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A REVIEW OF BROAD-LEAVED WEED AND WILD-OAT HERBICIDES AT REDUCED VOLUME RATES

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Summary Development work with reduced volume applications is traced from initial herbicide work in forestry to current arable trials. Reduced volume application at 10-40 l/ha were compared with conventional applications of 190-280 l/ha, when applied by commercial and prototype equipment. The equipment used ranged from simple hand held spinning discs to multiple stacked discs with quadrant shrouds, as well as conventional hydraulic nozzles, including those with electrical interruption devices.

Chemicals used in the trials covered broad-leaved and wild oat translocated herbicides, and included suspension concentrates in the arable broad-leaf weedkiller group and forestry grass weedkiller group.

The biological results obtained were similar but not superior to conventional applications however they can offer logistic advantages to the user.

INTRODUCTION

In anticipation of possible changes in chemical application techniques, replicated trials have been conducted by Shell Chemicals U.K., initially in forestry and later in arable crops to study the efficiency of various broad-leaf and wild oat herbicides when applied to the cereal crop at reduced volumes.

Application at reduced volume was achieved by the use of various spinning disc configurations, the Caruelle low volume nozzle, and boom mounted hydraulic nozzles.

Trials were carried out on winter and spring sown cereal crops in Scotland and Southern England. This paper summarises the information obtained during the 4 year period including the early work in forestry.

METHOD AND MATERIALS

1. Trial Details

Forestry Trials

Trials were laid down in Scotland for the control of herbaceous weeds (mainly grasses) in new plantings. Plots consisted of treated areas 1.2m wide along the rows of trees and contained up to 50 trees in one or more rows per plot. Treatments were compared with conventional knapsack or granular applicators.

Arable Trials

Trials were laid down on commercial crops with applications made at right angles to the direction of sowing to minimise variations caused by drilling and fertiliser application errors. Plot sizes varied from single observation plots of 1.2 x 22m, to plots of 3.2 x 22m in fully replicated experiments with hand-held equipment, and 10 x 60m using a tractor mounted prototype commercial CDA machine in 1978. Conventional applications were made either by a Land Rover mounted sprayer using Spraying Systems 8003 fan jets, or a Shell Panto mounted sprayer fitted with Hartvig Jensen 4110-20 fan jets. Applications were made at a control valve manifold pressure of 2.8 bars, with spray volumes between 220 and 280 l/ha.

2. Equipment Details

1. Micron 'Herbi'

A hand-held controlled droplet applicator with a 12 volt battery-powered motor rotating at approximately 1800 to 2000 r.p.m. Treatments were made using a disc feed of 60 mls/min. Applied volume rates of 10-15 l/ha were achieved by variations in forward speed, with the 80mm diameter disc producing droplets of 220-260 micron. This equipment was used for all the forestry work and the initial arable experiments. (Bals 1974 and 1978)

2. The Horstine Farmery Pedestrian CDA Machine

The above machine was distributed in kit form and included 2 spray head assemblies which when used together produced an effective spray width of 2.4m. The stacked disc head used 2 x 80mm diameter discs, and introduced partial shrouding of the top disc. This shrouding was designed to eliminate over-dosing at the swathe edges. Chemical was gravity fed to the disc with flow control effected by a simple plug tap. In this series of trials only one unit was used spraying between 10-20 l/ha. (H. Farmery 1976).

3. The Richmond Gibson CDA Trials Sprayer

The above machine was built to W.R.O. specification and has shrouded stacked discs, optional windshields support the machine when at rest. The sprayer has two spray heads adjustable vertically and horizontally. Each head is fitted with 3 discs vertically stacked, with the upper 2 discs shrouded for elimination of over-dosing at the swathe edge. A 24 volt DC motor drives the discs, and is fitted with a built-in tachometer. Liquid feed is maintained by air pressure, and flow rate is controlled by a needle valve and monitored by flow meters. Applications were made at 20 l/ha with a droplet size of 250 microns. (N. J. Hind 1978).

4. The Caruelle LVS Nozzle

The Caruelle low volume nozzle uses a wide angle flat fan jet spaced at 1m intervals along the boom. The nozzle body incorporates a solenoid which is intermittently actuated and interrupts the liquid flow to the jet. The nozzle applied 66 l/ha with the interruptor operating, and 77 l/ha without it.

5. The Evers and Wall Prototype CDA Sprayer

Five electrically driven micron 'Battleship' discs were equally spaced along a standard 10m boom (Bals E.J.) mounted on a conventional sprayer with a 300 litre tank. Electrical power was provided by the tractors 12 volt system. A power-take-off driven diaphragm pump fed liquid to each disc individually, and provided agitation in the tank. Applications were made at volumes between 28 and 40 l/ha, with tractor forward speeds of 5 to 8 kg/hour. Operating pressures varied between

1.05 and 1.26 kg/cm^2, the variation to provide the disc feed of 300-480 mls. per minute depending on the different flow characteristics of the formulations used.

6. Low Volume Boom and Nozzle Application

Low volume application was achieved by using Hartvig Jensen 110 x 10 fan jets operating at 2.0 kg/cm^2 and fitted to a conventional boom.

3. Assessments

(a) Crop Health

(i) Forestry - trees were assessed and counted prior to application and once again at the end of the growing season.

(ii) Arable - observations were made 2/3 days after spraying and continued through the season with a final assessment just before harvest.

(b) Broad-leaf weed control was assessed by quadrat counts of surviving weed species and assessments of the percentage ground cover were also made.

(c) Wild oat control (Avena spp) was assessed at all trial sites using a 0.5 x 0.5m quadrat, the number of throws per plot was determined by, and inversely proportional to, the density of the wild oat infestation in the control plots. Panicles below and above the crop were counted.

(d) Yield data was obtained where harvest facilities were available, with the grain yields corrected to 15% moisture content.

4. Agronomic Data is recorded in Tables 1, 3, 5,7 and 9

5. Chemical Treatments, used at commercial recommended rates, are listed under each series of trials. Tables 2, 4, 6, 8 and 10.

RESULTS

1975 and 1976

Chemical control of weeds in new afforested areas is now accepted owing to the high cost and time consumption of hand labour; as many forest areas are isolated, with poor water availability, granular materials or application of liquids by means of very low volume techniques are preferred. The development of stable suspension concentrate formulations enabled accurate use of spinning disc equipment giving comparable results with conventional methods without crop damage while the removal of weed competition has lead to beneficial growth increments.

The obvious advantages of reduced volume application in forestry and amenity work lead to rapid development in the field. Comparisons were carried out at 7 sites in 1974 (Jones and Allen 1976) to examine the effect of increasing volume applied by diluting the concentrate with water. No significant difference was found over the range but there was a trend in favour of applying the concentrate, Table (A).

Table A

% Weed Control-Cyanazine/atrazine applied by CDA

Treatment	Volume applied l/ha	Site Number						
		1	2	3	4	5	6	7
Cyanazine/atrazine 6.72 kg a.i./ha	-							
Conc.	13.4	84	95	82	88	95	90	81
Dilute 1:1	27	76	97	80	92		75	71
Dilute 1:1½	33.7	83	98	74			74	63

As a result a phytotoxicity trial was conducted in 1976 using the concentrate at three rates compared with conventional application by Oxford precision sprayer at 620 l/ha, Table (B).

Table B

1976 trials - Crop damage on the E.W.R.C. scale 1-9*

Rep.	Species	Control	CDA Cyanazine/atrazine 5.04	CDA Cyanazine/atrazine 6.72	CDA Cyanazine/atrazine 8.40	Knapsack sprayer app. 6.72	kg. a.i./ha
1	Viburnam opulus	2	4	4	1	7	
2	Cornus alba	2	2	1	1	4	
3	Crataegus monogyna	1	2	1	1	5	
4	Rubus cockburnianus	3	3	2	3	3	
5	Rosa carolina	3	3	2	3	3	
6	Berberis thunbergii	4	5	4	6	5	
7	Cotoneaster skogholm	2	1	7	2	3	
8	Cornus alba	1	1	2	4	3	
10	Mixed Forestry species	3	2	1	6	6	
11	" " "	3	2	1	3	1	
12	" " "	3	1	2	1	4	
13	" " "	3	4	2	3	1	
	% Weed cover	73.3	4.6	4.3	3.2	2.1	

* 1 = healthy 9 = dead (5 and above = unacceptable)

Mixed forestry species = Alnus glutinosa, Fagus sylvatica, Fraxinus excelsior, Pinus sylvestris, Salix alba, Sorbus aucuparia, Rosa canina

The high scores in the controls reflect difficult soil conditions at planting the previous winter.

These successes also lead to simple application in arable situations. Encouraging results from field trials, where selected broad-leaf and wild oat herbicides were applied at reduced volume, lead to further work to answer some of the many questions posed by the relatively new technique. The efficiency of the cyanazine/MCPA mixture,* and the dicamba/MCPA/CMPP mixture, *** was improved at reduced volume when applied by the Caruelle nozzle. Low volume application significantly improved the control of Galeopsis tetrahit with the latter mixture, Table 11.

Wild oat control, Table 12, from low volume application by the Caruelle nozzle was comparable to results obtained from conventional spraying except where crop flag proved difficult to penetrate (site 266).

In these experiments in 1976 spinning disc applications at 10 - 15 l/ha were generally disappointing, with the single unshrouded disc (Herbi) giving marginally better results than the early shrouded twin disc. Weed control by cyanazine/MCPA mixture applied by either spinning disc was poor but this was attributed to the uneven flow of liquid to the disc.

* Scogal *** Tetralex Plus

1977 Results

In this series of replicated trials low volume applications were made using the Caruelle nozzle and hydraulic flat fan jets. Cyanazine / MCPA * and dicamba/MCPA/ mecoprop *** applied at 66 l/ha gave inferior broad-leaf weed control to conventional application at 191 l/ha. The Caruelle nozzle showed no consistant improvement over low volume application by hydraulic fan jet. Drift proved more prevalent from both low volume applications. Reduced volume application was not as effective as conventional spraying at 280 l/ha, Table 13.

Wild oat control is shown in Table 14 and the uncompetitive nature of the crop in site 262 is reflected in the control obtained. No marked effects were seen from any change in application.

In the southern trials, Table 15, benzoylprop-ethyl, flamprop-methyl and l.flamprop-isopropyl when applied at volumes of 280, 55 and 20 l/ha gave similar wild oat panicle control at all volumes when applied to the spring wheat cultivar Sappo.

1978 Results

Broad-leaf weed control, Table 16, and wild oat control, Table 17, showed a trend towards lower control with the spinning disc application, but results were generally comparable.

DISCUSSION

Forestry Trials. The only crop effects noted were beneficial when application was correctly timed. In an amenity situation late timing caused some leaf scorch to deciduous species but the low level of the spinning disc coupled with the level of trajectory of the sprays produced less crop contamination than conventional application. This information lead to large scale commercial applications being made successfully in 1977 and1978.

Arable Trials

(a) Crop Health - Crop effects from low volume application of cyanazine/MCPA and cyanazine/CMPP were more marked than conventional treatments in 1976 and 1978 and resulted in reductions of crop yield in 1976. Low volume applications of the dicamba/MCPA/CMPP mixture did not cause crop effects and generally gave weed control comparable to conventional spraying. The wild oat herbicides tested did not produce adverse crop effects when applied at reduced spray volume.

(b) Weed Control - when applied to thin open crops of poor vigour broad-leaf and wild oat herbicide sprayed low volume, gave unacceptable weed control. The Caruelle nozzle gave no consistent improvement in weed control over low volume application achieved from the hydraulic fan jet. The recovery of weeds such as *Matricaria spp*. and *Galium aparine* which was seen to occur when sprayed at low volume could constitute a considerable problem in winter cereals. Wild oat control from reduced volume applications was generally poorer than conventional application at 191-280 l/ha The majority of surviving panicles at and below crop level would be classed into the "small" category of less than 11 spikelets per panicle. (Holroyd 1972).

(c) Yield - yield data is recorded where facilities for harvesting were available and the mean of all replicates is expressed as a % control yield for each site.

(d) General - the "Battleship" disc proved capable of applying the cyanazine suspension concentrate(s.c.) formulations, but constant output with this type of formulation was difficult to reproduce with the triple stacked disc unit. Where the "Battleship" discs were boom mounted the distance between the atomisers, plus the continual boom bounce caused missed application which become very apparent at assessment time. Uneven application was particularly noted when the liquid delivery from the disc was interrupted by boom bounce. The introduction of accurate droplet generation for herbicide spraying will inevitably demand a better understanding of the requirements in respect of droplet size for successful selective weed control.

The improved results obtained with the Caruelle nozzle are difficult to explain in the light of the mode of operation, the spray pressure at the nozzle only being correct for a theoretically ideal nozzle performance for a very short interval of time between the spray pattern collapsing and being re-established, and must in some way relate to producing the droplet spectrum for optimum selective retention - perhaps this should also be examined in relation to over-fed spinning discs to produce a spectrum of drops as opposed to a uniform size droplet. Operator efficiency will have to improve considerably over existing standards. (Rutherford, 1976).

The commercial demand for low volume application may require the development of specialised formulations rather then the simpler and much more convenient adaption of currently available formulations of commercial compounds to the technique.

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References

ALLEN, M.G. (1974) An evaluation of methods and timing of application of candidate selective herbicides in young forest plantations. Proc. 12th British Weed Control Conference 1, 271-278

BALS, E.J. (1978) Reduction of active ingredient dosage by selecting appropriate droplet size for the target. Proc. BCPC Symp. Controlled Droplet Application Monograph 22, 101-106.

BALS, E.J. (1974) The operation of portable ULV atomisers. British Crop Protection Council, Monograph 11, 138

FARMERY, H. (1976) Potential and design of CDA from an engineers viewpoint. Proc 13th British Weed Control Conference 2, 369-376

JONES, G.R. and ALLEN, M.G. Experiments with a mixture of cyanazine and atrazine in amenity plantings in Northern Britain. Proc. 13 British Weed Control Conference 1, 71-78

HIND, N.J. The Richmond Gibson controlled drop application trials sprayer, Proc. BCPC Symp. Controlled Droplet Application, Monograph 22, 117-120.

HOLROYD, J. (1972) Techniques for the assessment of *Avena* spp. in the field. Proc. 11th British Weed Control Conference, 119-122

RUTHERFORD, I. ADAS survey of the utilisation and performance of field crop sprayers. Proc. 13th British Weed Control Conference, 2, 357-362

Table 1

1976 Broad-Leaf Trials

Site	Equipment	Location	Crop	Spray Date	Crop Stage	Crop Density
340	C	Perth	S.B.)Golden	13.5.76	23	Thick
341	C	Fife	S.B.)Promise	"	22	"
5	MH	Overton/Hants	S.W. Sappo	26.5.76	20-23	Thin
6	MH	Swallowfield/Berks	W.B. Asterix	8.4.76	20-24	Thick
7	MH	Alton/Hants	Grass Ley	10.6.76	20-24	Thin

C = Caruelle Nozzle MH = Micron Herbi HF = Horstine Farmery

Table 2

1976 Chemical Treatments and Their Occurence

Chemical	kg a.i. ha	Volume	Sites 5	6	7	340	341
Cyanazine/MCPA	2.05	191				/	/
" "	"	77				/	/
" "	"	66				/	/
" "	1.83	280	/	/			
" "	"	10					
" "	"	15	/	/			
" "	"	280			/		
Dicamba/MCPA/CMPP	1.76	191			/	/	/
" " "	"	66				/	/
" " "	"	10			/		
TBA/Dicamba/MCPA/CMPP	1.65	280			/		
" " "	"	10			/		
24D	2.5	280			/		
"	"	10			/		

Table 3

1976 Wild Oat Control (Avena spp.) Trials - Agronomic Details

Site	Equipment	Location	Crop	Spray Date	Crop Stage	Crop Density
263	C	E. Lothian	S.B.Golden Promise	14.5.	23	Thin
264	C	"	S.B. Midas	14.5.	24	Thick
265	C	Roxburgh	S.B. Maris Mink	2.6.	31	Thick
266	C	Perth	S.B. Mazurka	3.6.	30	Thin
1	MH	Arborfield, Berks	W.W. M.Huntsman	29.4.	30-31	Dense
2	MH	Theale, Berks	"	29.4.	28-31	Dense
3	MH	Lushill, Wilts	S.W. Sappo	2.6.	30	Thin
4	MH	Wantage, Oxon	W.Beans	13.5.	700 mm*	V.Dense
7	HF	Faringdon, Oxon	S.B. Julia	28.5.	30-31	Thin
8	HF	Strivenham, Oxon	S.B. Lofa Abed	20.5.	30-31	Thin

* Height of beans

Table 4

1976 Chemical Treatment & Occurence

Chemical Treatment	kg a.i./ha	Volume 10/280 l/ha	Site 1	2	3	4	7	8	263	264	265	266
Flamprop-isopropyl	1.0	10					/	/				
(Barnon)		280					/	/				
"	1.0	337							/	/	/	/
"	1.0	66							/	/	/	/
Benzoylprop-ethyl	1.12	10		/	/	/						
(Suffix)		280		/	/	/						
Flamprop-methyl	0.525	10	/		/							
(Mataven)		280	/		/							

Table 5

1977 Broad-Leaf Weed Control, Caruelle L.V.S. Evaluation

Site	Location	Crop	Application Date	Crop Stage
340	Arbroath	S.B. Golden Promise	3.6.77	22
341	Perth	S.B. " "	19.5.77	15
342	"	Spring Maris)	24.5.77	14
343	"	Oats Oberon)	27.5.77	14

Table 6

1977 Chemical Treatments and Volumes

Treatment	kg a.i.ha	Applied Volumes l/ha
Bladex/MCPA	2.05	191
"	"	66
"	"	66 Caruelle
Dicamba/MCPA/ CMPP	1.76	191
"	"	66
"	"	66 Caruelle

Table 7

1977, Wild Oat (Avena spp) Control

Site	Location	Crop	Application Date	Crop G.S.	Density
1	Hungerford, Berks	Julia	22.6.77	31	Thin
2	Coleshill, Oxon	Golden Promise	23.6.77	28	Thick
3	Garford, Oxon	Sappo	23.6.77	31	Thin
262	Angus	Golden Promise	7.6.77	30	Thin
263	N. Berwick	Midas	26.5.77	31	Dense
265	N. Berwick	Midas	26.5.77	25	Thick
266	Kelso	Midas	27.5.77	31	Thick

Table 8

1977 Chemical Treatments & Volumes

Treatments	kg a.i. ha	Volume	Sites 1	2	3	262	263	265	266
Flamprop-isopropyl	1.0	337							
(Barnon)		280	/						
		60							
		55	/						
		20	/	/					
Flamprop-isopropyl	0.6	337				/	/	/	/
(WL43425)		280	/	/	/				
		60				/	/	/	/
		55	/		/				
		20	/	/	/				
Benzoylprop-ethyl	1.12	280			/				
(Suffix)		55			/				
		20			/				
Flamprop-methyl	0.525	280			/				
		55			/				
		20			/				

Table 9

1978 Broad-leaf and Wild Oat Trials

Site	Type	Crop	Location	Spray Date	Crop Stage	Crop Density
788	B.Leaf	Hassan	Henley, Wilts	31.5.78	22	F.Dense
781	Wild oat	Julia	" "	13.6.78	31	Dense
782	"	"	" "	"	30	Thin
783	"	Lofa Abed	Ham, Berks	"	28	Open

Table 10

1978 Treatments & Applied Volumes

Treatments	kg a.i.h.a.	Volume	Site 788	781	782	783
MCPA	1.08	280	/			
(M 36)		31	/			
MCPA/Dicamba/CMPP	1.76	280	/			
(Tetralex Plus)		31	/			
Bladex/MCPA	1.83	280	/			
(Blagal)		36	/			
Bladex/CMPP	1.84	280	/			
		38	/			
		280		/	/	/
WL43425		30		/	/	/

Table 11

1976 - Broad-leaf Weed Control (Caruelle L.V. Nozzle) Mean of 4 Replicates

Treatment/Rate	Volume	Crop Damage 340	Crop Damage 341	Surviving Plants* Weed Control 340	Surviving Plants* Weed Control 341	Yield as % of Control 340	Yield as % of Control 341
Bladex + MCPA 2.05 kg a.i./ha	191	2.2	1.8	11.8	5.6	75.5	90.0
	77	5.2	1.8	11.1	4.0	45.4	95.6
	66	4.2	2.3	8.1	4.2	51.5	92.3
Dicamba, MCPA, CMPP 1.76 kg a.i./ha	191	1.5	1.3	22.4	9.3	75.7	96.6
	66	2.0	1.5	9.7	10.6	87.8	93.3
Control Weed plants/m^2 and yield in t/ha ( )	-	-	-	139	154	(3.3)	(6.0)

* Broad leaf weed control, expressed as overall surviving plants - mean no./sq.m.
\+ EWRS scale 1. No damage G - crop killed

Table 12

1976 Wild Oat Control (Caruelle L.V. Nozzle)

Application of Flamprop-isopropyl at 1.0kg/ha. Panicle Numbers as a % untreated control

Volume l/ha	Site 263 Above	Site 263 Total (wild oat)	Site 263 Yield	Site 264 Above	Site 264 Total (wild oat)	Site 264 Yield	Site 265 Above	Site 265 Total (wild oat)	Site 265 Yield	Site 266 Above	Site 266 Total (wild oat)	Site 266 Yield	Mean Above	Mean Total (wild oat)	Mean Yield
337	43.6	50.7	123.5	0	0	103.7	6.3	19.9	107.3	0	6.1	109.6	12.5	19.2	110.0
66	41.3	50.2	125.0	0	0.3	114.4	1.4	12.0	104.7	12.2	17.2	104.6	13.7	19.9	112.2

Table 13

1977, Broad-Leaf Weed Control and Yields as % of U.T.C.

Sites	340		341		342		343	
Treatments	BLWm^2	Yield	BLWm^2	Yield	BLWm^2	Yield	BLWm^2	Yield
Cyanazine/MCPA (Scogal)								
2.05 kg a.i. (S)	6.6	99.5	0.3	102.5	3.4	97.5	19.4	90.6
2.05 " (LV)	20.5	100.3	3.6	99.7	11.8	100.0	13.7	106.4
2.05 " (CAR)	23.4	97.1	2.7	97.5	9.8	99.6	19.8	106.9
Dicamba/CMPP (Tetralex Plus) 1.76 kg a.i. (S)	15.2	101.9	1.0	91.0	6.2	101.9	9.4	112.9
1.76 " (LV)	-	-	1.3	98.0	6.2	96.9	35.5	114.4
1.76 " (CAR)	29.7	95.8	1.3	100.3	5.8	99.8	11.9	98.9
Control weed/sq.m.(tonnes/ha)	95.3	(7.56)	76.3	(6.48)	125	(7.65)	223.8	(5.05)

CAR = Caruelle Nozzle (66 l/ha) L.V. = Low Volume (hydraulic nozzle)(66 l/ha) S = Standard Application at 191 l/ha

Table 14

1977 Wild oat Control, Spring Barley Caruelle L.V. Nozzle

Sites	265	266		262		263	
Treatments	Total W.O.	Total W.O.	Yield	Total W.O.	Yield	Total W.O.	Yield
WL43425 0.6 kg a.i. ha 191 l/ha	5.7	1.3	108.0	36.2	104.1	0	114.4
WL43425 0.6 kg a.i. ha (Car) 60 l/ha	9.2	1.3	109.3	29.8	106.4	0.2	115.8
WL43425 0.6 kg a.i. ha (LV) 60 l/ha	0	1.3	109.6	-	-	-	-
Control Wild oat m^2	22.8	46.3		55.3		165.3	
Yield (t/ha) expressed as % of control			(7.8)		(5.5)		(5.5)

Table 15

1977 % Wild Oat Control and Yield (Richmond Gibson/WRO C.D.A. Sprayer)

Treatment		Site 1 Spring Barley		Site 2 Spring Barley		Site 3 Spring Wheat	
Barnon	280	79	*100	48			
	55	76	105				
	20	74	110	48	*100		
WL43425	280	94	106	77	95	99.5	*92
	55	75	104			99.9	100
	20	81	106	78	77	98.6	108
Mataven	280					100	68
	55					100	93
	20					100	95
Suffix	280					99.5	80
	55					100	102
	20					97.7	102
Control		$140.3/m^2$		$50.6/m^2$		41.1/m	
		Mean of 4 replicates		Mean of 2 replicates			

* Yield expressed as % of control

Table 16

1978 Broad-leaf weed control 'Battleship' disc Site 788

Treatments	Volume l/ha	% Weed Control
MCPA 1.08 kg a.i./ha	280	55.0
	31	57.4
Dicamba/MCPA/CMPP 1.76 kg a.i./ha	280	89.0
(Tetralex Plus)	31	89.0
Cyanazine/MCPA (Blagal)	280	87.7
	36	70.7
Cyanazine/CMPP (Cleaval)	280	90.4
	38	70.7

Table 17

1978 Wild Oat Control "Battleship" disc nos. of Wild Oat Panicles/Quadrat at Crop Height

Treatment	Volume	Site 781 Below	781 Total	782 Below	782 Total	783 Below	783 Total
WL43425 @ 0.6 kg a.i./ha	280	12.9	13.4	25.5	27.9	13.4	15.4
"	31	22.35	26.2	28.9	30.8	21.5	25.76
WL43425 @ 0.3 kg a.i./ha	31	12.6	14.5	27.1	36.0	13.2	32.6
WL43425 @ 1.2 kg a.i./ha	31	13.0	13.0	-	9.4	-	13.2
Control		19.2	93.6	21.1	65.95	8.8	51.2

FURTHER FIELD EXPERIENCE WITH CONTROLLED DROP APPLICATION

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Summary Herbicide application through the Horstine Farmery Microdrop sprayer at 20-40 l/ha in trials and at 20 l/ha in farm usage was generally satisfactory in the 1978 season and further products are recommended for use through this machine. An extension of the work involved testing the recently introduced single disc Micron Battleship atomiser and the Microdrop sprayer, both at 30 l/ha in comparison with conventional hydraulic pressure spraying at 200 l/ha. Results with the two CDA systems were broadly similar and were generally acceptable. There was a tendency for both CDA methods to show inexplicable patchiness in weed control and results were therefore somewhat inferior to those of conventional application. There were indications as in 1977, that some reduction in the standard of weed control might be offset by reduced susceptibility to wind drift. This years' trials confirm the view that controlled drop application at 20-40 l/ha could provide the farmer with valuable economic advantages by permitting more timely application and by reducing water cartage.

INTRODUCTION

The performance of a range of herbicide products in 1977 through the prototype of the Microdrop sprayer at 20-40 l/ha in a programme of 14 field trials was generally satisfactory, (Farmery, 1978) (Mayes and Blanchard, 1978). Less wind drift was observed from the Microdrop sprayer than from conventional applications made at the same time. It was considered that in farm practice, the saving of water cartage together with the potential for spraying in windier conditions, would amply offset the lower standard of weed control compared to that of conventional application at 200 l/ha. A large programme was therefore planned for 1978, to test a further range of products and tank mixes through the Microdrop sprayer and to record its general performance in trials and farm usage. The effects of wind were to receive particular attention in order to quantify the advantages of reduced drift from this machine in terms of safer and more timely application. Also to be included in the programme was the more recently introduced Battleship atomiser (Bals, 1978).

METHOD AND MATERIALS

A programme of 17 trials was arranged to compare the performance of CDA sprayers in the volume range 20-40 l/ha with that of conventional application at 200 l/ha. Three types of sprayer were tested:-

The Microdrop sprayer*. The 1977 prototype model equipped with stacked disc units (Farmery, 1978) was made available for very limited periods during the season and was therefore included in only 7 trials.

The Battleship atomiser*. This development described by Bals (1978) was made available in the spring of this year. The unit comprised a single spinning disc at 4000 rev/min producing drops via ligament formation within the size range 100-400 µm. Two such units were fitted to half of a Hectacare 500 sprayer boom and fed from an auxiliary tank so that simultaneous CDA and conventional application could be made. This equipment was tested in 12 trials.

The Richmond Gibson CDA trials sprayer*. This machine designed to test stacked disc units in small plot work (Hind, 1978) was used in one trial.

The Microdrop and Battleship were compared with the Hectacare 500* (conventional) sprayer and comparisons of the Richmond Gibson machine were made with the Lenton small plot (conventional) sprayer, (Lush and Mayes, 1972).

Calibration details of the various methods of application were as follows:-

Type	CDA Flow rate ml/m	CDA Disc Speed rev/min	CDA Disc Spacing cm	Conventional application Pressure bar	Conventional application Nozzle Type	Conventional application Nozzle Spacing cm	Forward speed	l/ha
Microdrop	170	1800	62	-	-	-	8	20
	"	"	"	-	-	-	5.3	30
	"	"	"	-	-	-	4	40
Richmond Gibson	160	1700	120	-	-	-	4	20
	"	"	"	-	-	-	2	40
Battleship	1000	4000	220	-	-	-	10	30
Hectacare 500	-	-	-	2.8	F110/20	50	10	200
				2.8	F 80/20	50	6.4	200
Lenton small plot sprayer	-	-	-	2.1	8002SS	47	3.8	200

*The Microdrop sprayer - Horstine Farmery Ltd., North Newbald, Yorks.
The Battleship atomiser - Micron Sprayers Ltd., Bromyard, Hereford.
The Richmond Gibson CDA trials sprayer - Richmond Gibson Ltd., Downton, Wilts.
The Hectacare 500 sprayer - Boots Farm Sales Ltd., Nottingham.

Products were applied at normal and $\frac{2}{3}$ normal rates of use, the latter being included to show up treatment differences. Plot size was 50m x one pass of the sprayer for tractor mounted equipment and 10m x one pass for the small plot sprayers. Three replicates of each treatment were applied at all sites.

Crop safety and weed control assessments were scored on a 0-10 arithmetic scale. Weed weights were taken and wild oat counts were made whenever possible.

The following products were applied in the trials:-

Ingredients	Normal rate(s) of use/ha of product
benazolin + Dowco 290≠(w.p.)	1 kg
propyzamide (w.p.)	1.4 kg
isoproturon (aqueous suspension)	4.9 l
mecoprop (K salt a.c.)	3 l
benazolin + dicamba + dichlorprop (K salt a.c.)	4.2 and 5.6 l
dichlorprop + MCPA + Dowco 290≠(K salt a.c.)	7 l
dichlorprop + MCPA (ester s.c.)	4 l
3,6-dichloropicolinic acid≠	1.5 l

Ingredients	Normal rate(s) of use/ha of product
benazolin + 2,4-DB + MCPA (Na and K salt a.c.)	7 l
difenzoquat (w.s.p.)	1.6 kg
chlormequat (a.c.)	1.5 l

Trials were located as follows:-

Crop	Product based on	CDA method	volume rate l/ha	No. of trials
Oil seed rape	benazolin + Dowco 290 / propyzamide	Microdrop	20 and 40	3
Winter wheat	isoproturon	Microdrop	20 and 40	1
Winter wheat	mecoprop	Richmond Gibson	20 and 40	1
Spring oat	range of broad-leaf herbicides	Battleship	30	1
Spring barley				7
Spring wheat	chlormequat	Battleship	30	1
Spring barley	range of broad-leaf herbicides	Battleship / Microdrop	30 / 20 and 30	3

At all sites comparisons were made with conventional application at 200 l/ha.

It had been planned to augment the trial programme with the prototype Microdrop sprayer by monitoring extensive commercial usage of the production model equiped with the same type disc units. Mechanical problems curtailed the number of such applications and in the event it was only possible to visit 22 of these.

RESULTS

Herbicide applications through the Microdrop sprayer were generally satisfactory in the 1978 trials. In oil seed rape, the standard of control at 40 l/ha was similar to that with conventional application at 200 l/ha and at 20 l/ha was only slightly inferior (Table 1). Control of *Alopecurus myosuroides* in winter cereal was similar for all three volumes. In a very heavy population of *Stellaria media*, control with conventional application at 200 l/ha and with the Richmond Gibson sprayer at 20-40 l/ha was very similar at the recommended rate of 4.2 l/ha of mecoprop product. The standard of control at 20 l/ha CDA, although inferior to that of the conventional application, remained satisfactory. At the lower product rate of 2.8 l/ha the level of control with conventional application was not reduced but with CDA at 20-40 l/ha was inferior (Table 2).

In the limited number of trials in which both Microdrop and Battleship applications at a common volume of 30 l/ha were compared with conventional spraying, overall differences were very slight (Table 3). It should be noted that in order to achieve the same volume of output, the forward speed of the Microdrop sprayer, required to be approximately half that of the Battleship discs. The work of Jegatheeswaran (1978), would indicate that such a difference in speed could be to the advantage of the Microdrop sprayer, but this was not the case in the current trials. Microdrop application at 20 l/ha, although poorer, was still acceptable.

At sites where comparisons were restricted to those between Battleship disc and conventional application of herbicides, results were again generally satisfactory, although somewhat better with the latter method (Table 4). Chlormequat applied by either method produced a satisfactory shortening of wheat straw (Table 5).

Table 1

Scores for weed control in winter crops - early and late assessments*

Treatment (rate/ha product) and weed	Method of application and vol. rate (l/ha) M 20 early	M 20 late	M 40 early	M 40 late	C 200 early	C 200 late
Site 1 - Oil Seed Rape						
benazolin + Dowco 290 1kg + propyzamide 1kg (tm)						
Stellaria media	7.2	10	9.2	10	9.5	10
volunteer cereal	8.7	10	9.5	10	9.2	10
propyzamide 1.4kg						
Stellaria media	7.2	6.5	8.0	9.0	7.7	8.0
volunteer cereal	9.2	10.0	9.5	10.0	9.2	10.0
Site 2 - Oil Seed Rape						
benazolin + Dowco 290 1kg + propyzamide 1kg (tm)						
Matricaria spp	5.7	10	5.7	10	5.7	10
volunteer cereal	4.0	10	4.0	10	4.0	10
propyzamide 1.4kg						
Matricaria spp		0		0		0
volunteer cereal	9.5	10	9.2	10	9.2	10
Site 3 - Oil Seed Rape						
benazolin + Dowco 290 1kg + propyzamide 1kg (tm)						
Stellaria media	5	10			6	10
Lolium perenne	4	10			4	10
Site 4 - Wheat						
isoproturon 4.9kg						
Alopecurus myosuroides		5		6		6

KEY:- Weed assessment scores, 0 - 10 arithmetic scale (Tables 1, 3 and 4)
0 = no effect   6-10 = satisfactory to good
tm = tank mix (Tables 1 and 4)
( ) = number of observations (Tables 3 and 4)
M = Microdrop B = Battleship C = conventional application
R = Richmond Gibson

* = Early assessment - January/February
Late assessment - at flowering

Table 2

Weed weights expressed as percentage control

Stellaria media in winter wheat

Treatment (rate/ha product)	Method of application and volume rate (l/ha) R 20	R 40	C 200
Mecoprop			
2.8 l	87.2	89.3	99.1
4.2 l	93.2	96.9	99.7
sig. dif. (5% level) = 5.0			

Table 3

Mean scores for weed control in spring cereals

(sites comparing three methods of application)

Treatment (rate/ha product) and weed	Method of application and volume rate (l/ha) M 20	M 30	B 30	C 200
benazolin + dicamba + dichlorprop 3.7 l				
Polygonum persicaria	7.0 (1)	7.0 (1)	7.5 (1)	7.7 (1)
Polygonum convolvulus	7.0 (1)	7.2 (1)	7.7 (1)	7.8 (1)
Chenopodium album	8.3 (1)	8.0 (1)	8.5 (1)	8.7 (1)
Stellaria media	9.0 (1)	9.3 (1)	9.2 (1)	9.5 (1)
Sinapis arvensis	8.0 (1)	8.0 (1)	8.0 (1)	8.0 (1)
Mean	7.8	7.9	8.2	8.3
benazolin + dicamba + dichlorprop 5.6 l				
Polygonum persicaria	6.4 (2)	7.0 (2)	7.3 (2)	8.0 (2)
Polygonum convolvulus	7.8 (2)	8.5 (2)	8.7 (2)	9.6 (2)
Polygonum aviculare	6.6 (2)	7.2 (2)	7.7 (2)	8.2 (2)
Chenopodium album	8.5 (2)	9.2 (2)	9.1 (2)	9.6 (2)
Stellaria media	7.2 (3)	8.0 (3)	8.7 (3)	8.9 (3)
Sinapis arvensis	7.9 (2)	8.0 (2)	8.5 (2)	8.5 (2)
Fumaria officinalis	8.0 (1)	8.8 (1)	9.8 (1)	10 (1)
Mean	7.4	8.1	8.5	8.9
dichlorprop + MCPA + Dowco 290 7 l				
Polygonum persicaria	5.7 (1)	6.2 (1)	6.0 (1)	6.0 (1)
Polygonum aviculare	5.0 (1)	5.0 (1)	5.3 (1)	6.0 (1)
Stellaria media	6.3 (1)	6.8 (1)	6.3 (1)	7.2 (1)
Sinapis arvensis	7.3 (1)	8.5 (1)	8.0 (1)	8.0 (1)
Mean	6.1	6.5	6.4	6.8

Table 4

Mean scores for weed control in spring cereals

(sites comparing two methods of application)

Treatment (rate/ha product) and weed	Method of application and volume rate (l/ha) B 30	C 200
benazolin + dicamba + dichlorprop 2.8 l		
Polygonum persicaria	7.8 (1)	9.2 (1)
Polygonum convulvulus	7.1 (2)	8.1 (2)
Polygonum aviculare	6.5 (2)	6.6 (2)
Chenopodium album	8.0 (1)	8.8 (1)
Stellaria media	7.8 (1)	8.7 (1)
Mean	7.4	8.2
benazolin + dicamba + dichlorprop 4.2 l		
Polygonum persicaria	8.6 (2)	9.5 (2)
Polygonum convolvulus	7.9 (2)	8.7 (2)
Polygonum aviculare	8.3 (2)	8.4 (2)
Chenopodium album	8.5 (2)	8.6 (2)
Stellaria media	7.9 (3)	9.1 (3)
Matricaria spp	7.0 (1)	7.0 (1)
Mean	8.0	8.5
benazolin + dicamba + dichlorprop 5.6 l		
Polygonum persicaria	8.7 (1)	9.8 (1)
Chenopodium album	7.9 (2)	9.0 (2)
Stellaria media	8.1 (2)	8.7 (2)
Matricaria spp	6.5 (1)	7.5 (1)
Mean	7.8	8.7
dichlorprop + MCPA + Dowco 290 4.7 l		
Polygonum persicaria	6.1 (2)	6.8 (2)
Polygonum convulvulus	6.6 (2)	7.3 (2)
Polygonum aviculare	6.5 (2)	7.0 (2)
Chenopodium album	6.8 (2)	7.7 (2)
Stellaria media	6.2 (4)	7.1 (4)
Matricaria spp	6.0 (1)	6.0 (1)
Mean	6.3	6.9
dichlorprop + MCPA + Dowco 290 7 l		
Polygonum persicaria	8.3 (1)	9.2 (1)
Polygonum convulvulus	8.0 (1)	9.2 (1)
Polygonum aviculare	7.5 (1)	8.7 (1)
Chenopodium album	8.2 (2)	8.5 (1)
Stellaria media	7.5 (3)	8.1 (3)
Matricaria spp	6.0 (1)	6.0 (1)
Mean	7.5	8.2
dichlorprop + MCPA 4 l		
Polygonum convolvulus	8.0 (1)	8.0 (1)
Polygonum aviculare	7.0 (1)	7.2 (1)
Mean	7.5	7.6

Table 4 (continued)

Treatment (rate/ha product) and weed	Method of application and volume rate (l/ha) B 30	C 200
dichlorprop + MCPA + difenzoquat 2.7 l + 1kg (tm)		
Polygonum persicaria	5.2 (2)	5.3 (2)
Polygonum convolvulus	4.8 (2)	5.2 (2)
Stellaria media	5.7 (2)	5.7 (2)
Mean for broad-leaf weed	5.2	5.4
Avena fatua	6.0 (2)	6.1 (2)
dichlorprop + MCPA + difenzoquat 4 l + 1.6kg (tm)		
Polygonum persicaria	6.2 (2)	7.0 (2)
Polygonum convolvulus	6.7 (2)	7.4 (2)
Stellaria media	6.3 (2)	6.6 (2)
Mean for broad-leaf weed	6.4	7.0
Avena fatua	7.2	7.7
benazolin + 2,4-DB + MCPA 4.7 l/ha		
Polygonum persicaria	4.0 (1)	5.0 (1)
Polygonum convolvulus	4.7 (1)	5.2 (1)
Matricaria spp	4.8 (1)	5.5 (1)
benazolin + 2,4-DB + MCPA 7 l/ha		
Polygonum persicaria	5.5 (1)	6.0 (1)
Polygonum convolvulus	5.5 (1)	5.9 (1)
Matricaria spp	5.2 (1)	6.1 (1)

Table 5

Reduction in height (cm) of spring wheat

chlormequat treatment compared with untreated

Treatment (rate/ha)	Method of application and volume rate (l/ha) B 30	C 200
chlormequat		
0.5 l	2.8	3.3
1.0 l	3.2	3.5
1.5 l	3.2	3.7

Untreated or underdosed strips of irregular width between the two Battleship discs were often observed. These might be partially eliminated by moving the units a little closer. In addition, irregular areas of poor control similar to those reported previously, (Lush and Palmer, 1976) (Mayes and Blanchard, 1978), were observed in both Microdrop and Battleship plots. The distribution of these areas for each treatment is currently being plotted to provide quantitative data.

It was observed that areas of poor weed control in the swath of adjacent Battleship units did not coincide. It has been suggested that variation in the flow rate to individual units might have been the cause of this irregular distribution (Hamer, 1978).

Apart from some transient scorch of cereals following both CDA and conventional spraying, no adverse crop effect due to treatment was observed.

Wind speeds were generally light but occasional gusts up to 25km/h, caused noticeable drift from the conventional nozzles which could have damaged any adjacent susceptible crops. Very little drift emanated from the Battleship discs mounted on the same boom.

Weed control in farm usage of the Microdrop sprayer was generally satisfactory when the machines were functioning correctly. Of 22 applications visited, 17 have given satisfactory results, the other 5 being invalidated by machinery problems and/or lateness of application. Of the 17 commercially successful applications, 4 showed some variability of control as reported in the case of detailed trials but the overall effect was satisfactory. In most of the 17 cases, mechanical problems had occurred but had been rectified to allow spraying to continue. The benefits of drift reduction were not detected under the predominantly calm conditions in which fields were sprayed. Products used in the successful applications referred to above include those based on mecoprop; dichlorprop; benazolin + dicamba + dichlorprop; 2,3,6-TBA + dichlorprop + mecoprop; ioxynil + dichlorprop; terbutryne + terbuthylazine; triallate; difenzoquat; chlormequat.

Recommendations for the use of the following additional products through the Microdrop sprayer can now be made: benazolin + Dowco 290 used alone and in tank mix with propyzamide in oil seed rape, isoproturon formulated as an aqueous suspension in winter wheat and barley and chlormequat in wheat and oats.

DISCUSSION

A further season's work with the Microdrop sprayer and one season's trials with equipment fitted with Battleship units, has again demonstrated that acceptable weed control can be achieved at volumes in the range 20-40 l/ha with spinning disc units. The list of products which may now be used through the Microdrop sprayer, has been extended to include three further herbicides and the growth regulator, chlormequat. The 1978 results again show that a 40 l volume rate for stacked disc units would be preferable to 20 l/ha if this could be achieved at a practical forward speed. As results with the Battleship were broadly similar to those with the Microdrop sprayer at a common volume rate of 30 l/ha, the main advantage of the Battleship would appear to be in the convenience of attaching the units to a conventional spray boom and in its ease of operation. Design modification towards obtaining a more even distribution should be considered with both types of equipment in order to achieve improved weed control.

Quite apart from reducing the amount of water required and thereby saving valuable spraying time, the future success in farm practice of the Microdrop sprayer or any similar specialised CDA equipment must largely depend on its other main advantage of reduced drift hazard. This should provide more opportunities for spraying so that the somewhat lower standard of weed control that may be experienced in comparison with conventional application at 200 l/ha would be more than offset by safer and more timely treatment. Hopefully these benefits will be quantified next season.

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References

BALS, E. J. (1978) Reduction of Active Ingredient Dosage by Selecting Appropriate Droplet Size for the Target. Proc. Br. Crop Protection Council Symposium on Controlled Drop Application (Monograph No.22)101-106.

FARMERY, H. (1978) Development of the Microdrop CDA Sprayer. Proc. Br. Crop Protection Council Symposium on Controlled Drop Application (Monograph No.22)107-110.

HAMER, R. R.(1978) Private communication

HIND, N. J. (1978) The Richmond Gibson Controlled Drop Application Trials Sprayer. Proc. Br. Crop Protection Council Symposium on Controlled Drop Application (Monograph No.22)117-120.

JEGATHEESWARAN, P. (1978) Factors Concerning the Penetration and Distribution of Drops in Low Growing Crops. Proc. Br. Crop Protection Council Symposium on Controlled Drop Application (Monograph No.22)91-100.

LUSH, G. B.and MAYES, A. J. (1972) Towards more Efficient Field Experimentation. Proc. 11th Weed Control Conference 104-111.

LUSH, G. B.and PALMER, R. A.(1976) Field Trials Comparing the Biological Effectiveness of Controlled Drop Application with Conventional Hydraulic Pressure Spraying. Proc. Br. Crop Protection Conf. Weeds. 2 391-398.

MAYES, A. J.and BLANCHARD, T. W. (1978) The Performance of a Prototype Microdrop CDA Sprayer for Herbicide Application. Proc. Br. Crop Protection Council Symposium on Controlled Drop Application (Monograph No.22) 171-178.

A COMPARISON OF A FIELD SCALE CONTROLLED DROP APPLICATOR AND FAN JET SPRAYER FOR BROAD LEAVED WEED CONTROL IN CEREALS

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Summary Conventional spraying at 3 volumes, 200, 100 and 50 l/ha was compared in 3 trials with a prototype controlled drop applicator (CDA) at 20 l/ha. This latter machine was also used on several farms and compared with the farmer's machine at 225 l/ha. Weed control achieved by the 50 l/ha and CDA treatments was generally not as good as the 200 and 100 l/ha treatments. However this difference was insufficient to affect yield. The CDA machine had several small, but serious faults. These included blockages due to inadequate filtering, drive belts breaking, a tendency for flow rates to increase during operation, and insufficient suckback. If these problems can be overcome the machine can offer high work rates of up to 8 ha/hour and usually acceptable broad-leaved weed control.

INTRODUCTION

Two years work by the Agricultural Development and Advisory Service (ADAS) using experimental CDA machinery had shown generally satisfactory weed control, though somewhat inferior to a conventional treatment (Bailey et al 1978). Horstine Farmery Ltd are developing a commercial CDA sprayer and kindly loaned a prototype machine to High Mowthorpe EHF for use during the 1977 and 1978 spraying seasons. The machine was used on the farm on replicated trials in both years and on several commercial farms nearby in 1978. This allowed study of both agronomic and mechanical aspects of the sprayer.

METHODS AND MATERIALS

The CDA machine used in these trials was a prototype of the Horstine Farmery Microdrop Sprayer. Details of the machine have been published by Horstine Farmery (1978). Total volume of liquid applied was 20 l/ha at a forward speed of 8 kph.

The conventional treatments applied at High Mowthorpe were using an Allman sprayer. Three different volumes were used, 200, 100 and 50 l/ha. These were achieved by using Allman No. 3, No. 0 and No. 000 nozzles respectively and making minor alterations to forward speed. Pressure was 2 bar for the No. 3 and No. 0 and 2.4 bar for No. 000. Details of these trials appear in the following tables under sites 1-3.

When the machine was used on commercial farms the chemical chosen by the farmer was used and at the same rate of active ingredient. The farmer's machine was checked and calibrated prior to use to put on 225 l/ha. Fields were chosen with a fair weed population and an even spread and approximately half was sprayed with each machine. Details are given under sites 4-10.

Weed assessments were made by assessing percentage weed cover and giving a visual score of effectiveness on a 0 (no control) to 9 (complete control) scale, except on site 1. This technique alone was used on the field comparisons. Yields were taken on the replicated trials by combine harvester.

RESULTS

Table 1

Site and weed details

Site	Crop	Variety	GS at spraying		Weed density	Date of spraying	Conditions at spraying
1	S. barley	Lofa Abed	30	Thin	Light	27.5.77	Good
2	S. barley	Aramir	25	Medium	Medium	22.5.78	V. good
3	W. wheat	Maris Huntsman	30	Thin	Heavy	17.5.78	V. good
4	W. wheat	Maris Huntsman	30	Thick	Heavy	18.4.78	Fair
5	W. wheat	Hobbit	30	Thick	Heavy	25.4.78	Good
6	W. wheat	Maris Huntsman	30	Medium	Light	24.4.78	Good
7	S. barley	Athos	30	Thick	Light	22.5.78	V. good
8	S. barley	Porthos	30	Medium	Medium	22.5.78	V. good
9	S. barley	Ark Royal	30	Thick	Medium	26.5.78	V. good
10	S. barley	Hassan	25-30	Medium	Light	26.5.78	V. good

Site	Weed species
1	Veronica spp., Fumaria officinalis, Stellaria media, Matricaria matricarioide All seedlings.
2	Veronica spp., S. media, Papaver rhoeas, Galium aparine, F. officinalis. All seedlings
3	P. rhoeas 7-10 cm, S. media 5 cm.
4	S. media 7 cm overwintered, V. hederifolia up to 20 cm overwintered
5	V. hederifolia 15-30 cm, S. media 15-25 cm. All overwintered
6	M. matricarioides, V. persica, S. media, Mysotis arvensis, Capsella bursa-pastoris, Polygonum aviculare, Lamium purpureum, G. aparine. All seedlings
7	P. convolvulus, P. aviculare, S. media, G. aparine, F. officinalis. All seedlings
8	S. media, G. aparine, L. purpureum
9	V. persica, P. convolvulus, Sonchus oleraceus, S. media, P. aviculare, P. persicaria. All seedlings.
10	Sinapis arvensis, S. media, P. aviculare, P. convolvulus

Table 1 gives details of the sites with growth stage of crop and thickness of stand at spraying. This may have an affect on penetration of drops particularly fro the CDA machine. The weeds on sites 3 and 6 were mostly spring germinating, whilst those on the other 2 winter wheat sites were mostly overwintered weeds.

Weed assessments are presented in table 2. These were carried out about 4-6 weeks after spraying.

Yield results from the replicated trials are presented in table 3.

Table 2

Weed control - % ground cover of weeds and score 0-9
(0 = no control, 9 = complete control)

Site	Chemical dose/ha	Application method and vol 1/ha	% weed cover	Score
1	Untreated		43	
	ioxynil + mecoprop 7 1.	200 Conv.	10	
	"	100 Conv.	11	
	"	50 Conv.	18	
	"	20 CDA	17	
2	Untreated		53	0
	mecoprop 3.5 1. + 2,4-D 1 1.	200 Conv.	7	8.0
	"	100 Conv.	9	8.0
	"	50 Conv.	7	8.0
	"	20 CDA	8	8.0
3	Untreated		40	0
	TBA, dicamba, mecoprop, MCPA 5 1.	200 Conv.	6	7.5
	"	100 Conv.	9	7.5
	"	50 Conv.	10	7.0
	"	20 CDA	15	7.0
4	mecoprop 4.2 1. + MCPA 1.4 1.	225 Conv.		8
		20 CDA		6
5	mecoprop + ioxynil 8.4 1.	225 Conv.		1.5
		20 CDA		1.0
6	TBA, dicamba, MCPA, mecoprop 5 1.	225 Conv.		8.5
		20 CDA		8.5
7	dicamba, mecoprop, MCPA 5 1.	225 Conv.		9.0
		20 CDA		9.0
8	bromoxynil, ioxynil, dichlorprop MCPA 5.6 1.	225 Conv.		8
		20 CDA		7.5
9	bromoxynil, ioxynil, dichlorprop, MCPA 5.6 1.	225 Conv.		8.5
		20 CDA		8.0
10	mecoprop 2.8 1. + MCPA 1.4 1.	225 Conv.		8.5
		20 CDA		8.0

Table 3

Yield of grain in t/ha at 15% M.C.

Site		Treatment					
		Untreated	Conv. 200 1/ha	100 1/ha	50 1/ha	CDA 20 1/ha	S.E.
1	1977	5.28	5.41	5.43	5.24	5.03	± 0.089
2	1978	4.87	5.18	5.22	5.06	5.39	± 0.102
3	1978	Not available					

DISCUSSION

The aim of the investigations in the last 2 years has been twofold. Firstly by replicated trials to compare the weed control and yield from the different spray treatments. Low volumes of water applied with a conventional machine were included to see if these would give as good weed control as the more normal 200 1/ha.

The second part of the investigation has been on the mechanical aspect of using the CDA machine and different nozzles for achieving different application rates.

Weed Control

Weed control on all sites except one was satisfactory. On the replicated trials there were only small differences between treatments. The 200 l and 100 l treatments gave the best control overall, but 50 l and CDA were only slightly inferior. On site 1 the inferior control associated with reduced volumes was probably due to the ioxynil, a contact material, being less effective. Poorer control with this material at low volumes has been found by the Weed Research Organization (1976). Differences between treatments on site 2 were negligible. On site 3 the main weed was well grown Papaver rhoeas and 50 l/ha conv. and CDA were less effective than the other 2 treatments.

Yield data is only available from the spring barley trials. The 1978 winter wheat trial was harvested too late for the results to be included in this paper.

Differences between treatments in both years were generally non-significant (P = 0.05). However there are trends in the figures which relate to weed control or other observations. In 1977 weed control on the conventional 50 l and CDA 20 l treatments was somewhat less than on the other sprayed treatments and may have contributed to the lower yield. Another factor possibly affecting yield on these plots was crop scorching. This was worse on the CDA plots than the conventional 50 l plots, but on both treatments soon disappared and caused no visual differences thereafter.

In the 1978 spring barley trial, yields from all treated plots were higher than the untreated, though generally not significantly so. The poorest yield came from the conventional 50 l treatment, though this was not due to lack of weed control. No crop scorching occurred and the CDA treatment yielded slightly above the 200 l and 100 l conventional treatments.

The yield data from these trials indicates that when the weed control is as good as the 200 l/ha standard, reducing the volume of water will not in itself cause any significant changes in yield. The more concentrated drops from CDA may on occasions cause scorching which might have an adverse effect on yield.

The commercial crops were all sprayed at the same time as the farmer treated the rest of the field and using the same product. In the case of sites 4 and 5 this was later than optimum for controlling the weeds which were strong overwintered plants. At site 4 the conventional sprayer achieved a high level of control, while the CDA machine was noticeably poorer. At site 5 neither of the treatments were successful, though some suppression of the weeds was achieved. The most likely cause of the poor control was the weed being past the stage at which the chemical could be expected to kill it.

Site 6 was a well grown crop with a range of species, but only in moderate numbers and most of the weeds small. Both machines achieved a high degree of control with only a few stunted weeds surviving and no difference between treatments.

None of the spring barley sites was particularly dirty, site 8 having most weed. On sites 8-10 CDA gave marginally inferior weed control, but still quite acceptable. Where Veronica spp. were present on site 9 it was noticeable that CDA failed to kill them and stunted, yet flowering plants were seen. Once again this is probably due to the bromoxynil and ioxynil being less effective. Overall weed control on all the spring barley sites was quite acceptable.

The broad conclusion from these trials is that when the weeds were in the seedling stage, CDA gave almost or as good control as conventional. With large or overwintered weeds control from the CDA was noticeably inferior.

Machinery

The other purpose of the work was to look at the mechanical aspects of the CDA machine and reduce water volumes in the conventional sprayer. The only drawback with the latter was use of 000 nozzles. These produce very small drops and even a light wind will cause unacceptable drift. The pressure had to be increased to give the correct overlap and this aggravated drifting. They are also likely to block up more easily. The performance of the CDA machine was marred by several small, but serious faults. Due to insufficient filtering in this model, blockages at the metering valves were common. These either completely blocked the flow or just restricted it, neither of which could be seen from the tractor cab. On 2 occasions the flexible drive belts broke. Although easily replaced, they cannot always be seen from the cab and could leave unsprayed strips. Most serious was a tendency for the flow rate, as measured in the flow meters, to increase during spraying. This was partly overcome by setting the flow meters slightly lower than the calibration required. No apparent cause was found for this problem. With a total application of only 20 l/ha a small variation in output may affect weed control. Another fault was the inadequate suck back so that even when switched off spray would be deposited with obvious problems on headlands and when stopping and starting. Some scorching was recorded at most sites, though apart from site 1 this does not appear to have affected yield. When travelling over bumps, liquid splashed off the discs. This left a patch not properly covered and could cause scorch marks.

Calibration of the machine is relatively complex compared with a conventional sprayer. Two points did arise that created difficulties. One was the rather large graduations on the flow meter which meant that the actual figure often had to be estimated. With some chemicals which are either a very dark colour or opaque, seeing the float was difficult and could have lead to inaccuracies.

Drift of spray was never a problem, but only light breezes occurred on the spraying days. No more than one tank full, sufficent for 12.5 ha was sprayed at one site, so overall work rates could not be measured. Work rates while spraying of 8 ha/hour were achieved, though minor breakdowns slowed down work on several occasions.

The performance to be expected from CDA spraying seems well established, at least with translocated broad-leaved herbicides. Improvements in the machinery are needed to make the system commercially viable.

The ability to reduce volumes by at least half with a conventional sprayer and not sacrifice any weed control offsets to a certain extent the main advantage of CDA. The possibilities of reducing water volumes, confirmed by other trials (Bailey et al 1978), now deserve wider publicity.

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References

BAILEY, R. J. et al (1978) A review of ADAS results with a controlled drop application technique for herbicides in cereals. Proceedings British Crop Protection Council Symposium Controlled Drop Application (Monograph 22)

FARMERY, H. (1978) Development of the Microdrop CDA sprayer. Proceedings British Crop Protection Council Symposium Controlled Drop Application (Monograph 22) 107

ARC WEED RESEARCH ORGANIZATION (1976) Sixth Report 1974-75. 75-81