SESSION 4C

CEREALS – THE IMPORTANCE OF WEED SPECIES AND CONTROL THEREOF

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EFFICACY OF TRALKOXYDIM FOR CONTROL OF APERA SPICA-VENTI AND AVENA FATUA IN CEREALS IN POLAND

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ABSTRACT

Two years trials results are presented for Apera spica-venti and Avena fatua control in cereals with tralkoxydim (PP604 100 g/l EC formulation - trademark "Grasp"). Tralkoxydim was applied both alone and in mixtures with broad leaved weed herbicides MCPA, 2,4-D, pyridate, fluoroxypyr, chlorsulfuron, diflufenican and CGA 131036. There was no antagonism of tralkoxydim activity against Apera spica-venti control in mixture with these herbicides with the exception of chlorsulfuron and CGA 131036.

INTRODUCTION

Apera spica-venti (Silky Bent) is a weed infesting 3 million ha of winter cereals in Poland. More than 1 million ha are heavily infested, causing 15-30% grain losses. Avena fatua (Wild Oat) is a problem of approximately 100,000 ha of cereals, mainly in spring barley and wheat. Polish farmers are interested in extending the choice of selective herbicides for grass weeds control. They particularly require products compatible with BLW (Broad Leaved Weed) herbicides.

MATERIALS AND METHODS

Trials were carried out in 1986 and 1987 on degraded black soils around Wroclaw. Plot trials of $25m^2$ in 3 replicates were sprayed in spring by knapsack sprayer. Dosage rates are given in Table I and II. Spray volume was 500 l/ha. Herbicide activity on the crop and weeds was assessed according to European Weed Research Scheme method.

RESULTS

Results of trials in which A.spica-venti dominated are given in Table I. In 1987 very good activity was obtained with tralkoxydim alone and in mixture with the BLW herbicides with the exception of mixtures with chlorsulfuron and CGA 131036. For these two mixtures the efficacy of tralkoxydim was significantly reduced. In this trial herbicidal treatments produced significant yield increases (TableI).

Similar weed control activity was confirmed in other large scale trials which, however, were not taken to yield

The effect of A.spica-venti control in winter barley was significantly reduced because when the product was applied the growth stage of barley was advanced (height 15-20 cm) sheltering most of the weeds, so that much of the spray was retained on the barley leaves.

Both wheat and barley trials showed good efficacy of the herbicide mixtures against broad leaved weeds. Dominant weeds were Stellaria media, Gallium aparine, Anthemis arvensis, Tripleurospermum inodorum and Lamium spp. No antagonism of broad leaved weed control occurred.

Table II shows the efficacy of tralkoxydim against A.fatua. The results are the average of 2 years weed control for spring barley. Unfortunately grain yields are not high but this is characteristic of those regions of heavy A.fatua infestation. Nevertheless under these conditions after treatment with efficient herbicides a significant yield increase was obtained over untreated plots.

In the trial with winter wheat (Table II) slightly better A.fatua control with tralkoxydim was obtained when the herbicide was applied at the second timing of application, but there was no significant difference in yield compared to the untreated plots. This probably means that healthy winter wheat competed effectively with A.fatua. The broad leaved weed infestation in these trials was low and therefore the addition of MCPA or 2,4-D did not influence yields.

TABLE 1

Efficacy of A.spica-venti control in winter cereals

Herbicides	Rate g/ha ai	Milejowice 1987 Winter Wheat Yield t/ha	% Apera control	Oporow 1987 Winter Barley Yield	% Apera control
Control	-	5,68	82[xx]	4,05	67[xx]
Tralkoxydim	300	6,90	99	4,67	36
Tralkoxydim/MCPA	250/1200	6,88	96	4,74	49
Tralkoxydim/fluroxypyr	250/250	6,68	96	5,11	40
Tralkoxydim/diflufenican	250/400[x]	7,01	96	4.57	55
Tralkoxydim/pyridate	250/140	6.83	99	4.47	31
Tralkoxydim/CGA 131036	250/ 75[x]	6.98	66	4.54	51
Tralkoxydim/chlorsulfuron	250/ 10[x]	6.98	71	4.58	33
Date of treatment		24.04.87		24.04.87	

x - formulated product
xx - Number of A.spica-venti heads/m^2
Wheat GS 30, Barley GS 32, A.spica-venti GS 14,22

TABLE 2

A.fatua control in cereals

Herbicides	Rate g/ha ai	Lesnicaice 1987 Winter Wheat Yield	% A.fatua control	Sulecin 1986 and 1987 Spring barley Yield	% A.fatua control
Control	-	4,75	169[x]	2,53	78[x]
Trial 1					
Tralkoxydim	250	4,98	87	3,19	82
Tralkoxydim	300	4,85	7	3,27	97
Tralkoxydim/2,4-D	250/1500	4,68	84	2,95	81
Tralkoxydim/MCPA	250/1500	4,78	81	3,40	86
Diclofop methyl	840	4,72	90	3,24	96
Trial 2					
Tralkoxydim	250	4,85	96	3,84	95
Tralkoxydim/2,4-D	250/1500	4,92	78	3,79	80
Tralkoxydim/MCPA	250/1500	4,60	90	3,87	83

Treatment Dates and Growth stages	Trial 1 7.05.87 Wheat GS 14,22	Trial 1 15.05.86 & 87 Barley GS 13,21
	Trial 2 18.05.87 Wheat GS 32	Trial 2 26.05.86 & 87 Barley GS 14.22

A.fatua GS between 13 and 14,22

x - Number of A.fatua heads/m^2

DISCUSSION

In the last few years a significant increase in grass weed infestations in cereals has been observed. This tendency is as forecast in earlier years (Rola 1968, Rola 1976). Variation in climatic and soil conditions in Poland often hinder correct crop husbandry, and create good conditions for weed growth. Moreover in such situations the efficacy of even good herbicides is not reliable. Therefore, products with broad timing of application and which can be tank-mixed with chemicals against broad-leaved weeds are increasingly required. Based on the above trials it seems that tralkoxydim might be such a herbicide. Next seasons's trials should confirm that tralkoxydim is useful for weed control in cereals under Polish conditions.

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COMPETITION BETWEEN BLACK-GRASS (ALOPECURUS MYOSUROIDES) AND WINTER WHEAT

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ABSTRACT

In two field experiments different densities of *Alopecurus myosuroides* were established in winter wheat crops sown in October. Crop and weed dry weights were determined on several occasions during the life of the crop by sampling within each plot. Growth stages, crop and weed densities and crop yields were also recorded. Weed competition had a detectable effect on crop growth earlier in the growing season the greater the weed density. Effects of black-grass on crop growth prior to April were relatively small, but increased rapidly between April and June. Total biomass of crop + weed in June was similar for all black-grass densities on each experiment. This suggests that black-grass and wheat compete for the same resources and that competition is by direct replacement. All densities of black-grass (30 - 6000 plants/m^2) reduced crop yields. Densities of 250 - 500 black-grass plants/m^2 reduced yields by about 45% while the highest weed density reduced yield by 66%, or over 6 t/ha. Black-grass competition reduced crop head densities and numbers of grains/ear but had no effect on 1000 grain weights.

INTRODUCTION

In winter cereal crops about 80% of seedling emergence of black-grass (*Alopecurus myosuroides*) occurs during the autumn, from August to November (Moss 1982). Since most winter cereal crops are sown in September or October, crop and weed emergence often coincides. Black-grass plants usually develop at the same, or at a slightly slower rate than the cereal until the spring, when black-grass development becomes much more rapid (Wallgren & Aamisepp 1977). The aim of most weed control measures is to prevent crop and weed competition, thus it is important to know at what stage black-grass interferes with crop growth so that timely control measures can be used. Two experiments were conducted in which winter wheat crops were grown alone or in combination with black-grass so that the competitive effects of this weed could be assessed.

MATERIALS AND METHODS

Two field experiments at the AFRC Weed Research Organization, Oxford, comprised a randomised block design with four replicates. Plots were 21.5 x 5 m (Experiment 1) or 10 x 3 m (Experiment 2). Treatments consisted of three black-grass seed rates (Experiment 1) or twelve factorial combinations of three crop and four black-grass seed rates (Experiment 2). As there were no major interactions between crop and black-grass seed rates, only pooled results for the three crop seed rates are presented here. Results showing the effect of crop seed rate on black-grass competition have been published elsewhere (Moss 1985).

There was no natural black-grass infestation in either field so seeds were broadcast prior to drilling the crop. The black-grass seed rates were: Nil, 570 (Low) and 4570 (High) seeds/m^2 (Experiment 1) and Nil, 270 (Low), 1350 (Medium), and 13500 (High) seeds/m^2 (Experiment 2). Winter wheat (cv. Flanders) was drilled at a seed rate of 350 kg/ha on 15 October 1982 (Experiment 1) and at 54, 141 and 232 kg/ha on 5 October 1983 (Experiment 2). A commercial farm drill with 12 cm row spacing was used.

All plots were ploughed and cultivated prior to the start of each experiment. A compound fertilizer supplying 15 kg N/ha, 71 kg P_2O_5/ha and 71 kg K_2O/ha was applied to each seedbed prior to drilling. N top dressing was applied twice in spring - 50 kg N/ha in mid March and 110 kg N/ha in mid April each year. Broad-leaved weeds were controlled by applying mecoprop and either bifenox or ioxynil + bromoxynil. Fungicides were applied as necessary.

Samples of crop and weed were collected from each plot on six (Experiment 1) or five (Experiment 2) dates between November and June (Figs. 1 & 2). At each date, all black-grass and crop plants were removed from within four (Experiment 1) or one (Experiment 2) random quadrats per plot. Quadrats were 50 x 50 cm and were aligned so that four rows of crop were collected for each sample. Black-grass and wheat plants were separated and washed to remove soil. Assessments consisted of numbers of plants or heads, growth stages and dry weight of crop and black-grass after drying at 100 ^{o}C for 20 h. Crop grain yields were obtained in early August by sampling four (Experiment 1) or two (Experiment 2) 50 x 50 cm random areas within each plot. Grain samples obtained using a static plot thresher were sieved over a 2.00 mm sieve, dried and weighed. Yields were corrected to 85% dry matter. Grains/ear and 1000 grain weights were obtained by selecting 20 crop heads at random from the harvested samples. These were threshed separately and grains counted, dried and weighed.

RESULTS

In both experiments, growth stages at assessment dates were: November - black-grass 1-3 lvs, crop 2-4 lvs; April - black-grass 2-6 tillers, crop 2-3 tillers; May - black-grass 3-4 nodes (30-40% heads emerged), crop 3-4 nodes (no heads emerged).

Populations of wheat and black-grass

Crop plant populations were not significantly ($P \leqslant 0.05$) affected by the presence of black-grass in either experiment (Tables 1 & 2). The higher the black-grass population, the lower the number of wheat heads produced. The highest black-grass populations in Experiment 2 reduced wheat head densities by about 50%. Differences in black-grass head populations were smaller than differences in black-grass plant populations. At low weed densities, about 5 black-grass heads/plant were produced (head numbers/plants numbers in April). In contrast, at the highest weed density in Experiment 2, less than 1 black-grass head/plant was produced.

Wheat grain yields

Crop grain yields were reduced substantially by weed competition (Tables 1 & 2). Black-grass densities in the range 250 - 500 plants/m^2. reduced yields by about 45%. At the highest weed infestation in Experiment 2, a crop yield loss of over 6 t/ha (66%) was recorded. Effects on yields were due to large reductions in numbers of crop heads and smaller reductions in numbers of grains/ear. There was little adverse effect on 1000 grain weight.

TABLE 1

Experiment 1 Crop and black-grass populations/m^2, crop yield (t/ha) and yield components

Sown black-grass density ...	Wheat Nil	Low	High	S.E.±	Black-grass Low	High
Plants						
18 Nov. 1982	408	399	403	7.18	31	272
5 April 1983	455	468	440	13.85	44	262
Heads						
27 June 1983	739	684	488	28.50	220	580
Crop grain yield						
2 Aug. 1983	6.69	6.21	3.73	0.21		
Grains/ear	30.6	29.5	27.1	0.50		
1000 grain weight	36.4	36.2	39.8	0.69		

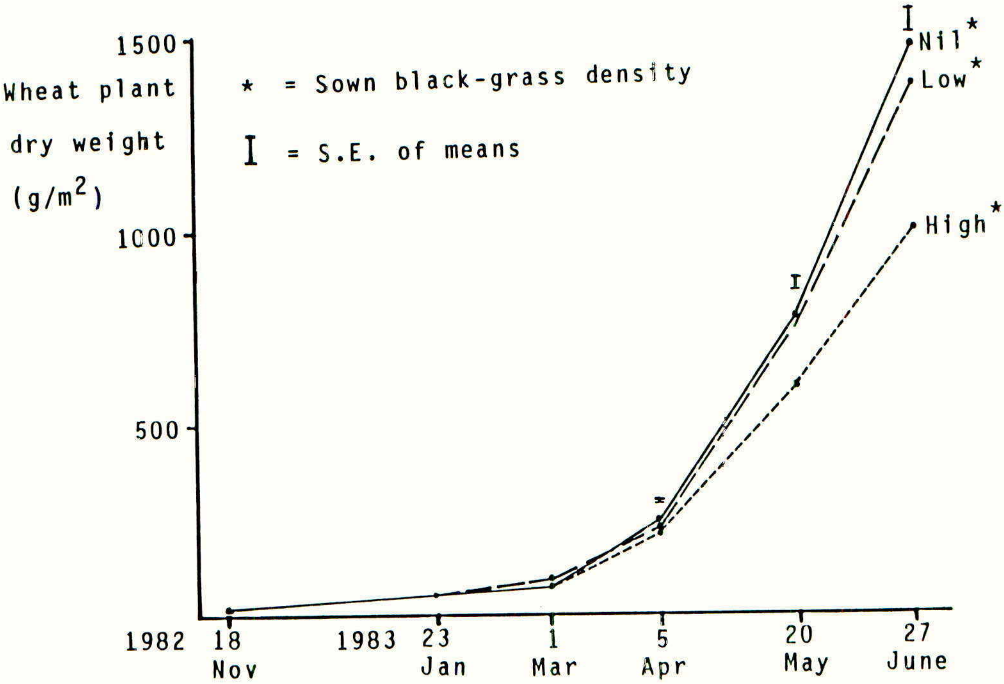
TABLE 2

Experiment 2 Crop and black-grass populations/m^2, crop yield (t/ha) and yield components

Sown black-grass density ...	Wheat Nil	Low	Med	High	S.E.±	Black-grass Low	Med	High
Plants								
28 Nov. 1983	303	313	314	313	8.35	83	497	6047
3 April 1984	292	301	296	270	9.48	110	451	4163
Heads								
27 June 1984	597	567	443	291	15.25	531	1607	3192
Crop grain yield								
6 Aug. 1984	9.62	7.19	5.30	3.26	0.16			
Grains/ear	37.4	32.9	30.8	27.8	0.59			
1000 grain weight	52.2	49.7	49.7	50.0	0.72			

FIGURE 1

Experiment 1 Effect of black-grass density on winter wheat growth (g plant dry weight/m^2) between November and June



Sampling date

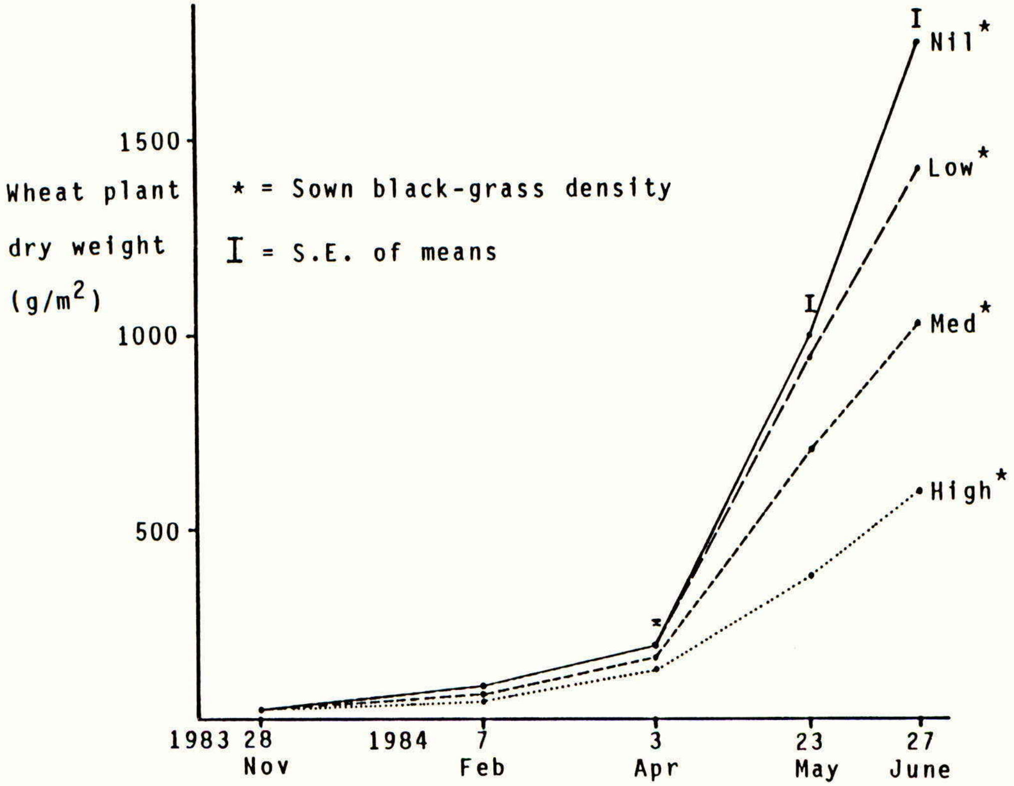
TABLE 3

Experiment 1 Proportional contribution of wheat and black-grass to total biomass in January and June 1983

	23 January			27 June		
Sown black-grass density ...	Nil	Low	High	Nil	Low	High
Black-grass	0%	2%	11%	0%	10%	29%
Wheat	100%	98%	89%	100%	90%	71%
(Total g/m2)	(48.2)	(51.9)	(55.0)	(1486)	(1528)	(1405)

FIGURE 2

Experiment 2 Effect of black-grass density on winter wheat growth (g plant dry weight/m^2) between November and June



Sampling date

TABLE 4

Exeriment 2 Proportional contribution of wheat and black-grass to total biomass in February and June 1984

	7 February				27 June			
Sown black-grass density ...	Nil	Low	Med	High	Nil	Low	Med	High
Black-grass	0%	5%	20%	64%	0%	15%	40%	59%
Wheat	100%	95%	80%	36%	100%	85%	60%	41%
(Total g/m2)	(80.6)	(78.2)	(87.6)	(152.1)	(1764)	(1685)	(1707)	(1479)

Crop growth

Although the presence of black-grass substantially reduced wheat grain yields, effects on crop growth prior to April were relatively small, except at the highest black-grass infestation in Experiment 2 (Figs 1 & 2). After April, effects of black-grass competition on the crop increased rapidly. Even at the very high black-grass density of 6000 plants/m^2, no significant ($P \leq 0.05$) effects on crop dry weight were recorded in late November, 8 weeks after drilling. In Experiment 1, there were no statistically significant differences ($P \leq 0.05$) between crop dry weights until the May sampling when there was a 24% reduction in crop dry weight at the higher black-grass infestation (262 black-grass plants/m^2), relative to the weed free crop. In Experiment 2, significant ($P \leq 0.05$) reductions in crop dry weight (13% and 32%) were recorded in February for the two highest black-grass densities (497 and 6047 black-grass plants/m^2). Similar reductions were recorded in April. By June, effects on crop growth had increased, with reductions of 42% and 66% in crop dry weight. No adverse effect on crop growth was detected at the lowest black-grass density (83 black-grass plants/m^2) prior to the June sampling, when a 19% reduction in crop dry weight occurred.

The proportion of total biomass (crop + black-grass) accounted for by black-grass increased substantially between January/February and June, except at the highest weed population in Experiment 2. For the two weed densities in Experiment 1, black-grass accounted for 2% and 11% of the total biomass in January but these proportions had increased to 10% and 29% of total biomass by June (Table 3). Similarly in Experiment 2 for the three weed densities, black-grass accounted for 5%, 20% and 64% of total biomass in February but 15%, 40% and 59% of total biomass in June (Table 4). The figures for total biomass in June were approximately similar for all treatments in each experiment.

DISCUSSION

The results of these experiments showed that the main phase of competition between wheat and black-grass occurred after early April, coinciding with the period of rapid crop growth. Although there were effects on crop growth prior to April, these were relatively minor at low to moderate weed infestations. After April the effects of black-grass competition increased rapidly such that, at harvest, substantial crop grain yield losses of up to 6.4 t/ha were recorded. Crop grain yield losses were due mainly to reductions in number of wheat heads and numbers of grains per ear. Black-grass competition had a large effect on the number of wheat heads produced and on the number of black-grass heads per plant. These results support those of Niemann (1979) who conducted competition experiments with mixed weed infestations in winter barley. In experiments in which plots were hand-weeded at different crop growth stages, he reported that the onset of competition depended on weed density and started earlier in the growing period the greater the weed density. His experiments also showed that weed competition reduced the number of winter barley heads and number of grains per ear, but had no effect on 1000 grain weight.

Between January and June, black-grass comprised an increasing proportion of the total biomass. This supports the view that competition from black-grass becomes increasingly severe during this period. At low weed densities such as in Experiment 2, black-grass comprised only 5% of total biomass in January but, at harvest, there was a 25% (2.4 t/ha) reduction in crop grain yield. This demonstrates that weed infestations that may appear relatively insignificant in winter can ultimately have substantial effects on the crop grain yields. Total biomass of crop + weed in June was similar for all treatments in each experiment, suggesting that black-grass and wheat compete for the same resources and that competition between wheat and black-grass is by direct replacement. Only one rate of nitrogen fertilizer was used in these experiments. The effects of competition may be different at other rates of nitrogen, as Naylor (1972) showed that suppression of black-grass by winter wheat was greater at high nitrogen levels.

Although these results indicate that low to moderate black-grass infestations have little adverse effect on wheat crops before April, there may still be benefits in applying herbicides for black-grass control during the autumn. Firstly, autumn applications of some herbicides tend to be more effective than spring applications because weeds are smaller and more susceptible (Baldwin 1979). Secondly, herbicides do not kill weeds and stop competition instantly. Many herbicides are slow acting and it can take several months for complete weed kill to be achieved. Thirdly, poor weather conditions in spring may prevent the application of herbicides until after competition has occurred. The aim of weed control measures should be to provide a weed-free environment by early April, so that the crop can grow rapidly without interference from black-grass.

In trials involving control of black-grass in winter cereals using the herbicide clofop-isobutyl, Wilson et al. (1985) obtained the highest crop yield responses from November applications. However, at populations of less than 150 black-grass plants/m^2, yield responses following January applications were almost as large as those obtained after treatment in November. Applications in March and April resulted in much larger yield penalties.

At present control of black-grass is best achieved by autumn applications of herbicides. However, if herbicides were to be developed which kill large black-grass plants very rapidly, then there may be advantages in applying herbicides in early spring. Spring applications could be more effective because the majority of black-grass are likely to have emerged prior to spraying. In contrast, soil residues of autumn applied herbicides may be insufficient to control later germinating weeds.

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EVALUATION OF HERBICIDES FOR THE CONTROL OF *ALOPECURUS MYOSUROIDES* (BLACK-GRASS) IN WINTER CEREALS. SUMMARY OF RESULTS OF ADAS TRIALS 1985 AND 1986 HARVEST YEARS.

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ABSTRACT

During 1985 and 1986 harvest years 9 trials were carried out on commercial winter wheat crops to evaluate products for the control of black-grass (*Alopecurus myosuroides*). High levels of control were obtained from most products in some situations but average performance and reliability varied. The highest level of control was achieved from pre-emergence isoproturon tank mixed with chlorsulfuron/metsulfuron-methyl. Good control was also achieved with isoproturon tank mixed with pendimethalin isoproturon alone and diclofop-methyl tank mixed with HBN. The reliability of products was related to the degree to which they were adsorbed by the soil and burnt straw residue. The relationship between level of control and yield response is also discussed on the 4 sites taken to yield.

INTRODUCTION

The yield reductions caused by black-grass (*Alopecurus myosuroides*) in winter cereals are well documented. Over the years the Agricultural Development and Advisory Service (ADAS) have undertaken a substantial trials programme to examine the efficiency of new products and to study the effect of combinations of products (mixed and in sequences), to extend both black-grass and broad leaf weed control. Additionally a range of timing pre and post emergence have been compared. The most recent review (Flint 1985) of ADAS trials, up to harvest 1984, showed that soil adsorption of herbicide, measured by Kd, could affect the level of control achieved by some herbicides. Isoproturon, chlortoluron, chlorsulfuron plus methabenzthiazuron and diclofop methyl either alone or in mixtures were identified as the herbicides giving the most consistant control over a range of soils, crops and weather conditions. This has also been confirmed by Moss (1984) who explained how the adsorption is related to organic matter and cultivation.

Additionally a review by Hewson and Read (1985) described the importance of black-grass and gave details of how the control from isoproturon varied with timing.

MATERIALS AND METHODS

The trials were carried out on a range of soil types in Eastern and South Eastern regions of England in the harvest years 1985 and 1986. The trials were on a range of winter wheat varieties and sited in commercial crops with naturally occurring black-grass populations. Details of soil type drilling dates and cultivar for each site are given in Table 1.

A range of pre-emergence, early post-emergence and spring treatments were applied with a plot sprayer at 200 - 225 l/ha of water with either 11002 or 8002 T-jets at 210 or 250 kPa. Minimum plot size was 12 m x 3 m with 3 replicates. A complete randomised block design was used.

TABLE 1

Harvest 1985		Lincs	Essex	Suffolk	Bucks	Hants
Variety		Avalon	Avalon	Mission	Avalon	Avalon
Drilling date		14 Sept	31 Oct	27 Oct	28 Sept	24 Sept
Soil type		n.a.	ZyL	SCL	ZyL	ZyL
Crop Stage (Zadoks)	b	11	12	11	12/13	13/14
	c	22	13	13	n.a.	n.a.
	d	22	22	22	-	-
Harvest 1986		Essex	Beds	Bucks 1	Bucks 2	
Variety		Galahad	Galahad	Mission	Avalon	
Drilling date		1 Oct	1 Oct	10 Oct	2 Oct	
Soil type		SL	SCL	Gault	ZyCL	
Crop Stage (Zadoks)	b	13	12	12/13	12/13	
	d	23	21	n.a.	n.a.	

Details of crop growth stage b, c and d, the herbicides tested, their timing and rates of a.i. applied are given in Tables 2 and 4 for 1985 and 1986 respectively.

The efficacy of the herbicides was assessed either by counting black-grass heads per m^2 or measuring head length per m^2 in late June or July. Quadrat size varied according to black-grass density. In four of the trials grain yield from a plot of at least 22 m^2 was measured by plot combine.

RESULTS

Harvest 1985 trials

In 3 of the 5 trials relatively poor control of black-grass was recorded (Table 2). This is largely attributable to site selection which was for high populations and/or where poor black-grass control had been encountered in the past. The best control was achieved at the Suffolk site where only 3 treatments (4, 5 and 15) gave less than 95% control. At the other 4 sites only 2 treatments (isoproturon/diflufenican and isoproturon 2.5 kg a.i. post-emergence at Lincs) gave over 95% control.

Only two trials were taken to yield (Table 3). The response was different at the 2 sites. The yield increases at the Suffolk site were lower and in the range of 113 - 147%. Yield response was not well correlated with black-grass control. At the Hants site, however, yield responses were in the range of 118 - 195%.

Harvest 1986 trials

In this year herbicide efficacy can be clearly related to soil adsorption (Table 4). This agrees with results from other ADAS trials (Flint 1987). As Kd increases the number of treatments in the trials where levels of 95% control were achieved declines.

At the Essex site (Kd 2.6) 16 out of 19 treatments gave over 95% control. Where the Kd was 12.1 (Beds) only 3 (12, 28 and 31) out of 19 treatments gave over 95% control. At the highest Kd of 16.5 (Bucks 2) no herbicide treatment gave 95% control. A similar pattern occurs if a target control level of 90% or more is selected.

Grain yields were obtained from 2 sites (Table 5). Both showed a similar pattern of response.

TABLE 2

Black-grass control as % of untreated (1985)

	Product	kg a.i./ha	Timing	Lincs	Essex	Suffolk	Bucks	Hants
	SED ±			11.7	23.6	13.2	13.8	32.7
1	isoproturon	2.5	a	93	61	97	62	77
2	isoproturon +	1.65						
	chlorsulfuron/metsulfuron-methyl	0.02	a	92	86	100	90	93
3	isoproturon/diflufenican	2.25	a	96	50	99	60	74
4	pendimethalin	2.0	a	43	59	70	46	34
5	terbutryne/trifluralin	2.0/1.0	a	58	89	90	71	57
6	chlorsulfuron/metsulfuron-methyl +	0.02						
	terbutryne/trifluralin	2.0/1.0	a	87	92	99	-	-
7	pendimethalin +	1.2						
	isoproturon	1.25	b	72	75	100	48	66
8	isoproturon +	2.5						
	isoxaben	0.075	b	89	55	99	56	70
9	isoproturon followed by	1.0	b					
	isoproturon	0.5	d	52	35	99	-	-
10	isoproturon	2.5	c	99	73	99	36	23
11	isoproturon	1.65	c	69	46	98	46	9
12	isoproturon +	1.65						
	chlorsulfuron/metsulfuron-methyl	0.02	c	71	61	97	32	74
13	isoproturon/diflufenican	2.25	c	64	64	100	28	19
14	chlortoluron/bifenox	3.5/0.96	c	89	41	97	41	25
15	diclofop-methyl +	1.14						
	ioxynil/bromoxynil	0.57	c	92	60	55	58	92
16	isoproturon +	1.4						
	cyanazine	0.57	c	62	87	95	47	22
17	isoproturon/bifenox	2.0/0.8	c	25	86	98	27	19
18	isoproturon/diflufenican	1.686	c	25	94	98	-	-
19	isoproturon/ioxynil/mecoprop	1.63/0.33/1.17	c	36	18	99	-	-
20	chlorsulfuron/methabenzthiazuron	2.45	c	63	38	99	-	-
21	chlorsulfuron/methabenzthiazuron	2.45	b	-	-	-	49	-
22	diclofop-methyl	0.285	b + c	-	-	-	21	-
23	" " + D256 (wetter)	0.285	b + c	-	-	-	36	-
	Untreated/m^2			14.8m	50.8m	17.41m	1016 heads	783 heads
	Treatment dates a (pre-emergence)			18 Sept	31 Oct	2 Nov	2 Oct	25 Sept
	b (BG 2 - 3 leaves)			27 Sept	19 Nov	19 Nov	23 Oct	26 Oct
	c (BG 2 - 3 leaves)			23 Oct	5 Feb	6 Feb	20 Nov	30 Nov
	d (Spring)			23 Oct	25 Feb	28 Feb	-	-
	Kd (chlortoluron)			-	18.0	-	16.5	-

TABLE 3

Grain Yield as % of untreated (1985)

	Product	kg a.i./ha	Timing	Suffolk	Hants
	SED ±			4.75	18.1
1	isoproturon	2.5	a	135	179
2	isoproturon +	1.65			
	chlorsulfuron/metsulfuron-methyl	0.02	a	133	196
3	isoproturon/diflufenican	2.25	a	121	183
4	pendimethalin	2.0	a	132	151
5	terbutryne/trifluralin	2.0/1.0	a	113	169
6	chlorsulfuron/metsulfuron-methyl +	0.02			
	terbutryne/trifluralin	2.0/1.0	a	122	-
7	pendimethalin +	1.2			
	isoproturon	1.25	b	125	170
8	isoproturon +	2.5			
	isoxaben	0.075	b	138	186
9	isoproturon followed by	1.0	b		
	isoproturon	0.5	d	133	-
10	isoproturon	2.5	c	136	150
11	isoproturon	1.65	c	147	118
12	isoproturon +	1.65			
	chlorsulfuron/metsulfuron-methyl	0.02	c	145	181
13	isoproturon/diflufenican	2.25	c	140	132
14	chlortoluron/bifenox	3.5/0.96	c	140	159
15	diclofop-methyl +	1.14			
	ioxynil/bromoxynil	0.57	c	121	177
16	isoproturon +	1.4			
	cyanazine	0.57	c	144	152
17	isoproturon/bifenox	2.0/0.8	c	144	127
18	isoproturon/diflufenican	1.686	c	128	-
19	isoproturon/ioxynil/mecoprop	1.63/0.33/1.17	c	123	-
20	chlorsulfuron/methabenzthiazuron	2.45	c	144	-
21	chlorsulfuron/methabenzthiazuron	2.45	b	-	-
22	diclofop-methyl	0.285	b + c	-	-
23	" " + D256 (wetter)	0.285	b + c	-	-
	Untreated t/ha			2.29	2.62

TABLE 4

Black-grass control as % of untreated (1986)

	Product	kg a.i./ha	Timing	Essex	Beds	Bucks 1	Bucks 2
	SED ±			2.42	7.53	n.a.	n.a.
1	isoproturon	2.5	a	-	-	96	22
2	isoproturon +	1.65					
	chlorsulfuron/metsulfuron-methyl	0.02	a	-	-	98	48
3	isoproturon/diflufenican	2.25	a	-	-	96	0
7	pendimethalin +	1.3					
	isoproturon	1.25	b	86	60	-	-
10	isoproturon	2.5	b	91	79	96	48
11	isoproturon	1.65	b	89	18	-	-
12	isoproturon +	1.65					
	chlorsulfuron/metsulfuron-methyl	0.02	b	99	98	96	66
13	isoproturon/diflufenican	2.25	b	93	38	91	44
14	chlortoluron/bifenox	3.5/0.96	b	-	60	91	42
15	diclofop-methyl +	1.14					
	bromoxynil/ioxynil	0.57	b	99	79	82	48
17	isoproturon/bifenox	2.0/0.8	b	77	39	85	53
19	isoproturon/ioxynil/mecoprop	1.63/0.33/1.17	b	98	78	77	46
24	chlortoluron	3.5	a	-	-	99	24
25	isoproturon +	2.5					
	chlorsulfuron/metsulfuron-methyl	0.02	a	-	-	94	46
26	chlortoluron	3.5	b	-	19	99	31
27	isoproturon	2.0	b	93	61	-	-
28	isoproturon +	2.5					
	chlorsulfuron/metsulfuron-methyl	0.02	b	99	99	98	69
29	chlorsulfuron/metsulfuron-methyl	0.02	b				
	followed by isoproturon	2.0	d	99	-	-	-
30	isoproturon	1.65	b				
	followed by isoproturon	0.85	c	99	86	-	-
31	chlorsulfuron/metsulfuron-methyl	0.02					
	+ diclofop-methyl	1.14	b	99	95	-	-
32	isoproturon +	2.5					
	diclofop-methyl	0.72	b	100	-	-	-
33	chlortoluron +	3.5					
	chlorsulfuron/metsulfuron-methyl	0.02	b			98	80
34	isoproturon/trifluralin	1.8/1.2	b	95	79	90	56
35	isoproturon/ioxynil/mecoprop	1.95/0.4/0.95	b	97	87	86	60
36	chlorsulfuron/metsulfuron-methyl	0.02	b	-	82	-	-
37	isoproturon +	2.0					
	diclofop-methyl	0.72	d	98	-	-	-
38	isoproturon	2.0	d	95	-	-	-
39	chlorsulfuron/metsulfuron-methyl	0.02	b				
	followed by diclofop-methyl	1.14	d	-	93	-	-
40	isoproturon/bifenox/mecoprop	2.0/0.75/1.0	d	95	66	64	46
	Untreated/m^2			52.5m	95.7m	383.4 heads	425 heads
	Treatment dates		a (pre-emergence)	-	-	11 Oct	4 Oct
			b (BG 2 - 3 leaf)	9 Dec	26 Nov	15 Nov	7 Nov
			d (Spring)	14 Mar	8 Mar	1 Mar	18 Apr
	Kd (Chlortoluron)			2.6	12.1	9.1	16.5

TABLE 5

Grain Yields as % of untreated (1986)

	Product	kg a.i./ha	Timing	Essex	Beds
	SED ±			6.2	3.03
1	isoproturon	2.5	a	-	-
2	isoproturon +	1.65			
	chlorsulfuron/metsulfuron-methyl	0.02	a	-	-
3	isoproturon/diflufenican	2.25	a	-	-
7	pendimethalin +	1.3			
	isoproturon	1.25	b	202	178
10	isoproturon	2.5	b	189	211
11	isoproturon	1.65	b	198	164
12	isoproturon +	1.65			
	chlorsulfuron/metsulfuron-methyl	0.02	b	218	224
13	isoproturon/diflufenican	2.25	b	199	189
14	chlortoluron/bifenox	3.5/0.96	b	-	173
15	diclofop-methyl +	1.14			
	bromoxynil/ioxynil	0.57	b	217	209
17	isoproturon/bifenox	2.0/0.8	b	186	174
19	isoproturon/ioxynil/mecoprop	1.63/0.33/1.17	b	210	195
24	chlortoluron	3.5	a	-	-
25	isoproturon +	2.5			
	chlorsulfuron/metsulfuron-methyl	0.02	a	-	-
26	chlortoluron	3.5	b	-	169
27	isoproturon	2.0	b	196	191
28	isoproturon +	2.5			
	chlorsulfuron/metsulfuron-methyl	0.02	b	210	224
29	chlorsulfuron/metsulfuron-methyl	0.02	b		
	followed by isoproturon	2.0	d	209	-
30	isoproturon	1.65	b		
	followed by isoproturon	0.85	d	203	219
31	chlorsulfuron/metsulfuron-methyl	0.02			
	+ diclofop-methyl	1.14	b	206	222
32	isoproturon +	2.5			
	diclofop-methyl	0.72	b	203	-
33	chlortoluron +	3.5			
	chlorsulfuron/metsulfuron-methyl	0.02	b	-	-
34	isoproturon/trifluralin	1.8/1.2	b	193	219
35	isoproturon/ioxynil/mecoprop	1.95/0.4/0.95	b	208	214
36	chlorsulfuron/metsulfuron-methyl	0.02	b	-	197
37	isoproturon +	2.0			
	diclofop-methyl	0.72	d	204	-
38	isoproturon	2.0	d	197	-
39	chlorsulfuron/metsulfuron-methyl	0.02	b		
	followed by diclofop-methyl	1.14	d	-	217
40	isoproturon/bifenox/mecoprop	2.0/0.75/1.0	d	207	208
	Untreated t/ha			4.24	3.75

DISCUSSION

Isoproturon activity

These trials can be examined to show the average as well as the range of results (Table 6), which gives an indication of herbicide reliability.

TABLE 6

Analysis of performance (products in over 7 [not always the same] trials)

		No of trials	Average % control	Range of % control
	Pre-emergence			
1	isoproturon (2.5 kg a.i.)	7	73	22 - 97
2	isoproturon (1.65 kg a.i.) + chlorsulfuron/metsulfuron-methyl	7	87	48 - 100
3	isoproturon/diflufenican	7	68	0 - 99
	Post-emergence			
10	isoproturon (2.5 kg a.i.)	9	72	23 - 99
11	isoproturon (1.65 kg a.i.)	7	54	9 - 98
12	isoproturon (1.65 kg a.i.) + chlorsulfuron/metsulfuron-methyl	9	77	32 - 99
13	isoproturon + diflufenican	9	60	19 - 100
17	isoproturon (2.0 kg a.i.) + bifenox	9	57	19 - 98
19	isoproturon (1.63 kg a.i.) + ioxynil + mecoprop	8	57	18 - 99
7	isoproturon (1.25 kg a.i.) + pendimethalin	7	73	48 - 100
	Other products (post-emergence)			
14	chlortoluron + bifenox	8	61	25 - 97
15	diclofop-methyl + HBN	9	74	55 - 99

The top end of the range shows that all these products can give excellent results (over 97%) in the right conditions.

Isoproturon alone gave the same efficacy at the full rate (2.5 kg a.i.) irrespective of time of application both in terms of average performance and range. Lowering the rate of isoproturon to 1.65 kg a.i. showed that although equal effectiveness could be achieved, both the average result and bottom of the range were reduced, therefore making the lower rate of the product applied alone less reliable.

The addition of chlorsulfuron/metsulfuron-methyl improved both average and the range of efficacy particularly if applied pre-emergence (treatment 2) making this treatment superior to a higher rate of isoproturon alone. Limited evidence in 1986 (treatment 28) suggests a high rate of isoproturon with chlorsulfuron/metsulfuron-methyl improved this reliability only slightly.

The addition of pendimethalin to an even lower rate (1.25 kg a.i.) of isoproturon (treatment 7) gave a similar range of results although the average efficacy was slightly lower. Given these results there seems to be scope for the manipulation of the isoproturon and pendimethalin rates in certain circumstances.

Other post-emergence additions of products, with broad leaf weed activity, to reduced rates of isoproturon (treatments 13, 17 and 19) were examined. Materials within this group gave similar and inferior results to those already mentioned. These were closely related to the rate of isoproturon used. The average performance of the isoproturon/ diflufenican mix was better pre-emergence than post-emergence at a level slightly below full rate isoproturon. One very poor result at the Bucks 2 site in 1986, due to a poor seedbed and a late spring flush of black-grass, had a large effect on the range. Other products coped better with these circumstances. This could indicate that diflufenican itself is strongly adsorbed.

Two additional post-emergence products/mixes appeared in at least 7 trials. The chlortoluron/bifenox (treatment 14) performed similarly to the majority of reduced rate isoproturon mixes. The contact material diclofop-methyl + HBN (treatment 15) gave the third best average performance, behind the two chlorsulfuron/metsulfuron-methyl treatments and the most reliable, never being worse than 55% control.

Relationship between yield response and control

Except for the Suffolk site in 1985 there was an average response of approximately 1% yield increase for every 1% increase in black-grass control. Within the range of black-grass populations encountered a yield increase of approximately 35 kg/ha was obtained for each 1% increase in control.

On a site of low adsorption there may be a possibility of reducing the rate of isoproturon. However, on higher adsorption sites the addition of chlorsulfuron/metsulfuron-methyl assists in maintaining black-grass control. Some growers may not wish to be bound by the cropping restrictions this product could impose. In these situations further work with isoproturon + pendimethalin mixtures may give a suitable alternative if growers do not wish to rely on the contact action of diclofop-methyl for black-grass control.

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BROMUS STERILIS CONTROL IN CEREALS USING TRIASULFURON COMBINATIONS

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ABSTRACT

The early control of competitive weeds such as *Bromus sterilis* and *Alopecurus myosuroides* is essential in order to maximise yield. The removal of such weeds by a single herbicide treatment eliminates the need for sequential treatments. This paper describes the efficacy and crop safety of two new products, chlortoluron/triasulfuron and isoproturon/triasulfuron (3479/20 and 2480/20 g a.i./ha) respectively which applied early post-emergence control *B. sterilis*, *A. myosuroides* and other annual grass and broad-leaved weeds in cereals.

INTRODUCTION

Barren brome (*Bromus sterilis* L.) has, in recent years, become increasingly important as a competitive weed of early sown winter cereals, as predicted by Froud-Williams *et al* (1980), Froud-Williams (1983), and Chancellor & Froud-Williams (1986). The rapid increase in incidence over the years 1985-87 can be attributed to; the increased area of continuous cereals, unusually dry conditions in early autumn delaying seed germination, the movement of straw from headlands into the body of the field prior to fire-break preparation and the continued absence of a successful commercial herbicide giving high levels of *B. sterilis* control from a single application.

B. sterilis is an annual weed and useful levels of control can be achieved by cultural methods such as stale seed beds and deep ploughing. The use of stale seed beds is rare due to time constraints of the farming calendar, and, unless soil inversion is complete and cleanly executed, deep ploughing can often result in poor control as soil inversion should bury seed to a depth greater than 13 cm to prevent establishement (Froud-Williams, 1981).

This report describes two new herbicidal products with high levels of activity against *B. sterilis* and *A. myosuroides* which when allied with cultural techniques for reducing viable seed production offer reliable control of these problem weeds.

MATERIALS AND METHODS

Twenty-three field trials were carried out on commercially grown cereal crops over the years 1985-87 to determine efficacy and selectivity of two herbicides with activity against *B. sterilis* and *A. myosuroides*.

For *B. sterilis* efficacy trials were located on field headlands where the severest natural infestations of *B. sterilis* occurred. Plots were 3 x 12 m, replicated 3 times with each replicate laid end to end along the headland. For *A. myosuroides*, efficacy trials were located in the body of infested fields, laid out as randomized complete blocks. Treatments were made using a precision plot sprayer incorporating 6 Lurmark F11002 nozzles delivering 200 l/ha at 233 kPa. Treatment application timing was governed solely by the growth stage of *B. sterilis* or *A. myosuroides* targeted at GS 12-13. Weed population was evaluated using quadrat counts at application.

Selectivity trials were located in weed free crops of winter wheat and winter barley and twice normal rates of the herbicides were applied post-emergence of the crop. Trial design was completely randomized blocks, 4 replicates, with a plot size of 3 x 12 m. Visual crop damage was monitored through the whole growing season.

Two products were under trial. The first (A7438A) contained 3479 g chlortoluron and 20 g triasulfuron as a 50% water disperable granule (WDG). The second (A7440A) contained 2480 g isoproturon and 20 g triasulfuron, also formulated as a 50% WDG. The standards for comparison in all trials were 'DICURANE 500FW' and 'HYTANE 500FW'.

RESULTS

Efficacy

Chlortoluron (3500 g a.i./ha) or isoproturon (2500 g a.i./ha) applied alone to B. sterilis at GS 11-13 gave modest levels of control (Table 1). Each applied in combination with 20 g a.i./ha triasulfuron achieved very high levels of B. sterilis control, triasulfuron increasing control by 26-30%.

Triasulfuron (20 g a.i./ha) in combination with a low rate of isoproturon (2000 or 1750 g a.i./ha) gave excellent control of A. myosuroides (Table 2). Levels of control were equal to those given by the commercially recommended rate of isoproturon alone (2500 g a.i./ha).

Crop safety

All treatments, applied at twice normal rate (Table 3) caused minimal effects to winter wheat and winter barley assessed at 21-32 days after treatment. Symptoms were principally slight leaf tip scorch, this was rapidly outgrown and spring assessments made 114-135 days after treatment revealed no effects.

Yield data (Table 4) confirms full crop safety for triasulfuron plus chlortoluron or isoproturon (40 + 6958, 40 + 4960 g a.i./ha) for winter wheat and winter barley applied post-emergence.

TABLE 1

Bromus sterilis % control from triasulfuron plus chlortoluron or isoproturon applied post-emergence at GS 11-13.

Treatment	Dose (g a.i./ha)	Site Number 1	2	3	4	5	6	Mean
untreated (no. plants/m^2)		(68)	(45)	(148)	(46)	(163)	(88)	
triasulfuron + chlortoluron	20 + 3479	96	87	92	93	93	98	93
triasulfuron + isoproturon	20 + 2480	90	95	97	93	94	94	94
chlortoluron	3500	45	62	80	57	72	-	63
isoproturon	2500	42	65	89	63	82	-	68

Assessments made in early May. Figures as visual % control compared with untreated.

TABLE 2

<u>Alopecurus myosuroides</u> % control from triasulfuron plus isoproturon applied at low rates post-emergence at GS 12-21.

Treatment	Dose (g a.i./ha)	Site Number 1	2	3	Mean
Untreated (no. plants/m^2)		(784)	(480)	(352)	
triasulfuron + isoproturon	20 + 1750	98	99	99	99
triasulfuron + isoproturon	20 + 2000	98	100	100	99
isoproturon	2500	98	99	99	99

Assessments made in early June. Figures as visual % control as compared with untreated.

TABLE 3

Crop phytotoxicity from post-emergence applications of triasulfuron plus chlortoluron or isoproturon (7 sites, 1986 and 1987).

Treatment	Dose (g a.i./ha)	% Crop Phytotoxicity	
		Winter Barley	Winter Wheat
Assessment Timing (DAT) - Late Autumn (21-32)			
triasulfuron + chlortoluron	40 + 6958	5	5
triasulfuron + isoproturon	40 + 4960	5	7
chlortoluron	7000	3	4
isoproturon	5000	6	9
Assessment timing (DAT) - Late Spring (114-135)			
triasulfuron + chlortoluron	40 + 6958	0	0
triasulfuron + isoproturon	40 + 4960	0	0
chlortoluron	7000	0	0
isoproturon	5000	0	0

Assessed as estimated % visual damage compared to untreated.

TABLE 4

Effect on grain yield (as % of untreated plot yields at weed free sites).

Treatment	Dose (g a.i./ha)	Winter Barley	Winter Wheat
untreated	-	100	100
triasulfuron + chlortoluron	40 + 6958	94 (2)	95 (3)
triasulfuron + isoproturon	40 + 4960	100 (2)	95 (3)
chlortoluron	7000	100 (2)	94 (3)
isoproturon	5000	101 (2)	93 (3)

() indicates number of trials

DISCUSSION

Triasulfuron in combination with chlortoluron or isoproturon provided effective grassweed control with a wide safety margin when applied post-emergence to winter wheat and winter barley.

All B. sterilis trials were located on headlands, where crops were generally poorly established or where a sterile strip was created along the field boundary and no crop was present. The levels of control recorded are therefore the minimum that could be expected. Control is likely to be enhanced where crop competition is greater, especially in winter barley.

Inter-specific competition between B. sterilis and winter cereals is very high, even at low B. sterilis populations of 12-24 plants/m^2 (Cousens et al, 1985). In order to minimise yield loss from B. sterilis competition in cereals, populations need to be reduced to less than 10 plants/m^2. Triasulfuron plus chortoluron or isoproturon gave an average B. sterilis population reduction to less than 7 plants/m^2 and therefore was effective in minimising yield loss from competition.

Optimum herbicidal activity of triasulfuron occurs when uptake is both root and foliar (Amrein & Gerber, 1985), this is also true for isoproturon (Blair, 1978). B. sterilis is most sensitive to phenyl urea herbicides from post-emergence application. Post-emergence application for triasulfuron plus chlortoluron or isoproturon is therefore favoured, ideally at GS 12-13 of B. sterilis. The germination and emergence period of B. sterilis is extending partially due to differential depths of seed present in the soil. The ability to wait until all seed has germinated and apply treatments at growth stages upto 13 affords flexible and reliable control.

B. sterilis is not uniformly distributed across fields and commonly occurs as a mixed infestation with A. myosuroides. In order to give maximum flexibility to farmers a reduced rate recommendation for triasulfuron plus isoproturon can be made for the control of A. myosuroides. The grassweed activity of triasulfuron allows the isoproturon rate to be reduced to 1750 g a.i./ha 70% of that normally recommended. Additionally, triasulfuron gives control of many broad-leaved weeds, including Galium aparine, Veronica spp., Viola arvensis, Stellaria media and Matricaria spp. (Amrein & Gerber, 1985).

Triasulfuron plus chlortoluron or isoproturon has been developed to give the farmer maximum flexibility for grass and broad-leaved weed control. The use of either of these products as a single application treatment replaces the use of sequences for B. sterilis control and the necessity for a separate broad-leaved weed treatment. Therefore, the number of treatments and application operations is reduced from three to one and control of all major autumn problem weeds is achieved.

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THE CONTROL OF ANNUAL GRASS WEEDS IN CEREALS IN FRANCE, THE FEDERAL REPUBLIC OF GERMANY AND GREAT BRITAIN WITH TRALKOXYDIM, A NEW SELECTIVE HERBICIDE.

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ABSTRACT

Tralkoxydim, a new foliar acting cereal selective herbicide, was evaluated in 1985 and 1986 for the control of annual grass weeds in cereals. The results from three countries (France, the Federal Republic of Germany and Great Britain) demonstrate tralkoxydim's activity on the following species:
Avena fatua/Avena ludoviciana. Well-controlled using 0.20 - 0.35 kg ai/ha from the two leaf stage up to second node detectable.
Alopecurus myosuroides. Good control from the two leaf stage up to early tillering at rates from 0.25 - 0.35 kg ai/ha.
Apera spica-venti. Controlled from the one leaf to first node stage at rates from 0.20 - 0.30 kg ai/ha.
Lolium perenne/Lolium rigidum. Good control from the three leaf stage until the end of tillering using 0.30 kg ai/ha.
Tralkoxydim was more active, rate for rate, than the standard herbicides used for comparison in these trials and has shown good crop tolerance.

INTRODUCTION

Grass weeds in cereals are important throughout the major cereal growing areas of the World. In Europe, particularly in France, Germany and Great Britain *Avena* spp (Wild-oats), *Alopecurus myosuroides* (Blackgrass), *Apera spica-venti* (Loose Silky-bent) and *Lolium* spp (Ryegrasses) are particularly damaging grass weed species. Table 1 illustrates the frequency of these weeds in the three countries.

A myosuroides is predominantly a weed of heavy soils and of winter cereals. It is abundant in all three countries. In France it is widespread but most frequent in the Northern half of the country. In Germany it is widespread throughout the country. In England it is widespread but less frequent in the north, and it is not a common weed in Scotland.

TABLE 1

Occurrence of grass weeds in cereals (million ha infested)
ICI Market Research Data. (Unpublished)

Weed Species	France	Federal Republic of Germany	Great Britain
Avena spp	2.8	0.1	1.1
A. myosuroides	4.4	0.9	1.0
A. spica-venti	1.0	1.6	-
Lolium spp	1.4	-	-
Total area of cereals	7.0	4.7	4.0

Avena spp are abundant throughout Great Britain and in southern and western France. *Avena* spp are not major weeds in Germany but can be found in the South.

A. spica-venti is abundant throughout West Germany and found occasionally in France. This weed tends to predominate on light/medium soils. It is not commonly found in Great Britain.

Lolium spp can be found throughout the three countries, and often infest cereals grown in rotation with grass seed crops and forage. *L. perenne* and *L. multiflorum* are widespread, *L. rigidum* is only found in the south of France.

The potential of these weeds to reduce cereal yields, often by 20-40%, is well documented in the literature, and some examples are quoted in Table 2. It is important to reduce such yield losses and to minimise return of weed seed to the soil.

TABLE 2

Yield benefits from grass weed control

Weed species	Crop	% yield increase	No of weeds/m^2	Country	Reference
Avena spp	Spring Barley	3-40%	-	Britain	Elliot(1980)
	Spring Barley	30-40%	-	Germany	Koch + Walter(1983)
Alopecurus myosuroides	Winter Cereals	20-65%	150-1400	Britain	Wilson(1985)
	Winter Wheat	10-40%	400-1000	Germany	Koch + Walter(1983)
Apera spica-venti	Winter Wheat	15-30%	80-160	Poland	Rola + Rola(1983)
	Winter Cereals	7-26%	-	Germany	Fröhling(1980)
Lolium spp	Winter Wheat	3-42%	25-200	France	Jauzein + Lochon (1986)

Tralkoxydim is a new post-emergence cereal selective herbicide for the control of grass weeds in cereals (Warner et al 1987). It is effective in controlling Avena spp, A. myosuroides, A. spica-venti and Lolium spp. The results presented here illustrate this activity.

MATERIALS AND METHODS

Tralkoxydim was evaluated on commercially grown cereal crops for activity aginst naturally occurring weed populations. The German and British trials were of randomised block design with three or four replicates. The French trials consisted of two blocks with an untreated plot adjacent to every treated plot. The minimum plot size used was 2m x 10m. Applications were made with hand-carried boom sprayers at volumes of 200-400 l/ha using a fine or medium quality spray. Weed numbers were assessed either visually or by counting a minimum of four 0.25 m^2 quadrats per plot. Phytotoxicity to crops was assessed by visual estimation of crop damage. In all tables treatment rates are quoted in g ai/ha and the figures within each trial with no letter in common are significantly different (P=0.05) based on a restricted LSD analysis of the complete trial.

The formulation of tralkoxydim used in the trials was a 100 g/l EC. 'Agral', a non-ionic wetting and spreading agent was always added with tralkoxydim to give a concentration of 0.1% in the diluted spray. The commercial standards used were: diclofop-methyl 380 g/l EC; difenzoquat 330 g/kg WP; difenzoquat 150 g/l SL; flamprop-isopropyl 200 g/l EC; isoproturon 500 g/l SC and chlortoluron 500 g/l SC.

Trial and site details are given in Table 3.

RESULTS

Speed of action

Glasshouse studies have shown that tralkoxydim activity is mostly foliar. Uptake and translocation from treated foliage to the growing point is rapid and growth ceases within two days (Warner et al, 1987).

In field trials chlorosis of the growing point was usually observed two to four weeks after application, depending on growing conditions. This was followed by necrosis of the growing points which often become reddish in colour. Maximum control was seen after 2-3 months.

Speed of kill is illustrated in Table 4. Sprays applied at 2-3 leaves (mid-February) gave a slow but very effective kill. Later sprays applied at early tillering (early March) were quicker-acting.

TABLE 3

Trial site details

Table	Trial	Country	Location	Crop	Year	Spray Dates
5	H342	FR	13 Aix en Provence	WB	86	14/3, 17/4
5	H603	FR	37 Chemille	WB	86	3/3, 17/4,7/5
6	H011A	DE	Niedersachsen	SB	85	30/5
6	H009	DE	Rheinland-Pfalz	WB	86	16/5
6	H011B	DE	Rheinland-Pfalz	SB	86	3/6
7	LN13	GB	Gotham, Notts	WW	85	10/4, 29/4
7	WM16	GB	Alderminster, Warks	WB	85	16/4
7	GB17	GB	Sudbury, Suffolk	WW	86	16/5, 28/5
7	GB15	GB	Lighthorne, Warks	WW	86	28/5
8	GB14	GB	Somerton, Somerset	WW	86	2/4
8	GB15	GB	Kineton, Warks	WW	86	4/4
8	GB16	GB	Balsham, Cambs	WB	86	23/4
8	EM14	GB	Hilton, Cambs	WW	85	12/3
9	GB15	GB	Alderminster, Warks	WW	86	6/12, 17/1
9	GB14	GB	Somerton, Somerset	WW	86	18/12
9	NE1	GB	Dorrington, Lincs	WW	85	13/11
9	WM9	GB	Alderminster, Warks	WB	85	4/12
9	EM13	GB	Hilton, Cambs	WW	85	5/12
10	H416	FR	02 Vigneux le Hognet	WB	86	20/12
10	H417	FR	51 Benie Mouray	WB	86	17/12
10	H111	FR	80 Hangest	WB	86	17/12
10	H112	FR	80 Bray/Somme	WB	86	16/12
10	H629	FR	37 Chambray les Tours	WW	86	10/3, 2/4
11	H102	FR	69 Azieu	WW	85	14/12
11	H109	FR	80 Ailly/Noye	WW	86	22/4
11	H010	DE	Niedersachsen	WW	86	25/5
11	H012	DE	Bayern	WW	86	7/5
11	H014	DE	Niedersachsen	WB	86	16/4
12	H302	FR	26 Pierre Latte	WW	86	13/3, 24/3
12	H505	FR	31 Villemur/Tarn	WW	86	25/2

KEY Country FR - France; DE - Federal Republic of Germany; GB - Great Britain

Crop: WB - Winter Barley; SB - Spring Barley; WW - Winter Wheat

TABLE 4

% *Avena* control, Mean of 5 trials, France (Toulouse) 1984

Tralkoxydim applied at 300 g ai/ha *Avena* spp growth stage at application.

Days after treatment	2-3 leaves	Early tillering
15	17	32
30	34	63
60	87	93
At maturity	95	92

Avena spp Control

Results from tralkoxydim evaluation trials are presented in Tables 5, 6 and 7.

TABLE 5

% *Avena* spp control, France 1986

Treatments (Rate)	Trial Weed GS	*Avena fatua* H342 Early Tillering	*Avena fatua* H342 End of Tillering	*Avena ludoviciana* H603 2-3 Leaves	*Avena ludoviciana* H603 Early Tillering	*Avena ludoviciana* H603 End of Tillering
tralkoxydim (300)		97	97	98	97	96
diclofop-methyl (760)		90	90	89	96	95
flamprop-isopropyl(600)		-	93	-	82	92
(untreated/m^2)		(77)	(83)	(120)	(23)	(58)

TABLE 6

% *Avena fatua* control, Germany 1985 and 1986

Treatments (Rate)	Trial Weed GS	H011A 1st Node	H009 1-2 tillers	H011B 1-2 tillers
tralkoxydim (200)		-	100c	98b
tralkoxydim (300)		98c	-	-
diclofop-methyl (945)		60b	98b	70b
(untreated/m^2)		(40)a	(70)a	(62)a

TABLE 7

% *Avena fatua* control, Britain 1985 and 1986

Treatments (Rate)	Trial Weeds GS	LN13 2-3 leaves	LN13 2nd node	WM16 1st node	GB17 1-3 leaves	GB17 1st node	GB15 1-2nd node
tralkoxydim (250)		98c	64c	85bc	79bc	92bc	99c
tralkoxydim (350)		95c	86c	97c	93c	97c	100c
diclofop-methyl (950/1140)		96c	-	64b	70b	-	-
difenzoquat (1000)		63b	32b	-	99d	100c	93b
flamprop-isopropyl (600)		-	100d	-	-	69ab	86b
(untreated/m^2)		(91)a	(95)a	(108)a	(84)a	(12)a	(153)a

Results from France (Table 5) demonstrate excellent activity of tralkoxydim on both A. fatua and A. ludoviciana. In these two winter barley trials tralkoxydim at 0.3 kg/ha gave 96-98% control of Avena spp when applied from the 2 leaf stage until the end of tillering. Results from Germany (Table 6) on winter and spring barley show that 0.2-0.3 kg/ha of tralkoxydim gave similar results on A. fatua up to the first node detectable stage. In Table 7 the British results from winter wheat and barley again confirm excellent activity from talkoxydim at 0.25 -0.35 kg/ha on A. fatua up to first node detectable. Noticeably, the rate response is more marked on Avena spp at the second node detectable stage.

In trial GB15 all the treatments reduced Avena numbers in the following oilseed rape crop - tralkoxydim by 93%, difenzoquat by 89% and flamprop-isopropyl by 75%.

Alopecurus myosuroides control

Spring applications of tralkoxydim in Britain indicate an interaction with growth stage, Table 8.

TABLE 8

% A. myosuroides control in Britain 1985 and 1986

	Trial	GB14	GB16	GB15	EM14
Treatments (Rate)	Weed GS (tillers)	2	1-5	2-4	7-8
tralkoxydim (350)		98b	96b	84c	78bc
diclofop-methyl (950/1140)		-	43a	50b	64b
isoproturonn (2100)		100b	97b	83c	91c
(untreated/m^2)		(137)a	(210)a	(752)a	(227)a

At early growth stages tralkoxydim gave 96-98% control, comparable to isoproturon, but large well-tillered over-wintered plants were only moderately susceptible. Autumn applications of tralkoxydim at 0.2 kg/ha gave good contact activity on A. myosuroides at the 2-4 leaf stage, but no residual control. Consequently at some sites further weed emergence reduced final control (Table 9).

TABLE 9

% A. myosuroides control, Britain 1985 and 1986

	Trial	GB15	GB15	GB14	NE1	WM9	EM13
Treatments (Rate)	Weed GS	2-3 leaves	up to 4 tillers	2 leaves	2-3 leaves	2-3 leaves	2-3 leaves
tralkoxydim (200)		67b	93b	94b	98c	98c	98bc
diclofop-methyl (570)		60b	76b	99c	89b	91bc	89b
isoproturon (2500)		83b	96b	100c	95bc	91b	95bc
(untreated/m^2)		(394)a	(342)a	(137)a	(145)a	(255)a	(241)a

In France autumn or early spring applications of 0.3 kg/ha tralkoxydim gave a similar pattern of results, good control being achieved from spraying at 2-3 leaves or the beginning of tillering, (Table 10).

TABLE 10

% A. myosuroides control, France 1986

Treatments (Rate)	Trial Weed GS	H416 tiller -ing	H417 3 tillers	H111 tiller -ing	H112 tiller -ing	H629 2-3 leaves	H629 tiller -ing
tralkoxydim (300)		82	96	97	98	98	90
diclofop-methyl (760)		93	85	98	96	-	-
isoproturon (1200)		-	-	-	-	99	99
(untreated/m^2)		(219)	(2300)	(304)	(369)	(300)	(300)

Apera spica-venti control

A. spica-venti control has been evaluated in both France and Germany. This weed was well controlled by 0.2-0.3 kg/ha of tralkoxydim in these trials at a range of growth stages from 1 leaf to first node (Table 11).

TABLE 11

% A. spica-venti control, France and Germany 1985 and 1986

Treatments (Rate)	Trial Weeds GS	H102 1 leaf	H109 3 leaves, tillering	H010 1-5 tillers	H012 1st node	H014 2-4 tillers
tralkoxydim (200)		-	-	100b	98b	94b
tralkoxydim (300)		98	93	-	-	-
tralkoxydim (400)		-	-	100b	100b	99b
(untreated/m^2)		-	(51)	(145)a	(106)a	(175)a

Lolium spp control

Both L. rigidum and L. perenne were well controlled in French trials at a range of growth stages from the three leaf stage until the end of tillering. (Table 12).

TABLE 12

% Lolium spp control, France 1986

Treatments (Rate)	Trial Weed GS	Lolium rigidum H302 3 leaves	Lolium rigidum H302 end of tillering	Lolium perenne H505 early tillering	Lolium perenne H505 1st node
tralkoxydim (300)		98	96	97	93
diclofop-methyl (950)		79	91	98	100
chlortoluron (2500)		62	100	98	88
(untreated/m2)		(17)	(21)	(300)	(281)

DISCUSSION

Tralkoxydim is a new foliar-applied cereal selective grass weedkiller. At rates of 0.2-0.35 kg ai/ha it has shown excellent activity for the control of Avena fatua, Avena ludoviciana, Apera spica-venti, Lolium rigidum and Lolium perenne, over a wide range of growth stages. Alopecurus myosuroides is also well controlled by tralkoxydim but control of this species was more growth stage dependant. The rates applied are lower than those of the commercially available standards.

Previous work has shown that Avena sativa (volunteer cultivated oats) are also susceptible to tralkoxydim (Stoddart and Sutton, 1987). Lolium multiflorum was also controlled by tralkoxydim in field screens (Unpublished data).

Tralkoxydim has shown a good margin of crop selectivity, confirmed in separate crop tolerance yield trials on weed free sites where tralkoxydim has been applied at single and double (overlap) rates (Authors' unpublished data). Tralkoxydim has also been shown to be compatible with the broad-leaved weed herbicides ioxynil, bromoxynil and fluroxypyr (Stoddart and Sutton 1987). This crop safety and compatibility will allow it to be used with considerable flexibility in grass and broad-leaved weed control programmes.

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WILD OATS CONTROL IN WINTER WHEAT IN THE SOUTH WEST PART OF FRANCE

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ABSTRACT

Eighteen weed control trials on winter wheat were set up from 1977 to 1984 on different soil types.

These trials follow previous experiments to determine the optimum time of spraying herbicide on the crop and the most susceptible stages of wild oats to herbicides.

This study allows better assessment of the selectivity, the efficiency, the yield increase and the profitability of the most commonly used herbicide treatments in this region.

INTRODUCTION

In the South west part of France wild oat, although rarely occurring alone in winter cereals, is the main weed control problem. Although its abundance is actually decreasing, this species is always very abundant. Thus, all weed control programmes must take account of wild oats.

A very precise stage of susceptibility to herbicide, a long period of emergence with deep germinating seeds always unpredictable, explain the difficulties found in controlling this species. Dominant in calcareous, clay-calcareous and valley soils Avena sterilis subsp. ludoviciana makes way for Avena fatua on loamy soils and on "Piemonts" soils of the Pyrenees and Massif Central.

In these trials, wild oat was frequently associated with black-grass (Alopecurus myosuroides) and numerous broad-leaved species.

EXPERIMENTAL METHOD

Locations and year of trials , dates of treatments and infestation levels are summarized in Table I.

Herbicides with dose rates and spraying time are summarised in Table II.

The trials were set up in randomized block system with four replicates.

Each plot area was $100m^2$. At least $60m^2$ was harvested.

Treatments were applied using a knapsack sprayer at a constant presssure of 2 kg/cm^2 and the volume sprayed was 400 litres/ha.

The infestation was assessed in each control plot on five places (0,10 m^2 each).

Weeds were counted during the month of March for broadleaved species and grasses.

The numbers of ears of black-grass and panicles of wild oats were determined during the earing stage of each species.

The herbicide efficiency was visually scored during the earing stage on the CEB* scale 0-10 (0=no effect - 10=total control of the weed).

RESULTS AND DISCUSSION

The results are summarised in Table III.

1. Efficiency

1.1 On wild oats
In all trials wild oats were present but their densities varied between 11 and 292 panicles per m^2. The herbicide efficiency in each trial, the average value for a herbicide treatment (its variation) and the comparative efficiency of treatments are summarized in Tables III, IV, V. The importance of interaction between treatments and trials, and the reduced number of trials for some herbicides, require caution in the comparison of the average efficiency and its variation.

1.1.1 Single treatments

a) Amongst the substituted urea compounds, isoproturon + dinoterb appear to be better. The quick foliar action given by dinoterb seems to be the main reason. In comparison with chlortoluron, the lower persistence and the higher solubility of isoproturon can decrease its efficiency especially when wild oat emergence was late (Trial No. 12)
and/or when substantial rain followed the treatment. The efficiences of chlortoluron and isoproturon + neburon are very similar. Metoxuron appears to be very inconsistent and difficult to use in this region.

b) Dichlofop-methyl applied from the 3 leaves to 3 tillers (wild-oats) stage was usually efficient except in Trial No. 13 where wild oats produced new tillers during the month of May.

c) L-flampropisopropyl had the best score for efficiency and was very consistent.

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1.1.2 Programmes

Invariably, programmes give good control of wild oats with no risk of failure.

1.2 On black-grass

Amongst the eighteen trials, two thirds were invaded weakly (5 ears/m^2) to strongly (360 ears/m^2) by this weed. The scores, obtained when possible, of the average efficiency of a treatment and the comparative efficiency of treatments are summarised in Table III, IV, V. Treatments including a substitued urea were very efficient (efficiency scores between 8.9 to 10). Applied on black-grass with 2-3 tillers, dichlofop-methyl had an average efficiency score of 6.2. With a 7.8 average score, L-flampropisopropyl can be considered as an anti-black-grass herbicide although it was applied later.

1.3 On broad-leaved species

Each time it was necessary, the treatment to control wild oats was complemented by a herbicide to control broad-leaved species. According to the floral composition, the active ingredients used were:
ioxynil + mecoprop; ioxynil + bromoxynil + mecoprop; 2,4-D + 2,4-MCPA + pichlorame; 2,4-D+2,4MCPA and cyanazine + ioxynil. The use of such an active ingredient was necessary with dichlorfop-methyl and L-flampropisopropyl on 11 trials out of 17. Chlortoluron on 4 trials out of 16; Chlortoluron + L-flampropisopropyl on 3 trials out of 11. The excellent efficiency of control of broad-leaved species avoids the need to take them into account in the analysis of yields.

2. Selectivity

It is not intended to discuss precisely the phytotoxicity of herbicides on all the trials. The main observed phytotoxicities which often influence yields will be emphasised together with consideration of the narrow margin of selectivity in the control of wild oats. Chlortoluron, sprayed in Trial No. 2 on calcareous soil, with a high level of free carbonates followed by heavy rain caused a high plant mortality on winter wheat (phytotoxity score = 3.3). Sprayed in Trial No. 13 on a slightly acid clay soil, it caused the highest phytotoxicity observed (phytotoxicity score = 3.5) of all the substituted ureas tested.

Isoproturon + neburon was the substituted urea with the smallest margin of selectivity. Important phytotoxic effects were observed in Trial No. 8 (phytotoxicity score = 2.5), Trial No. 9 (phytotoxicity score = 3.3), Trial No. 16 (phytotoxicity score = 4.7). Early treatments (2-leaf stage of cereal), followed by heavy rain and cold periods can explain the phytotoxicity. L-flampropisopropyl induced a high phytotoxicity in Trials No 3 and 4 (phytotoxicity score = 2.3 and 1.7). The reason was a cold spraying time (10°C) followed by a cold 10 day period (average temperature = 7.5°C

It was surprising to observe that the same herbicide used with chlortoluron did not induce phytotoxic effects. The other herbicides often induced weak phytotoxicity, without any consequence.

3. Yields (cf. Table IV and V)
Discussion is mainly based on Table V.

3.1 Single Treatments

3.1.1 Amongst the herbicides containing substituted urea (sprayed before the 3-leaves stage of wild oats) the mixture isoproturon + neburon give the highest average increase in yield. This was due to the good herbicide activity on grasses and probably also its good efficiency of broad-leaved species.
The increases given by chlortoluron and isoproturon + neburon were similar. The yields obtained with the association isoproturon + mecoprop corroborates the low efficiency observed on wild oats and the isoproturon + ioxynil + mecoprop association was very similar to chlortoluron and isoproturon + mecoprop.

3.1.2 Diclofop-methyl was of similar efficiency to the substitued urea herbicides, although it is applied two months later and very often on high black-grass populations (Table V, Figure A). It was more efficient than chlortoluron in trials with low black-grass populations levels (Figure B). We noticed that the yield increase was closely related to its efficiency.

3.1.3 L-flampropisopropyl was less interesting in terms of yield increase. But it is not so surprising considering the significance of the populations of wild oats and black-grass. If the locations with high populations of black-grass are excluded (50 ears/m^2) which are also the most invaded by wild oats (except Trial No. 11) L-flampropisopropyl is similar to diclofop-methyl and better than chlortoluron (Figures B and E).

3.2 Programmes of treatments
On the basis of limited data it is difficult to assess the programme chlortoluron then diclofop-methyl. The programme chlortoluron (2 500) then L-flampropisopropyl (600) consistently gave high yields and avoided all risk of failure. It is particularly recommended when wild oats populations alone or with black-grass are important (Table V, Figures D and E).

3.2.1 Benefit of treatments
It is not possible to discuss a very detailed economic analysis with this set of trials. We can just emphasize the main results obtained from the economic balances calculated in each experiment since 1977. Further information is given in Tables II, III, IV and V.

4.1 Single treatments
It is not necessary to point out the benefits obtained with herbicides. This benefit is linked with the weed population level, the competition between weeds and crop, the spraying costs, the price of winter wheat and so on

Amongst the substituted ureas, isoproturon + dinoterb though expensive, must be recommended, because it gives more benefit, with high population levels (Trial Nos. 3 and 11) or when wild oats begin to tiller.
Chlortoluron, an older herbicide, although less efficient on wild oats, appears an interesting economic solution especially because of the general decrease in the wild oat populations since 1980 and because of the frequent late emergence.
Dicloflop-methyl is also economically intresting.
L-flampropisopropyl gives less benefit in experiments where high population levels are observed with early emergence.
In numerous trials, it is similar to the other herbicides.

4.2 Programmes of treatments
On average, from this set of experiments, the programme chlortoluron (2 500) then L-flampropisopropyl (600) is most beneficial. But amongst the experiments with high population levels, only two economically justify the application of flampropisopropyl after chlortoluron.

CONCLUSION

Experiments reported in this paper permit assessment of the efficiency of different herbicides.

The yield increases were generally higher when the herbicide was more efficient and weed population more important. Obviously the link between the inflorescence density of grasses and the yield losses is very weak.

Single treatments gave benefits in all the trials even with low population levels.

Programmes of treatments are only economically viable when weed populations are substantial.

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TABLE I Experimental details and infestations levels

Year of Harvest	No. Trial	Location	Variety	Sowing date	Spraying date and wheat stage			Infestation level		
					2 leaves 2 tillers	Tillering	1-2 nodes	Broadleaved plants/m²	Black Grass Ears/m²	Wild oat Pani./m²
	1	81 Salies	Top	12.11	5.2	5.3	16.4	75	–	80
1977	2	81 Souel	Top	15.11	7.2	15.3	16.4	210	–	50
	3	81 St. Paul Cap-Joux	Etoile Choisy	15.11	28.2	22.3	12.4	47	90	120
	4	81 Lombers	Talent	25.10	6.1	2.3	8.4	15	64	31
1978	5	81 Salvagnac	Top	10.11	*23.12 et 17.1	28.3	13.4	90	240	115
	6	32 Manas-Bastanous	Top	26.11	3.2	22.3	–	55	36	12
	7	32 Avensac	Talent	25.11	3.1	15.3	5.4	50	–	70
	8	81 Cuq-Toulza	Talent	5.12	*29.1 et 12.2	22.3	4.5	41	230	130
1979	9	81 Salvagnac	Talent	15.11	22.2	20.3	3.5	77	360	196
	10	81 Cuq-Toulza	Top	debut novembre	8.2	28.3	7.4	34	177	100
1980	11	32 Ste Dode	Top	1.11	*6.12 et 8.1	5.3	9.4	–	–	292
	12	81 Pampelonne	Talent	23.10	16.1	27.3	17.4	80	–	75
1981	13	81 Rabastens	Talent	11.11	9.2	26.3	17.4	18	26	51
1982	14	81 Salvagnac	Talent	15.10	*4.12 et 29.12	12.2	9.3	14	5	45
	15	81 Cuq-Toulza	Castan	9.11	7.1	29.3	15.4	30	–	11
1983	16	81 Salvagnac	Top	3.11	* 20.12 et 24.2	30.3	15.4	43	10	29
	17	31 Mauremont	Gala	1.11	19.12	28.2	12.4	10	22	75
1984	18	31	Gala	20.10	28.12	6.3	17.4	9	6	86

TABLE II - Tested herbicides = doses and spraying stages

Average stage of Wild Oats	Wheat Stage	Treatment Numerous	Herbicides	Dose g of a.i./ha	Number of trials
		1	Chlortoluron	2 500 3 000 in trial No. 3	16
		2	isoproturon + dinoterbe	1 890 + 1 710 1 680 + 1 520 trials 5,6,12	
1 to 3 leaves	2 leaves 2 tillers	3	isoproturon + neburon	2 000 + 2 000 1 750 + 1 750 trials 6 and 12 flow 1 720 + 1 720 trial 14 1 935 + 1 935 trial 16	12
		4	Metoxuron	4 500 (4 000 trial 5)	5
		5	isoproturon + ioxynil + mecoprop	1 950 + 403 + 949	4
		6	isoproturon + mecoprop	1 935 + 2 187	3
3 leaves to 3 tillers	Tillering	7	diclofop-methyl	1 080 trials=1,2,3,4,5,9,11 900 trials= 6,7,8,10,12, 13,14,16,17,18	17
Tillering to 1 node	1-2 nodes	8	L-flampropisopropyl	600	17
1 to 3 leaves then 3 leaves to 3 tillers	2 leaves to 2 tillers then tillering	9	Chlortoluron then dichlofop-methyl	2 500 then 720	3
		10	Chlortoluron then diclofop-methyl	2 000 then 720	2
1 to 3 leaves	2 leaves to	11	Chlortoluron then L-flampropisopropyl	2 500 then 600	11
and tillering to 1 node	2 tillers then 1-2 nodes	12	Chlortoluron then L-flampropisopropyl	2 000 then 600	4

TABLE III - Results of trials
- Yield in decitons/hectare
- Efficiency on wild oats and Black-grass

Treatment	Trial 1		2		3			4			5			6			7		8			9		
No.	dT/ha	W.O	dT/ha	W.O	dT/ha	W.O	BG	dT/ha	W.O	BG	dT/ha	W.O	BG	dT/ha	W.O	BG	dT/ha	W.O	dT/ha	W.O	BG	dT/ha	W.O	BG
1	53.6	6.5	37.4	6.3	37.9	4.5	7	43.7	8	9.3	48.4	6.5	9.5	43.5	7	8	53	5	49.5	9	10	53.9	8	9.5
2	53.4	8	39.3	6	46	7.5	9.8	45.8	8	9.7	47.9	5.7	9.1	43.6	6	8	58	8	52.2	9	10	50.4	7.3	9.5
3	-	-	-	-	42.9	6.7	9.5	46.8	7.8	10	54.3	7.7	9.8	47.1	7	8	52.2	7	41.5	9	10	50.8	7.3	10
4	52.4	6	40.2	7	42.7	6.7	9.5	38.7	7.5	9.5	40.5	3.5	6	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	53.4	7.3	9.5
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35.2	1.4	7.	-	-	-
7	56.2	9	42.9	7.5	40	10	8	40.6	10	5	46.4	8.8	6.8	42.9	9	6	54.1	7	50.4	9.2	5.	52	8	6.5
8	58.2	10	35.2	8.7	37.3	8.7	8	38	10	8.1	29.3	7	8.7	-	-	-	54.8	9	47.8	9	6.	50.7	9.1	5.3
11	-	-	-	-	49.6	10	10	-	-	-	51.7	9.7	10	-	-	-	-	-	51.2	10	10	53	10	10
Control	40.9		28.3		21.7			31.5			24.6			37.2			40.7		26.9			32.6		
LSd 0.05	3.7		6.6		7.0			5.2			8.1			2.9			5.6		5.1			11.2		

Treatment	Trial 10			11		12		13			14		15		16		17			18	
No.	dT/ha	W.O	BG	dT/ha	W.O	dT/ha	W.O	dT/ha	W.O	BG	dT/ha	W.O	dT/ha	W.O	dT/ha	W.O	dT/ha	W.O	BG	dT/ha	W.O
1	55	7	9.5	37	5	56.6	7	55.8	5	10	60	7	69.4	7.8	55.3	7.9	-	-	-	-	7.9
2	-	-	-	50.1	9	61.4	4.5	61.4	8	10	60.5	9	61.4	9	51.6	7.4	-	-	-	66.5	-
3	55	8	10	36.9	5	56.8	5	-	-	-	54.2	5.6	-	-	49.8	8.4	-	-	-	-	-
5	-	-	-	42.7	7	57.4	5	-	-	-	54.6	8	-	-	-	-	-	-	-	-	7.5
6	-	-	-	-	-	-	-	61.7	8	10	-	-	-	-	-	-	-	-	-	63.2	8.4
7	48.8	8.8	4.8	44.2	8	36	8.3	56.2	6.5	7.6	-	-	62.7	7.8	52.4	8.6	58.3	8.5	5.5	65.4	9
8	48.6	8.8	7.8	37.5	8	56.7	10	62.7	8.5	8.5	55	9	64.6	10	55.3	9.8	57.6	9.4	9	62.3	-
9	-	-	-	-	-	-	-	59	9	10	57.5	9.3	62	9	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	58.3	9.3	-	-	-	-	59.7	9	9	-	-
11	58.7	10	9.7	50.5	9	57.7	10	63.2	9	10	63.9	9.7	63.1	10	53.5	10	-	-	-	-	-
12	-	-	-	-	-	-	-	62.3	9	10	60.4	8.8	-	-	52.4	10	57.6	9.4	9.5	-	-
Control	29			20.4		50.6		45.6			46.1		57.3		45.7		48.1			55	
LSd 0.05	4.3			6.4		3.4		6.1			5		3.2		5.3		3.2			4.7	

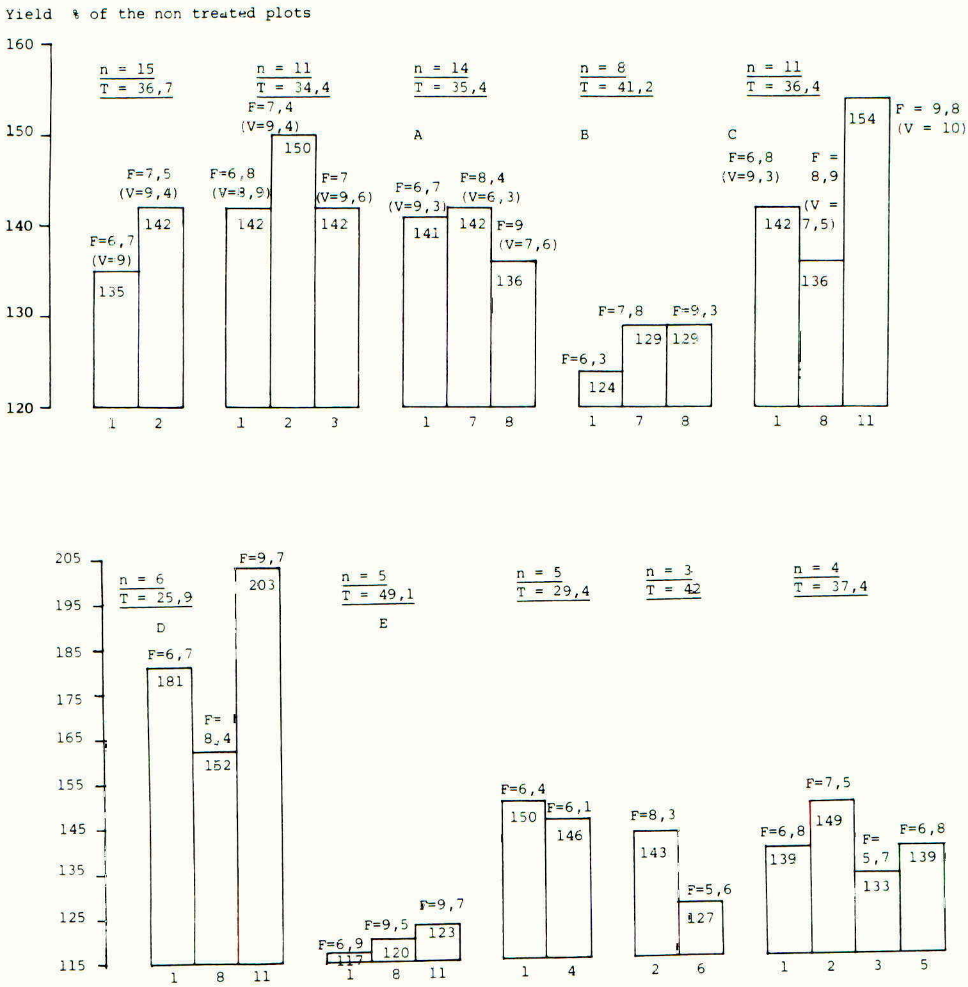
BG = Black-grass
W.O = Wild Oats

TABLE IV - Average yield and average efficiency of herbicides

Average stage wild oats	Herbicides tested	Average yield* (100–170)	Average yield of control rdt q/ha	Wild oats Score Avg	Wild oats Score S.E	Black-grass Score Avg	Black-grass Score S.E
1-3 leaves	Chlorotoluron	.138	36.20	6.70	1.30	9.10	1.00
	Isoproturon+dinoterbe	.140	37.80	7.50	1.30	9.40	0.70
	Isoproturon+neburon	.145	33.90	7.00	1.20	9.60	0.70
	Metoxuron	.146	29.40	6.10	1.40	8.30	1.60
	Isoproturon+ioxynil+ Mecoprop	.139	37.40	6.80	1.10	9.60	
	Isoproturon+mecoprop	.127	42.00	5.60	3.00	8.90	1.10
3 leaves 3 tillers	Diclofop methyl	.137	37.40	8.40	0.90	6.20	1.10
Tillering 1 node	L-flampropisopropyl	.132	37.90	9.10	0.80	7.80	1.10
1-3 leaves then	Chlorotoluron (2 500) then diclofop-methyl	.119	49.70	9.10	0.10	10.00	
3 leaves 3 tillers	Chlorotoluron (2 000) then diclofop-methyl	.125	59.00	9.20	0.20	9.00	
1-3 leaves tillering node	Chlorotoluron (2 500) then L-flampropiso-propyl	.154	36.40	9.80	0.40	10.00	0.10
		.125	46.4	9.30	0.50	9.80	0.30

* Percentage of the average yield of control plots

TABLE V - Comparisons of herbicide treatments
(Yield and efficiency)



n treatment of table III; n = number of common trials;
T = average yields in dT/ha of control plots
F = W.O
V = BG

Comparison 1,7,8
- Figure A on all common trials
- Figure B on trials with less than 50 ears/m²
(Black-grass)

Comparison 1,8,11
- Figure C all trials
- Figure D all trials with more than 100 inflorescences - (W.O or V.)
- Figure E trials with low population levels or late emerging wild oats

CONTROL OF PHALARIS BRACHYSTACHYS AND P. MINOR IN WHEAT GROWN IN NORTHERN IRAN

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ABSTRACT

Phalaris brachystachys (Short-spiked Canary-grass) and Phalaris minor (Lesser Canary-grass) are annual grass species that have become severe problems in certain parts of Iran in recent years. In chemical control experiments isoproturon applied as pre or post-emergence treatment at 2.5 or 2.3 kg a.i./ha, controlled P. brachystachys by 82 % and 86 %, respectively. Isoproturon, however, caused severe crop damage and did not significantly increase grain yield.

Post-emergence application of diclofop-methyl at 1 kg a.i./ha controlled P. brachystachys and increased grain yield. Application of tralkoxydim controlled P. brachystachys and P. minor by 85 % and 88 % and grain yields were increased by 65 % and 128 %, respectively. These yield increases were partly due to a decrease in lodging in the treated plots.

INTRODUCTION

In recent years certain species of Canary-grass have caused severe weed problems in some wheat producing areas, including Khuzestan (Montazeri 1987), Mazandaran and Gorgan (Daniali 1983, Mirkamali 1978). The level of importance of each species seems to be related mainly to location. P. minor is more abundant in Khuzestan (Chehrazi 1987), Gorgan and parts of Mazandaran (Mirkamali 1978). P. brachystachys occurs mostly in the lower plains around Sari in Mazandaran. Phalaris paradoxa rarely occurs as a severe grass problem in the Mazandaran area. Dominance of Canary-grass species could be due to differential responses of these grasses to herbicides commonly used against wild oats and also to other production practices.

In Khuzestan application of diclofop-methyl at 1 kg a.i./ha gave 78 % control of P. minor (Montazeri 1987), but in Gorgan and Mazandaran it did not result in satisfactory control of Canary-grasses (Daniali 1983, Shahsavarani personal communication 1983). The purpose of this study is to identify suitable herbicidal treatments to control major Canary-grass species in wheat grown in Northern Iran.

MATERIALS AND METHODS

Four experiments were conducted in the years 1986 and 1987 in wheat fields at the Dashte-Naz Agricultural Organisation, Sari, Northern Iran within a rotation of wheat, soybeans (or maize) and wheat which is carried out as common practice in the area. The wheat variety Inia was planted in October at a seed rate of 140 kg/ha in either 12 cm wide rows (experiments 1, 2 and 3) or broadcast (experiment 4).

A compound fertilizer supplying 27 kg/ha N and 75 kg/ha P_2O_5 was applied to each seedbed prior to sowing. Nitrogen top dressing was applied once in late winter at 23 kg/ha N. Broad-leaved weeds were controlled by the application of 2,4-D.

The dominant grass species were P. brachystachys in experiments 1, 2 and 3, and P. minor in experiment 4. The experimental sites were naturally infested with high populations of these grasses. All treatments were post-emergence applications except for experiment 1 where pre-emergence applications were used. In experiments 2 and 4 diclofop-methyl or tralkoxydim were applied at 2 or 3 different crop growth stages, respectively.

Experiments 1 and 2 were randomised complete block designs with a plot size of 30 m^2. Experiments 3 and 4 were carried out as large scale trials arranged in plots of 5000 m^2 and 3300 m^2, respectively, each plot replicated twice. The herbicide treatments were applied in 300 l/ha of water with a knapsack sprayer equipped with floodjet nozzle (experiments 1 and 2) or in 200 l/ha water with a tractor mounted sprayer with fan-jet nozzles (experiments 3 and 4).

Weed control and crop tolerance were estimated visually and when the wheat plants had matured. Grain yields were obtained from 2 and 10 fixed 1 m^2 quadrats per plot in experiments 1 and 2 and experiments 3 and 4 respectively.

RESULTS

Experiment 1 (Table 1)

Pre-emergence application of methabenzthiazuron at 2 or 2.7 kg a.i./ha and metoxuron at 2.7 or 3.2 kg a.i./ha did not significantly (p : 0.05) control P. brachystachys. Isoproturon at 2.5 or 2.8 kg a.i./ha significantly controlled the grass giving 82 % and 84 % control, respectively. This herbicide, however, induced crop damage causing yellowing of the entire wheat plants, which recovered, however, in about 4 months. A mixture of linuron and dinitramin also gave the same significant level of weed control, but without significant adverse effect on the crop. None of the treatments resulted in a significant crop yield increase.

Experiment 2 (Table 2)

Methabenzthiazuron at 2.5 kg a.i./ha, applied post-emergence did not significantly (p : 0.05) control P. brachystachys, whereas isoproturon controlled this species of Canary-grass satisfactorily. Isoproturon, however, caused crop damage. Diclofop-methyl at 1 kg a.i./ha applied at each of the chosen growth stages of the grass resulted in yield increases and acceptable crop tolerance. However, levels of weed control were significantly different (p : 0.05). At 1.08 kg a.i./ha Diclofop-methyl tended to decrease yield and crop tolerance. Tralkoxydim at 0.275 or 0.3 kg a.i./ha applied at the same crop and weed growth stages gave satisfactory results in terms of grain yield increase and control of the grass weed.

Yields over 4 t/ha were achieved by both tralkoxydim and diclofop-methyl. At these yield levels, Canary grass control was better following the use of tralkoxydim. The level of grass weed control from diclofop-methyl was improved by the later applications but these were associated with more crop damage and smaller yields.

TABLE 1

Control of P. brachystachys, using pre-emergence herbicides, Sari, 1986.

Herbicide	kg a.i./ha	Control %	Crop tolerance(2)	Grain yield t/ha
Methabenzthiazuron	2	18 b	1 b	2.71 a
Methabenzthiazuron	2.7	43 b	1 b	2.87 a
Metozuron	2.7	19 b	1 b	2.56 a
Metoxuron	3.2	0 b	1 b	2.64 a
Isoproturon	2.5	82 a	4 a	3.23 a
Isoproturon	2.8	84 a	4 a	2.75 a
Linuron + Dinitramin	0.56 + 1.128	64 a	1.75 b	3.02 a
Linuron + Dinitramin	0.62 + 1.25	75 a	2 b	2.51 a
Control	-	0 b	1 b	2.61 a

(1) : Means within a column followed by a common letter are not different (p : 0.05).

(2) : 1, no adverse effects of the herbicides; 5, plants completely killed.

Experiment 3 (Table 3)

In this experiment tralkoxydim at 0.25 or 0.3 kg a.i./ha controlled P. brachystachys by 80 % and 85 % and increased grain yields by 35 % and 65 %, respectively. A high proportion of the wheat plants in the untreated plots were lodged, mainly due to the heavy infestation with Canary-grass, while in the treated plots lodging of the crop only rarely occurred and was confined to small patches. In addtion, the Canary-grass plants in the treated plots, with the herbicide at 0.25 or 0.3 kg a.i./ha showed an average height reduction of 27 % and 34 %, respectively. The height of the crop itself was also reduced by 4.5 % and 10 % in the treated plots.

Experiment 4 (Table 4)

Tralkoxydim applied to the crop at 1 - 2 or 3 - 4 leaves resulted in 88 % and 86 % control of P. minor and yield increases of 128 % and 99 %, respectively. A proportion of the crop yield increase was due to lower lodging in the treated plots. Diclofop-methyl did not control P. minor satisfactorily in this experiment, however, increases in grain yields were recorded versus untreated plots.

TABLE 2

Control of P. brachystachys, applying herbicides post-emergence, Sari, 1986 (1)

Herbicide	kg a.i./ha	App. time (2)	Control %	Crop tolerance (3)	Grain yield t/ha
Methabenzthiazuron	2.5	A	29 a	1.75 abc	3.17 bc
Isoproturon	2.3	A	86 a	2.25 bc	3.82 abc
Diclofop-methyl	1.0	A	71 b	1.25 a	4.16 a
Diclofop-methyl	1.08	B	94 a	2.5 c	3.32 bc
Diclofop-methyl	1.0	B	92 a	2.0 abc	3.59 abc
Tralkoxydim	0.275	A	88 a	2.25 bc	3.94 ab
Tralkoxydim	0.3	B	86 a	1.5 ab	4.11 a
Tralkoxydim	0.25	B	60 b	1.0 a	3.71 abc
Tralkoxydim + Diclofop-methyl	0.16 0.576	B	94 a	1.75 abc	3.57 abc
Control	-	-	0 d	1.0 a	3.36 bc

(1) : Means within a column followed by a common letter are not significantly different (p : 0.05)

(2) : Canary-grass at 1 - 2 leaf stages (wheat 3LS) and B, Canary grass at 3 - 4 leaves stages (wheat full tillering)

(3) : 1, no adverse effects of the herbicides and 5, plants completely killed.

TABLE 3

Control pf P. brachystachys with tralkoxydim in large-scale plots, Sari, 1986.

Treatment	Rate kg a.i./ha	Control %	Grain yield t/ha	Yield increase %
Tralkoxydim	0.25	80	3.16	35
Tralkoxydim	0.30	85	3.86	65
Control	-	0	2.32	0

TABLE 4

Effect of time of herbicide application on the control of P. minor in large-scale plots, Sari 1987.

	Time of application (1)						
	Diclofop-methyl 1kg a.i./ha			Tralkoxydim 0.3 kg a.i./ha			Untreated
	A	B	C	A	B	C	
Control %	40	40	50	88	86	0	0
Grain yield t/ha	2.21	2.52	2.67	4.09	3.57	2.52	1.79
Increase %	23	40	49	128	99	41	0

(1) : A, B and C - 8, 12 and 16 weeks after seeding, respectively.

DISCUSSION

In experiments 1 and 2 it was noted that pre or post-emergence application methabenzthiazuron did not significantly (p : 0.05) control P. brachystachys. Similarly, metoxuron as pre-emergence treatments did not control the grass species. In Khuzestan, similar results have been obtained from post-emergence applications of these herbicides (Montazeri 1982). Isoproturon resulted in satisfactory control of the grass either as pre or post-emergence treatments, but it caused severe crop damage and gave no significant increase in grain yield.

Experiment 2 shows that diclofop-methyl gave effective control of P. brachystachys with increased grain yield. The results suggest that applying diclofop-methyl at a rate above 1 kg a.i./ha can cause crop damage. The latter results agree with those obtained on wheat varieties in the Khuzestan (Chehrazi 1987) and Gorgan (Daniali 1982, Mirkamali 1978) areas.

Applying diclofop-methyl against P. minor did not result in high levels of control of the grass (experiment 4) which suggests an unsatisfactory solution for the control of the weed population.

Experiments 2, 3 and 4 show that tralkoxydim applied at 0.3 kg a.i./ha at earlier stages of grass growth resulted in control pf Phalaris spp., with good crop tolerance and yield response. A high proportion of the yield appeared to be due to the fact that less lodging occurred.

The first priority for future studies must be to determine the optimum growth stage for both wheat and Phalaris spp. for application of diclofop-methyl and tralkoxydim.

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CO-APPLICATION OF FLUROXYPYR AND FLAMPROP-M-ISOPROPYL FOR THE CONTROL OF GALIUM APARINE (CLEAVERS) AND AVENA SPP (WILD OATS) IN CEREALS.

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ABSTRACT

The post-emergence cereal herbicide fluroxypyr (Starane* 2) has demonstrated excellent crop safety, flexibility of timing and outstanding efficacy on many broad-leaved weeds, including cleavers (*Galium aparine*). These properties offered the prospect of fluroxypyr being a suitable tank-mix partner for the wild oat herbicide flamprop-M-isopropyl (Commando), thus enabling both broad-leaved weeds including cleavers and wild oats (*Avena* spp) to be controlled with a single application.

Fluroxypyr and flamprop-M-isopropyl mixtures have been evaluated over a number of seasons. In 1982 and 1983, trials in spring barley showed no antagonism between the two active ingredients. In 1984, trials in winter and spring cereals again demonstrated the tank-mixture applied at the normal recommended rates, to be suited to the specific control of cleavers and wild oats. This was confirmed by trials in 1986.

Crop yields, on weed-free sites, were unaffected by co-application of single rates of the two herbicides. Co-application of double rates of fluroxypyr and flamprop-M-isopropyl did not increase the marginal yield effects which were occasionally seen with double rates of flamprop-M-isopropyl alone.

MATERIALS AND METHODS

In 1986, a total of 13 trials were established in winter and spring cereals to evaluate the efficacy (7 trials) and selectivity (6 trials) of the tank-mixture of fluroxypyr and flamprop-M-isopropyl. Treatment details are given in Table 1. All trials were situated in commercially grown crops and encompassed a range of cultivars under varying agronomic conditions. Agronomic details of selectivity trials are presented in Table 2 and details of efficacy trials in Table 3.

Trials were of randomised block design, replicated either 3 or 4 times, with plot width of 2 to 3.2m amd length 10 to 15m. Treatments were applied by modified Van der Weij knapsack sprayer fitted with flat fan nozzles, Spraying Systems 80015 or 8003 and calibrated to deliver 200 to 230 l/ha at a pressure of 210 to 280 kPa.

Wild oat control was assessed by counting panicle numbers in eight x $0.25m^2$ quadrats/plots, 8 to 10 weeks after treatment. Cleaver control was visually assessed as percentage ground cover compared to the untreated plot, both 2 and 8 weeks after treatment. Assessments for crop selectivity in the form of chlorosis, raggedness, stunting, thinning and lodging were made visually using a 0 to 100% scale at 1, 4 and 8 weeks after treatment. At crop maturity, selectivity trials were harvested with a modified Claas Compact 25 combine harvester and grain yields for each plot were recorded.

TABLE 1

Herbicide treatments used in the 1986 study were as follows:

Chemical	g a.i./l	Product	Product rate l/ha	Product formulation
fluroxypyr (1-methyl heptyl ester)	200	Starane 2	0.75** 1.0 2.0*	EC
flamprop-M-isopropyl	200	Commando	3.0 6.0*	EC

* Double rates used in selectivity trials only.
**Rate used on spring barley only.

TABLE 6

Percent control of cleavers and wild oats by fluroxypyr and flamprop-M-isopropyl combinations in cereals in 1986.

Treatment	Rate g ai/ha	Cleavers (4 trials)	Wild Oats (6 trials)
fluroxypyr	200	100	0
flamprop-M-isopropyl	600	0	97
fluroxypyr + flamprop-M-isopropyl	200 + 600	100	95
Untreated (Mean weed numbers/m^2)	-	(14.1)	(90.5)*

*Panicle number

TABLE 2

Agronomic details of 1986 selectivity sites

SITES	1	2	3	4	5	6
Location	Lemsford Herts	Easingwold N.Yorks	Chiltern Green Herts	Luddington Humberside	Keyingham Humberside	Bottisham Cambs
Crop	Winter wheat	Winter barley	Spring barley	Spring barley	Winter wheat	Winter wheat
Variety	Longbow	Igri	Triumph	Goldmarker	Mission	Avalon
Planting date	Nov '85	20.9.85	11.4.86	March '86	Sept '85	Oct '85
Soil type	Clay loam	Sandy loam	Clay loam	Silty loam	-	-
Crop growth stage at application (Zadoks)	33	31-32	33	32	33	37
Date of application	22.5.86	1.5.86	12.6.86	4.6.86	26.5.86	29.5.86
Air temperature (°C)	16.5	22.0	15.5	17.5	7.0	-
Soil temperature (°C)	11.0	12.0	15.0	14.5	12.0	-
Weather at application	Warm/dry	Warm/dry	Warm/dry	Warm/dry	Dry	Dry

All sites were weed free.

TABLE 3

Agronomic details of 1986 efficacy sites

SITES	7	8	9	10	11	12	13
Location	Sutton-on-Derwent, N.Yorks	Lilley Bottom, Herts	Sutton-on-Derwent, N.Yorks	Chapel Haddesley, N.Yorks	Quy, Cambs	Earith, Cambs	Bourne, Cambs
Crop	Winter barley	Winter barley	Winter wheat	Winter wheat	Winter wheat	Winter wheat	Winter wheat
Variety	Igri	Igri	Avalon	Galahad	Galahad	Boxer	Norman
Planting date	Sept 1985	Oct 1985	Oct 1985	-	-	-	-
Soil type	Sandy loam	Clay loam	Clay loam	-	-	-	-
Growth stage (Zadoks)-crop	31	32	32	39	32	37	37
Wild oats	20/22	23	21/22	-	21/22	32	15/22
Cleaver size	30cm	7cm	6cm	10-40cm	-	-	-
Application date	2.5.86	15.5.86	16.5.86	29.5.86	19.5.86	19.5.86	30.5.86
Air temp °C	20.0	9.0	14.0	21.0	15.0	15.0	15.0
Soil temp °C	13.5	11.5	11.0	19.0	13.0	15.0	15.0
Weather at application	Dry	Dry	Dry	Dry	Damp	Dry	Damp

RESULTS

Results from the co-application of fluroxypyr and flamprop-M-isopropyl to cereals in seasons 1982 to 1984 are summarised in Table 4. Results from the 1986 season are shown in Tables 5, 6 and 7.

Crop effects detected in all trials were small. Applications of fluroxypyr and of flamprop-M-isopropyl, both alone and in tank-mixture at recommended rates, caused slight, acceptable, visual crop damage. The double rates of fluroxypyr and of flamprop-M-isopropyl applied alone had a marginally greater visual effect on the crop. When applied in tank-mixture at the double rate, or greater, visual crop damage was increased but still within acceptable levels.

On weed-free sites, crop yields were unaffected by applications of single rates of fluroxypyr and of flamprop-M-isopropyl alone or in tank-mixture. At double rate, fluroxypyr did not effect crop yields. There were indications in some trials that crop yields were slightly reduced by double rates of flamprop-M-isopropyl, but co-application with double rates did not increase this effect.

The control of cleavers by fluroxypyr and of wild oats by flamprop-M-isopropyl was unaffected by tank-mixture and co-application.

DISCUSSION

Fluroxypyr has demonstrated excellent crop safety and control of broad leaved weeds particularly cleavers ((Ide 1984). Similarly, control of wild oats using flamprop-M-isopropyl alone and in combination with other chemicals is well documented (Morris et al. 1978, Luckhurst 1981). Tank-mixture of the two herbicides would enable cereal growers to control wild oats and certain broad-leaved weeds with a single application made within a wide range of crop growth stages. Since these 1986 trials and all previous studies have failed to identify any antagonism between fluroxypyr and flamprop-M-isopropyl in these respects, this tank-mixture has been accepted commercially and incorporated as part of the label recommendations of both products.

TABLE 4

Summary of the results (crop score, wild oat control and crop yield) from the co-application of fluroxypyr and flamprop-M-isopropyl to cereals from 1982-1984.

Treatment	Rate g a.i./ha	1982:4 trials			1983:6 trials			1984a:2 trials		1984b:6 trials		
		Crop score	Wild oat	Crop yield	Crop score	Wild oat	Crop yield	Crop score	Wild oat	Crop score	Wild oat	Crop yield
flamprop-M-isopropyl	600	-	-	-	-	-	-	2.1	90.0	0.2	97.6	99.9
flamprop-M-isopropyl	1200	-	-	-	-	-	-	-	-	0.2	-	100.8
fluroxypyr + flamprop-M-isopropyl	150 + 600	2.3	83.8	104.4	1.8	66.3	110.5	-	-	0	96.9	101.7
fluroxypyr + flamprop-M-isopropyl	200 + 600	2.4	86.5	102.1	2.1	69.9	107.0	2.2	92.3	0.4	-	97.8
fluroxypyr + flamprop-M-isopropyl	400 + 1200	-	-	-	-	-	-	-	-	3.8	-	93.4
Untreated	-	1.0	0	100.0	1.0	0	100.0	1.1	0	0	0	100.0

Trials from 1982, 1983, 1984a
Crop score on a 1-9 scale where 1=No damage : 5=Max commercially acceptable : 9=Total crop destruction
Wild oat control expressed as % numbers of panicles/m compared to untreated on a 0-100% scale
Crop yield expressed as % of untreated

Trials from 1984b
Crop score on a 0-4 scale where 0=No observable effect : 4=Severest effect observed on trial
Wild oat control expressed as % number of panicles/m compared to untreated on a 0-100% scale
Crop yield expressed as % of untreated

TABLE 5

Mean crop scores of winter and spring cereals treated with mixtures of fluroxypyr and flamprop-M-isopropyl in 1986.

Treatment	Rate g a.i./ha	Spring barley* (2 trials)	Winter barley* (2 trials)	Winter wheat* (1 trial)	5**	6**	10**	11**	12**	13**
fluroxypyr	200	-	0	-	-	-	-	-	-	-
fluroxypyr	300	0.1	-	-	-	-	-	-	-	-
fluroxypyr	400	-	0.2	0	-	-	-	-	-	-
flamprop-M-isopropyl	600	0.1	0.1	-	1.2	1.5	-	-	-	-
flamprop-M-isopropyl	700	-	-	-	-	-	-	-	-	-
flamprop-M-isopropyl	1200	-	0.3	0	2.1	2.1	-	-	-	-
flamprop-M-isopropyl	1400	-	-	-	-	-	-	-	-	-
fluroxypyr + flamprop-M-isopropyl	200 + 600	-	0.2	-	2.3	1.8	1.0	1.8	1.5	1.2
fluroxypyr + flamprop-M-isopropyl	200 + 700	-	-	-	2.3	1.5	1.0	1.5	1.9	1.6
fluroxypyr + flamprop-M-isopropyl	300 + 1200	0.4	-	-	-	-	-	-	-	-
fluroxypyr + flamprop-M-isopropyl	400 + 1200	-	1.1	0	2.3	1.8	-	-	-	-
fluroxypyr + flamprop-M-isopropyl	400 + 1400	-	-	-	3.1	2.4	-	-	-	-
Untreated	-	0	0		1.2	1.0	1.0	1.0	1.0	1.0

* Assessed on 0-10 scale where 0 = no damage, 10 = total crop loss
** Assessed on 1-9 scale where 1 = no damage, 9 = total crop loss

TABLE 7

Yield (% of untreated) of winter and spring cereals treated with mixtures of fluroxypyr and flamprop-M-isopropyl in 1986.

Treatment	Rate g a.i./ha	Site 1	2	3	4	5	6
fluroxypyr	300	-	-	94	103	-	-
fluroxypyr	400	111	100	-	-	-	-
flamprop-M-isopropyl	600	-	-	-	-	99.8	101.5
flamprop-M-isopropyl	1200	111	104	119	103	90.5	98.0
fluroxypyr + flamprop-M-isopropyl	200 + 600	-	-	-	-	100.5	101.5
fluroxypyr + flamprop-M-isopropyl	200 + 700	-	-	-	-	96.0	99.8
fluroxypyr + flamprop-M-isopropyl	300 + 1200	-	-	103	103	-	-
fluroxypyr + flamprop-M-isopropyl	400 + 1200	107	97	-	-	95.3	99.3
fluroxypyr + flamprop-M-isopropyl	400 + 1400	-	-	-	-	93.0	99.8
LSD (P = 0.05) expressed as percent of untreated		9.90	6.74	4.80	5.08	5.02	3.92

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THE INFLUENCE OF DOSE AND DATE OF APPLICATION ON THE CONTROL OF CLEAVERS (GALIUM APARINE) WITH MECOPROP AND FLUROXYPYR ALONE AND IN MIXTURE WITH IOXYNIL + BROMOXYNIL

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ABSTRACT

This paper reports the results of eight experiments carried out over two seasons on the the control of cleavers (*Galium aparine*) with mecoprop and fluroxypyr alone, or in mixture with ioxynil + bromoxynil. In each trial the herbicide treatments were applied at several dates between December and May. The results showed that 'winter' applications of mecoprop (2.4 kg a.e./ha) and fluroxypyr (0.2 kg a.i./ha) alone did not give reliable control of cleavers. The addition of 0.3 or 0.6 kg a.i./ha ioxynil + bromoxynil to the mecoprop and fluroxypyr improved their performance in winter, appreciably. However, applications of both mecoprop and fluroxypyr alone in the 'spring' resulted in very much better control of cleavers. Mecoprop achieved best results when applied in April, whilst fluroxypyr was most effective when applied in April or May. In these cases there was little need to mix ioxynil + bromoxynil with the fluroxypyr or mecoprop to improve control. In some trials fluroxypyr at 0.1 kg a.i./ha was as effective as 0.2 kg a.i/ha but in others the higher rate was needed.

INTRODUCTION

Cleavers (*Galium aparine*) is the most serious broad-leaved weed to occur in cereals. Not only is it much more competitive than other broad-leaved weeds (Wilson 1986), it is also difficult to control. A survey by Chancellor and Froud-Williams (1984) indicated that it was one of the most frequent species to be seen in cereal crops in June and July. Traditionally, this weed has been controlled with mecoprop but in recent years control has frequently been inadequate. This may be due to increasing weed densities, as a result of continuous cropping of early sown winter cereals, which favours the cleavers, or to attempts by farmers to reduce their work load in the spring by treating their weeds earlier in the year. When mecoprop was first introduced in 1956 (Lush 1956), cleavers plants were generally treated after the 'fully tillered' stage of the crop, normally in April. It has recently become more common to apply herbicides to cleavers during the winter and early spring. Applications of mecoprop alone at this time of the year tend to give inadequate control.

Improved reliability of control can be achieved in several ways. The performance of mecoprop can be maximised by delaying application until the weed is growing actively in the warmer weather of April (Orson 1985). Alternatively its activity can be enhanced by mixing with other herbicides, the commonest being the mixture of ioxynil + bromoxynil. The performance of this mixture is generally more reliable than mecoprop alone (Lovegrove *et al*. 1985, Orson 1985). Thirdly, the recently introduced herbicide, fluroxypyr (Paul *et al*. 1985), seems to be very effective on cleavers on its own and in mixture with ioxynil + bromoxynil. However, ioxynil + bromoxynil and fluroxypyr are considerably more expensive than mecoprop.

The eight experiments described in this paper compared the performance of mecoprop and fluroxypyr alone and in mixture with ioxynil + bromoxynil. In each trial these products were applied at several dates in the winter and spring, and at a number of doses. The trials were designed to show the interactions between date of application and herbicide performance, and the consequences of mixing herbicides to increase activity.

MATERIALS AND METHODS

General

All eight trials were carried out in central southern England in fields with natural populations of cleavers, except at the Hatherop site where the natural population was supplemented with cleavers seed broadcast prior to drilling. The general husbandry of the crops, excluding weed control and some fertiliser and fungicide treatments was carried out by the farmers. All the trials were of a randomised block design, with three replicates and

TABLE 1

Details of the herbicide applications and the stages of growth of the cereals and cleavers in two trials in 1983-84 and in six trials in 1984-85

	1984 - 1985						1983 - 1984	
Site	Kingham	Owlswick	Sidd-ington	Ett-ington	Knighton	Hath-erop	Merris-court	Owlswick
Crop	Wheat	Barley	Barley	Wheat	Barley	Wheat	Wheat	Barley
Cleavers plants/m^2	68	39	47	106	108	232	41	23
First application								
Date	5 Feb	11 Dec	10 Dec	23 Jan	12 Dec	7 Dec	9 Jan	7 Dec
Growth Stage*								
Crop	15 22	15 23	16 24	14 22	14 22	14 22	14 22	14 22
Weed								
leaf no.					1-2	1-3	2	1-2
size (cm)	4-15	5-12	5-15	6-15				
Second application								
Date	2 May	24 Apr	18 Apr	26 Apr	18 Mar	6 Feb	7 Mar	6 Mar
Growth Stage								
Crop	31	31	31	31	16 22	16 23	16 22	16 24
Weed								
size (cm)	30	20-25	25	30	8-12	2-10	5-12	9-15
Third application								
Date					17 Apr	9 Apr	8 May	4 May
Growth Stage								
Crop					30	17 23	32	33
Weed size (cm)					15-20	20-25	40	45
Fourth application								
Date					16 May	14 May		
Growth Stage								
Crop					32	33		
Weed size (cm)					25-30	35		

* Cereal Stage of Growth after Zadoks, Chang & Konzak (1974)
Weed stages of growth; small plants, number of whorls of leaflets
larger plants , average length of shoots.

the plots were either 2 x 6m or 2 x 10m. The treatments were all applied with an Oxford Precision Sprayer fitted with four 'Spraying Systems' 8002 'Teejet' nozzles, delivering 250 l/ha at a pressure of 207 kPa. The herbicides used were; mecoprop, potassium salt (570 g a.e./l ac)(Compitox Extra), fluroxypyr ester (200 g a.i./l EC)(Starane 2) and a formulated mixture of the esters of ioxynil and bromoxynil (190 + 190 g a.i./l EC)(Deloxil). Details of the sites, densities of the cleavers plants, dates of application and crop and weed growth stages are given in Table 1. The activity of the herbicide treatments was assessed by recording the number of cleavers shoots emerging through the crop canopy in June. Four or five $1m^2$ quadrats were counted in each plot. Where possible the 'raw' data were subjected to analysis of variance but where the data had a non-normal distribution a square root transformation was used ($X = \sqrt{(X + 1)}$).

Experiments 1983-84

Two experiments investigated the performance of mecoprop (2.4 kg a.e./ha) alone or with ioxynil + bromoxynil (0.6 kg a.i./ha), with that of fluroxypyr alone at three doses (0.1, 0.2, 0.4 kg a.i./ha), or at 0.2 kg/ha mixed with the 0.6 kg/ha rate of ioxynil + bromoxynil. The herbicide treatments were applied at three timings, between December and May (Table 1).

Experiments 1984-85

In four experiments (Experiments A) the performance of three doses of fluroxypyr (0.05, 0.1, 0.2 kg a.i./ha) alone, or in combination with ioxynil + bromoxynil (0.15, 0.3, 0.6 kg a.i./ha), was compared with mecoprop (2.4 kg a.e./ha) alone, or in mixture with the 0.3 kg/ha rate of ioxynil + bromoxynil. The treatments were applied in the winter (December - February) or in the spring (April - May) (Table 1). In two further trials (Experiments B), fluroxypyr (0.2 kg a.i./ha) alone, or with two rates of ioxynil + bromoxynil (0.15, 0.3 kg a.i./ha), was compared with mecoprop (1.2 kg a.e./ha) alone, or with the same rates of ioxynil + bromoxynil. These treatments were applied at four timings between November and May (Table 1).

RESULTS

Experiments 1983-84

The control of cleavers with fluroxypyr on its own was outstanding from 0.4 kg/ha at all dates of application and from 0.2 kg/ha, when applied in May at both sites and March at Merriscourt (Table 2). The lowest dose (0.1 kg/ha) generally gave poor control, although May applications reduced cleavers shoot numbers by more than 75%. The 0.2 kg/ha dose was significantly less effective when applied in December at Owlswick but was less adversely affected in January at Merriscourt. The addition of ioxynil + bromoxynil improved activity of the December application of fluroxypyr at Owlswick and appeared to have a similar beneficial effect at Merris Court but the difference was not statistically significant. Addition of ioxynil + bromoxynil in March and May had little effect, because of the high degree of control from the fluroxypyr alone. As with the fluroxypyr, the mecoprop was least effective when applied in December/January. Unlike fluroxypyr, its activity in May at Merriscourt was also lower. The March applications gave the best results. The addition of ioxynil + bromoxynil to mecoprop resulted in very good results, in excess of 85% kill of shoots.

TABLE 2

The numbers of surviving cleavers shoots following three dates of application of fluroxypyr and mecoprop alone, or in mixture with ioxynil + bromoxynil, at two sites. (data = $\sqrt{(\text{shoots}/m^2 + 1)}$)

fluroxypyr or mecoprop (dose kg a.i./ha)	ioxynil + bromoxynil	Merriscourt Date of treatment			Owlswick Date of treatment		
		9 Jan	7 March	8 May	7 Dec	6 March	4 May
fluroxypyr							
0.1	-	3.41	2.03	1.72	4.46	4.62*	2.81
0.2	-	2.35	1.00	1.22	4.26	2.77*	1.00
0.2	0.6	1.32	1.04	1.00	1.49	1.07*	1.00
0.4	-	1.34	1.04	1.00	1.07	1.00*	1.00
mecoprop							
2.4	-	4.01	2.49	3.97	2.87	1.88	2.04
2.4	0.6	1.22	1.00	2.39	1.07	1.15	1.11
untreated controls			6.30			7.53	
S.E. of mean ±			0.396			0.786	

* actual rates of fluroxypyr applied 0.08, 0.16, 0.16, 0.32 kg/ha

TABLE 3

The percentage reduction in cleavers stems/m^2 emerging from the crop canopy in June following applications of fluroxypyr and mecoprop alone, or in mixture with ioxynil + bromoxynil, in late April or early May, at four sites

Herbicide Dose (kg/ha)	Siddington			Owlswick			Ettington			Kingham		
	Dose of ioxynil + bromoxynil (kg a.i./ha)											
	0	0.15	0.30	0	0.15	0.30	0	0.15	0.30	0	0.15	0.30
fluroxypyr												
0.05	100	100	100	86	98	95	57	61	78	99	100	100
0.1/0.2	100	100	100	100	100	100	95	100	100	100	100	100
mecoprop												
2.4	100	-	100	100	-	100	80	-	94	95	-	100

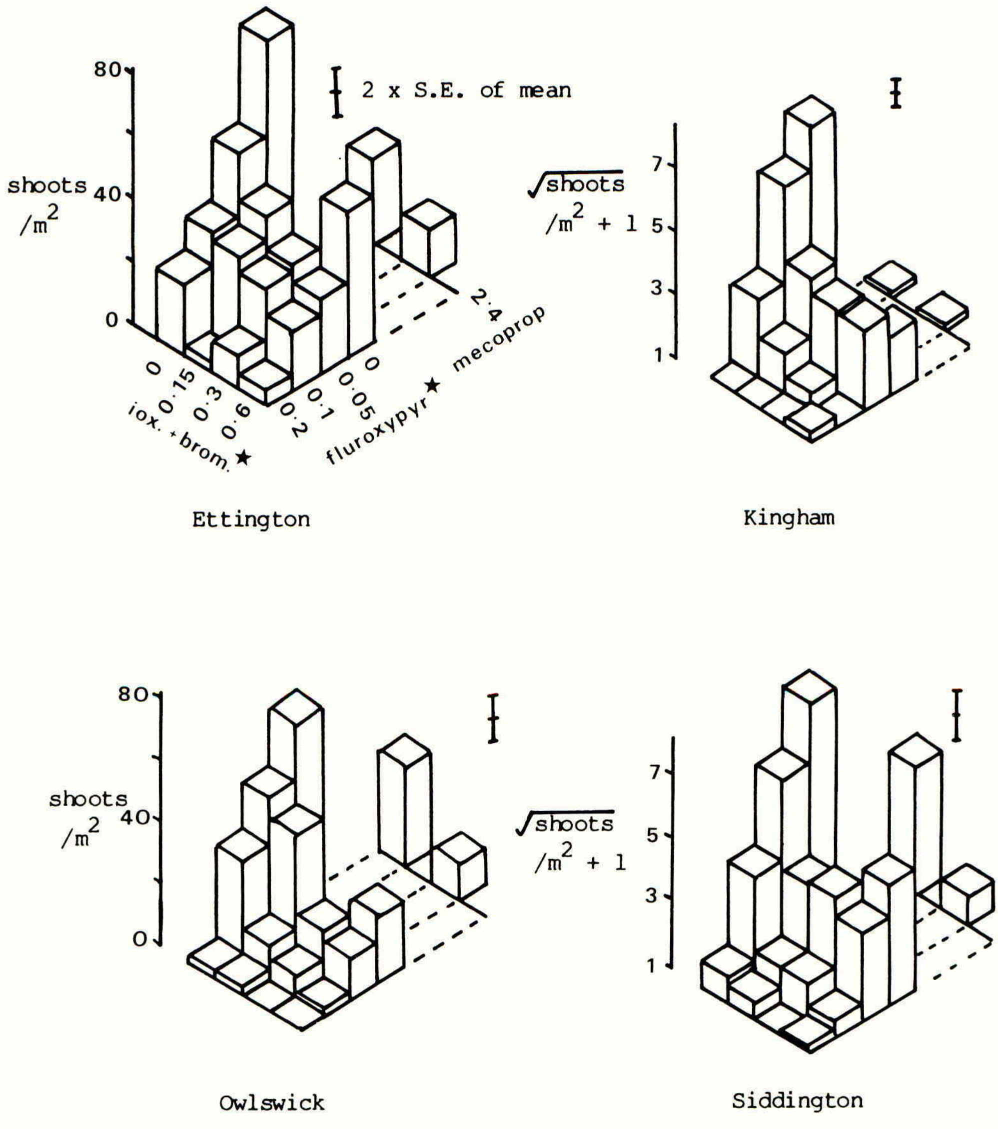
Experiments 1984-85

Experiments A (two dates of treatment/four trials)

The winter applications of fluroxypyr alone at 0.05 and 0.1 kg/ha failed to kill the cleavers but were successful at 0.2 kg/ha (Fig. 1) on three of the four trials. The performance of the lower rates was markedly improved by the addition of increasing rates of ioxynil + bromoxynil. Control was excellent from 0.1 kg/ha fluroxypyr mixed with 0.3 kg/ha ioxynil + bromoxynil at three of the four sites but the mixtures with

FIGURE 1

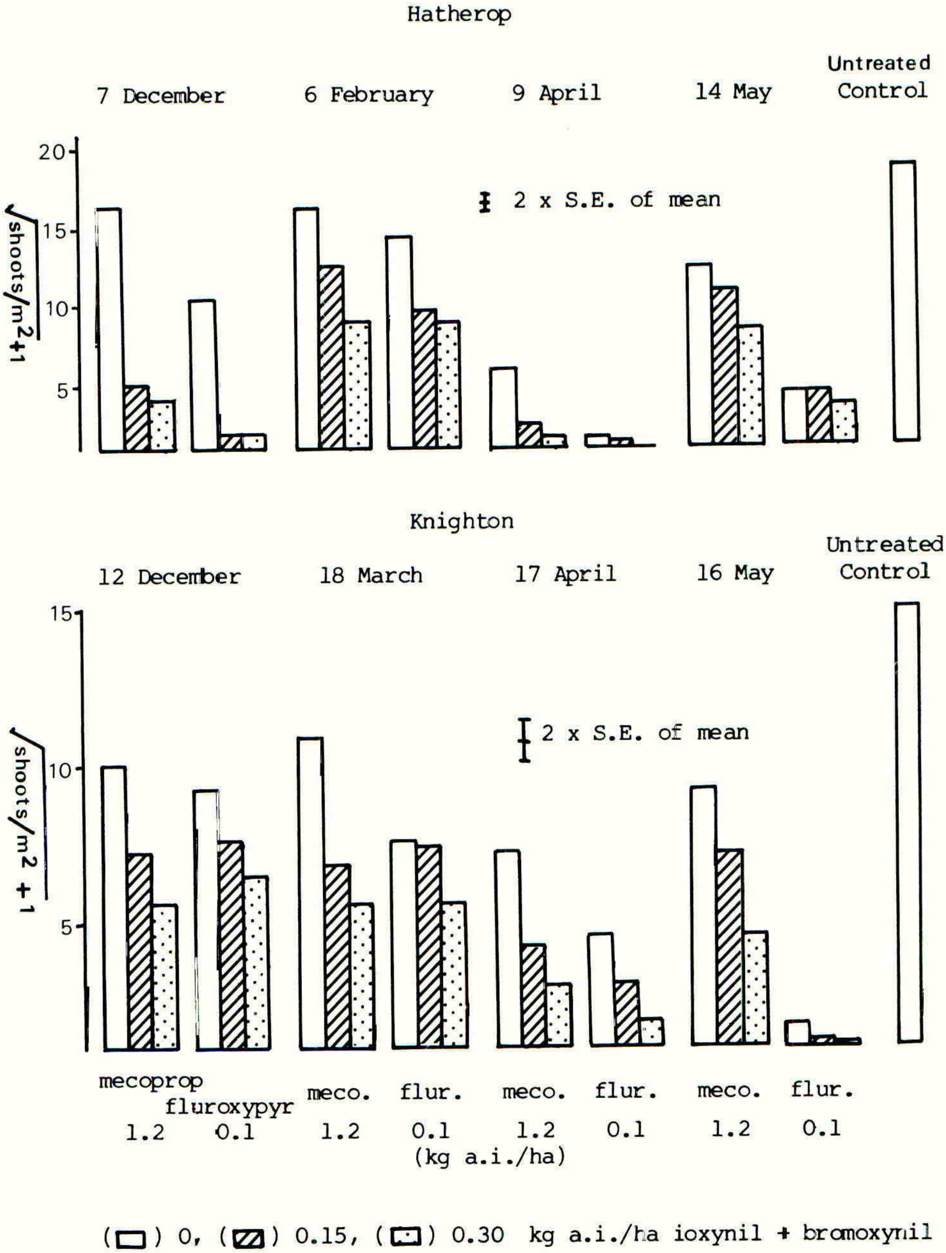
The number of cleavers shoots surviving treatment with fluroxypyr and mecoprop alone, or mixed with ioxynil + bromoxynil, at four sites in winter 1984 - 85.



★ Herbicide doses in Kg a.i.(or a.e.)/ha

FIGURE 2

The effect of mecoprop and fluroxypyr, applied at four dates, with and without ioxynil + bromoxynil, on the number of cleavers shoots emerging through the crop canopy in June, at two sites.



0.05 kg/ha fluroxypyr were frequently unsatisfactory. At the fourth site (Ettington), 0.2 kg/ha fluroxypyr mixed with at least 0.15 kg/ha ioxynil + bromoxynil was needed to achieve high reductions in cleavers shoot numbers. The winter activity of mecoprop alone at 2.4 kg/ha was poor at three of the four sites but its performance was greatly improved at these sites by mixing with ioxynil + bromoxynil (0.3 kg/ha).

In general, the activity of both mecoprop and fluroxypyr was much higher in the spring. At Siddington and Kingham all the treatments resulted in more than a 95% reduction in the numbers of cleavers shoots, even fluroxypyr alone at 0.05 kg/ha (Table 3). At the other two sites this dose was less effective and the addition of ioxynil + bromoxynil improved control, but both the two higher rates of fluroxypyr alone (0.1, 0.2 kg/ha) reduced cleavers shoot numbers by 95% or more. Mecoprop alone completely killed the cleavers at three of the four sites, the addition of ioxynil + bromoxynil improving control at the fourth site (Ettington).

Experiments B (four dates of treatment/two experiments)

The lower rates of fluroxypyr and mecoprop used in these two trials confirmed the lower activity of these two products, applied in the winter (Fig. 2). The best control from fluroxypyr alone occurred after the applications in April and May. Applications in December, February or March were much less effective. Addition of ioxynil + bromoxynil improved activity but the reduction in cleavers shoot numbers frequently remained poor. The 1.2 kg/ha rate of mecoprop alone failed at Knighton at each application date and was also inadequate when applied in December, February and May at Hatherop. The addition of ioxynil + bromoxynil to mecoprop improved control but even when 0.3 kg/ha was added the kill of cleavers sometimes fell below 80%. In general, the fluroxypyr was most active when applied in April and May, and the mecoprop when used in April.

DISCUSSION

These eight experiments have highlighted the effect of month of application and dose on the performance of fluroxypyr and mecoprop. Applications of these herbicides, especially mecoprop, prior to April tended to result in poor control of cleavers. The addition of ioxynil + bromoxynil to both of them improved their performance. The winter applications of fluroxypyr at 0.2 kg/ha with ioxynil + bromoxynil at 0.6 kg/ha achieved excellent control of cleavers, whereas fluroxypyr alone tended to be less reliable. In some trials the mixtures of lower rates of ioxynil + bromoxynil with 0.2 kg/ha fluroxypyr were equally effective, but performance became less reliable when the rate of fluroxypyr was lowered to 0.1 kg/ha. This conclusion agrees with the data of Paul et al. (1985) which indicated that reliable control of cleavers was achieved by 0.18 kg/ha fluroxypyr with 0.4 kg/ha ioxynil + bromoxynil. Lower rates were less active. Mecoprop alone, even at 2.4 kg/ha, was unreliable but in most trials the addition of 0.3 or 0.6 kg/ha ioxynil + bromoxynil resulted in high levels of control.

In April, both fluroxypyr and mecoprop, on their own, achieved high levels of control of cleavers. In many trials the control from 0.1 kg/ha fluroxypyr was excellent. Thus the addition of ioxynil + bromoxynil seemed unnecessary. The performance of mecoprop in May was less satisfactory but that of fluroxypyr remained at a high level. The poor results from mecoprop, applied in May, although of interest, are of no practical relevance because the use of this herbicide after the two node stage of the crop is not recommended, because of the risk of crop damage. This growth stage generally occurs in winter cereals in April. Although 0.1 kg/ha fluroxypyr often achieved very high levels of control in the spring, it must be remembered that even 0.2 kg/ha was unsatisfactory earlier in the year. Orson (1985) reported that although applications of 0.2 kg/ha in late April, at the second node stage of the cereals, achieved at least 97% control, earlier applications at the pseudostem erect stage were much less reliable. Thus it would be prudent to maintain the dose at 0.2 kg/ha to ensure high levels of control of this particularly competitive weed.

Because mecoprop is appreciably cheaper than the other products, it would be beneficial to the farmer if this product could be used more reliably. The addition of ioxynil + bromoxynil to the mecoprop improves its reliability in the winter months but makes control more expensive. Similarly the fluroxypyr, ioxynil + bromoxynil mixtures, although reliable, are expensive. Thus the cheapest reliable treatment, in these trials, would be the application of mecoprop alone in the spring, if the temperatures are high and the cleavers are growing actively before the crop has reached the second node stage of development. Further research is needed to identify more accurately the effects of climate on the control of cleavers with mecoprop. Fluroxypyr alone can be used up until the flag-leaf emerged stage of the cereals, thus permitting later control than that possible with mecoprop. As competitive effects of cleavers seem to be mainly exerted towards the end of the growing season (Wilson & Wright 1987), delayed treatment may not result in loss of yield.

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CONTROL OF GALIUM APARINE AND OTHER MAJOR WEEDS OF WINTER CEREALS WITH PRE- AND EARLY POST-EMERGENCE SC 0574

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ABSTRACT

In small-plot trials over four seasons in North-West Europe SC 0574 at 4.0 kg ai/ha gave a consistently high level of control of *Galium aparine* in winter cereals. Pre-emergence or early post-emergence treatments in the autumn were equally effective and excellent results were obtained irrespective of soil type or autumn weather conditions.

SC 0574 also controlled other major broad-leaved weed species including *Stellaria media*, *Veronica* spp., and *Lamium purpureum*, and grass species including *Alopecurus myosuroides*, *Apera spica-venti* and *Poa* spp. Tank mixtures with other herbicides extended the spectrum of control.

In weed free trials SC 0574, at single or double-rate, had little effect on the yield of winter barley, winter wheat or winter rye. Where weeds were present SC 0574 increased yield substantially particularly where *G.aparine* and *A.myosuroides* were controlled.

INTRODUCTION

Galium aparine is now a severe weed problem in many areas of Europe. Its increased importance is due to the intensification of winter cereal production, particularly earlier sowing and minimum cultivation techniques, and the popularity of rotational crops in which herbicides have given poor control. *G.aparine* is also economically damaging. Wilson (1986) proposed a system of crop equivalents to predict yield loss from broad-leaved weeds in winter cereals and rated *G.aparine* as the most competitive species. Yield losses of 30 to 50% have been recorded in winter wheat by populations ranging from 25 to 100 plants/m^2 (Peters 1984, Wilson 1984). Severe infestations also delay and increase the cost of harvesting (Elliot 1980).

SC 0574 (S-[phenylmethyl] dipropylcarbamothioate - proposed name prosulfocarb) is a novel herbicide developed by Stauffer Chemical Company. The physical, chemical, toxicological and biological properties of SC 0574 have been described by Glasgow *et al* (1987). Screening trials in glass-houses and at field stations demonstrated selectivity in cereals and excellent activity against a range of species including *G.aparine*. This paper reports the results of some 350 trials in winter cereals carried out from 1983 to 1987 in the United Kingdom, France and West Germany designed to investigate the effect of pre- and post-emergence applications of SC 0574.

MATERIALS AND METHODS

SC 0574 (an emulsifiable concentrate containing 800 g/l of active ingredient) was applied pre-emergence or post-emergence at rates ranging from 2.0 to 10.0 kg ai/ha to commercial crops of winter wheat and winter barley. The trials were located in the main cereal growing areas of the United Kingdom, France and West Germany. In West Germany winter rye was also treated. Trials were conducted on the major cultivars of each crop and on soil types ranging from loamy sand to clay. Post-emergence treatments were applied in the autumn or winter at crop stages from one leaf to early tillering. Comparisons were made with residual herbicides (standards), appropriate to each crop and each country, applied according to the manufacturer's recommendations.

All trials were of randomised block design with 3 or 4 replicates. Plots, 25 to 60 m^2, were treated with hand-held compressed gas sprayers, fitted with flat fan nozzles, in 200 to 400 l/ha water at an operating pressure of 200 to 300 kPa.

Weed control for each species was assessed by counts or a visual estimate in comparison with adjacent untreated plots. Broad-leaved weed assessments were made in the autumn and spring, and grasses at heading. Crop tolerance was monitored throughout the season by determining plant and fertile tiller number, leaf discolouration, % vigour reduction and grain yield. In the UK and France the trials harvested had low weed populations or were weed-free. In West Germany yields were taken from trials with a range of weed species and populations.

RESULTS

There were some 160 trials carried out on wheat, a similar number on barley but fewer (approximately 30) on rye. A wide range of broad-leaved and grass species were recorded in all crops but G.aparine occured in more trials and at higher numbers in wheat compared to barley. Typical populations of G.aparine recorded in untreated plots in the autumn ranged from 5 to 30 seedlings/m^2 though in six cases over 100/m^2 were present. The higher infestations tended to occur in crops drilled before mid-October and on medium or heavy soils. A population of 20 to 30 seedlings/m^2 in the autumn often led to complete or near-complete ground cover by G.aparine in the following summer.

Pre-emergence SC 0574 was effective against G.aparine at rates of 3.0 kg ai/ha and above and gave consistent control at 4.0 kg ai/ha. There was little advantage from using higher rates. These data are not presented in full but may be obtained upon request from the authors. Post-emergence treatment was also effective but applications in autumn or winter when seedlings of G.aparine were from cotyledon up to the early branching stage (approximately 50 mm across) were more effective than later timings, and 4.0 kg ai/ha again gave the most consistent results. The results in Table 1 show the control of G.aparine achieved by SC 0574 (4.0 kg ai/ha) compared to a range of standards. Pre- and post-emergence applications of SC 0574 gave a mean level of control of G.aparine ranging from 91 to 99%. This was greater than that achieved by the standards and was more consistent across the countries and seasons included in the trials.

Effects of SC 0574 on G.aparine were often slow to develop. Seedlings often germinated following pre-emergence treatment but died later. Post-emergence treatments affected the growing point of seedlings leading

TABLE 1

Mean % control of G.aparine in winter cereals with autumn applications of SC 0574 at 4.0 kg ai/ha compared to standards

Harvest Year	United Kingdom			West Germany			France		
	SC 0574		Standard	SC 0574		Standard	SC 0574		Standard
	Pre-em	Post-em		Pre-em	Post-em		Pre-em	Post-em	
1984	-	-	-	96 (4)	-	33 (2)*	99 (3)	-	22 (2)°
1985	95 (3)	-	90 (3)**	96 (27)	-	92 (11)**	93 (11)	-	82 (10)°
1986	97 (5)	97 (7)	82 (3)°°	96 (11)	97 (14)	93 (7)**	91 (5)	-	76 (4)°
1987	95 (5)	96 (6)	67 (4)§	99 (15)	99 (4)	89 (14)**	91 (6)	91 (3)	53 (3)°°°

Standards were, kg ai/ha, * 1.0 or ** 2.0 pendimethalin pre-em; ° pre-em or °° post-em chlorsulfuron + methabenzthiazuron 2.45; °°° chlortoluron + isoxaben 2.48 pre-em; § isoproturon + ioxynil + mecoprop, 3.84 post-em.

Figures in parenthesis are number of trials from which mean is derived.

TABLE 2

Susceptibility of major weed species to SC 0574 applied at 4.0 kg ai/ha in winter cereals

Species	Application timing	
	Pre-em	Early Post-em
Alopecurus myosuroides	MS/S	MS
Anthemis arvensis	MR	MR
Apera spica-venti	S	S
Aphanes arvensis	S	S
Avena fatua	MR	R
Chenopodium album	S	S
Fumaria officinalis	S	S
Galium aparine	S	S
Lamium purpureum	S	S
Legousia speculum-veneris	S	S
Lolium multiflorum	MS	MS
Matricaria chamomilla	MS	MS
Matricaria perforata	MR	MR
Myosotis arvensis	S	MS/S
Papaver rhoeas	MR	MR
Poa annua	S	S
Poa trivialis	S	MS
Sinapis arvensis	MR	MR
Stellaria media	S	MS/S
Veronica hederifolia	S	S
Veronica persica	S	S
Viola arvensis	MR	MR

Based on a summary of 350 trials in UK, France and West Germany where:

S = Susceptible (90-100% control)
MS = Moderately susceptible (80-89% control)
MR = Moderately resistant (60-79% control)
R = Resistant (less than 60% control)

eventually to their death. Assessments in the spring, some 5-6 months after treatment, generally demonstrated a higher level of control than assessments in the autumn.

Other species of weeds commonly recorded in the trials are listed in Table 2 together with their susceptibility to SC 0574 based on assessments in spring or summer. Pre-emergence applications were very effective against many broad-leaved species germinating in the autumn including Stellaria media, Veronica hederifolia, V.persica, Lamium purpureum and Legousia speculum-veneris. Post-emergence applications were also effective if they were applied early when seedlings were at the cotyledon to two expanded leaf stage. Other broad-leaved species were less susceptible to SC 0574, but control of these was improved by tank-mixing SC 0574 with other herbicides (Tables 3 & 4). Isoxaben pre-emergence or post-emergence

TABLE 3

Mean % control of broad-leaved and grass weeds with pre-emergence SC 0574 mixtures in UK, France and West Germany, 1985-86

Treatment (kg ai/ha)		*Alopecurus myosuroides*	*Matricaria* spp.	*Papaver rhoeas*	*Viola arvensis*
SC 0574	4.0	91 (16)	61 (9)	65 (5)	76 (18)
SC 0574 + isoxaben	3.0-3.5 + 0.05-0.08	91 (16)	97 (11)	93 (5)	96 (18)
SC 0574 + chlortoluron	3.2 + 1.05	93 (3)	96 (5)	-	77 (3)

Figures in parenthesis are numbers of trials from which mean is derived

TABLE 4

Mean % control of broad-leaved and grass weeds with post-emergence SC 0574 mixtures in UK, France and West Germany, 1986-87

Treatment (kg ai/ha)		*Alopecurus myosuroides*	*Matricaria* spp.	*Papaver rhoeas*	*Viola arvensis*
SC 0574	4.0	84 (19)	80 (10)	93 (6)	77 (7)
SC 0574 + isoxaben	2.4-4.0 + 0.06-0.075	84 (13)	92 (11)	97 (7)	92 (9)
SC 0574 + ioxynil	2.4-4.0 + 0.2-0.25	83 (14)	96 (12)	95 (7)	77 (8)
SC 0574 + isoproturon	3.0 + 1.0	96 (6)	-	100 (2)	51 (2)

Figures in parenthesis are numbers of trials from which mean is derived

or ioxynil post-emergence were particularly effective in this respect.

Grass weeds also occurred widely in these trials. *Alopecurus myosuroides* was present in all countries but infestations were particularly high in the UK where populations in excess of 100 seedlings/m^2 were frequently recorded. Pre-emergence SC 0574 gave good control of this species particularly in France and West Germany and results were comparable to pendimethalin or chlorsulfuron + methabenzthiazuron in all countries. Post-emergence applications were slightly less effective if treatment was delayed beyond the two leaf stage. The control of *A.myosuroides* was improved by tank-mixing SC 0574 with chlortoluron or isoproturon (Tables 3 & 4). Other grass species including *Apera spica-venti*, *Poa annua* and *Poa trivialis* were also susceptible to SC 0574 (Table 2).

TABLE 5

The effect of pre-emergence SC 0574 on mean yield (t/ha) of winter cereals in 'weed-free' trials, France 1985-1987

Treatment (kg ai/ha)	Winter barley			Winter Wheat	
	1985	1986	1987	1985	1986
Untreated	5.97	5.71	7.17	7.44	6.07
SC 0574 4.0	6.13	5.78	7.44	7.30	6.10
SC 0574 8.0	6.04	5.70	7.24	7.12	6.10
No trials	5	9	3	5	12
SED	0.11	0.10	0.23	0.18	0.07
CV (%)	2.91	3.88	3.80	3.97	2.80

TABLE 6

The effect of pre- and early post-emergence SC 0574 on mean yield (t/ha) of winter cereals in 'weed-free' trials, UK 1986

Treatment (kg ai/ha)	Timing	Winter barley	Winter wheat
Untreated		7.66	7.62
SC 0574 4.0	Pre-em	7.64	7.64
SC 0574 8.0	Pre-em	7.57	7.54
SC 0574 4.0	Post-em	7.68	7.52
SC 0574 8.0	Post-em	7.35	7.72
No trials		5	2
SED		0.15	0.17
CV (%)		3.23	2.28

TABLE 7

The effect of pre-emergence SC 0574 on mean yield (t/ha) of winter cereals in West Germany compared to pre-emergence standards

Treatment (kg ai/ha)	Winter barley		Winter wheat		Winter rye	
	1985	1986	1985	1986	1985	1986
Untreated	5.06	5.12	6.19	5.57	4.61	5.03
SC 0574 4.0	6.31	5.99	7.20	6.61	4.41	5.10
Standard	6.17*	5.95*	7.39**	6.24°	4.61**	5.10°°
No trials	7	14	6	11	4	5

Standards, kg ai/ha, were * pendimethalin, 2.0; ** methabenzthiazuron, 2.8; ° methabenzthiazuron, 2.8 (5 trials) or chlortoluron 2.1 (6 trials); °° methabenzthiazuron, 2.8 (3 trials) or pendimethalin, 1.5 (2 trials).

When applied pre-emergence SC 0574 showed excellent selectivity in all crops drilled at normal depth into conventionally prepared seedbeds on all soil types, confirming the findings of Glasgow et al (1987). Post-emergence applications also showed excellent selectivity in wheat treated at all stages from emergence to tillering but sometimes caused transient leaf scorch and vigour reduction in barley. There was no indication of varietal sensitivity to SC 0574.

The effect of SC 0574 on grain yield in trials with low weed infestations is presented in Tables 5 and 6. Under these conditions SC 0574 did not significantly ($p = 0.05$) affect the overall yield of wheat or barley in any season. In weedy trials in West Germany (Table 7) SC 0574 increased yield, particularly where A.myosuroides and G.aparine were present. These increases were often greater than with the standards where G.aparine was the dominant species. For example, in winter barley SC 0574 increased yield by 1.13 t/ha (a 32% increase) and 1.36 t/ha (a 21% yield increase) in two trials where G.aparine comprised 60% and 40% respectively of the total weed population. Yield increases by the standard in the same trials were 0.88 t/ha and 0.87 t/ha.

DISCUSSION

Post-emergence herbicides currently recommended for the control of G.aparine in winter cereals are mostly used in spring and tend to be effective only when the weather is warm (Orson 1985). Residual products applied in the autumn, though effective against many species, have given rather variable and often poor control of G.aparine (Bradford & Smith 1982, Orson 1984). Lovegrove et al (1985) related this variability to soil type finding that residual herbicides were less effective on heavy soils. The trials reported in this paper have demonstrated that SC 0574 applied pre- or early post-emergence in the autumn gives consistently high levels of residual control of G.aparine. SC 0574 was effective on heavy soils (where G.aparine was more widespread) as well as light soils, in wet or dry autumns and when temperatures were low.

In a review, Makepeace (1982) concluded that the control of broad-leaved weeds had generally benefited yield but with no difference in the yield increase between autumn applications of herbicides compared to spring. However, Wilson et al (1985) suggested that autumn or winter control of heavy infestations of competitive broad-leaved species in addition to the early control of competitive grasses such as A.myosuroides was desirable. This contention is supported by results from these trials where SC 0574 increased yield substantially where high populations of G.aparine and A.myosuroides were controlled.

SC 0574 was effective against a range of broad-leaved and grass weed species germinating in the autumn. Broader spectrum control was obtained by using mixtures of SC 0574 and other herbicides. SC 0574 is thus an alternative residual herbicide offering flexible application timing with the benefit of reliable control of G.aparine. Reliable weed control combined with a high degree of crop safety offers the potential for maximising the yield benefit achieved by weed control in winter cereals.

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A NOVEL SALT/ESTER COFORMULATION CONTAINING BENAZOLIN FOR BROAD-LEAVED WEED CONTROL IN CEREALS

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ABSTRACT

CR 17607 is a new post-emergence herbicide developed for cost effective wide spectrum broad-leaved weed control in cereals. It is a solubilised concentrate combining benazolin and mecoprop salts with ioxynil and bromoxynil esters (22.2 + 413.0 + 27.8 + 55.6 g a.i./l).

In extensive United Kingdom trials in 1985 and 1986, CR 17607 at 4.5 l/ha gave quick, and highly effective control of major overwintered broad-leaved weeds of winter cereals including cleavers (Galium aparine), common chickweed (Stellaria media) mayweeds (Matricaria spp., Anthemis spp. and Chamomilla spp.), and speedwells (Veronica spp.). CR 17607 has a wide application window and was well tolerated over a range of crop stages from GS 12 to GS 31 inclusive.

Efficacy and crop safety compared favourably with standard treatments based on hydroxybenzonitrile esters + mecoprop or fluroxypyr, and metsulfuron-methyl tank mixed with mecoprop. These trials results were confirmed in the first season's commercial usage of CR 17607 (JAGUAR*) in 1987.

INTRODUCTION

In the late 1970's the introduction of products based on hydroxybenzonitriles and mecoprop or dichlorprop esters set a new standard of broad-leaved weed control in cereals. These have now been largely phased out because of the risk of vapour drift damage to susceptible neighbouring crops from the mecoprop and dichlorprop ester components.

To overcome this problem products based on hydroxybenzonitrile esters were introduced for use either alone or in tank mixture with mecoprop salt. One such product, containing benazolin + ioxynil + bromoxynil esters (ASSET+) was launched in 1982 particularly for spring use against tough overwintered weeds (Orson and Marshall 1985).

However, a ready for use coformulation was clearly desirable, and the difficult problem of preparing a biologically active and stable mixture based on these constituents and mecoprop salt was eventually resolved by

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the use of a special formulation system. The field performance of CR 17607, and that of appropriate standard treatments was compared in extensive trials undertaken in spring and winter cereals. This paper examines the response of tough winter hardened weeds in autumn sown cereals to late winter and spring treatments of CR 17607 during 1985 and 1986.

MATERIALS AND METHODS

CR 17607, a solubilised concentrate formulation of benazolin salt + ioxynil ester + bromoxynil ester + mecoprop salt (22.2 + 27.8 + 55.6 + 413 g a.i./l) was tested in trials in 1985 and 1986 at 4.5 l/ha, covering the major varieties of autumn sown wheat, barley and oats.

In 64 small plot efficacy trials, distributed throughout the United Kingdom, the performance of CR 17607 was compared with two commercial standard treatments:

A a benazolin + ioxynil + bromoyxnil ester product (50 + 62.5 + 125 g a.i./l) tank mixed with mecoprop salt (570 g a.i./l) at 2.0 + 3.25 l/ha

B an ioxynil + bromoxynil esters + mecoprop salt product (56 + 56 + 448 g a.i./l) at 4.5 l/ha.

In 18 trials double doses were also tested.

In 27 trials a further standard treatment was included:

C an ioxynil + bromoxynil + fluroxypyr ester product (100 + 100 + 90 g a.i./l) at 2.0 or 2.5 l/ha.

In 1986 a comparison was also made in nine trials with:

D metsulfuron-methyl 200 g a.i./kg tank mixed with mecoprop (570 g a.i./l) at 0.03 kg + 4.2 l/ha.

Crop yield was recorded in 12 weed free trials in 1985 and 1986, six in each year, for CR 17607 at 4.5 and 9.0 l/ha. Standard treatment A at 2.0 + 3.25 and 4.0 + 6.5 l/ha was included in both seasons and standard treatment B at 4.5 and 9.0 l/ha in 1985.

Applications in the efficacy trials were made in the spring at crop stages ranging from GS 12 to GS 32 to weeds which were frequently tough, having survived winter conditions. In later sprayed trials, weeds were often large i.e. up to 40cms high or 15cm diameter. In the yield trials applications were made at crop stages GS 30, GS 31 and GS 32.

Plot sizes were 7 to 10 x 2m in small plot efficacy trials and 21 x 3m in yield trials with three and six replicates respectively. Treatments were applied by pressurised knapsack sprayer fitted with TeeJet 8001 or 11002 nozzles in 200-220 l/ha of water at 210 to 280 kPa pressure to deliver a BCPC medium quality spray.

Assessment of crop safety in winter wheat and barley, (scorch or vigour loss) and weed control (cover and number) was made visually on a percentage scale. Yield trials were harvested by Claas or Massey Ferguson combines adapted for small plot work. Grain yields were statistically analysed and hectolitre weights recorded.

RESULTS

Efficacy

The results from both years' trials were similar. Initial weed response to CR 17607 at 4.5 l/ha was very satisfactory and fully comparable to standard treatment A (benazolin + ioxynil + bromoxynil esters + mecoprop tank mixture) and the two hydroxybenzonitrile based products, standard treatments B and C (Table 1). CR 17607 was however, considerably faster acting than metsulfuron-methyl + mecoprop, standard treatment D.

Final control (10 weeks after treatment) of common chickweed, mayweeds, cleavers and common poppy, the most competitive yield depressing weeds in cereals (Wilson 1984) together with that of speedwells, dead-nettles (Lamium spp.), polygonums (Polygonum aviculare, Bilderdykia convolvulus), and many other important species was excellent and at least equal to the standards (Table 2). Indeed, CR 17607 outperformed metsulfuron-methyl + mecoprop, particularly on cleavers and speedwells. Field pansy (Viola arvensis), a much less competitive but perceptibly important weed was well suppressed by CR 17607. None of the standards were more effective.

Crop Safety

CR 17607 was well tolerated by the crops. Crop effects were restricted to slight scorch which disappeared within 2-3 weeks. Scorch was far more apparent for standard treatment B (Table 5). In the absence of weed there was no adverse effect on yield for CR 17607, even at 9.0 l/ha up to and including GS 31. However, some reduction in yield followed treatment at GS 32 (Tables 3 and 4).

TABLE 1

Efficacy trials 1985 & 1986 : percentage weed control (1-2 week assessment)

Weed	CR 17607		Standard Treatments A		B		C		D	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
<u>Stellaria media</u>	47-87	61 (18)	45-89	65 (18)	38-88	64 (18)	52-65	57 (6)	33-50	41 (4)
<u>Matricaria</u> spp.*	65-100	86 (10)	68-100	84 (10)	55-100	82 (10)	68-91	78 (3)	43-50	47 (2)
<u>Galium aparine</u>	50-100	78 (10)	40-97	75 (10)	47-99	78 (10)	49-61	55 (2)		47 (1)
<u>Veronica persica</u>	40-100	78 (9)	35-100	74 (9)	42-100	77 (9)	55-56	55 (2)		18 (1)
<u>Veronica hederifolia</u>	57-85	74 (5)	61-88	78 (5)	58-85	70 (5)	45-49	47 (2)		20 (1)
<u>Viola arvensis</u>	20-87	51 (13)	17-90	47 (13)	17-83	45 (13)	17-58	45 (5)	8-42	24 (2)
<u>Papaver rhoeas</u>		95 (1)		97 (1)		97 (1)				
<u>Fumaria officinalis</u>	63-88	75 (2)	72-78	75 (2)	68 75	71 (2)	53-70	62 (2)		57 (1)
<u>Polygonum aviculare</u>	75-95	85 (4)	75-90	76 (4)	63-100	76 (4)		72 (1)		45 (1)
<u>Bilderdykia convolvulus</u>	69-79	75 (4)	75-88	76 (4)	63-76	72 (4)	75-83	79 (2)		39 (1)
<u>Sinapis arvensis</u>	83-88	85 (2)	82-88	85 (2)	79-86	82 (2)	75-100	83 (2)		59 (1)
<u>Lamium purpureum</u>		88 (1)		92 (1)		87 (1)				
<u>Aphanes arvensis</u>		45 (1)		40 (1)		50 (1)				
Overall		72 (46)		71 (46)		72 (46)		68 (9)		42 (9)

( ) = Number of trials
* includes <u>Anthemis</u> spp. and <u>Chamomilla</u> spp.

TABLE 2

Efficacy trials 1985 & 1986 : percentage weed control (10 week assessment)

Weed	CR 17607		Standard Treatments A		Standard Treatments B		Standard Treatments C		Standard Treatments D	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Stellaria media	90-100	99 (35)	90-100	99 (35)	83-100	99 (35)	98-100	99 (15)	94-100	99 (5)
Matricaria spp.*	90-100	98 (20)	88-100	99 (20)	87-100	99 (20)	78-100	95 (12)		100 (2)
Galium aparine	91-100	98 (19)	90-100	99 (19)	93-100	99 (19)		100 (4)	3-80	42 (3)
Veronica persica	93-100	99 (15)	93-100	99 (15)	93-100	99 (15)		100 (4)	3-80	42 (2)
Veronica hederifolia	88-100	98 (12)	89-100	99 (12)	75-100	98 (12)		100 (2)	78-99	89 (2)
Viola arvensis	10-100	81 (26)	10-100	78 (26)	10-100	82 (26)	10-100	77 (8)	75-99	91 (4)
Papaver rhoeas	93-98	94 (3)	93-100	97 (3)	91-100	97 (4)	93-98	96 (2)		
Lamium purpureum	98-100	99 (4)	98-100	99 (4)	99-100	99 (4)		100 (2)		100 (1)
Myosotis arvensis		97 (2)	97-98	97 (2)	93-98	95 (2)	98-100	99 (2)		
Aphanes arvensis	84-100	93 (4)	64-100	86 (4)	87-100	94 (4)		64 (1)		
Fumaria officinalis		100 (3)		100 (3)		100 (3)				
Polygonum aviculare		93 (1)		100 (1)		100 (1)		98 (1)		
Bilderdykia convolvulus	97-100	99 (4)	99-100	99 (4)	99-100	99 (4)		100 (1)		100 (1)
Legousia hybrida		100 (2)	98-99	98 (2)		100 (2)				96 (1)
Sinapis arvensis		100 (1)		100 (1)		100 (1)				
Chenopodium album		91 (1)		92 (1)		96 (1)		95 (1)		
Capsella bursa-pastoris		100 (1)		100 (1)		100 (1)		100 (1)		
Senecio vulgaris		100 (1)		100 (1)		100 (1)		100 (1)		
Overall		95 (64)		95 (64)		96 (64)		93 (18)		85 (9)

( ) = Number of trials
* includes *Anthemis* spp. and *Chamomilla* spp.

TABLE 3

Weed free yield trials 1985 & 1986 : yields as percentage of untreated, winter barley

Treatment l/ha	Growth stage, year and trial number											
	GS 31						GS 32					
	1985			1986			1985			1986		
	1	2	3	1	2	3	1	2	3	1	2	3
CR 17607 4.5	101.0	93.2	99.2	98.3	103.0	101.3	99.9	100.9	99.4	96.7	100.7	98.4
CR 17607 9.0	107.7	92.4	98.8	99.6	106.4	102.8	102.5	96.0	93.4	94.2*	96.7	95.1
Standard treatment A 2.0+3.25	103.9	100.3	96.5	96.9	103.0	102.2	99.8	94.0	98.0	96.7	99.7	98.0
Standard treatment A 4.0+6.5	97.0	91.5	95.0	101.1	103.1	98.5	94.0	91.2	92.5	92.4*	97.6	98.5
Standard treatment B 4.5	105.5	95.6	100.0				95.0	94.3	102.4			
Standard treatment B 9.0	97.7	90.3	96.0				93.1	90.7	91.0*			
LSD p = 0.05*	NS	NS	NS	NS	NS	NS	NS	NS	7.1	4.2	NS	NS
CV	3.0	3.5	2.6	1.5	3.1	2.9	3.0	3.5	2.6	1.5	3.1	2.9
Untreated t/ha	4.6	3.7	6.8	5.3	4.3	4.4	4.6	3.7	6.8	5.3	4.3	4.4

TABLE 4

Weed free yield trials 1985 & 1986 : yields as percentage of untreated, winter wheat

Treatment l/ha	Growth stage, year and trial number									
	GS 31				GS 32					
	1985			1986	1985			1986		
	1	2	3	1	1	2	3	1	2	3
CR 17607 4.5	97.6	98.1	99.3	97.0	98.2	101.6	102.4	100.6	104.3	95.7*
CR 17607 9.0	101.9	96.4	99.5	99.7	96.5	98.8	101.0	96.0	98.9	93.6*
Standard treatment A 2.0+3.25	98.1	97.6	100.1	101.1	99.4	100.6	101.1	98.0	102.5	97.3
Standard treatment A 4.0+6.5	100.5	96.5	99.3	98.9	96.2	96.4	99.4	96.6	99.5	93.1*
Standard treatment B 4.5	100.1	96.3	99.4		95.9	100.4	99.0			
Standard treatment B 9.0	98.7	93.1*	98.7		95.0	99.1	98.7			
LSD p = 0.05*	NS	3.6	NS	NS	NS	NS	NS	NS	NS	3.1
CV	1.6	1.3	1.1	1.5	1.6	1.3	1.1	1.5	4.9	1.1
Untreated t/ha	5.2	5.5	7.6	6.0	5.2	5.5	7.6	6.0	7.0	8.0

TABLE 5

Crop safety, application GS 12-31 : percentage scorch, maximum effect

Treatment	l/ha	Maximum effect Winter barley		Winter wheat	
CR 17607	4.5	6	(14)	3	(9)
Standard treatment A	2.0 + 3.25	4	(13)	3	(11)
Standard treatment B	4.5	11	(24)	8	(18)

( ) = double doses

DISCUSSION

Two seasons' replicated trials with CR 17607 at 4.5 l/ha have demonstrated its excellent and consistently high standard of efficacy against the major broad-leaved weeds of winter cereals under a wide range of conditions. Similarly effective results were achieved in over 200 grower trials.

This special salt/ester formulation combines the benefits of a quick weed response to hydroxybenzonitrile esters with the sustained activity of benazolin and mecoprop to give cost effective season long control of a wide spectrum of weeds. The use of mecoprop salt eliminates any risk of vapour drift to neighbouring susceptible crops. CR 17607 achieved a high standard of crop safety over a wide application window from GS 12 to GS 31 inclusive.

Although not reported in this paper CR 17607 has also been successfully developed for use in spring cereals at the reduced dose of 3.0 l/ha and the trials results in both winter and spring cereals have been borne out by a successful season of commercial usage in 1987.

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WEED CONTROL IN WINTER CEREALS WITH DPX-L5300 IN MEDITERRANEAN COUNTRIES

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ABSTRACT

DPX-L5300, a new herbicide from Du Pont, has been tested in cereals in the Mediterranean countries, during the last five years. It has demonstrated a high activity at very low rates (5 to 20 g a.i./ha) in a wide spectrum of broad leaved weeds. Although DPX-L5300 can be applied to cereals from 2/3 leaves to stem elongation, the best results have been obtained at the mid-tillering stage of the cereal, when all weeds have already germinated and are in active growth. High temperatures and soil moisture enhance DPX-L5300 activity. In dry situations, the addition of a wetting agent increases its effect. A good selectivity has been observed in all the most important varieties of wheat and barley cultivated in Mediterranean countries. Tank mixtures with the most frequent grass herbicides have been tested and no interference has been noticed to either broad leaved weeds or grasses. DPX-L5300 did not affect the normal rotational crops sowed after cereals.

INTRODUCTION

The control of broad leaved weeds in the Mediterranean countries has been adequate with the phenoxy herbicides alone or in mixtures. However the phenoxy herbicides have limitations :

1 - The late application time of the phenoxy herbicides allows early weed competition particularly the uptake of nutrients and soil water.

2 - The late time of application does not allow tank-mixing with many of the herbicides used for grass weed control and consequently two applications are required for complete weed control.

3 - The volatility of many herbicides causes a big risk for the neighbouring crops, particularly from aerial application.

The chemical and physical properties, toxicology, mode of action, selectivity, environmental fate, and the first field test results for DPX-L5300 were well described by Ferguson et al (1985).

During 1985 and 1986 a wide programme of field trials was carried out to determine efficacy, dose rate, persistence, residual effects and crop safety under a wide range of field conditions.

The main objectives of the current series of trials with DPX-L5300 were :

1 - To establish the lowest effective use rate required to control the most important weed species ;

2 - To determine the specific rate or mixture required to control the main weed species ;

3 - To check the compatibility of DPX-L5300 with other grass and broad leaved herbicides ;

4 - To check the selectivity of DPX-L5300 in most of the main varieties of wheat and barley used in this region;

5 - To verify whether the addition of a wetting agent could improve the performance of DPX-L5300;

6 - To check the persistence of the compound in the soil ;

7 - To establish the optimum time of application.

METHODS AND MATERIALS

Trials were conducted in the main cereal areas of Spain and Italy and included many climatic and soil conditions and both irrigated and non irrigated fields.

A 75 % dry flowable formulation of DPX-L5300 was used in all trials. The standard compounds used for comparison were 2,4 D isobutylic ester or mixtures of 2,4 D + MCPA in tests with susceptible weeds to DPX-L5300. In tests including Galium aparine, Veronica hederaefolia and V. persica, mecoprop, bromoxynil and ioxynil mixtures were used.

Applications were made with knapsack motor sprayers or hand-held sprayers using an inert gas propellant. Spraying pressure was about 200 KPa and application volumes varied between 200 and 500 l/ha. Plots were between 2 m x 5 m and 4 m x 10 m replicated 3 or 4 times. Evaluations were made considering the population density reduction compared with untreated plots on a 0-100 % scale. Evaluations were made at least two times, at 10 to 15 DAT and at 60 to 80 DAT. Evaluations of Avena spp. were made by counting the number of ears per m^2 and calculating the percentage reduction relative to untreated plots.

The times of application varied between cereal growth stages Zadoks 12 and 37. A visual assesment on a 0 - 100 scale was made in order to determine crop damage, 0 = no damage and 100 = total crop destruction.

RESULTS

The results show that DPX-L5300 is a broad spectrum herbicide, effective at very low rates. Table 1 shows the weed control in Spain at 7.5 and 10 g a.i./ha versus 2,4 D at 500 g a.i./ha. Some species tolerant to 2,4 D such as Stellaria media, Lamium amplexicaule, Lithospermum arvense, Spergularia rubra and Spergula arvensis were controlled at 7.5 g a.i./ha DPX-L5300.

TABLE 1
DPX-L 5300 FIELD TEST RESULTS IN SPAIN 1985/1986/1987
EVALUATION 50 - 60 DAT
% WEED CONTROL - SUSCEPTIBLE SPECIES TO DPX-L5300

WEED SPECIES	Number of Tests	Rate of DPX-L5300 g a.i./ha 7.5	10	2,4D ester 500 g a.i./ha
Papaver Rhoeas	19	88.46	98.03	83.31
Stellaria media	7	94.00	100.00	0.00
Anthemis spp.	5	95.50	95.50	80.29
Silene spp.	4	100.00	100.00	58.50
Sinapis arvensis	4	91.00	95.45	97.23
Lamium amplexicaule	3	70.50	83.75	7.50
Anagallis arvensis	1	93.00	97.13	75.19
Carlina corimbosa	1	97.00	99.38	100.00
Capsella bursa pastoris	1	75.00	91.25	93.25
Diplotaxis erucoides	1	71.25	93.75	93.75
Lithospermum arvense	1	-	87.50	0.00
Spergularia rubra	1	-	98.75	0.00
Spergula arvensis	1	-	97.50	31.60
Vaccaria pyramidata	1	-	88.80	89.50
Chenopodium album	1	91.25	-	98.75

TABLE 2
DPX-L5300 FIELD TEST RESULTS IN ITALY 1986/1987
EVALUATION 50 - 60 DAT
% WEED CONTROL - SUSCEPTIBLE SPECIES TO DPX-L5300

WEED SPECIES	Number of Tests	Rate of DPX-L5300 g a.i./ha 5	7.5	10	2,4D ester 550 g a.i./ha	2,4D+MCPA amine salts 250 + 310 g a.i./ha
Stellaria media	12	97	98	99	-	64
Papaver Rhoeas	9	94	94	95	94	-
Capsella bursa pastoris	5	90	93	98	-	80
Ranunculus arvensis	5	92	95	96	90	90
Bifora radians	4	96	97	97	37	-
Cardamine hirsuta	2	100	100	100	-	100
Myagrum perfoliatum	2	92	96	99	-	34
Matricaria chamomilla	2	100	100	100	82	-
Ranunculus sardous	2	91	96	100	-	85
Sinapis arvensis	2	87	93	94	100	-
Rhynchosinapis cheiranthos	2	98	100	100	100	-
Viola tricolor	2	77	92	95	-	98
Calepina irregularis	1	100	100	100	100	-
Geranium dissectum	1	90	90	95	85	-
Rapistrum rugosum	1	100	100	100	100	-
Thlaspi arvense	1	100	100	100	100	-
Vicia sativa	1	95	98	98	70	-
Viola arvensis	1	82	90	95	82	-

In Italy, (Table 2), the same level of efficacy was confirmed at lower rates of DPX-L5300. Over 90 % control of almost all species tested was found following the application of DPX-L5300 at 5 g a.i./ha; only Viola tricolor, V. arvensis and Sinapis arvensis needed 7.5 g a.i./ha DPX-L5300 to achieve greater than 90 % control.

The addition of a wetting agent (Table 3) dramatically increased the efficacy of DPX-L5300 particularly in the warm areas. 58.5 % and 55.5 % control of the important weeds Chrysanthemum segetum and Fumaria officinalis respectively were achieved at relatively high rates (18.75 g a.i./ha of DPX-L5300). The addition of a surfactant (alkylphenol polyglycol ether) at 0.02 % increased the control of these weeds to 94.0 and 94.2 % respectively.

TABLE 3

DPX-L5300 FIELD TESTS RESULTS IN SPAIN 1986/1987
INFLUENCE OF SURFACTANT. DPX-L5300 18.75 g a.i./ha.
EVALUATION 50 - 60 DAT -
% OF WEED CONTROL

WEED SPECIES	Number of Tests	DPX-L5300 alone	DPX-L5300 Surfactant 0.02 %
Chrysanthemum segetum	3	58.5	94
Fumaria officinalis	8	55.5	94.2

Tank mixtures were tested in order to improve the performance of DPX-L5300 in weeds considered tolerant such as Galium aparine, Veronica hederaefolia and V. persica. In Italy (Table 4) a mixture of 10 g a.i./ha of DPX-L5300 with either 1000 g a.i./ha of mecoprop or 87.5 + 87.5 g a.i./ha of ioxynil and bromoxynil increased the control of G. aparine from 54 % to 85 and 83 % respectively. On V. persica and V. hederaefolia an improvement in control from 40 % for DPX-L5300 alone to 85 and 95 % for DPX-L5300 + Surfactant respectively.

TABLE 4

DPX-L5300 TANK MIXTURES FOR SPECIFIC WEEDS
% OF WEED CONTROL - ITALY
EVALUATION 50 - 60 DAT

PRODUCT	Rate g a.i./ha	Weed Species Galium aparine	Veronica persica	Veronica hederaefolia
DPX-L5300	10	54 (4)	76 (6)	40(12)
DPX-L5300 + mecoprop	10 + 1000	85 (3)	-	85 (3)
DPX-L5300 + ioxynil + bromoxynil	10 + 87.5 + 87.5	83 (4)	100 (2)	95 (2)

( ) = Number of Tests.

In Spain three mixtures were tested of 15 g a.i./ha DPX-L5300 in combination with :

1 - Mecoprop at 1800 g a.i./ha.

2 - Ioxynil + bromoxynil at 150 g a.i./ha each.

3 - Cyanazine at 250 g a.i./ha.

On G. aparine the mixtures with mecoprop and with ioxynil + bromoxynil increased control from 37 to 97 % and on V. hederaefolia, the three mixtures improved control from 0 % to 96, 91 and 98 % respectively.

In one experiment in southern Spain poor control of Raphanus raphanistrum was achieved due probably to the short persistence of DPX-L5300. In this area, this species emerges early in the season and grows quickly, so that by the time DPX-L5300 is applied, even at early cereal growth stages, weed plants are at rosette stage with a deep pivotal root. In this situation the quantity of chemical absorbed by the plants is only enough to control weed growth for about 2 to 3 months after which regrowth occurred. In this case improved control was achieved by sequential applications. 95 % control obtained with two applications of 7.5 g a.i./ha at GS13 followed by GS30.

Two series of tests were carried out to test the compatibility of DPX-L5300 with other compounds, mainly grass herbicides : one with isoproturon and another with diclofop methyl, difenzoquat and flamprop isopropyl in order to check possible interferences in their efficacy on Lolium rigidum and Avena spp. Up to date, no antagonism has been observed with any of the mixtures examined (Table 5).

All varieties of wheat and barley tolerated double rates of DPX-L5300 (30 - 32 g a.i./ha). Nevertheless the addition of surfactant caused temporary yellowing in some cases. This was particularly noticeable in Durum wheat varieties.

All crops subsequently planted in the trial sites were evaluated to check the residual effect of DPX-L5300 and specific rotational tests were carried out with DPX-L5300 at 20 and 40 g a.i./ha. Crops were drilled as follows :

- 230 DAT Corn, Sunflower and Sorghum;

- 250 DAT Wheat, Barley, Oats, Broad Beans, Vetch, Lupine and Lentil.

- 270 DAT Beans, Broad Beans, Turnips, Vetch, Oil seed rape and Peas;

- 399 DAT Cotton, Corn, Chickpea, Melon, Sorghum and Potatoes;

- 450 DAT Sunflower, Chickpea, Corn, Sorghum and Beans.

All these crops grew normally and no symptoms of phytotoxicity were evident.

TABLE 5

DPX-L5300 COMPATIBILITY FIELD TESTS WITH GRASS HERBICIDES - SPAIN - 1987.
% WEED CONTROL - EVALUATION 80 - 90 DAT.

PRODUCTS	Rates in g a.i./ha	SPECIES Avena ludoviciana	Avena macrocarpa	Lolium rigidum	Alopecurus myosuroides
DPX-L5300 + Diclofop methyl	11.25+900	64.5(2)	88.8(4)		
Diclofop methyl	900	57.5(2)	92.8(4)		
DPX-L5300 + Difenzoquat	11.25+1000	66.5(2)	96.3(4)		
Difenzoquat	1000	62.5(2)	95.6(4)		
DPX-L5300 + Flamprop isopropyl	11.25+600	96.7(2)	99.5(4)		
Flamprop isopropyl	600	99 (2)	100(4)		
DOX-L5300 + Isoproturon	11.25+1 500	-	-	91.9(6)	84.5(2)
Isoproturon	1500	-	-	85.5(6)	86.7(2)

( ) = Number of Tests.

DISCUSSION

DPX-L5300 (5 - 10 g a.i./ha) applied in winter and spring at early growth stages of broad leaved weeds demonstrated a wide range of efficacy on the main weeds present in the cereal fields examined, including Papaver Rhoeas, Sinapis arvensis, Stellaria media, Anthemis spp., Lamium amplexicaule, Capsella bursa pastoris, Ranunculus arvensis.

The addition of a surfactant enhanced the activity of the compound particularly in warm climates such as those in southern Spain and Italy. This effect was particularly noticeable on Fumaria officinalis and Chrysanthemum segetum. The control of specific weeds such as Veronica hederaefolia, V. persica and Galium aparine was improved by mixtures of DPX-L5300 with mecoprop, ioxynil, bromoxynil or cyanazine.

Since the application time for DPX-L5300 is similar to many of the products used in grass control and no indication of incompatibility using the full recommended rates of these compounds were found, tank mixtures may be used in order to save one application.

Since DPX-L5300 is not volatile, it will have less propensity to move from treated areas to sensitive crops.

DPX-L5300 was selective in most of the varieties of wheat and barley examined. When a surfactant was used to increase product efficacy, some temporary yellowing was recorded, but the crop recovered in 10 to 20 days.

DPX-L5300 rapidly dissipates under mild climates giving complete flexibility in the use of the normal rotational crops grown in Mediterranean countries.

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THE CONTROL OF CIRSIUM ARVENSE (CREEPING THISTLE) BY SULFONYL UREA HERBICIDES AND A COMPARISON OF METHODS OF ASSESSING EFFICACY

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ABSTRACT

The aim of this study was to assess the efficacy of the sulfonyl urea herbicides DPX-L5300 and metsulfuron-methyl on Cirsium arvense, and to develop and examine the usefulness of a technique to assess root viability of treated plants in the season when herbicides were applied.

There were four field trials of randomised block design. Two were in winter wheat and two were on land which had not been disturbed for two years. Eight weeks after spraying, samples of C. arvense were removed from each plot. The shoot material was counted and weighed. The root material was planted in compost and after three weeks, assessments of shoot regrowth were made.

Mecoprop, MCPA, glyphosate and clopyralid proved more effective than sulfonyl ureas in controlling C. arvense. The root viability test gave an indication of herbicidal activity.

INTRODUCTION

Cirsium arvense (creeping thistle) is a perennial weed of both grassland and arable crops. It is strongly competitive and is reported to have an allelopathic effect on crops (Wilson, 1981). At present, control of C. arvense is difficult and expensive, being largely based on glyphosate or clopyralid. The two sulfonyl urea herbicides DPX-L5300 (Ferguson, 1985) and metsulfuron-methyl offer the possibility of cheaper control.

The aim of the trials was to assess the efficacy of metsulfuron-methyl and DPX-L5300, with and without surfactant, compared with chemicals which are currently used to control C. arvense. The treatments were evaluated by field assessments and, since control of below ground material is essential, by the viability of the roots.

Turner and Cussans (1981) reported a technique for assessing the effect of glyphosate on Elymus repens (common couch) in field experiments. Samples of rhizome were divided into single node lengths, planted in compost and the amount of regrowth measured. Since the roots of C. arvense produce buds and new shoots (Hamdoun, 1972) the adoption of this technique could be used as an alternative to measuring the growth in treated areas in the year after spray application.

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MATERIALS AND METHODS

Four field trials were sprayed during May to August 1986. Two of these trials were in winter wheat and two were on land which had not been disturbed for at least two years. Natural populations of C. arvense were used. A randomised block design was used with three or four replicates.

The trials were sprayed with a knapsack plot sprayer fitted with Lurmark F03-110 nozzles at 2.5 bar pressure. A volume equivalent to 300 l/ha was used. Before spraying the trials, permanent quadrats totalling $1m^2$ were marked out in each plot. Six-eight weeks after application of the spray, the area of the permanent quadrats was dug, including one in each untreated plot. Work by Sagar & Rawson (1964), and preliminary digs at two of the sites suggested 20 cm was a reasonable sampling depth to obtain most of the root material. Both shoot and root material were collected from the quadrats. The shoots from each sample were counted and weighed. The root material was divided into tap root and lateral roots and cut into fragments 40-60 mm long. Each sample was planted in a wooden fruit tray on 20 mm of Levingtons potting compost and covered with a further 20 mm. The trays were placed randomly on flat ground in the open and watered as necessary to keep them moist. After three weeks the proportion of root fragments which had produced shoots were counted.

Additionally, the trials on undisturbed land were assessed the year after treatment, either by shoot numbers (Cambridge) or a percentage of control score (March).

TABLE 1

Site Details

	Winter Wheat		Undisturbed Land	
	Norfolk	Essex	Cambridge	March
Spray dates	6/5/86	19/5/86	2/6/86	12/6/86
	11/6/86	29/5/86	16/6/86	-
	12/8/86	-	-	-
Sampling dates				
1st Spray	3/7/86	26/6/86	15/7/86	24/7/86
2nd Spray	3/8/86	17/7/86	5/8/86	-
3rd Spray	19/8/86	-	-	-
1987 assessments	-	-	26/6/87	27/7/87

Winter wheat trials

The main purpose of this work was to assess the efficacy of DPX-L5300 (methyl 2-[3-(4-methoxy-6-methyl-1,3,5,-triazin-2-yl)-3-methylureidosulphonyl] benzoate) and metsulfuron-methyl. They were applied at two timings; second node detectable stage (GS 32) and full flag leaf emergence (GS 39) of the crop. Growth stage 32 may have corresponded to a normal commercial application to control broad-leaved weeds in the spring. C. arvense was at the rosette, vegetative stage with many shoots still emerging. At the second timing, the maximum number of shoots had emerged and the C. arvense was at flower bud emergence. This was beyond the time when effective control of many other weeds could be expected. At each of these timings, metsulfuron-methyl and DPX-L5300 were applied with and without a non-ionic surfactant. They were compared with mecoprop salt and clopyralid at GS 32 and clopyralid at GS 39. Pre-harvest glyphosate applied at a bulk grain moisture content of 30% was included as a treatment in one trial. The rates of the chemicals used were standard label recommendations (Table 2). There were two unsprayed plots per block.

TABLE 2

Treatments - winter wheat trials

Treatment	Rate/ha	GS of crop
mecoprop salt	2.85 kg a.i.	32
metsulfuron - methyl	6 g a.i.	32, 39
metsulfuron - methyl + non-ionic wetter*	6 g a.i.	32, 39
DPX-L5300	22.5 g a.i.	32, 39
DPX-L5300 + non-ionic wetter*	22.5 g a.i.	32, 39
clopyralid	75 g a.i.	32, 39
glyphosate salt	1.44 kg a.e.	pre-harvest

* Agral at 250 ml per 1000 l of water.

Undisturbed land trials

DPX-L5300 and MCPA were applied at full flower bud emergence. Clopyralid was applied at early flower bud emergence at the Cambridge site and full flower bud emergence at the March site. DPX-L5300 was applied with and without a non-ionic surfactant (Table 3).

TABLE 3

Treatments - undisturbed land trials

Treatment	Rate/ha
clopyralid	200 g a.i.
MCPA - salt	1.7 kg a.i.
DPX-L5300	15 g a.i.
DPX-L5300 + non-ionic wetter	15 g a.i.
DPX-L5300	30 g a.i.
DPX-L5300 + non-ionic wetter	30 g a.i.

RESULTS

The results are given in Tables 4-10. Overall, control was disappointing. There was a large variability between the trials. The poorest control was recorded at the two sites with the highest and most vigorous populations of *C. arvense* (Norfolk and March).

Control of shoot number was generally poor (Tables 4 and 5). In the winter wheat trials, treatment at GS 32 was more effective than treatment at GS 39. In the undisturbed land trials, clopyralid was most effective at the Cambridge site, where it was applied before the thistles reached full flower bud emergence. The recommendations for clopyralid are for application at the rosette stage of _C. arvense_. This was not achieved in the trials on undisturbed land or for the later timing in the winter wheat trials. The sulfonyl ureas gave poor control in undisturbed land trials, stunting but not killing the plants. The addition of surfactant did not produce a consistent effect. Mecoprop and clopyralid in the wheat trials and clopyralid and MCPA in the undisturbed land trials gave the best control, particularly in the Cambridge and Essex trials where the _C. arvense_ was not so dense and vigorous. All the treatments (except glyphosate) prevented thistledown production.

TABLE 4

Change in shoot number between spraying and assessment expressed as proportion of shoot number at spray application in winter wheat trials (standard errors in brackets)

Treatment and timing	Norfolk	Essex
GS 32		
mecoprop	0.48 (± 0.06)	0.58 (± 0.19)
metsulfuron - methyl	1.37 (± 0.47)	0.62 (± 0.16)
metsulfuron - methyl + non-ionic wetter	0.79 (± 0.20)	0.96 (± 0.47)
DPX-L5300	1.28 (± 0.16)	0.99 (± 0.22)
DPX-L5300 + non-ionic wetter	0.69 (± 0.21)	0.57 (± 0.15)
clopyralid	1.18 (± 0.38)	0.56 (± 0.15)
control	1.09 (± 0.26)	0.96 (± 0.34)
GS 39		
metsulfuron-methyl	1.18 (± 0.09)	0.70 (± 0.16)
metsulfuron - methyl + non-ionic wetter	0.97 (± 0.24)	1.26 (± 0.34)
DPX-L5300	0.62 (± 0.13)	1.18 (± 0.13)
DPX-L5300 + non-ionic wetter	1.30 (± 0.06)	0.89 (± 0.12)
clopyralid	0.92 (± 0.06)	0.95 (± 0.03)
untreated control	1.22 (± 0.09)	0.56 (± 0.12)

Control of _C. arvense_ fresh weight (Tables 6 and 7) was more satisfactory than the control of shoot numbers but showed a similar trend. In terms of control of regrowth from the roots (Tables 8 and 9) early timing again proved most effective in the winter wheat trials. The sulfonyl ureas were significantly less effective at preventing regrowth than clopyralid, mecoprop or MCPA. Metsulfuron-methyl and DPX-L5300 gave similar levels of regrowth and there was no consistent advantage in adding surfactant to either. Shoots emerging from clopyralid treated roots showed symptoms of the herbicide six weeks later. Glyphosate treated roots showed very little regrowth.

TABLE 5

Change in shoot number between spraying and assessment expressed as proportion of shoot number at spray application in undisturbed land trials (standard errors in brackets)

Treatment	March	Cambridge
clopyralid	1.10 (± 0.084)	0.56 (± 0.099)
MCPA	0.95 (± 0.257)	0.60 (± 0.12)
DPX-L5300 15 g ai/ha	1.4 (± 0.171)	1.91 (± 0.04)
DPX-L5300 15 g ai/ha + non-ionic wetter	1.32 (± 0.276)	1.16 (± 0.058)
DPX-L5300 30 g ai/ha	1.28 (± 0.519)	1.18 (± 0.20)
DPX-L5300 30 g ai/ha + non-ionic wetter	1.43 (± 0.05)	1.92 (± 0.29)
untreated control	1.48 (± 0.114)	1.56 (± 0.18)

TABLE 6

Percentage control of shoot fresh weight/m^2 in winter wheat trials (standard errors in brackets).

Treatment and timing	Norfolk	Essex
GS 32		
mecoprop	89.8 (± 4.6)	74.7 (± 15.1)
metsulfuron- methyl	55.0 (± 19.7)	61.3 (± 14.7)
metsulfuron - methyl + non-ionic wetter	93.9 (± 1.1)	70.3 (± 13.1)
DPX-L5300	44.5 (± 18.1)	44.8 (± 18.5)
DPX-L5300 + non-ionic wetter	67.4 (± 22.8)	58.5 (± 17.5)
clopyralid	49.5 (± 16.7)	60.1 (± 9.1)
GS 39		
metsulfuron - methyl	27.1 (± 10.3)	16.6 (± 9.6)
metsulfuron - methyl + non-ionic wetter	25.2 (± 20.7)	78.2 (± 14.1)
DPX-L5300	29.7 (± 22.8)	60.2 (± 21.7)
DPX-L5300 + non-ionic wetter	41.2 (± 20.6)	33.0 (± 22.5)
clopyralid	32.9 (± 23.1)	57.4 (± 25.7)

TABLE 7

Percentage control of shoot fresh weight/m² in undisturbed land trials (standard errors in brackets).

Treatment	March	Cambridge
clopyralid	52.3 (± 13.5)	50.3 (± 27.6)
MCPA	39.9 (± 19.2)	64.4 (± 23.4)
DPX-L5300 15 g ai/ha	9.2 (± 4.3)	38.2 (± 21.6)
DPX-L5300 15 g ai/ha + non-ionic wetter	1.9 (± 1.9)	36.7 (± 6.7)
DPX-L5300 30 g ai/ha	42.6 (± 5.2)	32.9 (± 23.3)
DPX-L5300 30 g ai/ha + non-ionic wetter	16.8 (± 8.6)	54.3 (± 13.2)

TABLE 8

Percentage control of regrowth of root pieces in winter wheat trials (standard errors in brackets).

Treatment and timing	Norfolk	Essex
GS 32		
mecoprop	88.4 (± 11.6)	58.8 (± 18.4)
metsulfuron - methyl	36.1 (± 21.9)	47.4 (± 25.1)
metsulfuron - methyl + non-ionic wetter	33.3 (± 28.9)	50.0 (± 28.9)
DPX-L5300	13.6 (± 13.6)	74.0 (± 24.7)
DPX-L5300 + non-ionic wetter	19.3 (± 11.7)	25.0 (± 25.0)
clopyralid	83.8 (± 5.4)	59.6 (± 21.2)
GS 39		
metsulfuron - methyl	24.5 (± 21.7)	66.6 (± 28.9)
metsulfuron - methyl + non-ionic wetter	26.7 (± 13.9)	28.2 (± 14.8)
DPX-L5300	0 (± 0)	52.9 (± 25.1)
DPX-L5300 + non-ionic wetter	10.5 (± 7.1)	43.6 (± 25.6)
clopyralid	43.8 (± 20.1)	53.2 (± 29.0)
Pre-harvest glyphosate	97.7 (± 2.3)	-

DISCUSSION

The sulfonyl ureas were expected to give good control over both shoot material and regrowth from the roots. It is possible that warm and dry weather in June and early July created conditions of water stress. During such times, little growth would occur and the sulfonyl ureas could be immobilised before they were phytotoxic.

TABLE 9

Percentage control of regrowth of root pieces in undisturbed land trials (standard errors in brackets).

Treatment	March	Cambridge
clopyralid	55.7 (± 28.9)	98.9 (± 1.1)
MCPA	73.6 (± 13.3)	67.7 (± 19.5)
DPX-L5300 15 g ai/ha	0.0 (± 0.0)	25.3 (± 25.3)
DPX-L5300 15 g ai/ha + non-ionic wetter	8.5 (± 8.5)	27.3 (± 13.9)
DPX-L5300 30 g ai/ha	3.7 (± 3.7)	24.3 (± 24.3)
DPX-L5300 50 g ai/ha + non-ionic wetter	0.0 (± 0.0)	43.1 (± 29.7)

TABLE 10

1987 assessments of shoot regrowth in undisturbed land trials (percentage control)

Treatment	March	Cambridge
clopyralid	49%	89%
MCPA	40%	72%
DPX-L5300 15 g ai/ha	1%	27%
DPX-L5300 (15 g/ha) + non-ionic wetter	0%	4%
DPX-L5300 30 g ai/ha	0%	27%
DPX-L5300 (30 g/ha) + non-ionic wetter	19%	47%

Almost all the results show high standard errors. This is probably due to the difficulty experienced in positioning plots in a natural and uneven population of a perennial weed. Although care was taken in siting the trials, it was difficult to judge the density of root material from shoots present. Two of the trials had unusually large and established populations which were atypical of those normally found in cereals. There was also a large variability in the results of the root viability test.

Root collection and planting is time consuming and labour intensive. This method gave an indication of the herbicidal effect on the shallower roots and these results compared favourably with shoot assessments made in 1986 and 1987 and shoot fresh weight assessments made in 1986. However, the heavy workload involved in this method is unlikely to make it a practical alternative to assessing shoot material in the season after treatment.

In conclusion, the work indicates that mecoprop at GS 32 and the pre-harvest application of glyphosate provide the best control of C. arvense in cereals, and clopyralid at or before bud emergence and MCPA give better control than DPX-L5300 on undisturbed land. The root viability test gave a useful indication of herbicidal activity on the subterranean region of the plant.

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