessarily as precise as is often thought while the spray can be seriously affected by wind without the advantage of crop canopy penetration of hydraulic sprays (Johnstone et al 1977; Lake et al 1976).

In conclusion, simple field experiments can show that a chemical such as asulam responds well to CDA. For the other materials discussed, results are not straightforward and field results can conflict. For such cases, understanding the complex interactions between formulation, drop size, volume rate and weeds can only be gained through more detailed investigations in both the laboratory and field.

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