THE INFLUENCE OF APPLICATION METHOD ON THE CONTROL OF BLACK-GRASS (ALOPECURUS MYOSUROIDES HUDS.) IN WINTER CEREALS BY POST-EMERGENCE APPLICATIONS OF A RANGE OF HERBICIDES

P. Ayres

ARC Weed Research Organization, Begbroke Hill, Yarnton, Oxford OX5 1PF

Summary In four experiments over two years the performance of post-emergence applications of herbicides for the control of black-grass in cereals applied either by CDA or by hydraulic nozzle equipment was examined. In 1975/76 chlortoluron alone was applied at 15, 30, 45 and 225 l/ha and in 1976/77 chlortoluron, isoproturon, clofop-isobutyl, diclofop-methyl and metoxuron were applied at 30 and 225 l/ha. In both seasons the herbicides were applied at their respective recommended or one half recommended rate. Black-grass control from early post-emergence controlled drop applications at 30 and 45 l/ha was as good as that from 225 l/ha. Later controlled drop applications were generally poorer and possible reasons for this are discussed.

Treatments did not always increase cereal yields assessed on two experiments but where increases were recorded there was no trend related to either dose or volume rate.

INTRODUCTION

The influence of reduced cultivations and the increasing practice of continuous winter cereals has encouraged the trend towards earlier sowing which can also be important in maximising yields leading to considerable financial advantage. However, the climatic conditions in September and early October that promote the growth and establishment of the crop also favour the development of black-grass (*Alopecurus myosuroides*) and one of the major factors in realizing the full yield potential is the prevention of weed competition (Hubbard *et al*., 1976). The application of pre-emergence herbicides for black-grass control by conventional hydraulic nozzle equipment may be restricted because of the large volumes of water required, which can limit the speed of operation, and the imposition of an additional work load at an already busy time. Early post-emergence applications however are more likely to be restricted by the inability to use a heavy sprayer on wet land. One of the advantages of controlled drop application (CDA) compared to conventional hydraulic nozzles is that of greatly reducing the water requirement. Thus a reduction in spray volume with CDA can mean a major reduction in total payload and the possibility of applying herbicides in conditions that would preclude the use of heavy conventional sprayers.

Although good results have already been achieved with CDA various foliar translocated herbicides in spring cereals (Cussans & Taylor, 1976) the application of soil-acting chemicals in winter cereals by this method requires further study.

This paper describes four experiments, carried out between 1975 and 1977 designed to study the performance of controlled drop applications of a range of black-grass herbicides applied post-emergence in winter cereals.

METHOD AND MATERIALS

Two experiments were set up in winter wheat during autumn 1975 and one in winter wheat and one in winter barley during late autumn 1976 (Table 1). The experiments were of randomised block design containing three replicates and in each year plots measured 3 x 10 m.

Both cereal and black-grass growth stages referred to in these experiments are those described by Zadoks, Chang and Konzak (1974).

In 1975/76 chlortoluron was applied when the crops had two leaves unfolded and the black-grass had between 1-2 leaves unfolded. Applications were made at the field recommended rate (3.14 kg a.i./ha) and one half of this, and at spray volume rates of 15, 30 and 45 (CDA) and 225 (conventional) l/ha.

In 1976/77 chlortoluron, isoproturon, clofop-isobutyl, diclofop methyl and metoxuron, were all applied at their half or full recommended rate. At Hardmead chlortoluron was applied when the crop had three mainstem leaves unfolded and one tiller and the black-grass had between 2-3 leaves unfolded. The other treatments at this site were applied when the black-grass had tillered (between 2-12 tillers/plant) and the crop had 4 mainstem leaves unfolded and 2-3 tillers. All treatments at Elsfield were applied when the crop had 4 mainstem leaves unfolded and 1-2 tillers and the black-grass had either 3 mainstem leaves unfolded or had tillered (between 3-16 tillers/plant). Treatments were applied at either 30 (CDA) or 225 (conventional) l/ha.

Table 1

Crop, variety, crop population, application date and number of black-grass seedlings at each site

Sites	Crop	Variety	Crop population/m^2	Application date	Black-grass seedlings/m^2
Goddington	Winter wheat	Atou	222	10 Dec 1975	573
Lewknor	Winter wheat	Bouquet	266	22 Dec 1975	62
Hardmead	Winter barley	Mirra	349	i 15 Feb 1977 ii 16 April 1977	467
Elsfield	Winter wheat	Maris Huntsman	223	3 April 1977	217

Conventional applications were made using a propane or carbon dioxide pressured sprayer fitted to a hand-held 3 m boom, using Spraying Systems 6502 'Tee-jets' at a pressure of 2.07 bar and walking at 1 m/s.

In 1975/76 the controlled drop treatments were applied using the machine described by Ayres (1976) with the exception that 3 units were used to cover the plot width of 3 m. The units (Farmery, 1975) embodied 2 spinning discs of the type described by Bals (1975). Volume rates were achieved by calibrating the flow-rate of the herbicide to the units and then adjusting the forward walking speed. The volume rates and relative walking speeds were 15 l/ha (0.9 m/s), 30 l/ha (0.5 m/s) and 45 l/ha (0.3 m/s).

Applications in 1976/77 were made with a new machine (Hind, 1978) which had units incorporating 3 spinning discs. The new machine enabled both flow-rate and disc speed to be monitored accurately. A single CDA volume rate of 30 l/ha was used in these 2 experiments and a walking speed of 0.7 m/s.

In both years all CDA treatments were applied using uniform drops 225 μm in diameter.

Assessments

At each site before the treatments were applied densities of crop and black-grass were determined using a number of random quadrats (0.1 m^2).

In June the black-grass heads were assessed before seed shedding commenced. All heads were counted in six random quadrats which measured 2 x 0.5 m on the treated plots and 1 x 0.25 m on the unsprayed plots. The mean length of black-grass head was determined from a random sample of 30 heads/plot. From this data estimates of the mean length of black-grass head (m)/m^2 were derived.

Crop yields were obtained at Hardmead and Elsfield by cutting a single swath of 1.5 m from the centre of each plot with a small plot combine harvester. The ends of the plots were first removed as discards. The grain from each plot was weighed and from this a sample of approximately 1 kg was taken, dried and reweighed. A sub-sample (≃300 g) was taken from this sample, cleaned and sieved to remove wild-oat seeds, trash and grain $<$ 2.0 mm. From these data the yield of clean grain $>$ 2.00 mm at 85% d.m. was determined.

RESULTS

1975/76

Table 2

Influence of volume rate and dose on length of black-grass head produced (m)/m^2

Site	Goddington		Lewknor	
Dose (kg a.i./ha)	1.57	3.14	1.57	3.14
Vol. rate (l/ha)				
15	22.30(2.319)	11.26(1.756)	8.96(1.936)*	5.28(1.681)*
30	21.21(2.046)	8.01(1.696)	6.87(1.785)	1.27(1.071)
45	12.90(2.037)	3.49(1.493)	2.02(1.300)	1.72(1.134)*
225	18.47(2.187)	2.25(1.267)	2.62(1.393)	0.49(0.663)
Unsprayed control	88.41(2.925)		16.48(2.185)	
SE for comparing volume & dose rate	(0.1639)		(0.1460)	
SED for comparing volume & dose rates with unsprayed control	(0.2005)		(0.1788)	

*Control significantly poorer (p = 0.05) than conventional volume rate at the same dose level

Logarithmically transformed values ($Log_{10}x$) in parentheses.

Table 3

Influence of herbicide, volume rate and dose level on length of black-grass head produced (m)/m²

Site		Hardmead		Elsfield	
Volume rate (l/ha)		30	225	30	225
Herbicide	Dose (kg a.i./ha)				
Chlortoluron	1.57	2.65 (2.337)	≠	8.13 (1.762)	6.59 (1.815)
	3.14	0.76 (1.788)*	0.17 (0.943)	6.46 (1.815)*	2.34 (1.374)
Isoproturon	1.05	6.74 (2.799)	4.28 (2.518)	2.93 (1.454)	2.56 (1.194)
	2.10	1.44 (2.020)*	0.34 (1.460)	3.30 (1.499)*	0.96 (0.900)
Clofop-isobutyl	0.37	3.31 (2.513)	5.88 (2.730)	1.61 (1.187)	1.86 (1.279)
	0.75	4.29 (2.601)*	0.44 (1.542)	0.39 (0.659)	0.19 (0.278)
Diclofop-methyl	0.54	34.22 (3.531)	41.91 (3.622)	24.90 (2.388)	18.30 (2.252)
	1.08	28.65 (3.441)	35.55 (3.471)	10.78 (1.998)	8.50 (1.899)
Metoxuron	2.19	1.49 (2.150)	6.45 (2.757)	17.13 (2.067)	6.20 (1.761)
	4.38	0.62 (1.789)	0.40 (1.567)	5.48 (1.696)	3.07 (1.474)
Unsprayed control		40.74 (3.540)		34.63 (2.480)	
SE for comparison between volume and dose rates		(0.1699)		(0.1415)	
SED for comparison between volume and dose rates with unsprayed control		(0.1849)		(0.1581)	

* Control significantly poorer ($p = 0.05$) than conventional volume rate at the same dose level

≠ Results not included because of an error in the spraying procedure

Logarithmically transformed values in parentheses

Hardmead ($\log_{10} 100x$)

Elsfield ($\log_{10} 10x+1$)

At both Goddington and Lewknor chlortoluron applications at 15 l/ha with the recommended dose resulted in poorer control of black-grass than that achieved at 225 l/ha (Table 2). This was also true at the lower dose rate at Lewknor. At the other volume rates with one exception 30 and 45 l/ha were as effective as 225 l/ha at both dose levels. The exception was at Lewknor where control obtained with the higher dose rates of chlortoluron applied at 45 l/ha was inferior to that obtained at 225 l/ha but not to that achieved at 30 l/ha.

1976/77

In both experiments (Table 3) control at 30 l/ha by the recommended rates of chlortoluron and isoproturon was significantly lower than that from 225, although at Hardmead there was a 98 and 96.5% reduction of metres of black-grass head/m^2 respectively. The results at Elsfield are complicated by the presence of a chlortoluron/metoxuron sensitive variety of winter wheat, Maris Huntsman. Greater herbicide damage was observed initially from the CDA treatments of chlortoluron and metoxuron, although the crop subsequently recovered and yields were not drastically reduced. It is possible that the difference in degree of control could be partly attributed to the early set-back in crop growth. Metoxuron was very effective at Hardmead from both types of application. At Elsfield although the levels of control were somewhat lower the difference between volume rates was not significant.

The control from the higher dose rate of clofop-isobutyl at Hardmead was also considerably lower with the CDA treatments but there were no differences between volume rates at Elsfield. Although the degree of control from diclofop-methyl was generally poor with all treatments at Hardmead and with the half rate at Elsfield there was no difference between volume rates. At both sites there was no statistical difference between levels of control obtained at the lower dose rates at either volume rate for any of the herbicides used.

Table 4

Influence of herbicide, volume rate and dose level on cereal yield (clean grain > 2.00 mm) at 85% d.m. in t/ha

Site		Hardmead		Elsfield	
Volume rate (l/ha)		30	225	30	225
Herbicide	Dose (kg a.i./ha)				
Chlortoluron	1.57	4.56	-	5.65	6.27
	3.14	5.49	4.74	5.93	5.52
Isoproturon	1.05	5.06	5.11	7.22	6.69
	2.10	5.00	5.37	6.64	6.76
Clofop-isobutyl	0.37	5.18	4.62	6.22	5.50
	2.10	4.99	5.28	5.35	6.92
Diclofop-methyl	0.54	4.39	4.88	4.82	5.68
	1.08	4.57	3.96	5.74	6.53
Metoxuron	2.19	4.99	4.76	5.16	6.36
	4.38	4.75	4.79	6.20	6.11
Unsprayed control		4.45		4.82	
SE for comparisons between vol. rates		0.317		0.453	
SED for comparison between vol. rates and unsprayed control		0.355		0.507	

Significant yield increases over the untreated controls were recorded for a number of treatments at Elsfield but those from Hardmead (table 4) where although yield appeared to be increased by the herbicide treatments were not significantly different from the yields of the untreated plots. There were virtually no differences in the yields of the plots at the two volume rates and only slight effects of dose rate.

DISCUSSION

With the exception of the results at 15 l/ha the early post-emergence CDA treatments gave levels of black-grass control comparable to that achieved from the conventional applications. The poor control from 15 l/ha may indicate the importance of drop numbers for soil-acting herbicides as in previous work (Ayres & Merritt, 1978; Wilson & Taylor, 1978) good control was obtained at this volume rate with translocated herbicides. Black-grass control from CDA treatments applied at later dates however was less consistent but when interpreting these results it is important to distinguish clearly between the different herbicides and the timing of application in the different experiments. With chlortoluron and isoproturon the main route of uptake appears to be via the soil, even from post-emergence applications (Richardson et al, 1977; Richardson & Parker, 1978). If this is so then the crop and possibly the weed foliage could be acting as a filter preventing drops from reaching the soil surface. For chlortoluron there is some evidence to support this with first the indication that drop numbers are important, and second the greater difference in black-grass control between 30 and 225 l/ha recorded with the later post-emergence application at Elsfield. Although results with isoproturon are limited in these experiments to late post-emergence applications further evidence exists (Ayres, unpublished data) that post-emergence controlled drop applications of both chlortoluron and isoproturon are poorer than conventional applications particularly at later dates.

Clofop-isobutyl, diclofop-methyl and metoxuron, all of which exhibit some degree of foliar uptake (Richardson & Parker, 1976, 1978; Richardson et al, 1976) were not so severely affected by volume rate although in most cases control at 30 l/ha tended to be inferior. Although this supports the possibility of a crop/weed filtering effect it also suggests that reduced control with CDA may be due to another factor, possibly concentration, which could influence herbicide uptake through the foliage. Both canopy penetration (Ayres, 1978) and drop concentration effects (Merritt, pers. comm.) have been observed with controlled drop applications of difenzoquat on wild-oats and it is possible that they may be important with post-emergence applications of these herbicides.

Although black-grass control from some CDA treatments was lower than that from conventional applications this was not generally reflected in the yield data. This lack of difference would seem perhaps to outweigh the slight reduction in herbicide performance. The ability to get on the land in order to remove early weed competition must be considered if potential yields are to be realised, and CDA with its low water and therefore low weight requirement together with a suitable light-weight machine offers all the mechanical and logistic advantages to do so. There is therefore still a case for controlled drop low volume application and a small loss in control may be preferable to either late application or not spraying at all.

Acknowledgements

I wish to thank Messrs. J.A. Carrington, K. Irwin, A.J. Smith and Miss J.E. Birnie for their assistance in the field work, Mr G.W. Cussans for his helpful criticism and the farmers who provided the sites.

<u>References</u>

AYRES, P. (1976) Control of annual broad-leaved weeds in spring barley by controlled drop application: comparisons of the activity of two herbicide mixtures at three doses and four volume rates. <u>Proceedings British Crop Protection Conference - Weeds</u>, <u>3</u>, 895-904.

AYRES, P. (1978) The influence of application method on the control of wild oats (AVENA FATUA L. and AVENA LUDOVICIANA DUR.) in winter wheat by difenzoquat applied at a range of growth stages. <u>British Crop Protection Council, Monograph</u> <u>22</u>, 163-170.

AYRES, P. & MERRITT, C.R. (1978) Field experiments with controlled drop applications of herbicides for the control of dicotyledenous weeds. <u>Weed Research</u>, <u>18</u> 209-214.

BALS, E.J. (1975) The development of A CDA herbicide hand sprayer. <u>PANS</u>, <u>21</u>, 345-349.

FARMERY, H. (1975) Controlled droplet engineering - an engineers viewpoint. <u>Proceedings 8th British Insecticide and Fungicide Conference</u>, 171-174.

HIND, N.J. (1978) The Richmond Gibson controlled drop application trials sprayer. <u>British Crop Protection Council, Monograph</u> <u>22</u>, 117-119.

HUBBARD, K.R., LIVINGSTON, D.B. & ROSS, B.L. (1976) Chemical control of <u>Alopecurus myosuroides</u> in winter cereals. <u>Proceedings British Crop Protection Conference - Weeds</u>, <u>1</u>, 63-70.

RICHARDSON, W.G. & PARKER, C. (1976) The activity and post-emergence selectivity of some recently developed herbicides: HOE 22870, HOE 23408, flamprop-methyl, metamitron and cyperquat. <u>Technical Report, Agricultural Research Council Weed Research Organization</u> <u>(39)</u>.

RICHARDSON, W.G., DEAN, M.L. & PARKER, C. (1976) The activity and pre-emergence selectivity of some recently developed herbicides: metamitron, HOE 22870, HOE 23408, RH 2915 and RP 20630. <u>Technical Report Agricultural Research Council Weed Research Organization</u> (38)

RICHARDSON, W.G., DEAN, M.L. & PARKER, C. (1977) The activity and selectivity of the herbicides: ethofumesate, RU 12709 and isoproturon. <u>Technical Report Agricultural Research Council Weed Research Organization</u>, <u>(44)</u>.

RICHARDSON, W.G. & PARKER, C. (1978) The activity and selectivity of the herbicides: methabenzthiazuron, metoxuron, chlortoluron and cyanazine. <u>Technical Report Agricultural Research Council Weed Research Organization</u> (50).

WILSON, B.J. & TAYLOR, W.A. (1978) Field trials with controlled drop application of barban and difenzoquat for the control of wild oats (<u>Avena fatua</u> L.) in spring barley. <u>Weed Research</u>, <u>18</u> 215-221.

ZADOKS, J.C., CHANG, T.T. & KONZAK, C.F. (1974) A decimal code for the growth stages of cereals. <u>Weed Research</u>, <u>14</u> 415-421.

NOTES

A REVIEW OF ADAS RESULTS IN 1978 WITH THE CONTROLLED DROP APPLICATION OF HERBICIDES IN CEREALS

R. J. Bailey, R. Kitchen, A. Smartt and J. Roebuck

Agricultural Development and Advisory Service, Cambridge

Summary Normal dosage rates of four post-emergence herbicides (dicamba with mecoprop + MCPA, bromoxynil + ioxynil + dichlorprop, bromoxynil + mecoprop, bromofenoxim with terbuthylazine) were sprayed at very low volumes (20, 40 and 60 l/ha), using a Controlled Drop Application (CDA) method, on broad-leaved weeds in spring barley. Each herbicide was also sprayed at 60, 120 and 200-225 l/ha with conventional hydraulic equipment. In general, the most consistent and reliable results were obtained at 120 and 220-225 l/ha with conventional equipment, the two being equally effective.

Applications of chlortoluron and isoproturon to winter wheat and winter barley, both pre and early post-emergence of the crop, at 40 l/ha (CDA), 120 and 200-225 l/ha (conventional equipment) provided relative blackgrass control of 93.5, 100 and 100 respectively.

INTRODUCTION

The Agricultural Development and Advisory Service has investigated, by means of an experimental programme now completing a third year, the biological effectiveness of a CDA technique for herbicide application in arable crops.

The results of the first two years have been reported previously (Bailey et al, 1978, Evans, 1976, O'Keeffe 1976, Bailey and Smartt 1976) and indicated that conventional volume spraying (200-225 l/ha) gave the most consistent and reliable control of wild oats and broad-leaved weeds in cereal crops. In these trials, CDA resulted in approximately 80% efficiency, relative to conventional spraying, when used at 40 l/ha and even lower efficiency if used at lower volumes. This paper presents a third year's work with CDA in order to investigate the technique under a different set of environmental conditions as imposed by another season and to increase the range of herbicides investigated.

The previous work also gave very tentative indications that low volume spraying with conventional hydraulic booms (not CDA) at 100-120 l/ha resulted in equivalent weed control to that obtained at 225 l/ha. This paper also presents the results of further investigation into this possibility.

METHOD AND MATERIALS

The CDA sprayers used for the trials were constructed by WRO and Cropsafe Limited, and were of the rotating disc type, producing a spray swath of 2.50 metres and a constant drop size of 250 µm diameter

NB. ADAS has also carried out investigations using other CDA sprayers and these are reported elsewhere in these proceedings (Harris, P.B.1978:Phillips M.C.1978)

All experiments were laid down with a randomised block design, there being 3 or 4 replicates per trial. Chemicals were sprayed at various volumes as indicated. The conventional sprayers used for the trials differed between regions, but were of the knapsack type with various nozzles fitted to obtain the volume of application required. Allman 00 and 000 were used at 225 and 120 l/h respectively for the blackgrass work, but for the broad-leaved weed trials, Spraying Systems Tee-jet nozzles 8003, 80015 and 800067 were used for 225, 120 and 60 l/ha respectively.

For broad-leaved weeds, there were differences between groups of workers with regard to the method of assessment of treatment effectiveness, eg the trials were sometimes scored visually on a 0-9 basis and sometimes by counting remaining weeds. For the purpose of this paper, however, all results were transformed to a 0-9 range of score.

The herbicides selected for the experiments were:- dicamba with mecoprop and MCPA, bromoxynil with ioxynil and dichlorprop, bromoxynil with ioxynil and mecoprop, bromofenoxim with terbuthylazine, chlortoluron and isoproturon.

RESULTS

a) Broad Leaved Weed Control in Spring Barley

12 comparisons were executed and the results are presented in Table 1. The figures are not based on a common scale but vary according to which individual was responsible for the assessment. It is therefore only valid to compare figures within the experiment, not between experiments. By this means, we can arrive at a ranking order for each treatment within each trial. An examination of these figures indicates that in every case the best result was obtained by spraying with a conventional hydaulic nozzle rather than a CDA sprayer. Furthermore, it should be noted that the 120 l/ha treatment is as equally effective as the conventional 225 l/ha treatment. The 60 l/ha treatment with the hydraulic nozzle is less effective, (statistically significant, P = 0.05) however. The analysis of variance confirms that each of the three CDA treatments were less effective than conventional spraying (P = 0.01), a result which conforms to our previous conclusions with similar work. It should be remembered, however, that these results merely confirm that CDA was less effective at broad leaved weed control in spring barley, and do not at all reflect on the magnitude of this loss of effectiveness.

b) Blackgrass Control in Winter Cereals

Twelve comparisons were carried out and the results are presented in Table 2. In this case, results have been expressed as a percentage and conclusions can be drawn. The figures indicate that CDA is once again slightly inferior to conventional volume spraying in terms of weed control. However, this difference is not statistically significant, and even if we accept that it may reflect a superiority of the conventional technique, we can see that the performance of CDA has much improved compared with results obtained with broad-leaved weed control. It appears that blackgrass control with soil-applied herbicides lends itself to low volume applications more readily than broad-leaved weed control with herbicides applied through a crop canopy. If we take the mean of our blackgrass results, CDA has resulted in 93% efficiency, relative to conventional spraying, whereas, as reported previously, the spring treatments result in 80% efficiency.

Table 1

Control of broad-leaved weeds in spring barley with CDA and conventional volume spraying - 1978

Herbicide	Region	Date of Application	Dominant Species	Level of Control at Each Volume of Application (ranking order in brackets) 0 = nil control 9 = max weed control					
				CDA			Hydraulic Nozzles		
				20 l/ha	40 l/ha	60 l/ha	60 l/ha	120 l/ha	225 l/ha
Dicamba with mecoprop + MCPA	Yorks/Lancs	22 May	Stellaria media Matricaria spp	7.5 (4)	8.3 (2)	6.8 (6)	7.5 (4)	9.0 (1)	8.3 (2)
" " " "	"	" "	Polygonum spp	6.8 (6)	8.5 (2)	8.2 (3)	7.7 (4)	8.8 (1)	7.5 (5)
" " " "	"	19 May	Matricaria spp Volunteer oil seed rape	6.5 (4)	5.8 (6)	6.5 (4)	7.0 (3)	7.4 (1)	7.4 (1)
Bromoxynil + ioxynil + dichlorprop	"	22 May	Stellaria media Metricaria spp	6.2 (6)	7.5 (4)	8.0 (3)	7.3 (5)	8.5 (2)	9.0 (1)
" " "	"	" "	Polygonum spp	4.7 (6)	5.5 (5)	5.8 (4)	7.8 (2)	8.5 (1)	7.8 (2)
" " "	"	19 May	Matricaria spp Volunteer oil seed rape	5.4 (6)	6.4 (5)	7.2 (3)	6.9 (4)	8.4 (2)	8.5 (1)
" " mecoprop	South East	11 May		6.8 (4)	6.8 (4)	5.9 (6)	7.7 (1)	7.7 (1)	7.7 (1)
Bromofenoxim + terbuthylazine	" "	" "		6.0 (6)	7.3 (4)	6.7 (5)	8.0 (3)	8.2 (2)	8.4 (1)
			TOTALS OF RANKING ORDER	(42)	(32)	(34)	(26)	(11)	(14)

Table 2

Control of blackgrass in winter cereals with CDA and conventional volume spraying

Region	Herbicide	Timing of application	Date of application	Percentage Control at Each Volume of Application 40 l/ha(CDA)	120 l/ha(Conventional)	225 l/ha (Conventional) N.B. Each figure is the mean of three replicates
Eastern	Chlortoluron	Pre-em	20 Oct	88	71	92
"	"	"	" "	68	86	66
"	"	"	" "	67	72	75
"	"	Post-em	30 Nov	93	96	96
"	"	"	" "	43	64	86
"	"	"	" "	12*	55*	69*
"	Isoproturon	Pre-em	20 Oct	84	87	89
"	"	"	" "	87	92	73
"	"	"	" "	72	70	73
"	"	Post-em	30 Nov	97	98	98
"	"	"	" "	90	100	98
"	"	"	" "	65	83	77
			Mean *	77.6	83.5	83.0

* The mean excludes those figures marked with an asterisk as there is reason to suspect a mechanical fault with the CDA. sprayer.

DISCUSSION

The results with broad-leaved weed control (ie herbicides sprayed into a crop canopy in spring) lend support to previous conclusions (Bailey et al, 1978), namely, that CDA at 40 l/ha produces inferior weed control relative to conventional spraying. Although 1978 did not include any work with wild-oat control, previous reports indicate that a similar situation exists.

However, the results with soil-applied blackgrass herbicides are much more promising. In this case, we have the CDA technique giving a mean of 93% control relative to conventional spraying. Furthermore, as the trials showed no statistical differences, we may have a situation in which CDA is as effective as conventional spraying. Clearly, more work is required with these herbicides, as they appear to be ideally suited to low-volume applications.

The results with lower volumes from conventional hydraulic nozzles (120 l/ha) are very promising. Previous work suggested that such a treatment may result in weed control equivalent to conventional treatment, and 1978 results fully support this theory. The blackgrass herbicide treatments provided very good control, such that it is not surprising to observe that a low-volume system for soil applied blackgrass herbicides is already receiving commercial backing, viz Ciba-Geigy 7 gallon system. It is also noted furthermore, that the post-emergence treatments were equally effective at the low volumes of application; in fact, 120 l/ha applications of spring applied foliar acting herbicides to broad-leaved weeds in spring barley were extremely successful. Obviously more work is needed, and we may eventually find that low-volume application of herbicides may safely be employed in many situations, with very efficient results.

Acknowledgements

The authors wish to thank all those responsible for providing equipment and assisting in the experiments.

References

BAILEY, R.J., and SMARTT, A. (1976) The results of a controlled drop application technique for herbicides in cereals. Proceedings 1976 British Crop Protection Conference - Weeds, 2, 383-389

BAILEY, R.J., KITCHEN, R., SMARTT, A., O'KEEFFE, M.G., HARRIS, P. and PHILLIPS, M. (1978) A review of ADAS results in 1976 and 1977 with controlled drop application of herbicides in cereals. Proceedings BCPC Symposium, Controlled Drop Application

EVANS, S.A, and KITCHEN, R. (1976) A comparison of some cereal herbicides applied by fan jets and by a CDA system. Proceedings 1976 British Crop Protection Conference - Weeds, 2, 745-751

HARRIS, P.B., BAWCUTT, D. and OFFER, A. (1978) The application of herbicides to cereals at different volume rates using hydraulic nozzles and spinning disc heads. Proceedings 1978 British Crop Protection Conference - Weeds

O'KEEFFE, M.G., DUDLEY, J. and DICKSON, J.W. (1976) The application of some cereal herbicides by controlled droplet applicator. Proceedings 1976 British Crop Protection Conference - Weeds, 2, 377-381

PHILLIPS, M.C. (1978) A comparison of a field scale controlled drop applicator and a fan jet sprayer for broad-leaved weed control in cereals. Proceedings 1978 British Crop Protection Conference - Weeds

NOTES

Proceedings 1978 British Crop Protection Conference - Weeds

THE FIELD PERFORMANCE OF SOME HERBICIDES APPLIED BY THE MICRODROP (C.D.A.) SPRAYER

O. Grosjean and I. K. Cook

Union Carbide U.K. Limited, Agricultural Chemicals Division, Princes House, Princes Square, Harrogate. HG1 1LW

Summary The performance of six hormone based herbicides applied at 20 l/ha by a Microdrop sprayer was compared with that achieved by conventional medium volume spraying in a series of large-scale trials conducted in 1977 and 1978. There was little difference in overall weed control although control of some of the more resistant weeds was poorer with the Microdrop sprayer. Further trials designed to exploit the potential advantage of increased flexibility in timing offered by the Microdrop sprayer are advocated.

INTRODUCTION

During 1976, a range of hormone herbicides was applied using a kit-form Microdrop C.D.A. sprayer at a volume rate of 20 l/ha. A comparison was made with a conventional fan-jet sprayer applying the same herbicides at a volume rate of 314 l/ha. Five randomized block design trials were conducted in winter wheat.

Results were considered to justify continued technical development of the Microdrop sprayer (Farmery et al, 1976).

This paper reports trials conducted in 1977 and 1978 with the tractor-mounted prototype model of the Microdrop sprayer.

METHOD AND MATERIALS

The prototype Microdrop sprayer is fitted with 16 spinning disc units each receiving 170 ml. liquid/minute to apply, at a forward speed of 8 Km/h, a total volume of 20 l/ha with a drop size range of 250 - 300 µm (Farmery, 1978). For 1977 trials the sprayer was fitted with double disc units but in 1978, triple disc units, to produce improved droplet uniformity, were used.

In both 1977 and 1978 the efficacy of a range of hormone type herbicides was assessed through the C.D.A. equipment in comparison with conventional farm sprayers operating at 200 - 225 l/ha. The trials were sited on farms in East Anglia and Yorkshire. All trials were non-replicated and consisted of a series of parallel adjacent strips, alternating each application method, one spray swath wide (10 m in the case of the Microdrop prototype) and at least 200 m long. Each chemical tested was applied by both methods of application in adjacent paired strips.

Conventional applications were made using farm sprayers, a note being made of the volume applied per hectare.

Eight trials (three winter wheat, five spring barley) were laid down in 1977. In each trial normal production formulations were tested as shown in Table 1.

Table 1

Herbicides used in 1977 trials

	g. a.e./ha
MCPA K salt	1400
MCPA dimethylamine salt	1425
2, 4-DP/MCPA K salts	1865/935
CMPP K salt	2490
CMPP/dicamba K salts	1848/115

Biological efficiency was measured by assessing weed population using quadrat counts at spraying and eight weeks after spraying and then calculating percentage kill.

Eight trials were again laid down in 1978 (two winter wheat, six spring barley) using the herbicides shown in Table 2.

Untreated areas were left in each plot and weed populations were assessed using quadrat counts after eight weeks. Percentage kill was calculated using assessments of weed populations in treated and untreated areas. These assessments were supported by visual scoring on a 0 - 10 basis, 0 indicating no effect and 10 indicating excellent control.

Table 2

Herbicides used in 1978 trials

	g. a.e./ha
MCPA K salt	1400
CMPP K salt	2490
CMPP/dicamba K salts	1848/115
2, 4-DP/MCPA K salts	1865/935
dicamba/CMPP/MCPA Na/K salts (Banlene Plus)	(5 l/ha formulation)

RESULTS

1977 Trials

The cold, wet and windy weather during the 1977 spraying season provided stringent testing conditions for a novel application method. The formulations tested presented no problems in mixing and application at 20 l/ha.

Considering overall weed control the results indicated that the Microdrop sprayer was marginally inferior to conventional sprayers (Table 3) except with the CMPP/dicamba formulation. Considering all formulations tested 79.4% and 80.4% average levels of weed control were obtained with the Microdrop and conventional sprayers respectively. If, however, the control of more resistant weeds is selected out (Table 4) the Microdrop sprayer is more markedly inferior. An average 67.8% control was obtained compared with 74.5% with conventional spraying. No crop phytotoxicity was detected with any treatment.

TABLE 3

MEAN PERCENTAGE WEED CONTROL OF ALL SPECIES - 1977

(8 sites)

Herbicide	Method of Application Microdrop	Conventional
MCPA K salt	77	77
MCPA dimethylamine	74	76
2, 4-DP/MCPA K salts	80	82
CMPP K salt	82	86
CMPP/dicamba K salts	84	81

TABLE 4

MEAN PERCENTAGE WEED CONTROL OF INDIVIDUAL SPECIES - 1977

Weed species (no. of comparisons)	2, 4-DP/MCPA K salts		CMPP K salt		CMPP/dicamba K salts	
	Microdrop	Conventional	Microdrop	Conventional	Microdrop	Conventional
Stellaria media (5)	46	56	54	69	62	79
Polygonum aviculare (6)	73	75	80	80	86	90
Anthemis cotula (3)	69	76	78	63	65	82
Veronica arvensis (3)	63	64	67	85	62	66

TABLE 5

WEED CONTROL MEANS OF ALL SPECIES - 1978

Herbicide	Number of Comparisons	Mean percentage weed control Method of application Microdrop	 Conventional	Visual Score (0 - 10) Microdrop	 Conventional
MCPA K salt	2	68.5	85.5	7.5	8.5
CMPP K salt	8	78.4	72.4	7.6	7.1
CMPP/dicamba K salts	8	84.1	83.5	7.9	8.1
2, 4-DP/MCPA K salts	2	90	94	8.8	9.0
dicamba/CMPP/MCPA Na/K salts	3	90.3	95	8.8	8.2

TABLE 6

MEAN PERCENTAGE WEED CONTROL OF INDIVIDUAL SPECIES - 1978

Weed Species	CMPP K salt		CMPP/dicamba K salts		dicamba/CMPP/MCPA Na/K salts	
	Microdrop	Conventional	Microdrop	Conventional	Microdrop	Conventional
Stellaria media	91(3)	97(3)	89(3)	90(3)	-	-
Polygonum aviculare	83(7)	85(7)	73(7)	86(7)	76(3)	96(3)
Polygonum convolvulus	64(2)	64(2)	91(2)	92(2)	-	-
Anthemis cotula	79(4)	96(4)	94(4)	89(4)	-	-

( ) number of comparisons

1978 Trials

Considering all results (Table 5) there was virtually no difference in terms of average overall weed control either on a weed count or visual score basis. Average weed control with the Microdrop and conventional sprayers was 82.1% and 82.2% respectively, the corresponding visual scores being 8.0 and 7.9.

As in 1977, the control of more resistant weeds was inferior with the Microdrop at 81.8% compared to 88.5% with conventional spraying.

Transient scorch was noted in three trials with all formulations tested through the Microdrop. However, there were no subsequent effects in terms of time of ear emergence or ear deformity.

A reduction in drift with the Microdrop sprayer when compared to conventional sprayers was observed on several occasions during both years.

DISCUSSION

The potential advantages of the C.D.A. technique for the application of herbicides have already been well documented. To date several trials have been conducted with the prototype Microdrop sprayer, including the series described in this paper, based on comparisons with conventional sprayers used on the same day (Lush and Palmer, 1976; Mayes and Blanchard, 1978).

Results with essentially translocated herbicides applied through prototype sprayers fitted with triple-disc units indicate that weed control is slightly inferior to that obtained with conventional spraying but, nevertheless, commercially acceptable.

Because of the reduced drift hazard associated with the Microdrop sprayer it is highly likely that the number of suitable spraying days in any given season will be increased.

It is suggested that future trials should be designed to exploit this potential advantage by comparing herbicides applied at the most suitable time for maximum performance allowed for by respective machinery.

Acknowledgements

The authors wish to thank Horstine Farmery Limited for the use of a prototype Microdrop sprayer and Mr. R. Makepeace for advice on trials' design.

References

FARMERY, H. (1978) Development of the Microdrop C.D.A. sprayer. Proceedings British Crop Protection Council Symposium Controlled Drop Application, Monograph 22, 107-109.

FARMERY, H., PECK, A. and GROSJEAN, O. (1976) Potential and design of C.D.A. from an engineer's viewpoint. Proceedings 1976 British Crop Protection Conference - Weeds, 369-376

LUSH, G.B. and PALMER, R.A. (1976) Field trials comparing the biological effectiveness of Controlled Drop Application with convential hydraulic pressure spraying Proceedings 1976 British Crop Protection Conference - Weeds, 391-398

MAYES, A.J., and BLANCHARD, T.W. (1978) The performance of a prototype Microdrop (C.D.A) sprayer for herbicide application. Proceedings of British Crop Protection Council Symposium Controlled Drop Application (Monograph 22)171-178

Proceedings 1978 British Crop Protection Conference - Weeds

THE APPLICATION OF HERBICIDES TO CEREALS AT DIFFERENT VOLUMES USING HYDRAULIC NOZZLES AND SPINNING DISC HEADS

P.B. Harris

Bridgets Experimental Husbandry Farm, Martyr Worthy, Winchester, Hampshire SO21 1AP

D.E. Bawcutt, A.R. Humphrys and A.L. Offer

Agricultural Development and Advisory Service, Winchester

Summary Two experiments comparing two herbicides applied at a range of volumes from 25 to 200 l/ha were carried out at Bridgets Experimental Husbandry Farm on wheat and barley using a tractor mounted rig fitted with spinning disc heads and hydraulic nozzles on separate booms to apply the different volumes. The same rig was used on nine farms in Hampshire to compare several herbicides over a smaller range of volumes of application mostly in spring barley. Weed control was generally satisfactory with all volumes except 25 l/ha using spinning discs in some situations but from the assessments made weed control tended to be better using hydraulic nozzles. The indications from the work carried out were that using these nozzles volumes of application could be reduced to 50 or 100 l/ha without loss of efficiency. Reducing the active ingredient used by 50% in some trials had variable effects.

INTRODUCTION

In 1977 a spraying test rig based on a commercial tractor mounted sprayer was constructed at Bridgets E.H.F. to compare the efficiency of hydraulic nozzles and unshrouded spinning disc heads for applying herbicides at different volumes. This was designed by Rutherford of the ADAS Liaison Unit N.I.A.E. (1978). In 1977 the rig was evaluated by using two herbicides at different volumes of application in a crop of spring barley and the results of this were summarised by Harris (1977).

In 1978 this rig was modified by replacing the 10 electrically driven single disc Micron Herbi heads by 3 electrically driven Micron Battleship heads with a solenoid controlled flow at 2.0 m centres to cover the same 6.0 m width. Drop size produced by these units is in the range 160 - 220 microns at a disc speed of 3000 r.p.m. and a flow rate of 1.0 l/min.

In order to examine the efficiency of application of herbicides by these heads at volumes of 25 and 50 l/ha compared to volumes of 50, 100 and 200 l/ha applied by hydraulic nozzles a series of trials was carried out in 1978 in winter wheat and spring barley at Bridgets E.H.F. near Winchester, Hants and on some farms in the vicinity. These are summarised in Table 1.

Table 1

Details of trials in 1978

Site	Crop	Principal weeds	Herbicide	Volume of application l/ha	Method of application	Herbicide dose rate a.i.
Bridgets EHF	Winter wheat	G. aparine P. rhoeas P. convolvulus	Ioxynil/ mecoprop (Actril C)	25 50 50 100 200	disc heads " hydraulic nozzles " "	2.5 kg/ha
Bridgets EHF	Spring barley	P. aviculare P. convolvulus	Ioxynil/ mecoprop (Actril C)	25 50 50 100	disc heads " hydraulic nozzles "	2.1 kg/ha
			Dicamba/ mecoprop/MCPA (Banlene Plus)	 200	" "	100g/470g/ 1.4 kg/ha
2 sites Easton Manor Fm Hookpit Fm Kings Worthy	Spring barley	S. arvensis P. convolvulus P. aviculare C. album	Dichlorprop (2, 4 - D P)	50 50 200	disc heads hydraulic nozzles "	2.7 kg/ha
3 sites Woodmans Fm* Manor Fm East Stratton	Spring barley	S. arvensis P. aviculare P. convolvulus C. album	Bromoxynil/ ioxynil dichlorprop/MCPA (Tetroxone)	50 50 200	disc heads hydraulic nozzles "	140g/ 140g/ 1.7 kg/ 540 g/ha
2 sites Itchen Down Fm	Spring barley	C. album P. convolvulus G. tetrahit P. aviculare	Mecoprop (CMPP)	50 50 200	disc heads hydraulic nozzles "	1.9 kg/ha
1 site Robeys Fm Brown Candover	Spring barley	S. media P. aviculare T. maritimum	Dicamba/ mecoprop/ MCPA (Banlene Plus)	50 50 200	disc heads hydraulic nozzles "	90g/ 420g/ 1.26kg/ha

*At this farm the two lower volumes were applied with only one quarter of the stated a.i. per ha.

In the trials at Bridgets E.H.F. the three herbicides used at the different volumes were applied both at the 100% dose rate shown in the table and at a 50% dose rate.

METHOD

The spraying rig was mounted on a 50 hp tractor. Nozzle sizes, pressures and forward speeds used are given in Table 2 together with calibrated outputs from the different heads and nozzles. The herbicide used was generally selected according to the weeds present. The concentration of the spray liquid was changed to apply to the appropriate amount of water and herbicide for each treatment.

Table 2

Details of pressures, forward speeds and outputs

Volume of application l/ha	Method of application	Teejet No	Pressure bar	Forward speed km/hr	Head/nozzle output ml per min
25	disc heads	-	1.4	9.6	1000
50	" "	-	1.4	6.1	1000
50	hydraulic nozzle	800067	2.5	8.5	250
100	" "	800067	2.5	4.5	250
100	" "	80015	2.5	8.5	500
200	" "	8003	2.5	8.5	1000

In all the trials each treatment was replicated three times. Plot size in the experiments at Bridgets E.H.F. was 120 sq m and at the farm sites 180 sq m. In the former untreated plots were included in the randomisation; in the latter untreated strips of 21 sq m were left in each plot by covering the crop with a plastic sheet before spraying.

Spraying was carried out generally under dry conditions with little wind at the correct stage of growth of the crop before stem elongation during mid-May.

Assessments of the effects of treatments were carried out at all sites about 4 - 6 weeks after spraying by visual scoring by 1 or 2 persons per plot in the Bridgets E.H.F. trials and by 3 persons per plot in the trials on other farms. Also at Bridgets E.H.F. in both trials cuts 1 m x 10 m long were made in the centre of each plot by a reciprocating mower close to ground level. The cut swath was then sampled and dissected to ascertain the relative content of broad leaved weeds for the different treatments on a dry matter basis. Grain yields will also be taken on these two trials.

RESULTS

Bridgets E.H.F. - winter wheat

The results of the scores for scorch and weed infestation and dry matter assessments made on this trial are shown in Table 3.

Table 3

Effect of treatments on winter wheat Bridgets E.H.F.

Volume & method of application	Percentage scorch score 100% dose rate	Percentage scorch score 50% dose rate	Percentage weed infestation score* 100% dose rate	Percentage weed infestation score* 50% dose rate	Dry Matter wt of weeds as percentage of untreated 100% dose rate	Dry Matter wt of weeds as percentage of untreated 50% dose rate
	(± 4.3)		(± 6.2)		(± 7.8)	
Untreated	0		100		100	
25 l/ha discs	27	30	57	57	10	8
50 l/ha discs	20	3	47	80	9	39
50 l/ha nozzles (800067)	33	10	57	57	20	16
100 l/ha nozzles (800067)	37	3	47	60	9	23
100 l/ha nozzles (80015)	27	3	27	70	3	27
200 l/ha nozzles (8003)	7	0	33	77	12	17

* (0 - no infestation
100 - complete infestation)

Application of the herbicide resulted in scorching of the wheat plants at all volumes of application less than 200 l/ha at the 100% dose rate. It was worse at the 50 l/ha rate where hydraulic nozzles were used than where disc heads were used. At the 50% dose rate scorching was significantly greater than in the untreated wheat only at the 25 l/ha rate. The scorching was transient and disappeared within a week or two. All treatments killed weeds. The 100 l/ha rate of application using 80015 nozzles gave a better kill than all the lower volumes where the 100% dose rate was used. Reducing the dose rate to 50% resulted in increased weed infestation at some application volumes. From the weed dry matter assessment all volumes of application were as effective as 200 l/ha at the 100% dose rate with the 100 l/ha (80015 nozzles) giving rather better results than 50 l/ha (800067 nozzles). Reducing the dose rate to 50% gave as good results at all volumes except 50 l/ha (discs) and 100 l/ha (80015 nozzles).

Bridgets EHF - spring barley

The results of treatments in this trial are shown in Table 4. There was no scorching of the barley.

Table 4

Effects of treatments on spring barley Bridgets EHF

Volume & method of application	Percentage weed infestation score* Ioxynil/mecoprop 100% dose rate	50% dose rate	Dicamba/mecoprop/MCPA 100% dose rate	50% dose rate	Dry matter wt of weeds as percentage of untreated Ioxynil/mecoprop 100% dose rate	50% dose rate	Dicamba/Mecoprop/MCPA 100% dose rate	50% dose rate
	(+ 0.83)				(± 10.8)			
Untreated	93				100			
25 l/ha discs	67	73	47	52	28	52	4	8
50 l/ha discs	38	60	27	38	5	19	6	2
50 l/ha (800067 nozzles)	27	42	13	22	9	3	1	2
100 l/ha (800067 nozzles)	22	50	18	32	1	4	1	1
100 l/ha (80015 nozzles)	22	38	12	25	0	13	0	0
200 l/ha (8003 nozzles)	28	37	22	38	1	2	0	2

*(0 - no infestation
100 - complete infestation)

Using ioxynil/mecoprop at the 100% dose rate all volumes above 25 l/ha gave similar control of weeds of over 70%. Reducing the concentration by half resulted in a greater weed infestation but the difference was significant only at 100 l/ha applied with 800067 nozzles. Using the dicamba mixture similar results were obtained.

Where the assessment was made on the basis of weed dry matter recovered all treatments gave as good control of weeds as each other either at the 100% or 50% dose rate for the two herbicides except that at 25 l/ha using the spinning disc heads ioxynil/mecoprop gave rather poorer results especially where the 50% dose rate was used.

Farm Trials

These are grouped according to herbicide used and the results of treatments on spring barley are set out in Table 5.

Table 5

Results of trials on spring barley on 8 Hampshire farms

Sites grouped according to herbicide used	Volume of application	Percentage weed infestation score* Herbicide applied	Untreated	Percentage reduction by herbicide
		(VI ± 0.32; H: ± 0.29)		
Dichlorprop (2 sites)	50 l/ha discs	20	48	58
	50 l/ha (800067 nozzles)	20	51	61
	200 l/ha (8003 nozzles)	18	46	61
		(VI ± 0.27; H: ± 0.25)		
Bromoxynil/ ioxynil dichlorprop/MCPA (3 sites)	50 l/ha discs	14	49	71
	50 l/ha (800067 nozzles)	6	47	87
	200 l/ha (8003 nozzles)	2	46	96
		(VI ± 0.25; H: ± 0.25)		
Mecoprop (2 sites)	50 l/ha discs	23	44	48
	50 l/ha (800067 nozzles)	20	53	62
	200 l/ha (8003 nozzles)	21	51	59
		(VI ± 0.47; H: ± 0.31)		
Dicamba/mecoprop MCPA	50 l/ha discs	14	38	63
	50 l/ha (800067 nozzles)	11	41	73
	200 l/ha (8003 nozzles)	15	47	68

*(0 - no infestation; 100 - complete infestation)

Using dichlorprop on spring barley weed infestation was reduced to a lower level by use of the highest spray volume but the percentage reduction showed little difference between this and the 50 l/ha rate using hydraulic nozzles or disc heads.

In the next group of sites using bromoxynil/ioxynil mixture weed control was rather better and here weed infestation was at its lowest level where the highest volume of spray was used and worst where the spinning disc heads were used to apply controlled drops. In terms of the percentage reduction of weeds also the 200 l/ha rate was the best. This was so even if the one site where a reduced concentration of herbicide was applied at the lower volume is ommitted.

At the two sites where mecoprop was used the use of hydraulic nozzles gave slightly lower weed infestations than the use of the disc heads and the reduction in the amount of weeds was also higher. It was as good with 50 l/ha as with 200 l/ha.

Finally at the one site where a dicamba mixture was applied the CDA method and the highest rate resulted in the lowest weed infestation but the reduction due to the herbicide was best following the use of 50 l/ha volume applied by the 800067 nozzles.

Over all sites the percentage reduction of weed infestation following spraying was:-

50 l/ha disc heads	61%
50 l/ha (800067 nozzles)	71%
200 l/ha (8003 nozzles)	74%

One trial was also carried out on winter wheat at Itchen Down Farm and this resulted in percentage weed reductions of:-

50 l/ha disc heads	61%
50 l/ha (800067 nozzles)	87%
200 l/ha (8003 nozzles)	74%

DISCUSSION

Scorching of the cereals was only severe in one case on the trial on winter wheat at Bridgets. This was Maris Huntsman variety and scorching was only transient, but it was obviously worse at volumes lower than 200 l/ha. There was little drift the day the treatments were applied and with the material used this may have accentuated the effect but if the use of lower volumes of water is to be extended this is a problem that will have to be studied further.

For this series of trials days were selected when there was little wind in or order to minimise the risk of drift of treatments over plot boundaries. Spray drift is another associated factor that requires further investigation especially at the lower volumes used in these trials.

The efficiency of the herbicides in the winter wheat was better at the 100 l/ha volume of application (80015 nozzles) than at lower volumes and this was at least as good as the 200 l/ha rate. Reducing the concentration to 50% of the recommended dose rate gave poorer weed control at these volumes of application. Weeds in this trial were well grown and were probably at a fairly resistant stage. With the two herbicides used in spring barley only application at the lowest volume using spinning disc heads appeared to reduce the effect of the herbicide. The assessments showed that all other volumes could be used to as good effect as the highest even at half the dose rate in some cases.

The trials on local farms tended to show that all the three volumes of application used gave satisfactory weed control over a range of herbicides and different field and weed situations. Overall there was some indication that the use of the disc heads was not as effective as the use of hydraulic nozzles applying the same volume but that the latter gave as good control of weeds as where four times the volume of spray was used.

Acknowledgements

Acknowledgement is made of the work of staff at Bridgets E.H.F. in construction and operation of the spraying rig used and in carring out the experiments described. Thanks are due to the several farmers who allowed the use of their fields for trials and also to the Department of Statistics, Rothamsted Experimental Station for statistical analysis of the data.

References

HARRIS, P.B. (1977) Mixed results with CDA spraying. Arable Farming.

RUTHERFORD, I. (1978) The design and construction of a machine to compare CDA and hydraulic nozzles on a field scale. Proc. British Crop Protection Council Symp. Monograph 22. 111-115